

Green energy funding in Ukraine

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Abstract. Sustainable development of society is the only effective mechanism of development in the face of climate change and environmental pollution. One of the ways to solve these problems is the transition to a green economy. The purpose of this article is to identify current trends and prospects for the development of green energy financing in Ukraine.

This study analyses green energy financing, as this area is quite promising after the start of the full-scale invasion of the Russian Federation (RF) and a massive attack on Ukraine's energy infrastructure. As of the beginning of June 2023, according to preliminary estimates, direct losses of the Ukrainian energy sector amounted to USD 8.8 billion. It was found that 6% of RES were damaged; 25% were occupied. All this had a negative impact on energy production. A positive trend was observed during the periods 2016–2018 and 2020–2021. According to Climatescope's Most Attractive Markets for Renewable Energy Investment Ranking, Ukraine ranks 74th globally and 27th in the European region with a score of 1.83. In 2022, investments in clean energy decreased by 99.7%. The problems that hinder the attraction of green finance in Ukraine are identified. To develop green finance, it is proposed to adopt the subsidy system, features and specifics of contracts for difference from the experience of Poland. The experience of Germany is useful in the issue of the Energy Transition Fund. The experience of Denmark is worth using public-private partnerships. It is established that despite the growing share of non-performing loans, lending is a promising area of green energy financing.

Key words: financing, green energy, investments, renewable energy sources, loans.

Introduction

Climate change poses a serious global challenge that governments, investors, businesses and citizens need to respond to immediately. Addressing this challenge and the transition to a low-carbon or green economy requires significant investment. Green finance can be considered a key element of this transition, as it is essential to support measures to minimise greenhouse gas emissions and increase resilience to climate change. Green finance is a powerful tool that can have an effective positive impact on the environment, provided that an effective credit and investment policy is implemented. It promotes activities and projects focused on sustainable development, particularly those involving the use of renewable energy sources (RES), the purchase of environmentally friendly goods and services, and similar initiatives. In a world where the risk associated with environmentally hazardous practices is growing, green finance is becoming a key phenomenon and is

being implemented in various sectors. In other words, it can be argued that there is a need for an energy transition – a shift toward sustainable economies through renewable energy, energy efficiency, and sustainable development, where the ultimate goal is to phase out the use of coal and other non-renewable energy resources (Denysiuk, 2019).

This study focuses on green energy financing, as this aspect has become particularly important after the start of the full-scale invasion of the Russian Federation and the massive attack on Ukraine's energy infrastructure. This is confirmed by numerous air attacks on centralised energy infrastructure. One of the significant problems of the Ukrainian energy sector is the lack of decentralisation in this area. Distributed generation has both advantages and disadvantages, including higher construction costs and electricity production. Ukrainian experts predict that large-scale generation will reach 80% in the

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future development of the national energy system, with distributed dispatchable generation accounting for 20% (Hryhoruk, 2025). Currently, the number of small solar energy producers is growing significantly, installing solar power plants for their own needs and reducing dependence on the centralised grid.

The purpose of the study is to identify current trends and prospects for the development of green energy financing in Ukraine.

Materials and Methods

The study employed both empirical and theoretical methods. Specifically, observation and description were applied as part of the empirical approach. Theoretical methods used included analysis, synthesis, generalisation, and systematisation. The use of these methods made it possible to study the situation comprehensively, formulate our own vision of it and interpret the results. The sources of information were the developments of domestic and foreign scholars and practitioners, statistical data and index indicators. The statistical data were taken from open sources and presented using graphical and tabular visualisation.

Results and discussion

As of early June 2023, preliminary estimates placed the direct damage to Ukraine’s energy infrastructure and system at \$8.8 billion. The electricity generation and transmission sectors have been severely affected by the Russian aggression, which continues to target important energy facilities. At the same time, the population and non-infrastructure facilities are significantly affected. Preliminary estimates show that \$7.2 billion worth of damage has already been caused, and this figure is constantly growing. In their speeches,

the Prime Minister of Ukraine and the leadership of the ministries involved in this issue stressed that since the beginning of the invasion, all thermal power plants (TPPs) and hydroelectric power plants (HPPs) located in the territory controlled by Ukraine, as well as 13 combined heat and power plants (CHPs), have been damaged (Fig. 1) (Report on Direct Infrastructure Damage..., 2023).

A significant share of the damage was sustained by major electricity-generating facilities. In early June, Russian forces completely destroyed the Kakhovka Hydroelectric Power Station. The direct damage from this destruction is estimated at around \$600 million. At the same time, the annual losses of the state-owned company Ukrhydroenergo are estimated to be more than \$100 million. According to rough estimates, the construction of a similar hydropower plant would cost \$1 billion. It is also worth noting that the Zaporizhzhya NPP, which is the largest in Europe and provided more than 10% of the total energy capacity before the Russian invasion, and is currently under occupation and almost entirely out of Energoatom’s control. (Report on Direct Infrastructure Damage..., 2023).

Renewable electricity producers are also suffering significant losses (Fig. 2).

According to the Energy Charter Secretariat, as of June 2023, about 13% of solar generation capacity is occupied and 8% has been damaged. As for wind generation capacity, it should be noted that approximately 80% is occupied and damaged by shelling. As for bioenergy, 2% are also located in the temporarily occupied territories. In addition, at least 4 biogas plants have been destroyed. The Kyiv School of Economics team estimates that renewable energy producers, except for large hydroelectric power plants and nuclear power plants, have lost about \$220 million. The occupied energy facilities do not generate

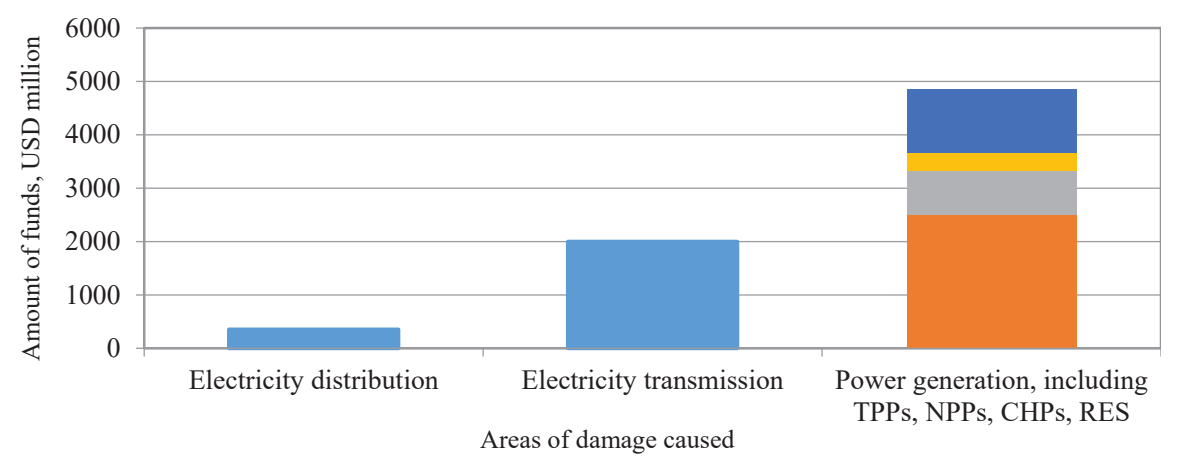


Figure 1. Direct damage to energy infrastructure, USD million.
Source: Compiled by the author based on data from (Report on direct damage to infrastructure..., 2023)

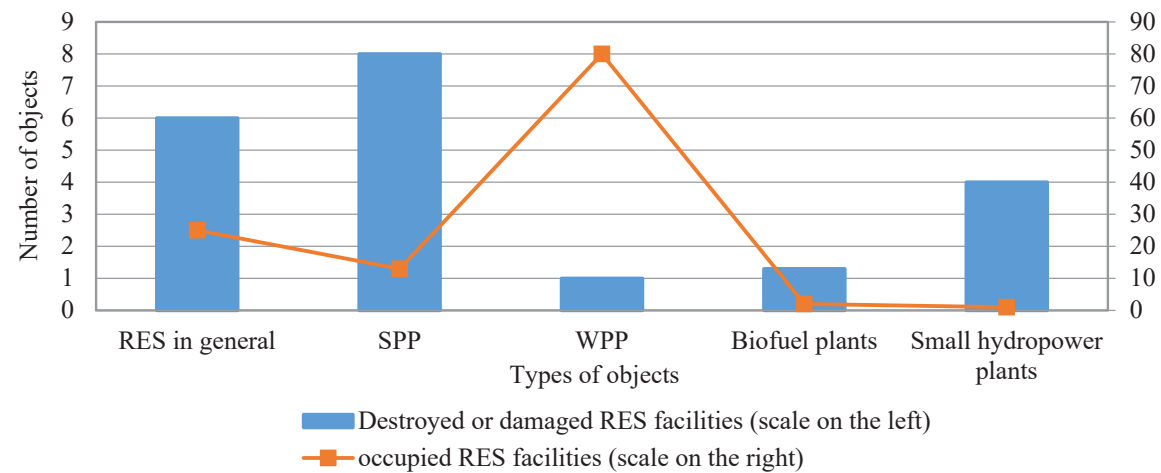


Figure 2. Destroyed (damaged) and occupied renewable energy facilities, %.

Source: Compiled by the author based on data from (Report on direct damage to infrastructure..., 2023)

electricity, which leads to a loss of revenue. Significant losses are also associated with the impossibility of commissioning facilities that were not completed in time, but at the same time made significant investments in them, including through loans.

These losses are exacerbated by the impossibility of commissioning new unfinished facilities in which resources, including credit, have been invested (Report on direct losses of infrastructure..., 2023).

In general, it can be stated that the volume of electricity production from renewable sources has significantly decreased (Fig. 3).

According to Fig. 3, energy production from renewable sources declined significantly in 2014 and 2015, by 13.65 TWh and 8.49 TWh, respectively. However, the situation improved in subsequent years: in 2016–2018 and 2020–2021, production volumes increased by 5.69 TWh (2016), 4.26 TWh (2017), 5.50 TWh (2018), 13.02 TWh (2020), and 11.61 TWh

(2021). In 2022, a significant decrease (-9.0 TWh) was again observed.

Despite the significant damage to renewable energy sources, this type of energy production remains one of the most promising, as Ukraine aspires to join the European Union and is therefore focused on achieving sustainable development goals. Therefore, this industry remains quite attractive for investment.

According to Climatescope’s Most Attractive Markets for Renewable Energy Investment Ranking, Ukraine ranked 47th among emerging markets, 74th in the global capacity ranking and 27th in the European region. In 2022, compared to 2021, Ukraine dropped 41 places in the global ranking (from 36th to 77th), and in 2023, compared to 2022, it rose 3 places. The capacity index in 2023 was 1.83, which is 0.35 below the regional average. Ukraine is implementing energy policy in three of the six categories: renewable energy

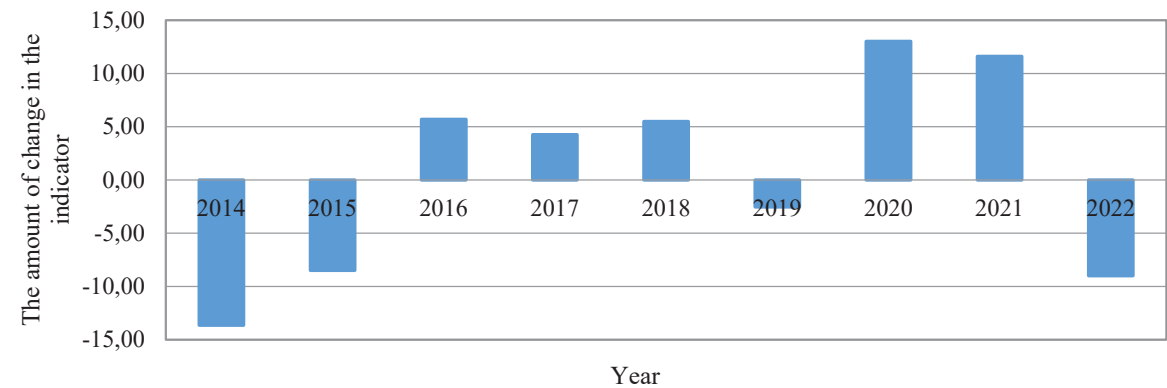


Figure 3. Annual change in energy production from RES (TWh).

Source: Based on data from (Annual change in renewable..., no date)

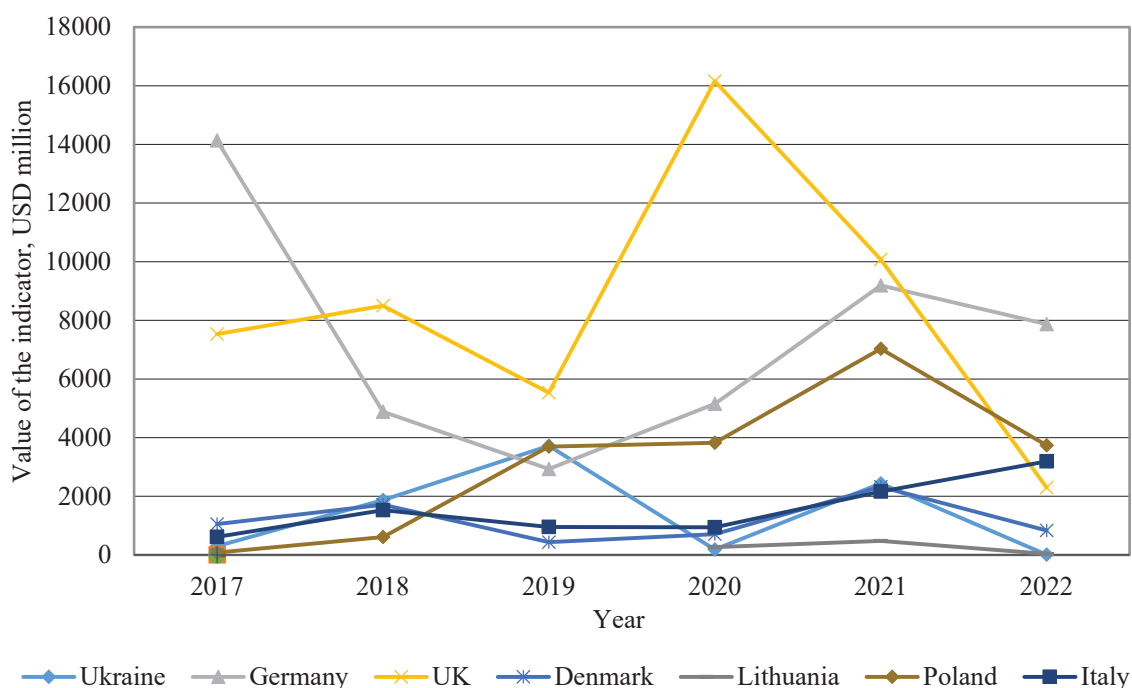


Figure 4. Most attractive markets for renewable energy investments, USD million.

Note: China has a separate scale on the right.

Source: Developed by the author based on Power Sector Results... (2023).

target, net metering and green tariff (Power sector results..., 2023).

To assess the financing of green energy, it is advisable to analyse the main trends (Fig. 4).

The Netherlands is at the top of the ranking with a score of 3.11. During the study period, the largest investments in clean energy were made in 2020 – USD 9,506.75 million; in 2022, compared to 2021, they increased by USD 2.9 million. Germany is in second place with a score of 2.91. Investments in clean energy in this country decreased by USD 11,202.06 million from 2017 to 2019. From 2019 to 2021, there was an increase (+ USD 6,257.65 million) and in 2022 their value decreased to USD 7,870.78 million. The third position with a score of 2.72 is occupied by the United Kingdom. Investments in clean energy increased by USD 8,621.99 million from 2017 to 2020 followed by a decline (-\$13,859.12 million). For Denmark, which is ranked fourth with a score of 2.72, the periods of highest investment were in 2021 (\$2,322.81 million) and 2018 (\$1,712.19 million). India's investments, ranked fifth with a score of 2.67, decreased by \$6,486.64 million from 2017 to 2020; growth in 2020–2022 was \$5,45.75 million. In 2021, compared to 2020, this figure increased by USD 2,10.28 million, and then significantly decreased in 2022 (-USD 4,42.36 million). Between 2017 and 2021, investments in clean energy in Poland, ranked

ninth with a score of 2.6, increased from \$81.37 million to \$7,030.47 million, representing a growth of \$6,949.1 million. However, in 2022, investment levels declined by \$3,290.54 million. Italy closes the top 10 in the ranking with a score of 2.54. Investments in clean energy in this country increased from \$6,16.27 million in 2017 to \$3,189.86 million in 2022.

In 2022, investments in clean energy in Ukraine amounted to USD 7.2 million, which is 99.7% less than in 2021. Looking at the range since 2017, the highest share was in 2019 (\$3,721.05 million), and the lowest in 2022.

In general, it is worth noting that investments in green energy are not only economic solutions but also a direct component of energy security and sustainable development. Given its uneven infrastructure development and complex geopolitical situation, Ukraine requires differentiated approaches to shaping its energy development prospects. Based on this, three key approaches should be distinguished: business-oriented, strategically oriented and combined (combining the two previous ones). Under the first approach, regions with high profit potential, such as the northern regions, where solar and wind power generation can be actively developed, are more attractive from a business perspective. Under such circumstances, the key criteria for investors include a high level of resource availability, the

potential for infrastructure development, transparent legislation, and access to investment incentives. ROI-oriented market instruments form the basis of the investment portfolio. Such projects are typically implemented with private capital, including foreign capital, and generate profits in the short to medium term. A strategically oriented approach is appropriate for regions where investments in green energy are of strategic rather than commercial importance, i.e. to ensure stable conditions for the functioning of the energy system. It is relevant for frontline areas; regions with limited access to centralised energy infrastructure and where infrastructure destruction has caused energy shortages. Under this approach, financial initiatives should be supported by the state. We believe that a combined approach should be used now. In Ukraine, in the context of war and the infrastructure transformation of the energy system, the state should support strategically important projects while keeping the market open to private investors.

Ukraine is now gradually bringing its legislation closer to EU standards, and renewable energy is no exception. The signed and ratified EU–Ukraine Association Agreement outlines several of Ukraine’s commitments, including the alignment of national standards with those of the EU, the development of green energy, and adherence to climate indicators. The key event in the renewable energy market in 2023 was the adoption of Law 3220-IX “On Amendments to Certain Laws of Ukraine on the Restoration and Green Transformation of the Energy System of Ukraine”, which came into force on 27 July 2023. This law, in particular, provided for: the definition of the term of guarantees of origin, the main aspects of their issuance and circulation, the introduction of a register; updating the feed-in tariff system; new incentive systems (market premium mechanism, self-production mechanism, etc.); changes to the auction support system, etc.

One of the key issues regulated by this law is the regulation of guarantees of origin of energy producing sources. The possibility of identifying these sources and confirming the environmental friendliness of the energy they produce is a certain bonus for companies engaged in the production and supply of this energy. Another positive aspect is that guarantees of origin issued by other countries are recognised in Ukraine and vice versa, subject to international agreements.

After the adoption of Law 3220-IX “On Amendments to Certain Laws of Ukraine on the Restoration and Green Transformation of the Energy System of Ukraine”, the only mechanism to support new commercial renewable energy facilities will be auctions, which, unfortunately, have proved to be unattainable for the market. Since 2019, they have

been announced regularly but have never taken place. The Cabinet of Ministers of Ukraine, on the recommendation of the Ministry of Energy, should determine the annual quota and auction schedule no later than 1 December, as well as provide indicative forecasts for the next four years. In addition to quotas, the regulator must set a maximum price offer for each auction. The Law also introduces the concept of a market premium mechanism, which is essentially the same as the concept of feed-in-premium. This mechanism will be applied to the winners of the auctions and will also apply to all producers who have already left or will leave the balance sheet group of the Guaranteed Buyer in the future and have a feed-in tariff. In practice, this mechanism implies that the producer will operate in the market in accordance with the contracts concluded by them and will receive compensation for the FIT or auction tariff according to the difference between the established tariff and the market value of electricity at which they sold the generated electricity (Savchenko, 2023).

Among the problems that hinder the attraction of green finance in Ukraine are the following (Table 1).

At Ukraine’s current stage of development, analysing the experience of leading countries plays an important role. In such circumstances, it is important to remember that the global goal is to achieve a “blue economy”, i.e. a perfect form of economy that would involve not only the rational and balanced use of available resources by society, but also the management of its own available capabilities without limiting the capabilities of others in space and time (Karlin & Ivashko, 2020).

For example, it is worth exploring Poland’s green finance policy, as this country has been actively promoting and expanding energy production from renewable sources since 2022. In particular, Ukraine should consider implementing a subsidy system similar to the one currently widely used in its neighbouring country.

As a result of Poland’s energy transformation, the government introduced a subsidy system for renewable energy sources. This initiative is aimed at supporting businesses and individual customers in their investment in replacing coal-fired furnaces with clean energy sources. Legislation on the use of RES sets out the rules and conditions for the production of bio-liquids, agricultural biogas, and electricity. The National Fund for Environmental Protection and Water Management acts as a regulator of subsidy programmes. The development of renewable energy technologies in Poland has been actively progressing for many years. The year 2024 will bring positive changes for investors and entrepreneurs interested in photovoltaic systems.

Table 1

Challenges in attracting green finance in Ukraine

Problem	Short characteristics	Solutions
Limitations/ unavailability of long-term loans	Meeting the national renewable energy and energy efficiency targets requires significant long-term financial resources, which are currently difficult to attract due to limited access to finance in the Ukrainian banking system and the domestic capital market.	To solve the problem of the financial gap, it is necessary to introduce the active use of green bonds, which are long-term financial instruments, in the Ukrainian market. This will provide access to global capital and a broader range of investors.
Insufficiency of financial instruments	Ukraine has many developed renewable energy and energy efficiency projects, but the lack of financial instruments makes it difficult to attract the low-cost investment funds needed to get them up and running.	The active use of green bonds in Ukraine will help to reduce the cost of financial resources for the implementation of green projects and create a market for investors, which will help to attract the necessary financial resources in the field of renewable energy and energy efficiency.
Underdeveloped securities market	Ukraine’s current securities market is at an early stage of development and integration into the global capital markets. Bonds of Ukraine and its issuers are not in significant demand on the international stock market.	«Green» bonds can be attractive to investors in both domestic and foreign markets. This requires the implementation of international green energy standards into Ukrainian legislation.
Low credit rating	Ukraine’s sovereign credit rating (B-) imposes an upper limit on the ratings of sub-sovereign and non-sovereign issuers within the country (such as companies and banks), which constrains international investor interest and complicates bond issuance.	The international organisation Climate Bonds Initiative assists countries in certifying green bonds according to international standards, making them attractive to investors.

Source: Developed by the author based on Frolov (n.d.)

Most of the renewable energy supported by national systems has gone through the auction system and is regulated in the form of contracts for difference. This mechanism ensures a stable level of income from energy sold over 15 years, with annual increases in line with inflation. Renewable energy producers compete for these contracts at auctions organised by the Energy Regulatory Authority, offering the lowest prices that guarantee the economic viability of the investment. The winners receive a guaranteed contract to purchase energy at the auction price. If the auction price exceeds the market price, the administrator of the renewable energy levy makes up the difference. This role is performed by the state-owned enterprise Zakładca Rozliczenia SA, which collects payments for renewable energy from all consumers (Dopłaty do energii..., 2023).

Amendments to the Law of Ukraine “On Alternative Energy Sources” provide for the possibility for RES producers who have left the balancing group of the Guaranteed Buyer to enter into contracts for the provision of services to ensure the stability of the price of electricity, produced from

renewable energy sources, with consumers, electricity suppliers or traders. In general, this mechanism is essentially a contract for difference, which has long been common as a form of cooperation in other countries. The concept itself was introduced in Ukrainian legislation back in August last year, but the law sets out a separate provision specifically for RES producers (Savchenko, 2023).

The transition to renewable energy in Germany is a remarkable and successful example. The federal government established the Energy Transition Fund to facilitate the shift to renewable energy sources instead of traditional ones. This fund has made it possible to finance projects related to wind and solar energy. The energy transition has been supported by legislation that has provided investors with confidence and promoted the development of renewable energy in general. Defining specific goals and creating a favourable investment climate has attracted significant private investment to finance the energy transition (Energiewendefonds Finanzierung der..., 2024).

Denmark, which is positioned as a world leader in wind energy, also has an Energy Transition Fund

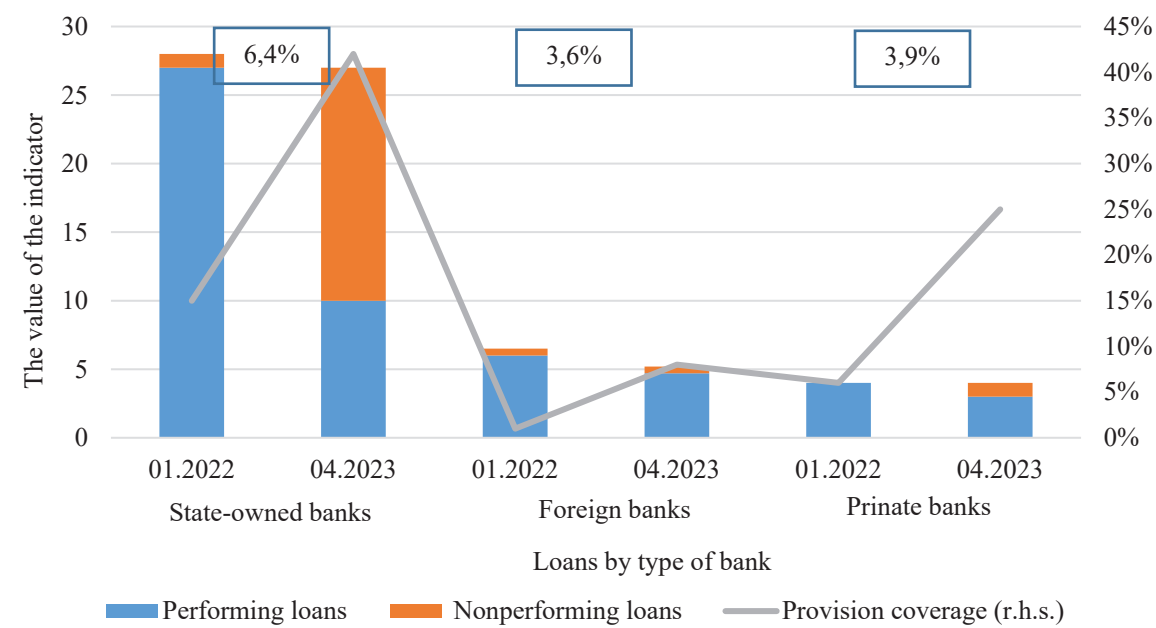


Figure 5. Gross loans in green energy, UAH billion.

Note: At the exchange rate as of 1 May 2023. The percentage box indicates the share of the green energy sector in the corporate loan portfolio of bank groups as of 1 May 2023.
Source: National Bank of Ukraine (2023)

that promotes the expansion of this sector in the country. The purpose of this fund is to finance wind energy projects, including infrastructure and research, and to provide subsidies for electricity generation from these sources. A key element of the Danish approach is its emphasis on cooperation between the public and private sectors. The fund has also helped to establish cooperation between wind turbine manufacturers, research institutions and energy companies. This cooperation helps to reduce costs and increase technological progress. This cooperation has intensified the development of wind energy and strengthened the Danish economy by creating new jobs and export opportunities (Energiewendefonds Finanzierung der..., 2024).

The share of loans to the renewable energy sector in the gross loan portfolio is almost 4%. This figure is significantly higher for state-owned banks, which hold more than 3/4 of the sector’s loans. Some banks have a portfolio share of 13%. For all banks, provisioning coverage increased significantly during the period under review: for state-owned banks, it was 15% as of January 2022, and reached 42% as of April 2023; for foreign banks, it increased from 1% to 8% during the period under review; for private banks, from 6% to 25%, respectively. The share of non-performing loans in May 2023 increased to 51% compared to 3% before the Russian invasion (National Bank of Ukraine, 2023).

Conclusions

Based on the analysis of direct infrastructure losses to electricity facilities, it was found that, as of the beginning of June 2023, a significant share of them falls on large producers. In total, the losses of RES for the period under study were estimated at USD 1184 billion. 25% of RES, including 80% of wind generation and 13% of solar power generation facilities, are currently not controlled by Ukraine; 8% of SPPs, 4% of small hydropower plants were destroyed or damaged.

In 2014 and 2015, annual energy production from renewable sources in Ukraine decreased by 13.65 TWh and 8.49 TWh, respectively. A further decline occurred in 2019, amounting to -2.54 TWh. By contrast, the period from 2016 to 2018 and from 2020 to 2021 saw consistent growth: production increased by 5.69 TWh (2016), 4.26 TWh (2017), 5.50 TWh (2018), 13.02 TWh (2020) and 11.61 TWh (2021). However, in February 2022, renewable energy production fell again, by 9.0 TWh.

In Climatescope’s Most Attractive Markets for Renewable Energy Investment Ranking, Ukraine was ranked 47th among emerging markets, 74th in the global capacity ranking and 27th in the European region. The capacity factor in 2023 is 1.83, which is 0.35 below the regional average. For comparison, the Netherlands is at the top of the ranking with a score of 3.11, and neighbouring Poland is in 9th place with a score of 2.6.

In 2022, investments in clean energy in Ukraine = \$7.2 million, which is 99.7% less than in 2021.

Ukraine is gradually bringing its legislation closer to EU standards in the field of green energy. A significant event in this market in 2023 was the adoption of Law 3220-IX “On Amendments to Certain Laws of Ukraine on the Restoration and Green Transformation of the Energy System of Ukraine”, which provided for the definition of the term of guarantees of origin, the main aspects of their issuance and circulation, the introduction of a register; updating the feed-in tariff system; new incentive systems; changes to the auction support system.

Problems hindering the attraction of green finance to Ukraine include restrictions/unavailability of long-term loans, a lack of financial instruments, an underdeveloped securities market, and a low credit rating.

Ukraine should adopt Poland’s experience in the field of green energy, including the subsidy system and the specifics of contracts for difference. Germany’s experience is useful in terms of the Energy Transition Fund. The experience of Denmark should be used for public-private partnerships.

A study of the loan portfolio showed that the share of green energy loans is 4% on average. For state-owned banks, this figure is 13%. The share of non-performing loans as of May 2023 increased to 51%, compared to 3% before the Russian invasion. Despite the difficulties currently faced by the banking system in lending to green energy, this source of financing is quite promising.

Currently, under martial law and conditions of macroeconomic instability, businesses face high interest rates (mostly exceeding 20%, except for preferential loans), which makes RES projects particularly capital-intensive. It would be advisable to introduce several categories of interest rates tailored to Ukraine’s conditions for investing in RES. In particular, for business-oriented projects implemented in relatively stable regions, an interest rate of 6–12% would be effective, depending on the project’s scale and specific characteristics. For projects of particular strategic importance implemented in high-risk regions, the interest rate should not exceed 3–4%. Such projects should also be subsidised through grant funding or subsidies. It is also important to attract international financing to the maximum extent possible for the implementation of renewable energy projects.

The implementation of investment projects has potential returns in several areas: economic (GDP growth, creation of new jobs); technological (introduction of modern technologies, improvement of energy efficiency); environmental (reduction of emissions and improvement of the overall

environmental situation); social (development of regional infrastructure). From an investor’s perspective, key benefits include stable income, increased asset value, portfolio diversification, and a positive impact on ESG indicators.

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