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Impact of Investments in Green Technologies on Energy Security and Sustainable Development in the Future

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Abstract: One of the key areas of technological development in the world is the development of the so-called green technologies, which allow to ensure the required level of economic growth without creating additional environmental risks. In recent years, green investments in general, and green bonds, in particular, have become an effective tool for financing green projects. The purpose of the study was to determine the impact of the development of green technologies on energy security and sustainable development of energy technologies. To achieve this goal, the following tasks were solved: the essence and main directions of development of investments in green technologies in the modern investment space were determined; the volume of investments in green technologies in the world was estimated; possible directions of influence of investments in green technologies on energy security were outlined. It is established that green bonds and green investments in general can attract investors and create prerequisites for effective ensuring a sufficient level of environmental safety. It is also noted that ESG criteria are increasingly penetrating the financial sector. The emergence of green investments is associated with growing requirements for environmental friendliness of production and corporate social responsibility. According to market participants, over the next five years, many of the world's largest companies will add ESG ratings to traditional credit ratings and metrics. In general, analysing the effectiveness of investments in green technologies will help to make informed decisions and choose optimal development strategies that help to reduce the negative impact on the environment and increase the competitiveness of companies in the global market. The study concluded that investments in green technologies have potential opportunities for companies in various industries, but the success of such investments depends on a thorough financial assessment, risk management, and long-term development strategy.

Keywords: green bonds, innovative technologies, threats to environmental safety, renewable energy, investment.

Introduction

The global energy crisis has accelerated the transition to green energy sources. And for the most part, it's not just about the climate - the development of clean energy resources is driven by the desire for energy security. This requires huge investments, for which governments are competing. Investments in renewable energy sources have never grown as fast as they will in 2022. The military conflict in Ukraine has forced many governments around the world to pay close attention to three key aspects of energy: security, affordability, and sustainability of energy supplies. The disruption of the political and economic balance in the world has led to the need to find ways to develop energy independence. Kazakhstan has now established a basic legislative and regulatory framework for the development of the green finance market. The Environmental Code of the Republic of Kazakhstan, adopted in 2022, introduces a taxonomy of green projects, provides a legislative definition of green finance and specific tools for economic incentives for activities aimed at environmental protection. In this context, an analysis of the global experience of financing green projects using investment resources can be extremely useful and relevant.

Research Problem

As the world tries to recover from COVID-19 and overcome the consequences of the loss of economic balance in the world after the outbreak of the war in Ukraine, investors are looking for opportunities not only to invest effectively but also to perform certain important social functions, in particular in the development of green energy technologies. An analysis of the scientific literature on the problems of developing modern investment instruments, in particular in the field of innovative

green technologies, indicates that for most modern investors, the issue of investing in green technologies is relevant and of clear interest. However, the issue of the relationship between investing in green technologies and ensuring energy security has not been considered in detail in the scientific literature. However, it is worth noting that today, investment sources are increasingly referring to green bonds issued by governments of different countries. At the same time, sovereign and corporate issuers are increasingly paying attention to the topic of responsible investment. The coronavirus has not slowed down the development of the sustainable bond market, but, on the contrary, has contributed to the popularisation of green and social bonds, which finance environmental projects, healthcare and education expenditures, and, more recently, the search for alternative energy sources after the complete rejection of Russian energy carriers. Given this, the problem of identifying the link between investment activity in green technologies and the development of energy security requires special attention.

Research Focus

The first issue of green bonds worth \$807.2 million in equivalent was placed by the European Investment Bank in 2007. By the end of 2020, the green finance market will have reached \$1 trillion, showing an average annual growth rate of 95%, according to the international organisation Climate Bonds Initiative (CBI). According to the CBI, investments in the energy sector account for the largest part of the market - \$354.7 billion, followed by low-carbon construction with investments of \$263.5 billion, transport with \$190.7 billion, followed by water infrastructure (\$98.7 billion) and waste management (\$36.9 billion) (Koval et al., 2023; Monetary policy strategy until 2030, 2023). In this context, the study focuses on analysing the experience of using green bonds and the impact of this instrument on energy security in developed countries.

Research Aim and Research Questions

Given the proven relevance of the research topic, the purpose of the article is to determine the impact of green technologies on energy security and sustainable development of energy technologies.

To achieve this goal, it is necessary to solve the following research objectives:

- 1) to define the essence and main directions of development of investments in green technologies in the modern investment space;
- 2) to estimate the volume of investments in green technologies in the world;
- 3) identify possible areas of impact of investments in green technologies on energy security.

Literature Review

Environmental issues have become one of the most pressing for the modern world. One of the ways to address these issues is to invest in green technologies, which can not only lead to environmental benefits but also become profitable for investors. "The green economy is not about economic growth at any cost, but rather about the principles of sustainable development. It is a low-carbon and resource-saving economy focused on strengthening social equality and improving the well-being of society. Green bonds can be one of the sources of funding for these ideas. In essence, these are debt instruments whose proceeds are used exclusively to finance green projects aimed at generating environmental benefits (Redko et al., 2022; Yin, 2019; Wang et al., 2022). The benefit of such projects may be to improve the environmental situation or to minimise damage to nature. Accordingly, in a general sense, we can talk about strengthening environmental security.

Many countries today have ambitious plans to develop alternative energy, preparing for a “green” transition. Moreover, the energy crisis, which is affecting the global economy due to manual price regulation mechanisms in global markets, is only accelerating the energy transition. By the end of 2022, investments in renewable energy sources exceeded \$1 trillion, and spending on green and clean energy technologies increased by 30% (Malynovska et al., 2022; Perruchas et al., 2020).

In 2007, the European Investment Bank issued the first Climate Awareness Bonds worth €600 million to finance alternative energy projects. A year later, the International Bank for Reconstruction and Development issued the first truly green bonds worth USD 300 million. The proceeds were used to finance green projects in the agricultural sector, waste management, and forestry development (Adebayo et al., 2021; Dykan et al., 2021; Johansson et al., 2021). Since 2013, large corporations have entered the green bond market, and today the trend towards responsible investment and sustainable development has become irreversible and has completely changed the stock market (Li et al., 2022).

The modern world is becoming increasingly environmentally orientated, and environmentally friendly technologies are playing an important role in public life. In addition, governments around the world are actively supporting investments in green technologies by providing subsidies and tax breaks. Thus, green technologies are aimed at developing these types of energy:

1. Solar energy: Efficient solar panels are becoming increasingly affordable and generate good returns. Investments in solar panel companies can be promising (Dudek et al., 2023; Hamlehdar et al., 2017).

2. Wind energy: Wind turbines are becoming more common, and many companies are investing in their production. Therefore, investing in this area can be profitable (Adebayo et al., 2022; Chabot et al., 2019).

3. Energy-saving technologies: technologies that reduce energy consumption are becoming increasingly popular. Investments in companies that produce energy-saving technologies can be successful (Burawat, 2019; Nguyen, 2020).

4. Investing in green technologies is one of the most promising and sought-after areas in the investment market. It is not only a way to make money, but also to contribute to environmental protection and reduce the carbon footprint (Hurova, 2021; Shen et al., 2021).

The development of energy technologies is closely linked to the issue of energy security, which is especially relevant for Kazakhstan, where the climate can be described as sharply continental, and the availability of energy resources is a matter of survival for the population. At the same time, ensuring energy security is the prerogative of the state, but the state encourages private companies and investors to invest in the development of energy technologies and energy security (Kovaliuk et al., 2020).

At the same time, the development of investment in green technologies may be of interest not only to the state but also to business representatives, as green investments are no less attractive today than classical financial investments and direct investment in investment projects, as investors can see a concrete not only financial result but also social and environmental one (Prokopenko et al., 2020).

Many companies on the market develop and manufacture green technologies. Investing in such companies can be a profitable and stable investment. In addition, there are various investment funds specialising in green technologies that allow you to diversify your portfolio and reduce risks.

Having studied the scientific literature, it becomes possible to note the methods of investing in green technologies (Prokopenko et al., 2021; Qamar et al., 2021; Reyes, 2022):

purchase of shares in companies engaged in the production of green technologies;

investing in investment funds specialising in green technologies;

buying bonds of companies engaged in green technologies;

In addition, investing in green technologies has a number of advantages, such as (Laeven et al., 2020; Macke et al., 2019):

increased demand for green technologies due to awareness of the importance of environmental protection;

steady growth in demand for green technologies, which does not depend on fluctuations in oil and other energy prices;

the possibility of generating high income through the growth of share prices and the profitability of investment funds.

Like any other form of investment, investing in green technologies is not without risks. However, there are several ways to minimise the risks:

- researching companies and selecting the most stable and promising ones;
- portfolio diversification, investing in several companies and an investment fund;
- the fundamental difference between green bonds and traditional securities is their intended purpose - the focus of the funding raised on environmentally related projects.

In general terms, green bonds are a type of ESG bonds. They must comply with special standards of the International Capital Markets Association (ICMA) - the Green Bond Principles (GBP). ICMA has also developed separate criteria for social bonds, sustainability bonds, and sustainability-linked bonds (Anser et al., 2021; Hamed et al., 2020; Saunila et al., 2019). In any case, the main difference between green bonds is that they have a dual function, combining financial and environmental effects.

Research Methodology

The study will be conducted on the basis of analysis of both qualitative and quantitative data, which will allow for an objective generalised result.

The data for the study was obtained from both official statistics and scientific literature, which allows us to form an idea of the current trends in the development of green technologies and the specifics of investing in securities directly related to the energy sector. The study pays special attention to investing in green bonds as the most effective tool for investing in energy security.

The data for the study were based on both scientific materials and scientific periodicals, as well as statistical materials on the use of green bonds, green technologies, and investment resources concentrated in the energy sector.

Results

Green and social bonds are part of the concept of sustainable development at the level of many international organisations, which is the acronym ESG (environmental, social, governance - the impact of companies on the environment, their social responsibility, and the quality of corporate

governance). In other words, responsible investing is not focused on short-term gains, but on long-term development, environmental protection, and compliance with high social standards.

Over the past few years, a large pool of investors has emerged around the world that use non-financial indicators in their investment decisions. They are willing to disinvest in a company if its environmental, social, or governance performance is poor. More than 2500 investment funds with almost \$90 trillion under management have signed up to the UN Principles for Responsible Investment (Koval et al, 2022; Li, 2020), pledging to incorporate ESG factors into their investment analysis and decision-making processes and mechanisms. (According to PwC, global assets under management of companies investing in green technologies in 2022 were \$110 trillion (Bosshardt et al., 2020; Megits et al., 2022)) Many institutional funds have already analysed their investment strategies for compliance with ESG standards. For example, the Norwegian Government Pension Fund, the largest sovereign wealth fund in the world, sold its entire stake in oil exploration and production companies at the end of 2020. The German company DWS, which manages \$951 billion in assets, announced that all new funds starting in 2021 will be ESG-related (Nurgaliyeva et al., 2022).

ESG factors are already becoming an integral part of the analysis of companies for investment decision-making and affect their ratings, including credit ratings, as they allow for a more comprehensive assessment of potential risks and opportunities of the company's activities and increase the transparency of information for investors when making investment decisions

With the help of green bonds, the issuer raises funds for projects related to nature protection and environmental improvement.

Green bonds, like other bonds, are usually listed on a stock exchange. Investment companies and funds, banks, and private individuals can buy them. Private investors can buy green bonds with the help of a broker.

Therefore, the main methodology of the study is to analyse the state and features of investing in green technologies, in particular, in green bonds, to understand the impact of such investments on energy and environmental security in the world.

A large number of investors and funds are emerging around the world that aim not only to make money but also to make the world safer and more independent of non-renewable energy resources. Amid this trend, an investment that evaluates assets in terms of ESG criteria is becoming increasingly common. For such investors, assets are not only about risk and return but also about environmental sustainability, as well as social and managerial responsibility.

Responsible ESG investing is an approach to investing that seeks to incorporate environmental, social, and governance factors into investment decision-making for sustainable and long-term investment returns (Ghulam et al., 2018; Prokopenko et al., 2020).

One of the most common types of ESG instruments is green bonds. These are bonds issued to finance environmental projects. The main principles that are recommended to be followed by the issuer of such bonds are formed by the International Capital Markets Association (ICMA) and are called Green Bond Principles (GBP). The compliance of a particular issue with these principles is certified by a verification company, which is often a credit rating agency. According to the GBP principles, the funds raised must be used exclusively for environmental projects. The GBP particularly emphasises areas that contribute to reducing environmental pollution, preserving biodiversity, mitigating climate change, and conserving natural resources. An issuer of green bonds must ensure the targeted use of funds and full transparency of the project implementation process. In return, it reduces the cost of borrowing and gains the image of a progressive organisation focused

on long-term development and caring for the environment. Table 1 shows the dynamics of the green bond market over the past two years.

Table 1

Green Bond Market Scorecard

	2022	2021	Change
Market size	USD 487.1 bn	USD 582.4 bn	-16%
Number of issuers	741	976	-24%
Average size of the instrument	USD 140 m	USD 124.6 m	12%
Number of countries	51	62	-18%
Number of currencies	33	35	-6%

Source: Statistics of energy and commodity markets (2023).

Table 2 shows the top 10 companies active in the green bonds and green technology market.

Table 2

Top Green Non-financial Corporate Issuers in 2022

Issuer name	2022		Cumulative totals	
	USDbn	Number of deals	USDbn	Number of deals
China Three Gorges Corporation	5.1	14	13.7	34
Orsted	4	6	9.4	15
Iberdrola	3.1	4	8.7	12
Honda Motor Company	2.8	3	2.8	3
Volkswagen	2.6	3	2.6	3
E.ON	2.6	3	7.6	8
EDP	2.4	3	2.4	3
General Motors	2.3	2	2.3	2
RWE	2.1	1	4.3	4
Huaneng Lancang River Hydropower	2	16	23	22

Source: Statistics of energy and commodity markets (2023).

Green bonds are no different from traditional bonds in terms of their issuance and subsequent redemption: they are debt securities that help issuers borrow money from investors. From the point of view of risks and income generation, green bonds are also similar to any other bonds. The green status is granted to securities that meet certain standards or principles. The most famous is the list of principles proposed by the International Capital Market Association (ICMA):

- Proceeds from bonds should be used strictly for the implementation of green projects;
- The issuer should provide the investor with information about the proposed projects and goals related to environmental sustainability, as well as how it will monitor and manage potential environmental and social risks;

- the issuer should accumulate the net proceeds from the placement of green bonds in a separate account or in a separate portfolio;
- the issuer must annually (or, if necessary, in case of significant changes) provide up-to-date information on the use of funds: a list and a brief description of the projects to which the funds were allocated, indicating their amounts, and the expected positive environmental impact of the projects.

Initially, green bonds were issued to finance renewable energy projects. Today, such bonds are used to finance any initiative or project aimed at improving the environment or facilitating the transition to a low-carbon economy.

An approximate list of green projects according to ICMA (Khatib et al., 2021; Kovaliuk et al., 2020; Nguyen et al, 2022): energy production from renewable sources; energy efficiency improvements (e.g. in new and renovated buildings, district heating, household appliances, and products, etc.); environmental pollution prevention (including reduction of atmospheric emissions); soil remediation, (waste recycling); environmentally sustainable management of natural resources (including sustainable agriculture, livestock, fisheries, forestry).

Over the past five years, green bonds have been used to finance the following key areas of environmental improvement:

- Conservation of terrestrial and aquatic biodiversity (including protection of coastal, marine, and watershed environments);
- Environmentally friendly transport (electric, hybrid, public, rail, infrastructure for environmentally friendly vehicles and activities to reduce emissions);
- Sustainable infrastructure for clean and/or drinking water and wastewater treatment;
- Adaptation to climate change (including efforts to increase the resilience of infrastructure to climate change impacts, as well as information support systems, such as climate change observation and early warning systems);
- Products, technologies, and processes adapted to the circular economy (development and implementation of reused, recycled, and recovered materials, tools, services, and/or environmentally friendly products) green buildings that meet recognised standards or certificates of environmental performance.

Of course, the list is not exhaustive. States can independently develop national green finance standards that define a set of criteria by which a project can be recognised as environmentally friendly. The investor, in turn, not only receives moral satisfaction from being involved in environmental care, but also reduces environmental risks and ensures that threats to environmental safety are minimised.

Figure 1 shows the main areas of influence of green technologies on environmental safety and the formation of a favourable climate for sustainable social development in the future.

Figure 1

Areas of Influence of Green Technologies on Environmental Safety and the Formation of a Favourable Climate for Sustainable Social Development in the Future



Thus, the study proved that in order to ensure the safe development of the global economy and each individual large company, it is necessary to take care of the environment and these processes can be considered not as aspects of charity, but as a direction of long-term investment and investment of funds to obtain both social and economic benefits.

Discussion

The analysis of the peculiarities of using green bonds to ensure energy security has shown that this type of investment can become one of the most appropriate and attractive ways for investors to invest in the development of green technologies.

An analysis of the scientific literature has revealed that green bonds are the main areas of investment in green technologies in the modern investment space.

The analysis of statistical material (Statistics of energy and commodity markets, 2023) on the volume of investments in green bonds indicates that this market will become increasingly attractive to investors as market volumes grow. It is also clear that green bonds can become a tool for ensuring the energy security of various countries, including Kazakhstan, in the long term.

The study confirmed the theses set out in the works (Shen et al., 2021; Qamar et al., 2021; Statistics of energy and commodity markets, 2023), in particular, that for a modern investor, not only the issue of financial efficiency of investments is important, but also social.

For most investors today, as proven by the analysis of statistical material, green bonds are becoming a universal tool that allows them to invest in investment projects efficiently and safely while forming an optimal investment portfolio with an understanding of the timing of investment return and profitability. This opinion is also expressed in modern scientific sources (Bosshardt et al., 2020; Dykan et al., 2021; Johansson et al., 2021; Malynovska et al., 2022). In the course of the study, this idea was developed and deepened.

Taking into account the previous results of the researchers, a new view of green finance as investments and other financial instruments aimed at implementing environmentally friendly, energy-efficient, and low-carbon projects has been obtained. The practical significance of the results obtained is that they substantiate the fact that the main instruments of green finance are green bonds, concessional lending, subsidies for green projects, etc. These financial instruments allow green projects to develop, which is impossible under standard financial conditions. Green financial instruments are a component of the capital market, expanding the range of financial instruments and opportunities for investors, mainly foreign ones, as green issues are well-developed in Europe and North America and are now actively developing in Southeast Asia. Over the past five years, green bond issuance has become a steady trend in the global market. Over this period, the market volume has grown twenty-fold, and in 2019 doubled compared to 2018. As the market grows and the practice of issuing green bonds expands, investor demands and requirements for issuers change, and taxonomies and methodologies for green finance are updated. The green and sustainable finance market in Kazakhstan is actively developing. The vast majority of existing market participants are only beginning to take an interest in sustainability, issuers are revising their goals to reflect sustainability objectives, and investors are shifting their focus towards responsible investment. The main goal of green bond issuers in this area is to attract investment in environmental projects implemented in Kazakhstan. This is achieved by launching and developing the green bond market in Kazakhstan and Central Asia.

Exchanges incorporate ESG factors such as the environment, social development, and corporate governance into their reporting requirements for public companies. This regulates the placement of green bonds and other sustainable securities.

In view of this, the main result and scientific novelty of the work is that for a modern investor, the issues of ensuring environmental safety may become critically important, given the above directions of the impact of green technologies on ensuring environmental safety and the formation of a favourable climate for ensuring sustainable social development in the future, and investment activity in the field of environmental safety can be implemented with the lowest risks using the instrument of green bonds, which is becoming quite popular today.

The reliability of the results obtained was affected by the fact that, even taking into account the active spread of green bonds in the modern investment space, the instrument is quite new and the assessment of financial risks of investing in such projects is not fully justified due to the lack of data.

Conclusions and Implications

Overall, the study proved that investing in green technologies is not only a profitable financial decision but also an important step towards a greener future. When choosing investment projects in the field of green technologies, factors such as environmental efficiency, financial sustainability, and growth prospects should be taken into account. The opportunity to reduce your carbon footprint and contribute to the fight against climate change should not be overlooked. Investing in green technologies is one way to capitalise on a greener future and benefit the planet and society at the same time.

At the same time, green bonds are becoming one of the main areas of green investment today, allowing for the implementation of large ambitious projects at the interstate, national, or microeconomic level and achieving strategic goals in ensuring long-term environmental safety.

Suggestions for Future Research

The issue of investing in green technologies is quite relevant and attracts considerable attention from scholars, but two main issues remain unaddressed today.

The procedure for issuing green bonds. In general, it includes several successive stages:

- Developing a policy on green bonds (describing the purposes of use, project evaluation and selection processes, and mechanisms for managing and reporting);
- assessing the compliance of bonds with the principles and standards of green securities. The assessment is usually carried out by independent experts. For example, the first green bonds were independently assessed by experts from the University of Oslo. The external assessment ensures investment transparency and increases investor confidence in the issuer;
- preparation of issue documents; marketing;
- placement of bonds;
- providing periodic reports on the targeted use of funds for relevant green projects.

However, it is the aspects of investor participation in the development of projects that can be financed by green bonds that require attention.

Demand for socially responsible business is growing every year: investors today want not only to receive returns on their investments but also to change the world for the better by choosing projects whose values and mission they share. In turn, in order to gain access to capital, issuers had to adapt their business to the needs of the market and choose to operate responsibly, taking on additional environmental and climate obligations. By issuing green bonds, organisations receive a number of significant benefits: improved image, an influx of new investors, and financing for environmental projects on favourable terms. In the foreign practice of some countries, green bond issuers can count on benefits. For example, they may not have to pay interest payments on their bonds - this function is fully or partially assumed by the state. Investors, in turn, may be exempt from paying income tax on interest on such bonds.

In this context, research should focus on identifying ways to not only socially incentivise investors to invest in green securities, but also to financially reward them.

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