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National Comprehensive Green Transition Assessment Report for Ukraine

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TABLE OF CONTENTS

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The core coordination team, led by Ivo Krustok, supervised the overall development of the report, with significant contributions from Ganna Gladkykh and coordination support from Bogdana Leshchyshyn, assisted by Erika Tšerkašina. João Pedro Silva provided methodological support.

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The contents of the assessment and any errors or omissions are the sole responsibility of the authors. The views expressed in the assessment do not represent those of Sida or SEI.

Photo Credit: Daria Kuchuk

Introduction

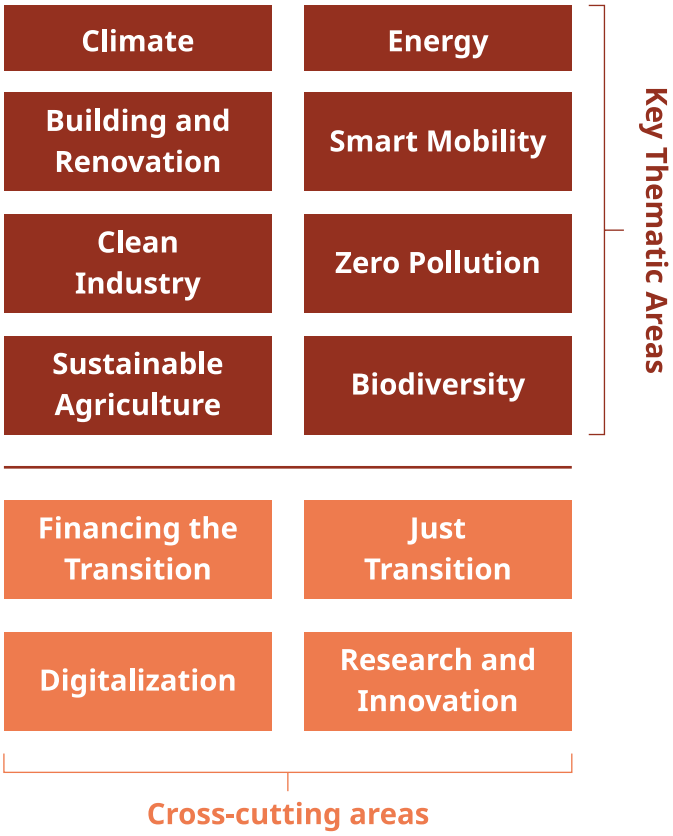
This report is part of the Sida-funded and SEI-implemented **Green Agenda project for Georgia, Ukraine, Moldova, and Armenia**. The project supports these countries in their journey towards climate neutrality and green transition, aligning with EU integration and Green Deal priorities.

Ukraine's situation is unique among the project countries due to the ongoing war. Since February 2022, Ukraine has been defending itself against Russia's full-scale invasion, allocating most resources to defence. Despite this, Ukraine remains committed to EU alignment. The authors acknowledge Ukraine's primary focus on national defence while emphasizing that building a green economy is crucial for Ukraine's long-term development. This report assumes that a green economy for Ukraine is a political, economic, and social necessity, creating a secure foundation for future development. **The authors believe that building a carbon-free, competitive, just and high-value-added economy in Ukraine is feasible, desirable, and should be a top priority during reconstruction.**

This report will benefit a wide range of actors involved in Ukraine's green transition and EU integration, including the research community, policymakers, donor organizations, media, international financial institutions, environmental NGOs, private sector companies, local authorities, energy sector stakeholders, academic institutions, policy experts, and relevant government agencies.

What is this report about?

This National Assessment for Ukraine presents the first-stage results of the Green Agenda project. **The report covers 12 main chapters corresponding to sectors relevant to green transition**: 8 key thematic areas (climate, energy, buildings and renovation, smart mobility, industry, zero pollution, farm to fork, and biodiversity) and 4 cross-cutting areas (finance for transition, digitalization, research and innovation, and just transition). The cross-cutting areas are distinguished from the key thematic areas because they are viewed as critical enablers for progress across all sectors. By separating them, the report emphasizes their fundamental importance in ensuring successful green transition and EU integration progress. These cross-cutting areas provide the necessary resources, tools, and frameworks that enable and accelerate developments in the key thematic areas.



Methodology

This report presents concise summaries of 12 comprehensive Thematic reports, each focusing on one of the 12 sectors relevant to green transition. These detailed thematic reports, some of which will be published in full-length in parallel to this report, serve as the foundation for the assessment presented here, with each chapter in this report offering a condensed overview of the corresponding in-depth thematic analysis.

The report is based on work led by theme experts and their teams for each sector. It utilizes both primary data (expert interviews, observational notes) and secondary data (desktop analysis, stakeholder mapping, published reports, research articles, policy documents). The analysis focuses on sector readiness for green transition in the context of Ukraine's EU integration and identifies key action areas.

Each sector's green transition readiness is assessed using three categories: "Little Progress," "Some Progress," and "Significant Progress." This assessment incorporates expert analysis from the detailed thematic reports and official EU tracking reports on candidate states' progress towards EU approximation.

The main value of the report

The report's main value lies in its comprehensive overview of multiple sectors, providing a holistic "big picture" of Ukraine's green transition. It identifies potential next steps and actions for future initiatives supporting Ukraine's green agenda implementation in the context of EU integration.

This holistic approach contrasts with single-sector analytics, creating a picture of interconnected sectors. By examining multiple sectors simultaneously, the report reveals the interconnections between different areas of Ukraine's economy and society in the context of green transition. **This multisectoral view allows for the identification of cross-sectoral opportunities and interdependencies often overlooked in isolated sectoral analyses.**

An additional and very important value is the partnership-building and knowledge exchange among contributing experts. Some thematic experts have become partners to the SEI team, with ongoing dialogue for future collaboration on Ukraine's green transition and EU accession process.

An additional and very important value of this report lies in the collaboration it has fostered. The process of creating this assessment has cultivated meaningful partnerships and facilitated valuable knowledge exchange among contributing experts. **Many of the thematic specialists involved have developed strong professional relationships with the SEI team, evolving into trusted partners.** This network of expertise has opened channels for ongoing dialogue and future collaborations, supporting Ukraine's green transition and EU accession process. These connections not only enrich the current report but also lay the groundwork for continued cooperation, ensuring that the momentum generated by this project can be sustained in future initiatives.

Executive summary

Amid the immense challenges brought on by Russia's full-scale invasion in 2022, Ukraine has demonstrated both the determination and potential to plan and implement a successful green transition in the coming decades. Its strong commitment to European Union integration, combined with the opportunity to leverage post-war reconstruction for sustainable development, positions Ukraine as a potential model for other EU enlargement candidate countries on their green transition paths.

While the ongoing war limits the ability to fully prioritize green transition efforts, ensuring that Ukraine maximizes its potential in this area remains essential. High-level, methodically designed governance is crucial to maintaining consistency across all relevant sectors and levels of administration. Strategic planning in green skills development and land use must also be prioritized. Addressing sector-specific challenges will require coordinated efforts with international donors and experts, while long-term policy decisions must align with the overarching goals of sustainability and resilience.

This report examines the key sectors driving Ukraine's green transition, balancing the requirements for future EU membership with the nation's own needs, considering its unique context and priorities. Rather than focusing solely on legislative requirements for EU accession, the analysis seeks to provide a macro-level perspective on the sectors most affected by and influencing the green transition. It highlights the critical challenges that must be addressed in the next 3 to 5 years to safeguard long-term sustainability goals. The report covers eight sectoral perspectives, three cross-cutting themes and the financial requirements necessary to support Ukraine's green transition.

The report highlights the importance of robust, high-level coordination and cross-sector collaboration in managing Ukraine's green transition. With war-induced disruptions in human resources, industrial capabilities, and environmental oversight, the nation faces significant challenges in reskilling its workforce and updating outdated, high-emission infrastructures. Comprehensive, multi-stakeholder initiatives supported by international allies are crucial to driving innovations in green technology and ensuring that reconstruction adheres to "build back better" principles.

Land use planning and thorough environmental assessment emerge as critical challenges in the context of reconstruction. The dual demand of developing infrastructure while restoring contaminated and degraded lands underscores the need for an integrated national strategy. By balancing immediate recovery needs with long-term environmental objectives, Ukraine can safeguard natural ecosystems, enhance biodiversity and secure sustainable agricultural practices.

Ultimately Ukraine's green transition is not solely an environmental imperative, but a strategic necessity for national resilience, economic competitiveness and a just society. By leveraging clean technologies, modernizing key industries, and integrating sustainable practices into every facet of reconstruction, Ukraine has the potential to emerge as a leader in sustainable recovery, setting an example for both regional and global green transformation efforts.

Green transition readiness

While each chapter of the report details the specific context and challenges of the sector, the report also gives a general assessment of each sector's green transition readiness.

Table 1. General assessment of the green transition readiness of each sector

Thematic area	Overall readiness score
Climate Change	**Significant Progress**
Energy	**Significant Progress**
Clean Industry	**Some Progress**
Buildings and Renovation	**Some Progress**
Transport and Mobility	**Some Progress**
Sustainable Agriculture	**Some Progress**
Biodiversity	**Some Progress**
Zero-Pollution	**Little Progress**
Financing the Green Transition	**Some Progress**
Just Transition	**Little Progress**
Digitalization	**Some Progress**
Research and Innovation	**Some Progress**

The criteria range from minimal to advanced progress:

Little Progress

"Little Progress" describes a situation where green transition efforts are just beginning, marked by isolated initiatives and scattered legal provisions, with policies largely misaligned with EU or international standards, and where institutional capacities, budget allocations, and stakeholder engagement are very low.

Some Progress

"Some Progress" indicates that foundational measures and institutional structures have been introduced and are beginning to align with green transition goals, but implementation remains uneven with significant gaps in enforcement, financial support, and cross-sector coordination.

Significant Progress

"Significant Progress" reflects advanced alignment with EU policies and global commitments, featuring robust legal frameworks, clear targets, strong institutional capacities and active stakeholder collaboration that yields tangible results, even though some refinement may still be needed.

Climate Change — Significant Progress

Ukraine's climate policy has undergone a significant transformation since 2021. The country has made notable progress in aligning with EU climate frameworks and setting decarbonization targets. The adopted Law on Climate Policy (2024) and National Energy and Climate Plan 2025–2030 (NECP) are key documents guiding Ukraine's decarbonization future, aiming for a 65% reduction in greenhouse gas (GHG) emissions by 2030 relative to 1990 levels and climate neutrality by 2050. Implementing these plans is complicated by the war's impact on emissions accounting and the emergence of significant war-related emissions. The conflict has made accurate GHG emissions reporting problematic, with the most recent comprehensive data available only up to 2021. Despite these challenges, Ukraine has taken steps to improve its climate governance and policy framework.

To achieve its climate transition goals, Ukraine needs to prioritize several areas:

- **First**, the country must improve its GHG emissions accounting system. This includes reintroducing and strengthening the Monitoring, Reporting, and Verification (MRV) system for GHG emissions, which is set to be fully relaunched in 2025.
- **Second**, Ukraine needs to focus on integrating climate objectives into its post-war recovery programs. This includes aligning reconstruction efforts with EU climate regulations and ensuring that rebuilding initiatives prioritize low-carbon and resilient infrastructure.
- **Lastly**, establishing a well-functioning Emissions Trading System (ETS) and adapting to the EU's Carbon Border Adjustment Mechanism (CBAM) are crucial steps for Ukraine's EU integration and economic competitiveness.

Energy — Significant Progress

Ukraine's energy sector faces significant challenges due to continuous Russian attacks. Despite these obstacles, the country has made notable progress in aligning with EU energy frameworks. The adopted NECP and Energy Strategy 2050 are key documents guiding Ukraine's energy future, aiming for 27% renewable energy by 2030 and carbon neutrality in the energy sector by 2050. These strategies envision Ukraine as a European green energy hub, with substantial increases in nuclear, solar, wind, and hydropower capacities. However, implementing these plans is complicated by severely damaged energy infrastructure and compromised energy security. The level of damage

to the energy system has created opportunities to rebuild for resilience, accelerating efforts towards energy system decentralization and further integration with the EU energy system. While Ukraine has made progress in governance capacity for implementing energy reforms and strategies, it remains insufficient. International cooperation in the energy sector has strengthened, helping to address this limited capacity.

To achieve its green transition goals, Ukraine needs to prioritize several areas:

- **First**, the country must address the skills shortage in renewable energy technologies and leverage its strong information technology sector for energy system digitalization.
- **Second**, building up domestic manufacturing capacity for clean energy technologies is crucial.
- **Additionally**, reforming energy tariff policies to improve the investment climate is necessary, as current tariff policy creates a major obstacle for energy sector investments.

Clean Industry — Some Progress

Before the Russian invasion, industry was the backbone of the economy. However, severe war-related damages have triggered an urgent need for reconstruction and modernization. Foundational measures are emerging through strategic initiatives such as the green industrial recovery programme and alignment with EU directives like the Industrial Emissions Directive.

On one hand, Ukraine's vision is robust. It plans to integrate best available technologies, promote digitalization, and enhance energy and resource efficiency through investments in green hydrogen, electrification, industrial symbiosis and circular economy. There is also clear emphasis on establishing new regulatory and financing mechanisms (e.g. green bonds, public–private partnerships) that align with European Green Deal objectives. However, significant challenges remain. Extensive physical and infrastructural damage, high carbon intensity and outdated industrial production methods hinder immediate progress. The implementation of key policies is uneven, and capacity constraints limit the pace of reform.

- **Firstly**, Ukraine needs to develop and implement key regulations like an EU-compatible emissions trading scheme, comprehensive greenhouse gas certification systems and a legal framework to support resource efficiency and the circular economy.
- **Additionally**, it is important for Ukraine to strengthen financial mechanisms by leveraging green bonds, public-private partnerships and dedicated industrial modernization funds aligned with EU taxonomy requirements. Securing these investments is critical for funding the necessary technology upgrades and sustainability initiatives throughout the sector.

Buildings and Renovation

Some Progress

Ukraine's buildings and renovation sector demonstrates foundational progress through the adoption of key legal instruments and strategic frameworks that align with EU directives (e.g. the 2021 energy efficiency law and the Long-term Strategy for the Thermal Modernization of Buildings). However, despite these policy advances, the annual renovation rate remains very low (currently at 1% per building type), and the sector faces significant challenges due to outdated building stock, high energy consumption, and severe implementation gaps. In addition, funding limitations, coordination issues, and an inability to harness the potential of its professional workforce during the war hinder large-scale transformation. While there is clear momentum toward modernization, the overall progress is uneven and changing it will be impossible before the end of the war.

- **First**, it is important to reflect new EU Energy Efficiency Directive and Energy Performance of Buildings Directive requirements in Ukraine's laws and by-laws. This should be done by requiring targeted technical assistance from international financial institutions and donor funding projects, as well as educational and capacity-building support to increase the expertise of existing staff members.
- **Secondly**, it is important to develop a national building renovation plan and define clear roles and responsibilities to carry it out.
- **Lastly**, it is vital that the build back better principle is followed when retrofitting or reconstructing damaged buildings.

Transport and Mobility

Some Progress

Successful green transformation of Ukraine's transport and mobility sector plays a crucial role in country's economic recovery, environmental protection, public health and social justice. The sector shows foundational steps toward a green transition through strategic frameworks like the National Transport Strategy 2030 and early initiatives in electrification and digitalization. These measures indicate a growing commitment to aligning with EU sustainability standards. However, significant challenges remain – including aging infrastructure, outdated technology, poor road safety, weak coordination among decentralized institutions and severe impacts from the ongoing conflict – that result in uneven implementation and limited measurable outcomes.

- **First**, Ukraine must continue to align its transport sector with EU legislation to bring transport services up to European standards and achieve transformative change, encompassing developing sectoral transport programs with a balanced distribution of cargo flows between modes of transport; creating a favorable investment climate; and introducing innovative technologies, including electric and hydrogen vehicles.

- **Second**, the transition to low-emission and alternative-fuel transport should be supported by a comprehensive national strategy to expand incentives for electric and hybrid vehicles, enhance EV charging infrastructure, and promote biofuels and hydrogen in public and freight transport.
- **Lastly**, Ukraine must prioritize expanding regulatory mechanisms and fiscal incentives supporting the implementation of strategic objectives and target achievement. These include tax incentives for switching to sustainable transport modes like carbon-based vehicle taxation, congestion charging and low-emission zones

Sustainable Agriculture — Some Progress

Ukraine's agricultural sector has taken initial steps toward sustainability, such as by developing organic agriculture. However, the sector is far from embracing the idea of the green transition fully. While the country benefits from its strong agricultural history and fertile lands, the funds currently dedicated for investments in sustainable practices are insufficient and there is no comprehensive national strategy for the green transition in agriculture. Additionally, the agri-food sector in Ukraine has faced substantial losses due to the war, with damages to the agricultural sector up to USD 80 billion, according to the most recent estimates. On a positive note, the existing strategic documents and regulatory adjustments indicate incremental progress; however, fragmented policy priorities and limited financial capacity mean that the transition is still uneven and far from transformative.

- **First,** the government must create an overarching vision and plan on how to achieve sustainability goals in agriculture. These plans are necessary not only in terms of EU accession and policy alignment, but for achieving Ukraine's sustainability goals and the competitiveness of its agricultural and food sectors.
- **Secondly**, Ukrainian farmers need financial and technical support with the transition towards EU practices. Dedicated support to small and medium-sized farmers will be crucial in reviving the rural economy after the war and make a major contribution to decarbonizing Ukrainian agriculture.
- **Additionally,** agricultural climate policy development and implementation needs to be strengthened. This needs to include both the reduction of emissions from the agricultural sector by improving farming practices as well as increasing the sector's climate resilience.

Biodiversity

Some Progress

Ukraine has been gradually expanding its Nature Reserve Fund and has established sites to be added to the EU's Emerald Network of protected lands, reflecting partial legislative alignment. Nonetheless, large-scale land conversion, war impacts, slow rate of protected area establishment and insufficient financial incentives impede full biodiversity protection. Key gaps include lack of a habitat-based conservation approach and ecosystem service valuation, as well as delayed legal reforms on the Emerald Network and the state environmental control. Overall, Ukraine shows moderate achievements while requiring stronger enforcement and institutional support.

On one hand, the country has partially transposed key EU Directives (Birds, Habitats, and others) and has significantly grown its protected area network since independence. Many international actors offer support to bolster national efforts. On the other hand, readiness is constrained by limited capacities and fragmented governance. Economic factors, especially in changing land use, continue to threaten biodiversity. Furthermore, the ongoing war places significant strain on governance structures, finances and priorities, delaying essential legislation (such as the long-pending draft law on the Emerald Network).

A strategic and coordinated approach is crucial to accelerate Ukraine's green transition in biodiversity:

- **First,** developing a comprehensive National Biodiversity Strategy and Action Plan would establish clearer targets, align policies and guide future legislative reforms.
- **Second**, financial incentives must be strengthened. Establishing dedicated environmental funds and integrating payments for ecosystem services could help local authorities, private landowners and businesses balance economic activities with nature protection.
- **Third,** bolstering institutional capacity is essential. Reestablishing or empowering a specialized agency for protected areas and biodiversity could improve coordination, enforcement and scientific monitoring. This also includes establishing new protected areas.
- **Finally,** it is important to ensure that war recovery efforts include biodiversity. Planning for ecological restoration in damaged areas can offer both environmental and socio-economic benefits.

Zero Pollution

Little Progress

Ukraine's environment remains deeply challenged by legacy industrial processes and the situation is exacerbated by the ongoing war. While recent steps such as creating the law on integrated industrial pollution prevention in 2024 and elements of the Environmental Security and Climate Change Adaptation Strategy until 2030 indicate progress toward aligning with EU standards, significant gaps persist in establishing comprehensive, enforceable targets for reducing air, water and soil pollution. The country's monitoring system – a combination of state-operated stations and public networks – shows promise, but remains fragmented and partly closed, with data collection hampered

by wartime disruptions. Institutional capacities are similarly strained due to limited resources, reduced inspections, and fragmented governance, which together impede effective enforcement of pollution regulations and accountability measures.

To advance its green transition, Ukraine must:

- **First** adopt a unified vision for reducing environmental pollution by strengthening legal frameworks, modernizing monitoring systems and boosting institutional capacities.
- **Secondly**, integrate pollution remediation and ecosystem restoration into post-war recovery plans, alongside financial incentives for clean technologies.
- **Finally**, enhance stakeholder engagement.

Financing the Green Transition — Some Progress

In times of war, Ukrainian budget revenues are mostly directed towards military needs, leaving green transition to be financed through international (bilateral and multilateral) support. The Ukraine Facility as well as finance from European Bank for Reconstruction and Development, the World Bank and the European Investment Bank play a major role. Sustainable finance is enabled by key legislative initiatives (e.g. those related to green bonds and ESG reporting) demonstrating strategic alignment with key EU and international principles. Private investors also show significant interest in aspects of the green transition that serve energy security and resilience (e.g. renewables, energy storage and energy efficiency).

However, significant gaps persist. Critical elements such as a national sustainable finance taxonomy and an EU-like emission trading system are either underdeveloped or only at the conceptual stage. These shortcomings create risks of large-scale green-washing and missing out on other ESG aspects. Strategic vision, institutional capacities and cross-sector coordination are also lacking, a challenge exacerbated by ongoing war impacts and fiscal uncertainties. In these conditions, good country potential cannot be translated into tangible, widespread and consistent progress in mobilizing and tracking green transition finance.

- **First,** the country must strengthen its institutional framework for tracking green transition finance as well as for monitoring its effectiveness in specific sectors.
- **Second**, already existing efforts at promoting sustainable finance should receive a better strategic direction linked not just to implementation of EU rules but also to accounting for specific market conditions and opportunities present in Ukraine.
- **Finally**, the public investment management reform (already ongoing) should be well-equipped to effectively integrate the full scope of ESG considerations.

Just Transition

Little Progress

A commitment to justice in the green transition will be key in ensuring an equitable and inclusive recovery process for Ukraine, supporting its EU accession aspirations. The planned closure of all coal mines will lead to job loss for over 60 000 individuals. Addressing the shift from coal mining towards renewables requires a just transition approach, ensuring that affected communities receive support through reemployment opportunities, including necessary (re-)training, economic diversification and social protections. Beyond energy, Ukraine's recovery depends on an inclusive strategy that integrates transportation, construction, pollution reduction, equitable transition to more sustainable agriculture and accessibility of social protection services. These sectors are not only crucial for rebuilding infrastructure but also for fostering social cohesion and economic opportunity.

- **First,** it is necessary to expand Ukraine's approach to just transition beyond coal. Legislative adoption of EU policies is progressing too slowly, which hampers Ukraine's ability to align fully with the European Green Deal (EGD). To overcome these challenges, Ukraine must accelerate policy alignment and broaden its just transition strategy to ensure a more holistic and inclusive transition.
- **Second,** Ukraine's regulatory landscape needs a unified framework for just transition implementation. Regulatory mechanisms must be strengthened, and a clear environmental, social, and governance reporting structure for companies, including a comprehensive data collection and monitoring system based on Sustainable Development Goals (SDG) criteria, must be established.
- **Moreover,** there is a need for a central capacity-building oversight body to coordinate just transition policies and ensure their enforcement, invest in human resource development, and improve data collection and stakeholder engagement.
- **Lastly,** the state must provide targeted subsidies to industries affected by the transition.

Digitalization

Some Progress

Digital technologies play a crucial role in supporting the green transition by providing real-time data, enhancing transparency, improving decision-making and supporting sustainable practices. Moreover, digital technology is applicable to multiple aspects of green transitions; as such, the digital and green transition are viewed as intertwined, or the "twin" transitions. At the same time, while information and communication technology (ICT) solutions support greening the economy, the ICT equipment and intangible assets, such as software and databases, have an environmental footprint of their own. To balance the two, the impact of the ICT sector needs to be assessed.

In Ukraine, digital tools are already used to monitor and manage greenhouse gas emissions, optimize energy use, and promote sustainable agricultural practices. This highlights the potential of

digital technologies in advancing the green transition. However, there are challenges across the sectors, as well; namely that data collection and exchange tend to be uneven and limited, prohibiting the full potential of digitalization for greening the economy.

To successfully implement the digital part of the twin transition in Ukraine, the government needs to implement several measures:

- **First,** to create regulatory and policy frameworks that support the integration of digital technologies for sustainability purposes while ensuring alignment with international and EU standards.
- **Second,** to create an integrated data ecosystem where data collection and management, as well data exchange across sectors, is seamless, to promote data-driven decision-making.
- **Third**, to improve digital security and provide capacity-building programs to equip professionals with the skills needed to use digital technologies effectively in their respective sectors.

Research and Innovation — Some Progress

Ukraine's research and innovation (R&I) sector faces significant challenges in supporting the country's green transition, despite some progress in aligning with EU frameworks. The sector is hindered by structural issues including underfunding, human capital gaps, obsolete infrastructure and low private sector innovation. In 2023, Ukraine's Gross Domestic Expenditure on Research and Development (GERD) reached a historic low of 0.33% of GDP, far below the EU average. Since the full-scale invasion started, 35% of research infrastructure was damaged or destroyed and one-quarter of researchers and scientists left the country. Funding cuts have also affected the sector, with the budget for the National Academy of Sciences dropping by 48% since 2021.

To enhance its R&I sector's readiness to support green transition, Ukraine needs to address several key challenges:

- **First**, the country must significantly increase funding for R&I, particularly in EGD-related areas, and develop necessary green skills by integrating EGD-relevant focus into curricula and training programs.
- **Second**, Ukraine should improve policy coordination and monitoring in the R&I sector, while enhancing science-industry cooperation with a focus on green R&I solutions.
- **Additionally**, modernizing and improving access to R&I infrastructure for all actors is crucial, as is leveraging the country's strong IT sector for energy system digitalization to accelerate the transition.

What is the Green Transition for Ukraine?

Current status of the Green Transition in Ukraine

As Ukraine has entered the fourth year of the full-scale war following Russia's invasion in 2022, national priorities remain centred on defence, survival, humanitarian assistance, and economic resilience. The ongoing war has placed immense strain on every sector of Ukrainian society, diverting attention and resources toward immediate security concerns. However, amidst the destruction, the environment remains a critical issue, not only due to the war's devastating ecological impact but also because of Ukraine's aspirations for European Union (EU) membership and long-term political and economic resilience, which necessitate ambitious commitments to sustainability and environmental reform.

The war has caused severe environmental damage, with destroyed industrial facilities, mined land areas, destroyed dams and polluted waterways. Explosions, shelling, and sabotage of key infrastructure have led to large-scale contamination of air, soil, and water. Addressing these environmental challenges will be crucial not only for public health, biodiversity, and ecosystem integrity but also for ensuring Ukraine's long-term economic stability and productivity.

Despite the ongoing war, Ukraine remains committed to aligning with the EU, including in the context of the European Green Deal (EGD). The country has already made steps in reducing future reliance on fossil fuels, expanding renewable energy projects, and implementing policies aimed at decreasing emissions. However, the destruction of energy infrastructure, including power plants and electricity grids, has made the transition significantly more complex.

Ukraine's green transition path is intertwined with broader war-related reconstruction efforts. The post-war recovery will require vast investments, and international partners, including the EU, are expected to play a significant role. Ensuring that this reconstruction is guided by "build back better" principles of sustainability and environmental responsibility will be essential for Ukraine to ensure long term sustainability and create a basis for a thriving clean economy. Moreover, rebuilding with a focus on clean technologies, energy efficiency, and sustainable infrastructure can position Ukraine as a leader in environmentally conscious post-war recovery, setting an example for others.

According to the Rapid Damage and Needs Assessment (RDNA4) conducted by the Government of Ukraine, the World Bank Group, the European Commission, and the United Nations, the total cost of reconstruction and recovery in Ukraine by December 31, 2024, is estimated to be €506 billion over the next decade. This figure represents approximately 2.8 times the estimated nominal GDP of Ukraine for 2024.

The RDNA4 highlights that direct damage in Ukraine has now reached €170 billion, with housing, transportation, energy, commerce and industry, and education being the most affected sectors. Notably, 13% of the total housing stock has been damaged or destroyed, impacting over 2.5 million households. In the energy sector, there has been a significant increase in damaged or destroyed assets, with a 70% rise since February 2024, affecting power generation, transmission, distribution infrastructure, and district heating. Across all sectors, the regions situated closest to the frontline (Donetska, Kharkivska, Luhanska, Zaporizka, and Khersonska), as well as Kyivska, be-

ing the country's strategic center, have suffered the majority of the damage, accounting for approximately 72% of the total damage.

Reconstruction and recovery requirements are especially acute in the housing sector, followed by the transport sector, the energy and extractives, commerce and industry, and agriculture sectors. Notably, the cost of debris clearance and management alone exceeds €12.6 billion.

While fighting the war continues to dominate Ukraine's agenda, environmental concerns cannot be overlooked. The country faces a dual challenge: mitigating the environmental damage inflicted by war while simultaneously working toward a greener, more sustainable future. Achieving this balance will require coordinated efforts from the government, international allies, and civil society.

Ultimately, Ukraine's green transition is not only about the environment — it is a strategic necessity for national resilience, economic recovery and long-term competitiveness, and integration into the European community. This was eloquently concluded in the seminal 2024 report "An Environmental Compact for Ukraine" written by the High-Level Working Group on the Environmental Consequences of the War, co-chaired by Andriy Yermak, Head of the Presidential Office in Ukraine, and Margot Wallström, former Deputy Prime Minister of Sweden:

> *"Ukraine can be an example for the world. We must get this right, so that the environment is no longer a silent victim nor seen as a luxury to be turned to only after war has ended.*
>
> *Indeed, Ukraine teaches us that this is not just a "post-war" issue. It is an urgent matter for today. The decisions taken now will directly determine what is possible later."*

This National Assessment report seeks to continue where the Environmental Compact for Ukraine left off by analysing the key sectors and cross-cutting issues of Ukraine related to the European Green Deal. The objective is not to concentrate solely on the specifics of each sector or set long-term objectives, but rather to realize the challenges that Ukraine is currently facing and prioritize based on them the essential green transition initiatives that are crucial for Ukraine to achieve a successful green transition.

The authors of the report have made efforts to incorporate the effect of the full-scale war in Ukraine throughout the sectoral and cross-cutting overviews as well as within the context of describing the needs of the green transition. This has not been easy as the complete picture of the war impact will be clear when it is over. However, where relevant, the situation before the full-scale invasion has been described.

What is the Green Transition?

This report evaluates the current state and requirements of Ukraine's green transition, drawing upon the European Green Deal as a reference framework. This is because Ukraine seeks to join the EU making the alignment of climate and environmental policy a priority. Furthermore, the European Green Deal represents a paradigm shift in the green transition approach from a traditional silo-based one to a more horizontal perspective which implies addressing climate change and environmental challenges across multiple sectors and policy areas simultaneously.

The European Green Deal is the EU's comprehensive strategy for transforming its economy and society to ensure long-term sustainability, competitiveness, and resilience. Launched in 2019, it aims to modernize key sectors of economy, including energy, industry, transport, agriculture, and finance while reducing environmental impact and resource consumption. The Green Deal was framed as a fundamental economic and social transformation designed to boost innovation, secure energy independence, improve public health, and enhance the overall quality of life for European citizens.

At its core, the Green Deal prioritizes climate action, aiming for carbon neutrality by 2050 through emissions reductions, energy efficiency, and the expansion of renewable energy sources. However, it also includes broader goals such reducing the use of raw materials through circular economy and waste minimization, protecting and restoring biodiversity, making food production more sustainable and resilient, reducing pollution in air, water and soil, etc. It also brings to focus the concept of a just transition which aims to ensure that the shift to a greener economy is fair, providing financial and technical support to regions and workers affected by the transition.

As the new European Commission took office in 2024, the focus has shifted from legislation to implementation and industrial transformation. The EU intends to continue its green transition by accelerating investments in clean technology and green infrastructure, ensuring that businesses and industries adopt sustainable practices while maintaining economic competitiveness. Energy security has also become a greater priority, with efforts to reduce dependency on fossil fuel imports (primarily from Russia) and strengthen Europe's position in global supply chains.

The priorities of the EU's green agenda are also of key importance to Ukraine, as the country seeks EU membership and a sustainable path for post-war recovery. As part of the EU accession process, Ukraine must align with European climate and environmental standards, modernize its industrial base, and integrate sustainable practices into its reconstruction efforts. The Ukraine Plan, which outlines the country's recovery strategy, incorporates these principles, ensuring that rebuilding is done in a way that enhances sustainability, economic stability, and social equity.

The transition to clean industry is particularly crucial for Ukraine as it rebuilds key economic sectors and modernizes its industrial base. Continuous Russian attacks during the war have greatly damaged the country's manufacturing capacity. Rather than restoring outdated, high-emission facilities, Ukraine has the opportunity to leapfrog to modern, low-carbon industrial production. This, particularly, includes investing in green steel, hydrogen production, and sustainable construction materials, which will not only reduce emissions and support the rebuilding effort but also

enhance Ukraine's competitiveness in the EU market.

Additionally, rebuilding industries with clean technologies and digital solutions will help future-proof Ukraine's economy, attract foreign investment, and facilitate integration into EU supply chains. By prioritizing clean industry in its recovery, Ukraine can establish itself as a leader in sustainable manufacturing, ensuring long-term economic resilience while advancing climate and environmental goals essential for EU accession.

Ukraine is also one of the best-positioned countries in the world to lead the integration of the defense and cleantech industries, given its urgent need for military resilience and its strong industrial and technological capabilities. The war has accelerated Ukraine's innovation in drone technology, battlefield energy solutions, and cyber defense, creating opportunities to develop and scale dual-use technologies that could serve both security and sustainability. For instance, investments in energy-efficient military infrastructure, renewable-powered field operations, and advanced materials for defense manufacturing can reduce reliance on fossil fuels while enhancing operational effectiveness.

A critical aspect of the green transition for Ukraine is energy security and independence, areas that have taken on even greater significance due to the war. The destruction of energy infrastructure has underscored the risks of fossil fuel dependency and centralized energy distribution, making decentralized and renewables-powered energy system a strategic priority. Expanding wind, solar, and bioenergy capacity in Ukraine will not only reduce reliance on external energy sources but also strengthen country's resilience against future disruptions. Additionally, integrating energy efficiency measures across industries, housing, and transport will be essential for both reducing emissions and ensuring cost-effective, secure energy supply.

However, the green transition in Ukraine cannot solely focus on climate, energy, industry, and raw materials. It is imperative that biodiversity restoration and protection are also highlighted. This necessitates the expansion and strengthening of protected areas, as well as the reduction of the detrimental effects of industrial sectors, particularly the agricultural sector. Therefore, alignment with the EU should not only prioritize achieving climate neutrality by 2050, but also biodiversity goals such as the expansion of existing Natura 2000 areas and the implementation of effective restoration measures to restore degraded ecosystems, particularly those with the greatest potential to capture and store carbon and mitigate the impact of natural disasters.

Thus, inclusive recovery for Ukraine can be defined as a comprehensive approach to reconstruction and development that balances immediate reconstruction needs with long-term sustainability goals, ensuring equitable distribution of resources and opportunities across all regions and demographics. This approach integrates environmental sustainability, economic inclusivity, gender responsiveness, and social equity into all aspects of recovery, while promoting participatory decision-making to create a more resilient and sustainable Ukraine for current and future generations[1].

[1] Baetens, F., Kopytsia, I., Dvornichenko, D. (2024). RE: BUILDING UKRAINE FOR ALL: Recommendations for Ukraine Recovery Conference 2025. University of Oxford.

Horizontal Challenges for Ukraine's Green Transition

This report describes the needs, challenges and opportunities of the green transition in Ukraine in specific sectoral and cross-cutting chapters. However, there are several horizontal issues that persistently affect almost every sector and need to be addressed independent of the sectoral goals.

The first key challenge is that of horizontal coordination

The green transition is an economy-wide process. In many ways the management of the green transition is a change-management challenge. To ensure success, it needs to be coordinated at the highest possible level.

This was also highlighted by the High-Level Working Group on the Environmental Consequences of the War in 2024 who stated in their report: "The Presidency of Ukraine should establish a high-level coordination body that oversees a robust system for the collection and preservation of evidence of war-related environmental damage."

This assessment shows that the coordination efforts must be further implemented beyond the documenting and safeguarding evidence related to war-related environmental damage. To foster understanding, shared responsibility, and collective ownership of the green transition, it is crucial to engage, involve, and integrate all sectors in planning and implementation process. Projects such as Green Deal Ukraïna and Green Transition Office exemplify the type of coordination required, but it must be more comprehensive and encompass the ministerial level, ideally with the Prime Minister leading the coordination efforts.

This is particularly crucial for addressing cross-cutting topics. This involves implementing a just and equitable transition, particularly for sectors most affected by transformations, as well as leveraging the synergies between the "twin" green and digital transformations. Additionally, maximizing the potential of research and innovation is crucial.

The second key challenge is that of human resources and skills

One of the biggest obstacles to Ukraine's green transition is the shortage of skilled human resources capable of supporting the country's shift toward a sustainable economy. The war has led to significant population displacement, labour force depletion, and brain drain, with millions of Ukrainians either leaving the country and hundreds of thousands voluntarily joining or being mobilized for military service.

Many professionals, including engineers, scientists, and energy specialists had to put their careers on hold, leaving critical gaps in expertise available for the sectors of economy not connected to the defense. The education and vocational training systems have also suffered disruptions, making it difficult to prepare the next generation of workforce for green jobs sectors such as renewable energy, sustainable construction, and circular economy.

Another key challenge is the lack of institutional capacity and workforce adaptability in sectors that need to transition away from traditional, high-emission industries. Many Ukrainian industries, such as iron and steel production, mining, and agriculture, have long relied on outdated, resource-intensive methods and technologies that require upgrading. Without strong, coordinated, government and private sector initiatives to reskill and upskill the workforce, there is a risk that Ukraine's industrial transformation will be delayed, or that the country will have to rely heavily on foreign expertise rather than developing its own green-labour market.

While this is a challenging issue to deal with during the active phase war, efforts need to be made into planning the reskilling of the work force in the most polluting and resource-intensive industries and ensuring well-coordinated technical support from international experts.

The third key challenge is that of land use and planning

The green transition will have complex and often conflicting demands for land use, especially in the context of post-war recovery and reconstruction, as well as the ongoing occupation of Ukrainian territory by Russia. Estimates from July 2023 indicate that around 174 000 sq. km of Ukrainian land is contaminated with landmines and unexploded ordnance, making it unsafe for development, agriculture, or ecosystem restoration without lengthy demining efforts. At the same time, land and water bodies that have been damaged by warfare require intensive remediation before they can be repurposed.

Ukraine also needs to balance competing land-use priorities as it aligns with the EU. Agriculture remains a cornerstone of Ukraine's economy and needs to shift towards more sustainable farming practices. At the same time, Ukraine must expand renewable energy infrastructure, particularly solar, wind, and bioenergy, which create additional demands on suitable land areas. This creates tensions between farmland use, natural habitat conservation, and energy production, particularly as Ukraine integrates with the European energy market and seeks to reduce reliance on fossil fuels. Additionally, the need for additional forestation and carbon sink expansion under EU climate goals will require setting aside land for reforestation and afforestation projects, further complicating land allocation decisions.

Another critical challenge is ensuring the integrity of environmental and strategic impact assessments (EIA/SIA). Large-scale development projects, including energy installations, transportation networks, and industrial reconstruction, must undergo rigorous environmental assessments to prevent unintended damage to ecosystems and local communities.

Ukraine's capacity for environmental oversight and impact assessment has been weakened by the war, making it difficult to secure environmental law enforcement. Additionally, SIA must consider the cumulative effects of multiple projects, ensuring that development efforts do not undermine biodiversity, water resources, or climate resilience. The need to accelerate reconstruction often clashes with the lengthy processes required for comprehensive environmental planning, creating pressure to bypass environmental safeguards in favour of rapid development.

To address these multiple challenges, Ukraine will need a cohesive national land strategy and co-ordination that balances the urgent and strategic needs of recovery and economic development while integrating long-term environmental resilience. This approach needs to ensure that while development should keep up with the needs of recovery, it does not work against the long-term goals of the green transition and instead aims at supporting it.

1. Thematic and Sectoral Analysis

This section outlines the key sectors related to the green transition in Ukraine. The report aims to capture the most relevant information for the status of these sectors in Ukraine at the time of writing.

1.1 Climate Change

Status and trends

The main challenge of the ongoing war in Ukraine in relation to climate change status and trend is twofold: first, it has become much harder to collect accurate data about emissions since the full-scale invasion. Moreover, the war itself has become a colossal source of emissions.

According to a recent analysis, warfare has become a primary contributor to the GHG emissions in Ukraine, with the total war-related emissions reaching 230 MtCO2e since the full-scale invasion in 2022. The war-related emissions include direct combat activities such as military equipment, ammunition, and fortification construction and indirect impacts such as landscape fires and emissions from reconstruction efforts. These total war-related emissions are equivalent to the annual emissions of European countries like Austria, Hungary, Czech Republic, and Slovakia combined.

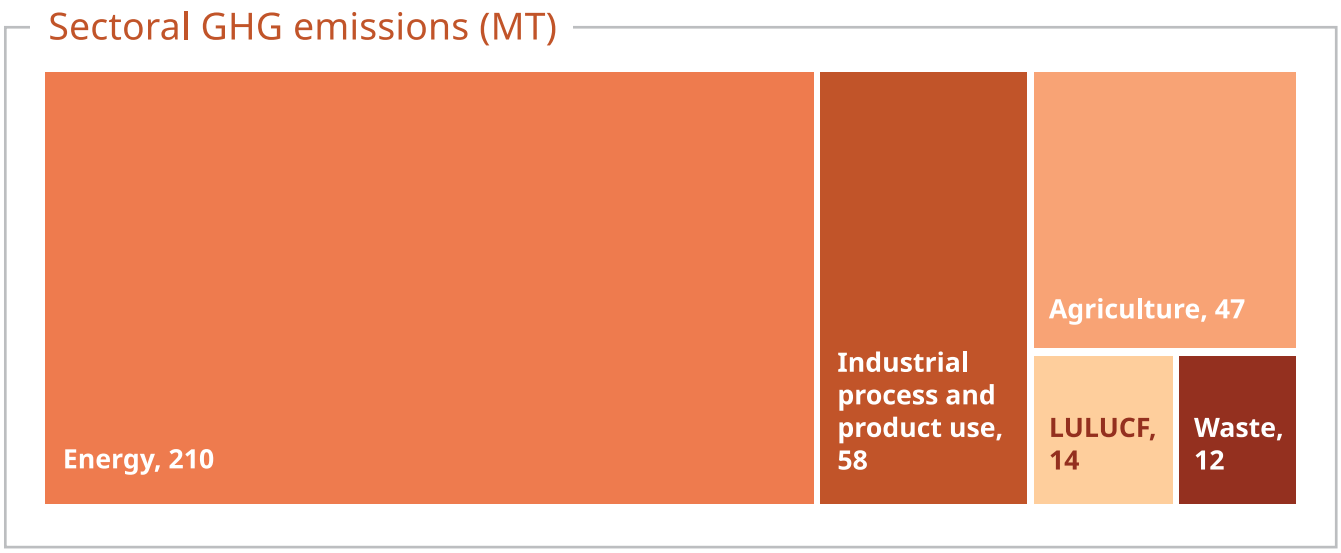
Accurate GHG emissions accounting and reporting in Ukraine has been exceedingly problematic during the war. The most comprehensive recent data on GHG accounting available to date is Ukraine's National Inventory Report (NIR), published in 2023, which contains data up until 2021. The NIR follows the IPCC methodology for assessing the emissions in various sectors and is submitted annually. Ukraine has faced many challenges in compiling NIRs since 2013, when Russia attacked Ukraine first. Since that time, Russia has been trying to include GHG emissions from the annexed Crimea and other occupied Ukrainian territories in its national reporting in an attempt to seek international validation for the occupied Ukrainian territories.

If Ukraine were the EU member state, it would be among the top 3 emitting countries based on its 2021 emissions. The 2023 NIR assesses the total level of Ukraine's emissions at 341,5 MT of CO2 eq[2], with the energy sector contributing more than half of the emissions' share. The energy sector, in terms of the amount of GHG emissions, is followed by the emissions in industrial process and product use (around 17% of all the emissions), agriculture (almost 14% of emissions), LULUCF - Land Use, Land Use Change and Forestry (approx. 4%) and waste (3,5%).

LULUCF in Ukraine contributes 4% of total GHG emissions, while in many EU countries LULUCF is a net carbon sink. The fact that LULUCF emits GHG emissions in Ukraine indicates inefficient land use and management practices.

[2] Ukraine, National Inventory Report (2023)

In the absolute values, in 2023, emissions per sector in Ukraine looked as follows:



Source: Green Deal Ukraina Report[3] based on NIR (2023) data

Establishing a well-functioning and reliable system for emissions accounting is fundamental for Ukraine in the context of its EU integration path and the country's commitments to achieve carbon neutrality and economic competitiveness. While Ukraine's GHG emission tracking generally aligns with IPCC methodology, it doesn't employ the highest-tier approaches. To meet EU standards and support its national climate goals, it is important for Ukraine to refine its emissions accounting system. In this regard, introduction of a robust Monitoring, Reporting, and Verification (MRV) system at the individual enterprise level, combined with regular reporting, is a crucial step that could substantially improve accuracy and reliability of emissions assessments.

Ukraine's Monitoring, Reporting, and Verification (MRV) system for GHG emissions, initially introduced in 2021, was suspended due to martial law but is set to be fully relaunched in 2025. On January 8, 2025, the Ukrainian parliament adopted Law No. 418: "On Amendments to Certain Legislative Acts of Ukraine on the Restoration of MRV of GHG Emissions"[4] that aims to reinforce mandatory registration and reporting requirements of Greenhouse Gas (GHG) emissions. Reintroducing MRV has several major impacts, including enabling the implementation of ETS in Ukraine and laying the foundation for attracting foreign investment for "green projects", and enabling Ukraine's ability to adapt to the EU's carbon border adjustment mechanism (CBAM).

[3] Report on GHG emissions assessment in Ukraine, Green Deal Ukraina (2024)
[4] The Law of Ukraine No. 4187-IX "On Amendments to Certain Legislative Acts of Ukraine on the Restoration of MRV of GHG Emissions"

Strategic capacity

Ukraine's climate policy landscape has undergone significant transformation since 2021, anchored by legislative reforms and strategic documents aligned with EU integration priorities. Figure 1 presents the overview of the most impactful climate laws and strategies shaping mitigation, adaptation, and post-war reconstruction efforts.

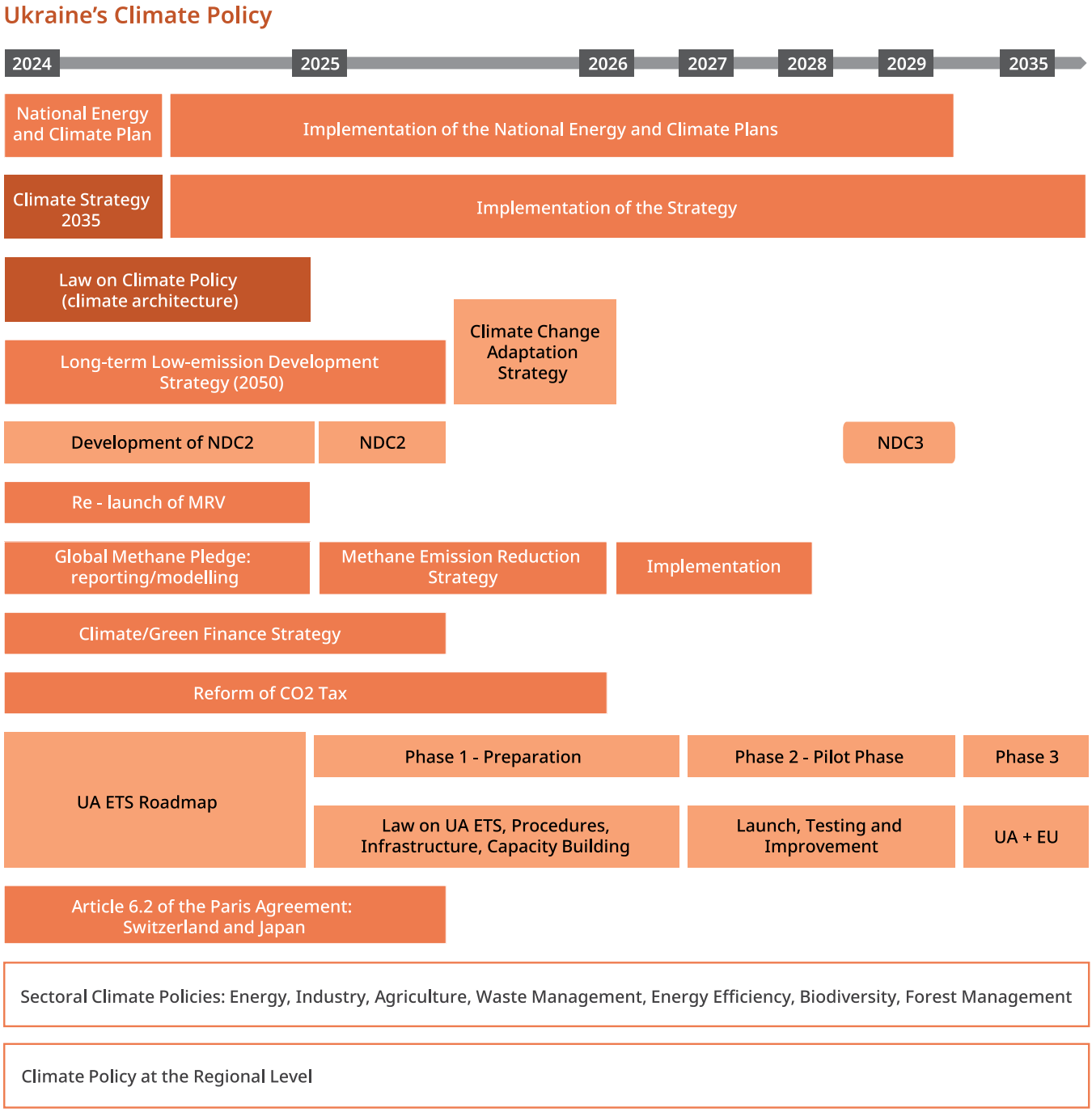


Figure 1. Ukraine's climate policy. Source: Green Transition Office in Ukraine (2025)

The core climate laws and policies comprise the following:

1. Law on State Climate Policy (2024)[5]

Adopted as a part of Ukraine's commitment under the Paris Agreement and the Association Agreement with the European Union, the Law creates an essential legal foundation for integrating climate policy across all sectors of the economy and governance, reinforcing Ukraine's ambition to align with European standards and integrate into the EU Emissions Trading System (EU ETS).

The Law sets a legally binding 2050 climate neutrality objective and 65% reduction target in GHG emissions by 2030 relative to 1990. Key provisions include:

1. Establishment of the national GHG inventory system with the scope, preparation, and update of the inventory to be determined by a secondary legal act;
2. The system for annual reporting on policies, measures, and projections, supplemented by secondary legislation procedures to ensure accountability for climate targets;
3. Mandatory development of National Energy and Climate Plans (NECPs), long-term low-emission strategies, and sectoral adaptation plans;
4. Integration of climate objectives into post-war recovery programs, requiring alignment with EU Regulation 2018/1999 (Governance of the Energy Union).

The legislation includes provisions for financial and fiscal instruments aimed at reducing GHG emissions, including fiscal instruments under the Tax Code promoting GHG emission reductions; emission trading schemes to incentivize businesses to reduce emissions; low-interest loans with state guarantees for businesses; and grants, subsidies, and loans for the public to implement energy-efficient technologies. However, unlike successful models in EU countries such as Germany, Sweden, Poland, and Estonia, **the law does not establish a dedicated National Climate Fund to finance adaptation and mitigation measures**. Additionally, Article 21 concerning funding measures **will only come into force one year after martial law is lifted**, creating uncertainty in resource allocation.

The law mandates regional state administrations and territorial communities to develop regional and local strategies for reducing anthropogenic GHG emissions and adapting to climate change and to integrate these into their comprehensive planning frameworks. This requirement ensures that climate objectives are incorporated into regional and local development strategies, post-war reconstruction plans, and all other local planning documents.

However, local and regional authorities may face significant implementation challenges when integrating climate objectives into their planning processes. These include insufficient funding allocations, limited access to specialized climate expertise, inadequate cross-sectoral coordination mechanisms, and minimal technical assistance from the central government. Furthermore, while the law emphasizes inclusivity, it lacks provisions addressing the specific needs of vulnerable groups who are disproportionately affected by climate change, such as people with disabilities, persons 65 years and older, and children.

[5] The Law of Ukraine No.3991-IX "On the main principles of state climate policy" adopted on 8 October 2024 (hereinafter "the Law No.3991")

The law mentions public participation in climate policy formation, requiring state authorities and local governments to ensure citizen information and involvement in discussing strategic documents. However, the law lacks specific mechanisms for implementation, leaving many open questions about the structure of the anticipated public engagement.

Despite shortcomings, the Law "On the Basic Principles of State Climate Policy" creates an essential legal foundation for European integration and green post-war recovery.

2. Law on Monitoring, Reporting, and Verification (MRV) of GHG Emissions (2021)[6]

Adopted in 2020 and entering into force on 1 January 2021, **the Law defined the legal and organizational principles for monitoring, reporting, and verification of greenhouse gas emissions, fulfilling Ukraine's obligations under United Nations Framework Convention on Climate Change (UNFCCC), Paris Agreement and the EU Association Agreement**, implementing EU Directive 2003/87/EC. The Law was a crucial step toward transparency and a prerequisite for launching Ukraine's Emissions Trading System (ETS) set to launch in 2025, ensuring compliance with the EU CBAM.

Under the MRV framework, legal entities and individual entrepreneurs operating installations that produce or may produce GHG emissions in Ukraine must comply with reporting obligations. The Law defines specific industries subject to MRV, including fuel combustion in large installations, oil refining, iron and steel production, cement and glass manufacturing, ammonia and nitric acid production, and other industrial processes with significant emissions. Operators must register their installations in the Unified Register for MRV of GHG Emissions and submit annual monitoring plans, operator reports, verification reports, and improvement reports. Notably, the Law allows operators to forgo submitting reports for 2021-2023 and grants them until the end of 2025 to complete reporting obligations for 2024.

Furthermore, the Law foresees administrative penalties for non-compliance with MRV obligations, but the current fines are low. In particular, operators who fail to register their installations, update records, or submit required reports may face penalties ranging from UAH 1,360 (EUR 31) for a first-time offense up to UAH 6,800 (EUR 155), along with potential restrictions on business operations for repeated violations. By comparison, under the European Union's Monitoring, Reporting, and Verification (MRV) Regulation (EU) 2015/757, companies failing to surrender the required allowances incur an excess emissions penalty of €100 (adjusted for inflation) per tonne of CO_2 equivalent, in addition to the obligation to surrender the necessary allowances.

The enforcement of the martial law in 2022 led to suspending mandatory reporting, which was replaced by a voluntary system. On January 8, 2025, Ukraine reinstated mandatory GHG emissions reporting with the adoption of Law No. 4187-IX, «On Amendments to Certain Legislative Acts of Ukraine on the Restoration of MRV of GHG Emissions»[7] restoring the mandatory registration and reporting requirements.

[6] Law of Ukraine "On the Principles of Monitoring, Reporting and Verification of Greenhouse Gas Emissions"

[7] Law of Ukraine "On Amendments to Certain Laws of Ukraine on the Restoration of Monitoring, Reporting and Verification of Greenhouse Gas Emissions

The recent legislative amendment ensures the continued collection of verified emissions data during wartime, reinforcing Ukraine's commitment to emissions reduction, strengthening transparency, harmonizing with EU standards, and laying the foundation for an effective ETS.

3. National Energy and Climate Plan (NECP) 2025–2030

Aligned with European Commission guidelines (Regulation (EU) 2018/1999), NECP focuses on five key dimensions in alignment with the Energy Union framework: Decarbonization, Energy Efficiency, Energy Security, Internal Energy Market, and Research, Innovation, and Competitiveness. Additionally, NECP integrates Ukraine's updated Nationally Determined Contribution (NDC) under the Paris Agreement, submitted in 2021, laying the ground for NDC 2.0 to be adopted in 2025. The plan outlines sector-specific targets, including reducing greenhouse gas (GHG) emissions by 65% compared to 1990 levels, increasing the share of renewable energy sources (RES) to at least 27% of final energy consumption, and enhancing energy efficiency to limit primary energy consumption to 72,224 thousand tons of oil equivalent by 2030, representing approximately a 9% reduction from 2020 levels. The strategy also aims to decrease fossil fuels import dependence to 33%, ensuring energy security through diversification of supply routes, integrating Ukraine's electricity and gas markets with the European Union, and modernizing infrastructure.

The NECP emphasizes policies to support the decarbonization of transport, industry, and residential sectors while also fostering innovation in clean technologies and implementing energy efficiency measures in both public and private sectors. The internal energy market strategy includes full-scale synchronization with ENTSO-E, market liberalization, and the development of smart grids. The NECP fosters innovation in clean energy technologies, biomethane production, and energy storage solutions, supporting research in low-carbon industrial processes and the decarbonization of transport, industry, and residential sectors. **Given the ongoing war, the plan also addresses infrastructure resilience, the impact of energy poverty, and the need for financial and institutional reforms to support a sustainable energy transition.**

4. Ukraine 2050 Long-Term Low Emission Development Strategy (LT-LEDS)[8]

Revised in December 2024, LT-LEDS provides comprehensive sectoral pathways to achieving climate neutrality by 2050.

The strategy focuses on decarbonizing the energy sector through increased energy efficiency, expanding renewable energy sources such as wind, solar, and biomass, and developing of green hydrogen. It also emphasizes modernizing power grids, integrating low-carbon technologies in steel and cement production, and promoting circular economy principles.

A significant priority is scaling up biogas production from agricultural and livestock waste, lowering reliance on fossil fuels while improving waste management. Additionally, LT-LEDS sets ambitious goals for reducing non-CO_2 greenhouse gas emissions, mainly methane and nitrogen

[8] Ukraine 2050 Low Emission Development Strategy

oxides, by improving fossil fuel extraction processes, enhancing waste treatment systems, and introducing climate-smart agriculture practices.

Beyond emissions reduction, the strategy aims to strengthen Ukraine's carbon sinks through afforestation and sustainable land use, aiming to increase forest cover to 19.4% by 2050 (compared to 1990 levels). It envisions a transition towards a low-carbon economy by fostering innovation, incentivizing clean technologies, and aligning industrial and transport sectors with climate goals. LT-LEDS is designed to be periodically reviewed and updated in response to technological advancements and economic shifts, ensuring its alignment with Ukraine's commitments under the Paris Agreement and its integration with EU climate policies.

5. Environmental Security and Climate Adaptation Strategy 2030[9]

Adopted in 2021, Ukraine's Environmental Safety and Climate Change Adaptation Strategy represents a comprehensive framework developed with EU4Climate support to fulfil the country's adaptation commitments under the Paris Agreement. The Strategy identifies ten sectors most vulnerable to climate impacts and establishes a roadmap for transforming Ukraine into a climate-resilient nation by systematically integrating adaptation measures across sectoral and local policies. These priority sectors include biodiversity, water resources, energy, public health, forestry, coastal areas, fisheries, agriculture, and soils, which form the focal points for the government's strategic climate resilience efforts.

On February 7, 2025, the Cabinet of Ministers of Ukraine approved the second operational plan for implementing the Environmental Safety and Climate Change Adaptation Strategy until 2030, covering a series of measures to be implemented during 2025-2027. The plan aims to further develop Ukrainian legislation in environmental and climate areas, including establishing the Unified State Register of Integrated Environmental Permits, developing procedures for air quality monitoring and public information using Ukraine's air quality index, and adopting comprehensive forest monitoring methodologies. The plan mandates sector-specific climate adaptation action plans across water resources, biodiversity, forestry, energy, public health, agriculture, transport, and tourism sectors, while reforming environmental supervision systems and initiating a national forest inventory. It also prioritizes alignment with EU acquis, particularly in chemical safety and product management regulations. Among its practical conservation measures, the plan commits to expanding protected natural areas at both local and national levels, though without specifying quantitative targets.

EU Approximation

Ukraine has made some progress in aligning its climate policies with EU standards, notably by adopting its first climate policy framework law and a National Energy and Climate Plan. Still, significant work remains in areas such as emissions trading and greenhouse gas monitoring.

[9] Cabinet of Ministers of Ukraine "On approval of the Strategy for Environmental Security and Adaptation to Climate Change for the period up to 2030"

Table 2. Ukraine's progress in EU approximation in the climate sphere

Thematic areas	Progress	Details
Climate Policy Framework	Significant	- Adopted the first framework law on national climate policy (October 2024) - Aligned with the EU's climate-neutrality objective by 2050
Long-term Strategy	Pending	- Update the long-term low-emission development strategy under Paris Agreement
Nationally Determined Contribution	Pending	- Preparation and submission of the new NDC
National Energy and Climate Plan (NECP)	Completed	- NECP adopted in June 2024 - Commitment to a dynamic review process - Revision planned by December 2025
Monitoring, Reporting, and Verification (MRV)	Partial	- Adopted resolutions partially implementing EU Regulation 2018/2066 (November 2023) - Full implementation hindered by the martial law, restarts in 2025
Emission Trading System (ETS)	In progress	- Actively working on establishing national ETS - Gradual convergence with EU ETS
Fluorinated Greenhouse Gases	Partial	- Implementing legislation enacted on administrative procedures - Kigali Amendment to Montreal Protocol ratification pending
Ozone-depleting Substances	Pending	- Alignment with new EU Regulations required
Carbon Pricing	In progress	- Working towards establishing an effective mechanism - Action plan for national ETS is necessary

Establishing ETS is one of the main priorities related to Ukraine's climate policy in the context of the EU approximation process.

Ukraine plans to launch pilot ETS already in 2025. While there is some progress in establishing ETS verification and accreditation processes, there are still areas that need further development to ensure a robust and reliable ETS that aligns fully with the EU standards (Table 3).

Table 3. Ukraine's ETS progress based on the Energy Community Annual Implementation Report 2024

Key aspects of ETS progress	Current progress	Gaps
Foundations & Institutions	- Law on Principles of MRV adopted in 2021 - Introduced basic ETS definitions - Established enforcement regime for registration/monitoring plan failures - Designated competent authority to check monitoring plans - Started process of identifying operators who will be subject to the MRV requirements	- The concept of permit was replaced by the registration obligation which might weaken enforcement - Economic sectors covered significantly reduced compared to EU ETS - Documents' submission, review, and approval is suspended due to the martial law - Full alignment with the EU ETS Directive pending
Monitoring & Reporting	- Partially transposed Monitoring and Reporting Regulation - Responsible authorities created templates and examples for registration and monitoring plan - Introduced provisions for authority to estimate emissions if operator fails to report	- Provisions for monitoring and reporting emissions from aviation activities are not included - Missing specific requirements for sustainable biomass criteria and CO2 transfers - No specific deadline for submitting and approving monitoring plans
Verification & Accreditation	- Partially transposed Accreditation and Verification Regulation - Introduced obligation for annual verified emissions reports - Appointed National Accreditation Agency of Ukraine as the accreditation body - Implemented procedures for accrediting emissions verifiers - Some verifiers already accredited and providing services	- Some elements of accreditation requirements are missing - The scope of accreditation for GHG verifiers is not fully defined

The Carbon Border Adjustment Mechanism (CBAM) is another key component of the EU's climate policy. It has been in a transitional phase since 2023 and is set to be fully operational by 2026. CBAM aims to reduce global carbon emissions by extending carbon pricing to imports, significantly impacting countries that export carbon-intensive goods to the EU market. CBAM will significantly impact Ukraine's exports to the EU, particularly in the iron and steel sector. About 15-17% of Ukraine's EU exports are subject to CBAM, with iron and steel products making up 93% of these affected exports.

The impact of CBAM on Ukraine's economy can potentially be severe, with considerable export losses, especially for the iron and steel industry. Prior to full-scale invasion, the iron and steel industry contributed 5.7% to Ukraine's GDP and 14.6% to total exports in 2023. 89% of Ukrainian steel is produced using carbon-intensive methods, and therefore, it faces the risk of losing competitiveness in the EU market.

The steps that Ukraine is taking to align its legislation with EU climate policy aim to help prepare Ukraine's economy for implementing the CBAM mechanism. At the same time, given the ongoing war and its destructive consequences on Ukraine's economy and infrastructure, there are calls for Ukraine to be excluded from CBAM obligations under Article 30.7 of the EU Regulation 2023/956. This exclusion could allow Ukraine to further integrate into the European economy while recovering from the war's impacts.

Ukraine's climate policy faces a turning point, balancing wartime challenges with ambitious decarbonization goals. The country's success in implementing ETS and adapting to the CBAM depends on three key factors: robust international support, swift regulatory reforms, and effective financing solutions.

Despite significant obstacles, Ukraine has a unique opportunity: The country can create a resilient, low-carbon economy that aligns with EU standards by integrating climate objectives into its post-war rebuilding efforts.

1.2 Energy

Status and trends

Ukraine's energy system primarily relies on fossil fuels and nuclear energy, with coal and nuclear energy composing 47% of the total energy mix in 2022 and 70% of the power generation mix (Figure 2). Renewable energy constituted 12% of the power generation mix in 2022 (Figure 2). In 2022, the energy sector in Ukraine emitted 210 Mt CO2 equivalent, making it the highest emitter among all sectors of the economy[10].

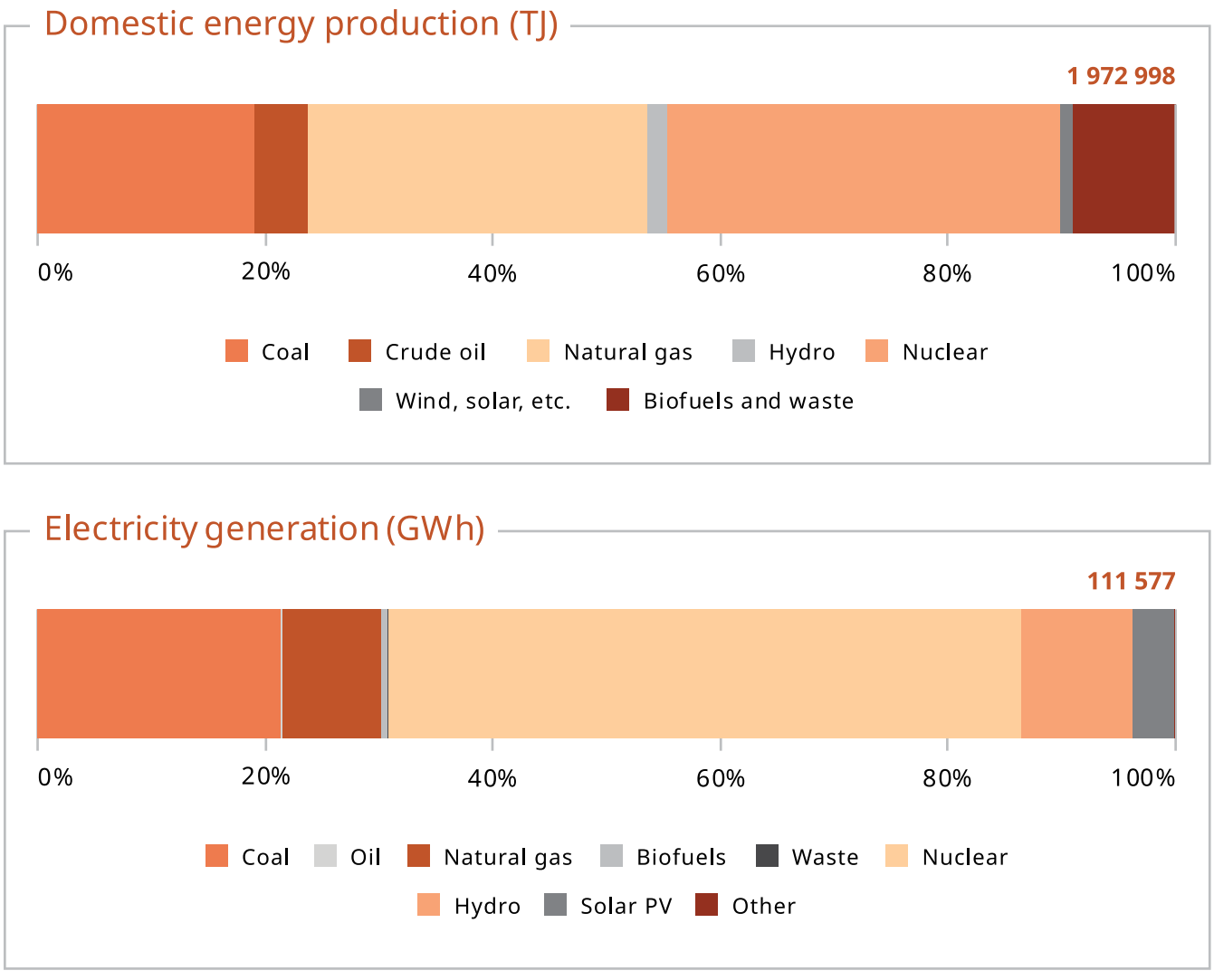


Figure 2. Ukraine's domestic energy production (TJ) and electricity generation (GWh) in 2022. Source: IEA[11].

[10] Ukraine, National Inventory Report (2023)

[11] IEA Country overview of Ukraine, Accessed in March 2025

Prior to the Russian full-scale invasion, industry was the largest energy consumer in Ukraine (33% of final energy consumption[12]), followed by the residential and transport sectors. However, due to the ongoing war, large-scale destruction of infrastructure and industrial facilities, and military occupation of Ukrainian territory by Russia, this proportion has changed.

From being an electricity exporter with the seventh largest power generation capacity in Europe, 56 GW, Ukraine has turned into an electricity importer due to the energy system damage caused by Russian attacks. Currently, Ukraine imports 6% of its electricity from the EU[13]. The estimated electricity deficit in Ukraine in winter 2024-2025 is 5.8 GW[14]. In monetary terms, the total losses of the Ukrainian energy sector are estimated to be $20 billion[15].

Military occupation of energy objects and physical destruction of energy infrastructure are significant impacts of the Russian invasion on the Ukrainian energy system. 50% of the energy generation capacity in Ukraine is located on the currently occupied territories, corresponding to 18 GW of energy generation capacity[16]. After the Russian full-scale invasion, the Ukrainian energy system experienced significant damage due to regular targeted Russian attacks. The energy demand in Ukraine also experienced substantial changes due to the occupation of Ukrainian territories by Russia, making it impossible to access data on exact energy demand and supply changes.

Russian attacks on energy infrastructure in the first half of 2024 destroyed about 50% of energy production capacity[17]. Additionally, in February 2025, Ukraine reported that it lost up to 40% of its domestic gas production due to Russian attacks[18]. Main gas extraction fields in Ukraine are located in Kharkiv and Poltava regions near the Russian border and are very vulnerable to attacks. 50% of renewable energy generation is under Russian occupation,[19] significantly impacting Ukraine's ability to meet its renewable energy targets.

District heating systems (DHS) have been significant targets of Russian attacks, causing severe disruptions for Ukrainian civilians, especially during winter months[20]. One-third of Ukraine's urban population relies on DHS for hot water and space heating, with over one-third of Ukrainian households connected to the network as of 2022. The system is predominantly fuelled by natural gas (70%), with combined heat and power (CHP) plants generating about a third of the heat supply. By May 2024, 18 large-scale CHP plants were damaged or destroyed, resulting in direct damage estimated at USD 2.4 billion, with over half attributable to CHP plant attacks. These assaults disproportionately impact vulnerable groups, exacerbating the strain on Ukraine's energy sector during harsh winter conditions.

[12] IEA, 2020. Ukraine energy profile.
[13] Green Deal Ukraina. Ukraine Electricity Generation 2023 vs 2022
[14] IEA, 2024. Ukraine's Energy Security and the Coming Winter, Report
[15] Ukraine Fourth Rapid Damage and Needs Assessment report (RDNA4), 2024
[16] KSE, 2024. Assessment of Damages and Losses to Ukraine's energy sector due to Russia's full-scale invasion
[17] Green Deal Ukraina. Ukraine Electricity Generation 2023 vs 2022
[18] Pavel Polityuk, Reuters, 2025. Ukraine plans to import 800 mcm of gas until April after Russian strikes.
[19] Green Deal Ukraina. Ukraine Electricity Generation 2023 vs 2022
[20] UN OHCHR, 2024. Massive Attack on Ukraine's Energy Infrastructure Damages and Disrupts Essential Services

From January 2025, Ukraine stopped being a country transiting Russian gas to Europe. Before the Russian full-scale invasion, Ukraine transited large amounts of Russian gas to Europe, with 41.6 billion cubic meters having been transited only in 2021. At the beginning of 2025, Ukraine stopped transitioning Russian gas through its territory, ending "the era" of its gas transit. Gas transit used to bring Ukraine 3% of GDP before 2014, 1.5% of GDP before 2022.[21]

Several main trends related to energy reforms in Ukraine were triggered by the tragic events of the Russian invasion but can become powerful drivers for sustainable energy system development. From energy policy and energy market perspectives, developments have set back the progress with energy reforms previously achieved.

Overall, energy reforms in Ukraine that are aligned with EU integration goals and Paris Agreement targets are challenged by the need to save the energy system from emergencies. The main challenge is to ensure that short-term survival solutions, which often include fossil-fuel-based solutions, do not contradict long-term sustainability goals, creating additional challenges for the green transformation of the Ukrainian energy system.

Ukraine's progress in reforming heavily subsidized residential heat tariffs until 2021 was undone by the war, forcing a return to subsidies and leading to a significant accumulation of debt in the energy sector. Between 2014 and 2016, large subsidies to district heat producers had previously been reduced due to energy price reforms. By 2021, the public service obligation (PSO) requiring Naftogaz, Ukraine's national oil and natural gas company, to supply discounted gas to district heating companies was phased out. It was re-introduced in 2022 in response to the war, fixing gas prices for residential heat producers at less than half the market rate, and has been extended until at least 30 April 2025. The current PSO scheme has contributed to significant financial challenges for Naftogaz. Currently, the company has an accumulated debt from district heating companies estimated at UAH 95 billion (USD 2.6 billion), corresponding to 1.5% of Ukraine's GDP[22].

Energy system decentralization is one of the significant energy system trends in wartime and foreseen post-war Ukraine. Multiple expert reports and assessments point out that despite high investment risks, constructing a more decentralized energy system has already started, increasing resilience to Russian attacks and "laying the groundwork for a distinctive longer-term transition pathway". Examples of energy system decentralization efforts in Ukraine include accelerated deployment of smaller-scale gas-fired combined heat and power plants, solar PV, and wind systems complemented by batteries and other storage technologies[23].

Since 2022, the Ukrainian energy system has become more integrated with the EU energy system. The Russian full-scale invasion of Ukraine in 2022 sped up the synchronization of Ukraine (and Moldova) with the European electricity system. This has led to increased security and resilience for the grid in Ukraine and created opportunities for Ukraine to increase electricity exports to the EU and Moldova until attacks on generation capacity reversed this trend, turning Ukraine into a net electricity importer.

[21] Enerdata, Ukraine Energy Information, Accessed on March 2025.
[22] IEA, 2024. Ukraine's energy system under attack
[23] IEA, 2024. Empowering Ukraine Through a Decentralised Electricity System

Strategic capacity

The National Energy and Climate Plan (NECP) and the Energy Strategy 2050 are the two main strategic documents guiding Ukraine's energy sector development post-2022. These documents, adopted after the Russian full-scale invasion, hold higher relevance in comparison to the earlier strategy documents due to the significant changes in Ukraine's energy sector and development priorities.

Ukraine's first NECP, adopted in 2024 during the full-scale invasion, aligns with EU Regulation 2018/1999 requirements and sets ambitious targets for the country's energy future[24]**.** The plan aims for 27% renewable energy in Ukraine's gross final energy consumption by 2030 and includes specific goals aligned with the Energy Union's dimensions. While marking a significant step towards energy security and sustainability, achieving these objectives will require substantial support and investment from the EU and other international partners. Implementing the NECP is crucial and will demand significant resources and a robust monitoring framework, considering adaptive planning amidst ongoing energy facility destruction. The Ministry of Economy leads NECP implementation reporting, with success largely dependent on efficient inter-ministerial coordination.

Ukraine's Energy Strategy 2050[25] **presents an ambitious vision for decarbonization and positions the country as a European green energy hub.** The strategy aims for carbon neutrality in the energy sector by 2050 through significant expansion of nuclear and renewable power generation capacities. It outlines a substantial increase in the installed capacity of nuclear, solar, wind, hydropower, hydrogen, bioenergy, and energy storage. Specifically, it sets targets for installed capacity, including 140 GW of wind, 94 GW of solar, and 30 GW of nuclear generation by 2050. The plan emphasizes modernizing transmission and distribution systems, European electricity network integration, and increasing renewable energy's share in power generation to 50% by 2035. Additionally, it envisions Ukraine as a key player in clean electricity production and hydrogen supply for the EU, aligning with the country's goals of EU integration and broader decarbonization objectives.

In addition to the NECP and the Energy Strategy 2050, a relevant document that will drive Ukraine's energy sector development in the coming years is the Strategy for the Development of Distributed Generation until 2035[26]**.** The Strategy for the Development of Distributed Generation until 2035, adopted in July 2024, marks a significant shift towards a more resilient and flexible power system. This strategy aims to decentralize Ukraine's energy infrastructure by promoting smaller, dispersed generating facilities closer to consumers, including gas-based and renewable energy sources. Distributing generation across numerous local sites enhances the power system's resilience against potential disruptions. The strategy also anticipates the future repurposing of gas-based units to use renewable gases. An Operational Action Plan for 2024-2026 accompanies this initiative.

[24] National Energy and Climate Plan (NECP) of Ukraine 2025-2030
[25] Ministry of Energy of Ukraine, 2022. Energy Strategy
[26] UNDP, 2025. Ukraine's parliament passes law on sustainable transformation of country's energy sector

Governance capacity

The Ministry of Energy of Ukraine is the primary governmental body overseeing the country's energy sector. It develops and implements state policy in electricity, nuclear energy, coal industry, and oil and gas. The ministry works closely with several key organizations to manage Ukraine's energy system.

Ukrenergo serves as the national electricity Transmission System Operator (TSO), responsible for operating the high-voltage power grid and ensuring its stability. The Distribution System Operators (DSOs) manage the lower-voltage networks and are mostly privately owned following several rounds of privatization since 1995. **Energoatom, a state-owned entity, operates Ukraine's nuclear power plants.**

The National Energy and Utilities Regulatory Commission (NEURC) acts as the independent regulator for the energy sector, setting tariffs and licensing energy companies. The State Agency on Energy Efficiency and Energy Saving of Ukraine also promotes energy efficiency and renewable energy development. This governance structure aims to balance state oversight with market-driven operations as Ukraine continues to align its energy sector with European Union standards and work towards full integration with the European energy market.

In governing the energy sector, the Ukrainian government faces several simultaneous and enormous challenges: Rebuilding and modernizing its energy system to align with the EU goals, phasing out fossil fuels in the electricity sector by 2035, ensuring short-term stability of the energy system at the backdrop of continuous Russian attacks on the energy system, addressing energy system deficit which has been increasing since 2022 and is expected to rise in the following years.

Overall, Ukraine's public governance system, including the energy sector, has made progress in recent years. At the same time, many challenges remain regarding Ukraine's government's capacity to develop, adopt, and especially implement strategies.

International support, particularly from the EU, G7, and organizations like UNDP, is crucial in advancing energy reforms in Ukraine. Donor support has been primarily oriented toward supporting Ukraine in reforming its energy sector in line with the EU approximation process. However, since the Russian full-scale invasion, the focus has shifted, understandably, towards building a more resilient, decentralized, and sustainable energy system in Ukraine.

The Recovery and Reform Support Team (RST) at the Ministry of Energy in Ukraine is one of the examples of the public institutions' capacity-building reforms funded by external donors to support the process of reforms in Ukraine as part of the EU integration process[27]. The RST at the Ministry of Energy is part of the Ukraine Recovery and Reform Architecture (URA) programme, which is, in essence, a technical assistance initiative launched in 2016 and supported by the European Bank for Reconstruction and Development (EBRD) in partnership with the EU. The

[27] Minsitry of Energy, Accessed in March 2025. The Recovery and Reform Support Team at the Ministry of Energy of Ukraine

RST consists of Ukrainian professionals who are not civil servants and are funded by international donors to provide targeted technical support for priority reforms in the energy sector and help build expertise in policy formation and analysis.

Ukrainian local governments face significant challenges in implementing energy reforms despite some progress in developing tools and capacity. For example, the mandatory adoption of Municipal Energy Plans (MEPs) under Ukraine's Energy Efficiency Law is a key step towards local energy reform, but many municipalities face significant challenges. MEPs are designed to guide energy efficiency and sustainability efforts, yet many local governments lack the technical expertise and financial resources to develop and implement them effectively. The ongoing war and destruction of the energy infrastructure have complicated these efforts, as municipalities are now forced to prioritize immediate energy security over long-term planning. Additionally, a disconnect between national policies and local realities complicates alignment with broader energy goals. Despite these obstacles, some pioneering cities have made progress, often with crucial support from Ukrainian NGOs and international organizations providing technical assistance and capacity building.

In 2022, Ukraine officially joined the International Energy Agency (IEA) as an Association country[28]**.** This is an important step for strengthening its energy sector reform capacity and international cooperation. Ukraine's membership in the IEA effectively significantly boosts its energy sector reform and development capabilities. This partnership grants Ukraine access to IEA's extensive knowledge base on energy policy, market analysis, and technology while also providing targeted technical support for priority reforms. Additionally, it opens doors for international cooperation through participation in IEA standing groups, committees, and ministerial meetings. These benefits collectively enhance Ukraine's capacity to modernize its energy infrastructure, implement crucial reforms, and align with international standards, particularly in the context of its EU integration goals and post-war reconstruction efforts. Since Ukraine joined the IEA, the agency has published at least three significant reports focusing on both short-term and long-term outlooks and recommendations to help energy sector development in Ukraine. These reports include "Ukraine's Energy Security and the Coming Winter" (2024)[29], "Empowering Ukraine Through a Decentralised Electricity System" (2024)[30], and a special report on "Ukraine's Energy Security and the Coming Winter" (2024)[31].

Sectoral capacity

There is a significant shortage of education and training programs in Ukraine targeting renewable energy technology specialists who would drive and support the energy transition in line with the EU accession process. This shortage is not reflected in any government strategies in Ukraine. However, there are good examples of donor-supported capacity and skills-building projects addressing energy skills existing as separate, fragmented activities. For instance, the Green

[28] IEA, 2022. Ukraine officially joins IEA as Association country
[29] IEA, 2024. Ukraine's Energy Security and the Coming Winter, Report
[30] IEA, 2024. Empowering Ukraine Through a Decentralised Electricity System
[31] IEA, 2024. Ukraine's Energy Security and the Coming Winter, Report

Deal Ukraïna project, a 4-year initiative running from 2023 till 2027, addresses the skills gap in Ukraine's energy sector[32]. It offers courses for various professionals, from engineers to policymakers, focusing on EU Green Deal compliance and the EU accession negotiation process. This program is run by the Kyiv School of Energy Policy and the Florence School of Regulation.

There are also examples of energy companies investing in laboratory capacities and large-scale renewable energy skills education. In February 2025, DTEK, a prominent Ukrainian energy company, opened a renewable energy laboratory and a wind energy lecture hall at Kyiv Polytechnic Institute to train specialists for Ukraine's energy sector, presenting it as a long-term commitment to support renewable energy education in Ukraine[33]. Similarly, Schneider Electric Ukraine has launched an ambitious initiative to train 1 million Ukrainians in energy management basics by the end of 2025[34] as part of a memorandum signed with the Ministry of Education and Science.

The level of energy literacy among the Ukrainian population has increased significantly due to Russian attacks on the Ukrainian energy system. Regular electricity generation shortages in Ukraine due to Russian attacks and blackouts in most Ukrainian cities and communities led to increased energy consumption awareness among the Ukrainian population and a dramatic energy-saving behaviour change. This increased understanding among the general public of how the energy system works and adjustments in energy demand might improve the stability of the energy system. This increased level of forced energy literacy in Ukraine could help build a sustainable and resilient energy system with strong demand-response capacity and a good foundation for energy efficiency improvement. However, further research is needed to explore the potential of long-term energy-saving practices in Ukrainian households.

Achieving the targets in Ukraine's key energy strategy documents would require a strong digitalization capacity to support energy sector reforms. In January 2025, the Government of Ukraine adopted the new Digital Innovations Development Strategy of Ukraine until 2030[35]. The Strategy aims to support innovative activity across all sectors of the economy, including those aimed at decarbonisation of the energy sector, energy saving, and energy efficiency technologies. While this is an essential step in supporting the twin transition in Ukraine, the effectiveness of the Strategy's implementation and its transformative potential for the Ukrainian economy remain to be seen.

Ukraine has a developed IT sector, but its potential for the twin transitions, particularly for energy system digitalization, is not utilized. Similar to skills and training developments, there are individual initiatives from private companies like DTEK that are implementing digitalization projects that would enable energy system reforms in Ukraine. For example, DTEK has implemented a Grids Digital Twin pilot project in the Kyiv region[36]. While such projects indicate positive developments, significant efforts are still needed from the central government to initiate large-scale pro-

[32] Green Deal Ukraina, Accessed in March 2025. About the project

[33] National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", 2025. Opening of a renewable energy laboratory and a wind energy lecture hall for training specialists

[34] Interfax Ukraine, 2025. Schneider Electric Ukraine plans to train 1 mln people in energy management basics in 2025

[35] Ukrainian Global Innovation Strategy 2030, Part 1; Part 2

[36] Smart Energy International, 2023. Ukraine's DTEK plans Kyiv region smart grid

jects, allocate resources, and ensure that energy sector transition goals set in the NECP and other strategies are achieved.

As digitalization becomes more prevalent across different sectors in Ukraine, cybersecurity is becoming increasingly important in Ukraine as it rebuilds its energy system. Historically centralized and thus vulnerable to cyberattacks, the energy system in Ukraine has become a testing field for anti-cyberattack innovation and an example for other countries to learn from. Since 2014, Russian cyberattacks on Ukrainian energy infrastructure have become regular, and after 2022, they reached an unprecedented scale,[37]. leading to the creation of advanced security protocols in Ukraine and coordinated efforts from the Ukrainian government, business, research, and the international community in building cyber-attack resilience as part of overall digital resilience in Ukraine. These advancements are powerful enablers that ensure that the new energy system in Ukraine will have a much higher level of resilience.

Reaching the targets of Ukraine's NECP would imply building up manufacturing capacity for clean energy technologies in Ukraine. This would include establishing domestic manufacturing capabilities in renewable energy equipment, biomethane production, smart grid technologies, and potentially small-scale gas turbines and engines. The ambitions for increasing the manufacturing capacity might sound very ambitious considering Ukraine's current level of clean energy manufacturing capacity, lack of investment, and gaps in skills and expertise.

The defense sector development in wartime Ukraine could serve as a great example and learning base to foster innovation and build up manufacturing capacity in other sectors of the economy, with the energy sector being one of the key areas where these lessons would be instrumental. A notable example of a coordinated, large-scale, government-driven program is Brave1[38] – a platform supporting over 1,500 military technology start-ups, successfully accelerating technological progress in the defense industry. The rapid development in the defense sector offers potential lessons for other industries, including experiences in rapid prototyping, public-private partnerships, decentralized production, and streamlined procurement.

Financial capacity

Full recovery, modernisation and decarbonisation of the Ukrainian energy system will require significant support from foreign investors and donors.

Several financial instruments and investment funds are available for Ukraine's energy system, targeting both short-term emergency needs and longer-term strategic projects. Most short-term investment in Ukraine's energy sector, primarily for emergency support during the war, comes through the EU Civil Protection Mechanism. This mechanism also includes buying and delivering equipment for Ukraine.

[37] Ukrainian Global Innovation Strategy 2030, Part 1; Part 2

[38] Ukrainian Defence Innovations. Brave 1 Cluster

Among the other substantial mechanisms are the following:

- Ukraine Energy Rescue Plan (EIB) – total allocation USD 600 million[39]
- Ukraine Energy Support Fund managed by the Energy Community Secretariat (EUR 1.1 billion allocated to projects by February 2025)[40]
- G7+ Ukraine Energy Coordination Group support (mobilized USD 5 billion by the end of 2024)[41]
- USAID energy support for Ukraine – more than USD 1 billion[42]
- Ukraine Facility – total allocation EUR 50 billion[43] (two-thirds in loans, one-third in grants)

The Ukraine Facility, allocating funds to Ukraine's Recovery by 2027, is the most significant financial support mechanism. It has three pillars: direct financial support, a specific investment framework, and EU accession assistance. Adopting the NECP in Ukraine was a condition for accessing Ukraine Facility funds to ensure investment is targeted to strategic priorities in Energy sector reform and decarbonization. The EIB expects implementing projects within the Ukraine Facility instrument to attract additional investment.

As part of the Ukraine Facility, the European Investment Bank (EIB) has announced several significant energy-related projects to support Ukraine's recovery and infrastructure resilience. These projects include EUR 100 million for Ukraine District Heating projects at local levels to restore heat generation capacity. Another announced project is a EUR 120 million loan to Ukrhydroenergo to help restore damaged hydroelectric plants[44]. Ukrenergo, Ukraine's state grid operator, received EUR 86 million to build anti-drone protection for critical parts of the energy infrastructure[45].

Regarding the internal investment climate in Ukraine's energy sector, substantial obstacles exist (apart from the ongoing war and continuous attacks) that make any investment very difficult. Ukraine's energy sector faces significant debt challenges that hinder investment and EU integration progress. As of October 2023, district heating companies owed Naftogaz UAH 95 billion (2.6 billion USD), while the electricity and gas markets faced debts of 1.6 billion USD and 3.2 billion USD, respectively[46]. The renewable energy sector and universal service providers also owe substantial amounts. These debts, exacerbated by excessive regulation and subsidies, pose barriers to attracting new investment and generation capacity. To improve the investment climate, Ukraine must address debt issues by reforming the Public Service Obligation (PSO) mechanism and accelerating market reforms aligned with EU regulations.

[39] EIB, 2024. Energy rescue plan approved to finance EU-backed emergency heating and power projects for Ukraine ahead of winter season

[40] Energy Community, 2024. Ukraine Energy Support Fund reaches EUR 1 billion as attacks on energy infrastructure intensify

[41] Interfaxt, 2024. G7+ partners announce over $1 bln in additional assistance for Ukraine's energy sector - ministry

[42] As for March 2024, all USAID support for energy projects in Ukraine have stopped.

[43] European Commission, Accessed in March 2025. Ukraine Facility

[44] EU NeighborsEast, 2025. EIB announces major new projects for Ukraine's recovery

[45] EIB, 2024. EIB provides €86 million to protect Ukraine's energy infrastructure from Russian attacks

[46] IEA, 2024. Ukraine's Energy Security and the Coming Winter, Report

EU Approximation

The main progress achieved and the main gaps remaining in relation to the key themes of EU approximation activities in Ukraine's energy sector is summarized in Table 4. Most points are based on three recently published reports: the Energy Community Implementation Report 2024, the European Commission's 2024 Enlargement Package, and Ukraine's NECP adopted in June 2024.

Table 4. The main progress achieved and the main gaps remaining in relation to the key themes of EU approximation activities in Ukraine's energy sector

Theme	Main Progress Achieved	Main Gaps Remaining
Energy Markets and Integration	- 69% implementation progress (according to the Energy Community Report) - NECP adopted in June 2024 with sectorial renewable energy targets - Market-based support schemes for RES introduced in June 2023 - Law on REMIT adopted in June 2023 - Gas storage operator certified	- Decrease in transparency and independence of stakeholders under martial law - Renewable energy surcharge not separated from transmission tariff - Need to accelerate transposition of Electricity Integration Package - Re-establishment of gas market fundamentals is needed
Decarbonization	- 44% implementation progress (according to the Energy Community Report) - Emissions' tracking system launched in 2021 - Partial transposition of Monitoring and Reporting Regulation - Resolutions implementing Regulation (EU) 2018/2066 adopted in November 2023	- Reporting at installation level not compulsory under martial law - Omission of aviation emissions and biomass sustainability criteria in the emissions tracking legislation - Need for comprehensive, standardized MRV system
Energy Security	- 61% implementation progress (according to the Energy Community Report) - Electricity system operation preserved despite infrastructure damage - Gas storage targets fulfilled	- Transposition of Regulation (EU) 2019/941 on Risk-preparedness in Electricity Sector pending - Risk assessment for gas market and transposition of Security of Gas Supply Regulation is needed
Environmental Protection	- 52% implementation progress (according to the Energy Community Report) - Legislation adopted for horizontal issues, water quality, waste management, chemicals, and noise	- Implementation is compromised by ongoing military aggression

Theme	Main Progress Achieved	Main Gaps Remaining
Regulatory Bodies	- 76% implementation progress (according to the Energy Community Report) - The National Energy and Utilities Regulatory Commission (NEURC) certified Ukrtransgaz as the independent Storage System Operator of Ukraine - Secondary legislation for Regulation on Wholesale Energy Market Integrity and Transparency (REMIT) implementation adopted	- Remaining REMIT legislation to be adopted - Need to launch relevant investigatory and enforcement actions for REMIT violations
Energy Efficiency	- Energy Efficiency Law aligned with EU Directive 2018/2002 - Strategy for Thermal Modernisation of Buildings until 2050 adopted - Energy Efficiency Fund (EEF) is launched and provides grants for energy efficiency renovations with integrated renewables - All energy labelling regulations related to Labelling Directive adopted	- Mandatory energy efficiency criteria in public procurement not introduced - Full alignment with Energy Performance of Buildings Directive (2018) pending - Rules for efficient district heating sector not adopted - Energy Efficiency Fund requires replenishment of funds from state budget
Renewable Energy Sources	- National Renewable Action Plan 2030 approved - Legislation on guarantees of origin and active customer procedures adopted - Biofuel trading platform established - Program to support solar panels and heat pumps initiated in summer 2024	- Sustainability criteria for biofuels/bioliquids not fully transposed - Regulatory barriers preventing biomethane potential utilization - Article 24 of REDII on district heating not transposed - Secondary legislation for renewable energy communities pending
Nuclear Safety	- Energoatom transformed into joint-stock company; supervisory board approved in June 2024 - Centralised Spent Fuel Storage Facility operational since 2023 - New radiation protection legislation adopted - Invited to join ECURIE system	- 33% of posts remain vacant at nuclear regulatory authority due to inadequate salary levels - Further harmonization with Euratom acquis is needed

Theme	Main Progress Achieved	Main Gaps Remaining
Trans-European Networks (TEN)	- High-Level Understanding signed with EU to improve transport connectivity - Integration of TEN-E guidelines into legislative framework ongoing - Alignment with TEN-E Regulation 2022/869 in progress - Four TEN-T corridors extended to Ukraine	- Significant damage to electricity transmission infrastructure requiring constant repairs - Need for modernization of cross-border electricity network - Strengthening of administrative capacities and project preparation needed - Pipeline of priority projects for cross-border connectivity to be further developed

Main priorities for the green transition

The primary recommendation for Ukraine's energy sector development is to continue ongoing energy sector reforms aligned with the EU approximation process. Ukraine has made significant progress in EU approximation, but challenges remain in implementing available strategies. These challenges span a broad spectrum of aspects.

One of the most pressing needs is addressing the shortage of technical professional capacities in government teams and improving collaboration between different Ministries on multisectoral strategies. For instance, the Dixi Group energy think tank led a team of experts who drafted the NECP. It also supported the establishment of the Green Transition Office under the Ministry of Economy, which is working on the first NECP progress report and developing the plan's monitoring framework. While this demonstrates efficient collaboration between the government and expert society in Ukraine, it also indicates limited capacity within Ukraine's public institutions, signalling vulnerability and a lack of long-term implementation capacity.

The energy sector development strategy needs stronger connections to other sectoral strategies, particularly the industrial strategy. Achieving energy sector development goals requires a substantial build-up of industrial capacity, as Ukraine aims to develop domestic manufacturing of clean energy technologies. A robust industrial strategy is needed to enable the transformation of the energy sector. Importantly, planning the manufacturing strategy related to Ukraine's energy sector should align with the EU's Clean Industrial Deal to ensure Ukraine's integration into European value and supply chains, maximizing value creation and effective collaboration with other European countries.

Ukraine's unique "lab-to-fab-to-field" experience gained with military technology could potentially inform innovation, production, and testing cycles for energy technology solutions. Further research and analysis are needed to explore this topic in depth.

Cross-cutting enablers for energy sector development are crucial yet underprioritized for achieving strategic goals. Developing and implementing strategic plans to build clean-energy-related skills at different levels – from technical experts to policymakers – is essential. Learning from successful small-scale projects in Ukraine and investigating their potential for scaling up would be a good first step.

Building up digitalization capacity, a significant enabler of the clean energy transition within the "twin transition" framework, is crucial and needs greater acknowledgment from policymakers as a green transition enabler in Ukraine. Like skills building, learning from successful ongoing energy system-related digitalization projects, identifying potential for scalability, and pinpointing primary digitalization needs and gaps related to energy sector development would be critical initial steps.

Although continuous Russian attacks have greatly challenged investment in modern energy infrastructure, it remains an essential priority for ensuring a solid foundation for the long-term development of modern energy systems. In this regard, investment in transmission, distribution, and storage infrastructure is crucial.

Implementing the energy decentralization strategy requires strong multi-level governance capacity, primarily more substantial capacity, and autonomy at the local government level. This necessitates continuing to implement decentralization reform in Ukraine while simultaneously strengthening the capacity to align strategies, priorities, and projects across local, regional, and national levels, ensuring well-coordinated investment projects that synergistically contribute to achieving priorities set in energy plans.

The investment climate remains a significant challenge in Ukraine, exacerbated by the ongoing active phase of the war with Russia. Energy tariffs set below market levels have led to accumulated debt in the energy sector, hindering investment opportunities for Ukrainian energy companies. Reforming energy tariff policy during the full-scale invasion should consider the crucial importance of social justice. Research, expertise, and policy support related to energy justice would be essential enablers. There is an insufficient knowledge base on energy justice in Ukraine, which should be strengthened through collaboration with EU research and policy actors.

1.3 Ukraine's Clean Industry Challenge

Status and trends

Ukraine has historically been one of Eastern Europe's most industrialized economies, with a manufacturing base centred on heavy industry, metals, chemicals, and food processing. The Russian invasion has severely disrupted this foundation, damaging critical infrastructure, disrupting supply chains, and challenging the country's path toward sustainable industrial (re)development.

Before February 2022, Ukraine's industrial sector played a crucial role in the economy, contributing about a third of the country's GDP and providing 40% of total employment. In 2021, industrial sectors (manufacturing and mining) in Ukraine were represented by 41 736 entities, which contributed 16.7% to GDP.

The structure of Ukrainian industry remained consistent during 2018-2022. The four major sectors (food, basic metals, oil and gas, metals ore mining) covered 58.5% of total industrial turnover before the Russian full-scale invasion (Figure 3).

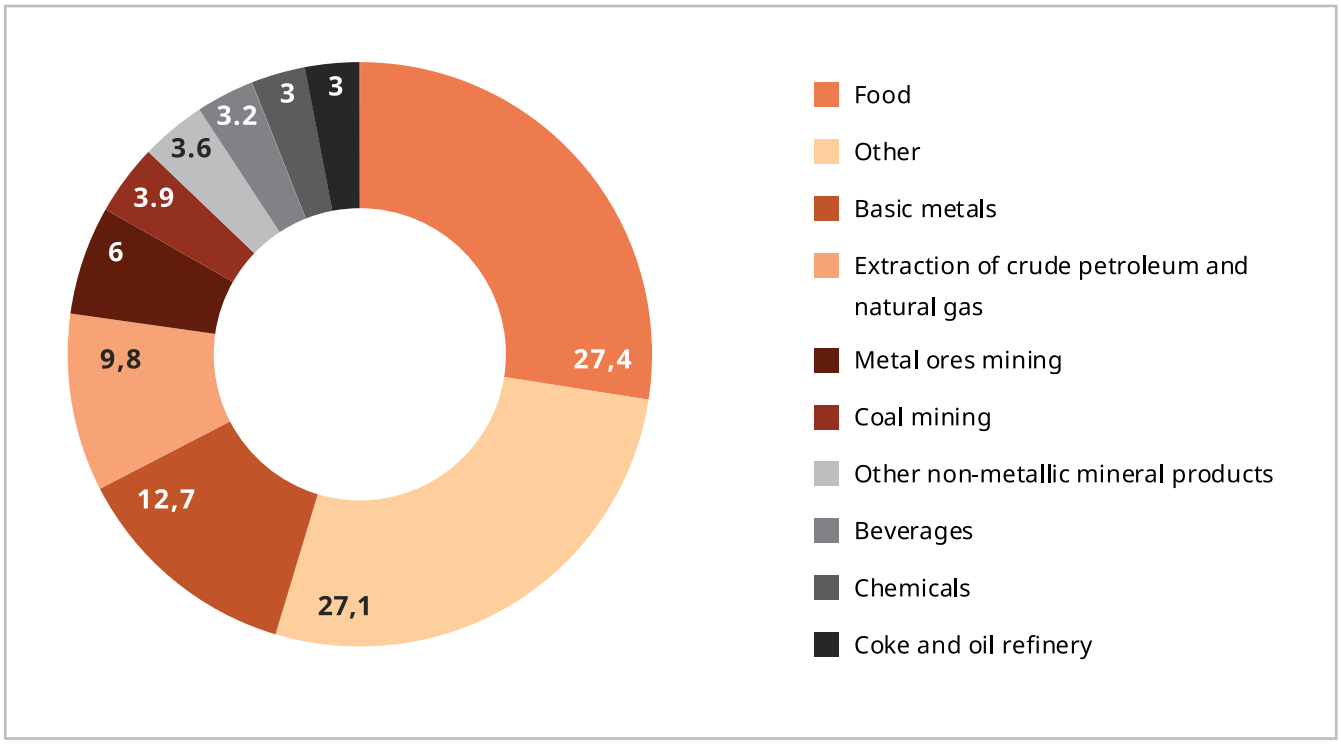


Figure 3. Ukraine industrial sector composition in percentage (2022). Source: State Statistics Service of Ukraine.

In terms of the overall trend, Ukraine's industrial sector experienced a steady decline over the past 15 years, driven by geopolitical instability, economic downturns, and global crises, diminishing the sector's contribution to GDP (Figure 4).

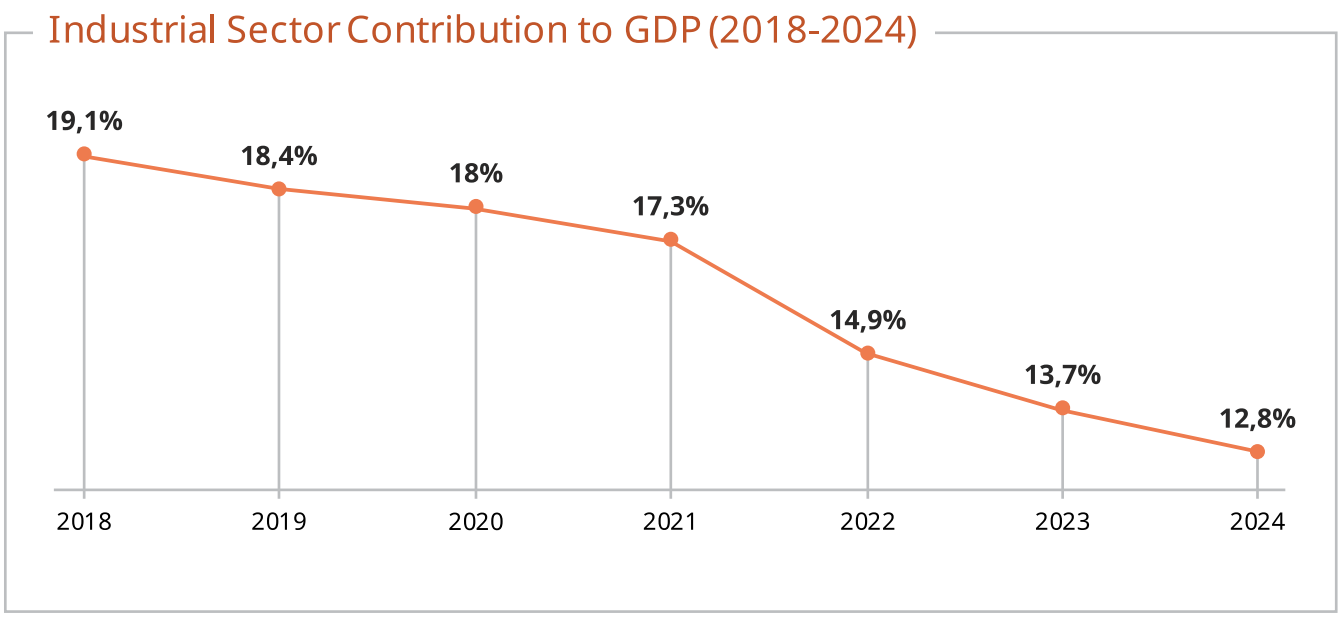
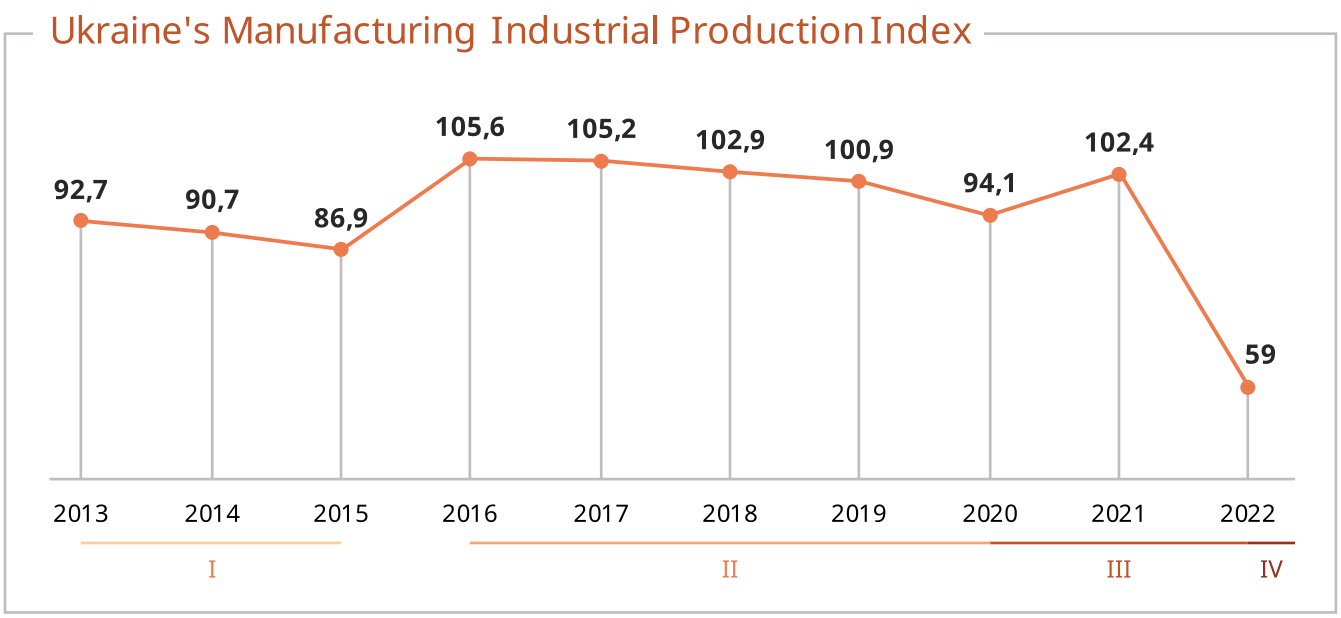


Figure 4. Ukraine's industrial sector's contribution to GDP (2018-2024). Source: State Statistics Service of Ukraine.

The 2008–2009 global financial crisis caused a 30% drop in industrial production, particularly affecting metallurgy and machine-building. Russia's annexation of Crimea in 2014 and the outbreak of war in Donetsk and Luhansk led to a 21.2% decline in industrial output between 2014 and 2015, as Ukraine lost significant industrial assets and trade routes. Deindustrialization continued due to underinvestment, outdated infrastructure, and external economic pressures. The COVID-19 pandemic in 2020 led to supply chain disruptions and declining demand, causing yet another contraction in industrial production. Although 2021 showed signs of recovery with 1.5% growth, industrial production remained well below pre-war levels (Figure 5).



I: Non-recognized annexation of Crimea and beginning of the conflict in eastern Ukraine; II: Continuation of the conflict in eastern Ukraine; III: Continuation of the conflict in eastern Ukraine and spread of the COVID-19 pandemic; IV: Full-scale Russian War in Ukraine.

Source: State Statistics Service of Ukraine

Figure 5. Ukraine's Manufacturing Industrial Production Index[47].

Ukraine's industrial geography demonstrates a high concentration in eastern and central regions, with five regions generating over 60% of the country's manufacturing value and 60.2% of capital investment in 2021 (Figure 6). The occupation of industrial centres in Donetsk and Luhansk regions and damage to facilities in Kharkiv, Zaporizhzhia, and Dnipropetrovsk regions have exacerbated the industrial decline.

[47] The Industrial Production Index (IPI) measures the output of industrial establishments, covering sectors such as mining, manufacturing, electricity, gas, and steam, and is expressed as an index based on a reference period that reflects changes in production volume. In Ukraine, the IPI includes mining and quarrying, manufacturing, and the production and distribution of electricity and natural gas, reflecting real production volume changes, independent of price fluctuations, and serves as a key indicator of industrial performance. The State Statistics Service of Ukraine provides the Industrial Production Index with the base of the same month in the previous year set to 100.

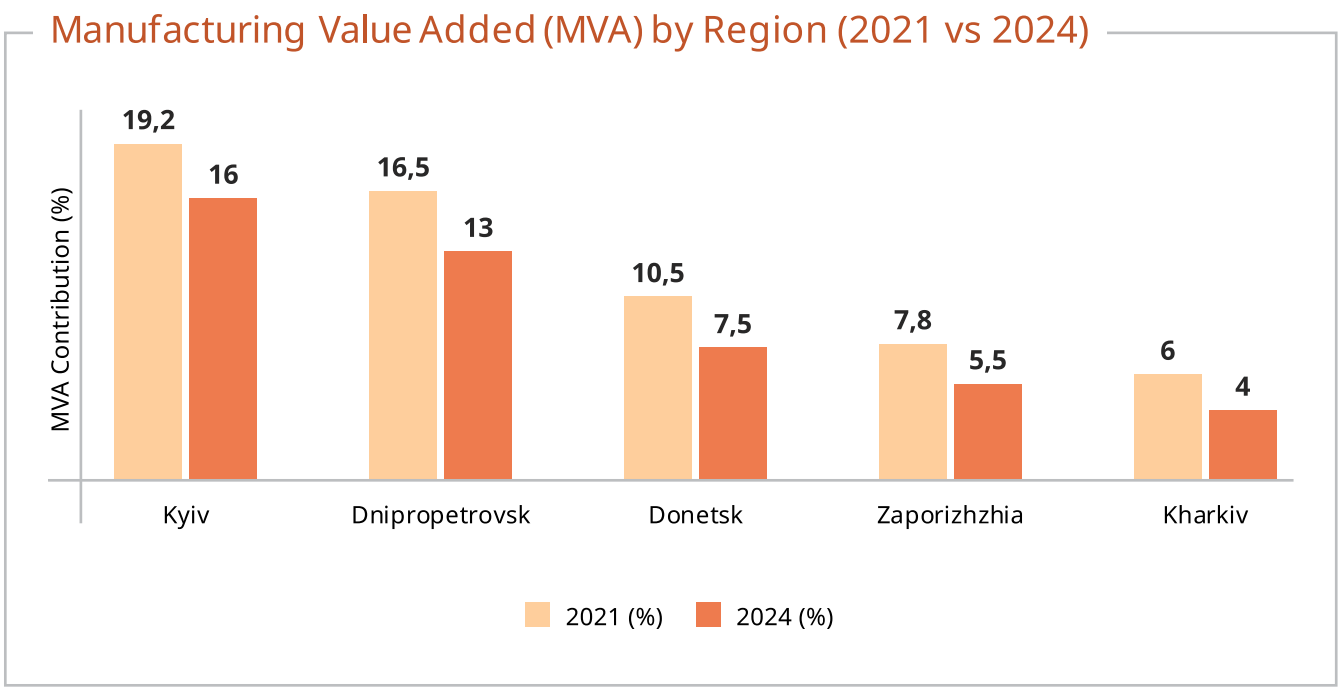


Figure 6. Manufacturing Value Added (MVA) accounted for 19.2% of GDP in 2021, with major industrial hubs located in Kyiv, Dnipropetrovsk. Zaporizhzhia and Kharkiv.

Meanwhile, Ukraine remains one of the most resource-intensive economies in Europe, with its industrial sector facing low material efficiency, outdated manufacturing techniques, high levels of resource consumption, and aging industrial infrastructure. Ukraine's industry is associated with a substantial environmental footprint due to its heavy reliance on energy-intensive processes, significant raw material consumption, and high industrial water use[48]. The raw material consumption intensity is particularly high in steel, cement, and chemical production sectors.

The industrial sectors' CO2 emissions intensity is approximately seven times higher than the EU27 average and considerably exceeds levels in comparable economies like Poland, Romania, and Turkey (**Error! Reference source not found.**).

[48] UNIDO (2023). Ukraine Industrial Country Diagnostics 2023

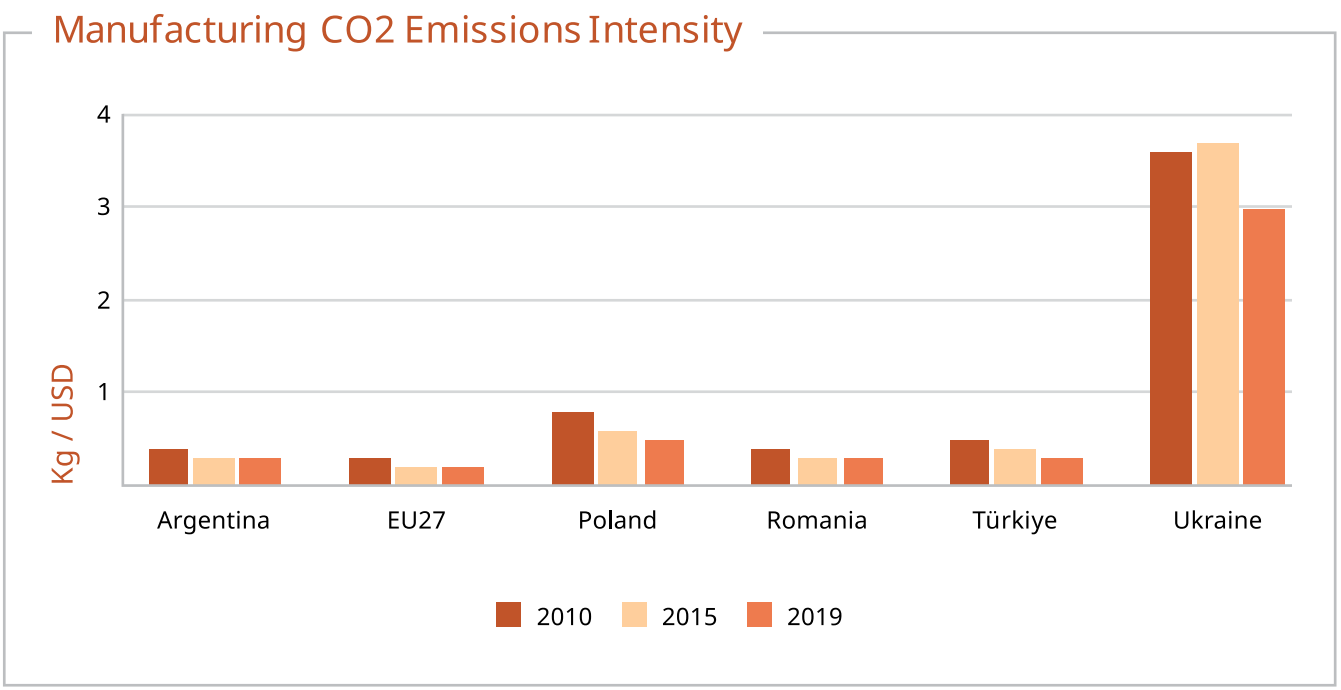


Figure 7. Manufacturing CO2 emissions intensity, 2010-2020. Data source: Organisation for Economic Co-operation and Development (OECD) (manufacturing CO2 emission) and World Development Indicators, World Bank (MVA)

Most industrial waste in Ukraine is either landfilled or abandoned, with minimal recycling efforts. According to Ukrstat (2020), the recycling rate for industrial materials remained below 5%, significantly lower than EU benchmarks. Unlike the EU, where industrial symbiosis and waste valorisation strategies are widely implemented, Ukraine lacks sufficient infrastructure and incentives to enhance industrial waste processing.

The transition toward a circular economy and improved industrial waste management practices represent a key priority for Ukraine's sustainable recovery, particularly as the country seeks alignment with EU environmental standards. Meanwhile, Ukraine's industrial recovery depends on fostering clean technology innovation to enhance competitiveness and support sustainable growth.

Export diversification is another priority, particularly in renewable energy technologies, sustainable agriculture, and low-emission industrial goods. In collaboration with international financial institutions, the Ukrainian government has a lot of opportunities to implement policies that enhance market access for micro, small, and medium-sized enterprises (MSMEs) by providing technical assistance, improving logistics infrastructure, and supporting trade facilitation agreements.

The impact of war on industry

The ongoing war has impacted Ukrainian industry through widespread physical damage to industrial facilities, disruption of supply chains, an increase in export logistics costs, workforce shortages, and energy infrastructure destruction, fundamentally altering the country's industrial landscape.

Total damage to commerce and industry facilities between February 2022 and December 31, 2024, is estimated at US$17.5 billion, with 84% of this damage affecting industry specifically[49].

Over 80% of total industrial damage occurred in five key industrialised regions affected by military activity: Donetsk, Kharkiv, Kyiv, Zaporizhzhia, and Mykolaiv regions, with heavy industry and defence sectors affected the most. The volume of industrial products sold declined in 15 out of 24 major industrial categories[50], with particularly severe reductions in machinery and equipment (-38%), basic metals (-29%), and non-metallic mineral products (-34%).

The steel industry, a critical pillar of Ukraine's heavy industry, was significantly impacted. Basic metals and the coke/refined petroleum industries saw production declines of over 60% in 2022 compared to the 2019-2021 averages. According to the Ukraine Fourth Rapid Damage and Needs Assessment (RDNA4), 44% of the total industrial damage (US$4.2 billion) resulted from the destruction of two major steel plants in Mariupol—the Azov Steel Plant and Ilyich Iron and Steel Works.

Manufacturing and heavy industry sectors have experienced significant workforce disruptions due to mobilization, displacement, and migration. In response, some industrial facilities have adapted by repurposing segments of their operations to support defence requirements. In contrast, others have invested in accelerated training programs, skill development initiatives, and robust workplace support systems to sustain operational capacities. Notably, coal mines in Pavlohrad have employed approximately 400 women in underground mining roles, now accounting for 2.5% of their total workforce[51]. Meanwhile, Reskilling Ukraine Initiative has trained women to become excavator operators and front-end loader drivers, with over 1,000 women applying for just 350 available spaces[52].

The defence sector has seen a partial shift towards localised production and increased military-industrial output due to wartime needs. However, disruptions in supply chains and workforce displacement have created challenges in scaling up operations. While certain industries, such as ICT and localized defense production, have shown resilience, broader industrial recovery re-

[49] In this context, "industry" refers primarily to manufacturing facilities, processing plants, mining operations, and utilities infrastructure as defined by ISIC sections C (Manufacturing), B (Mining and quarrying), and D (Electricity, gas, steam and air conditioning supply), excluding commercial service establishments and retail.

[50] Based on the International Standard Industrial Classification (ISIC) system.

[51] This shift was possible due to the July 2022 legislation by the Ukrainian parliament that lifted the ban on women working in "harmful and dangerous conditions," which was necessitated by critical workforce shortages. Verkhovna Rada of Ukraine (2022). "Law of Ukraine 'On the Principles of State Policy for the Transition Period'".

[52] Reskilling Ukraine (2024). "Ironwomen."

quires strategic investments in energy efficiency, green transition, and modernization of manufacturing processes. Strengthening industrial policy and aligning with EU Green Deal objectives will be essential for long-term recovery and competitiveness.

Despite these setbacks, recovery signs have emerged. In 2024, Ukraine's steel production output reached 7.5 million tons by year-end—an increase of 21% over the previous year, although still 65% below the 2021 pre-war level (21.4 million tons). This improvement was primarily due to the "Sea Corridor" launched in late 2023, which eased export logistics[53]. Further boosting production, the second blast furnace at ArcelorMittal Kryvyi Rih was inaugurated in the spring of 2024, spurring a notable increase in exports, with semi-finished product exports rising by 650 thousand tons (a 60% increase in 2024) and finished steel exports by 500 thousand tons (a 40% increase). Additionally, the "Sea Corridor" played a key role in revitalizing iron ore exports to China in the amount of 13.0 million tons in 2024, representing 43% of all its iron ore exports.

The damage to energy infrastructure has elevated energy efficiency from an environmental consideration to an operational necessity. Industrial facilities are increasingly investing in on-site renewable energy generation, energy storage solutions, and efficiency improvements, both as security measures and as alignment with environmental principles. For instance, Ukrainian Agricultural Holding MHP has deployed 15 MW of solar capacity with integrated storage systems on industrial buildings across their poultry and grain divisions. These installations include battery systems that absorb surplus energy during peak solar production and enable load-shifting to meet internal demand or feed into biogas processes, potentially expanding to 800 MW if fully scaled across all rooftops[54]. At the municipal level, the city of Khmelnytskyi, for example, has connected critical infrastructure through an electricity transmission system with combined heat and power generation, while the city of Zhytomyr has built Ukraine's first biomass-based cogeneration plant using Organic Rankine Cycle technology[55].

Governance capacity

The Ministry of Economy of Ukraine is the central government body responsible for shaping and executing state economic and social development policies, including industrial policy, investment, and entrepreneurship development. The ministry coordinates green industrial growth strategies, develops economic incentives for clean technology adoption, and manages trade aspects related to Carbon Border Adjustment Mechanism (CBAM) compliance.

The Ministry of Strategic Industries of Ukraine is tasked with formulating and implementing state industrial and military-industrial policies, encompassing the defence-industrial complex, the aircraft industry, and space activities. It oversees technological modernization programs in these sectors, coordinates research and development for clean production methods, and implements sectoral roadmaps for emissions reduction while maintaining production capacity

[53] Andrii Tarasenko, GMK Center, 2024. Prospects for iron and steel sector of Ukraine in 2025

[54] Roman Cheplyk, GT Invest. Ukrainian Agricultural Holding MHP Produces E-Methane from Solar Energy

[55] DiXi Group, 2024. Ukrainian Energy Security Dialogue 2024: Key Challenges, Solutions, and Prospects for Ukraine's Energy Security

The Ministry of Environment and Natural Resources of Ukraine (MEPNR) is the primary regulatory authority for industrial pollution control and clean production standards. The ministry develops and implements permitting systems for industrial facilities, establishes emission limits aligned with EU standards, and conducts environmental impact assessments. MEPNR leads the implementation of Best Available Techniques (BAT) requirements that drive technological modernization in manufacturing sectors.

The Ministry of Energy is the principal body in the system of central executive authorities responsible for energy policy development[56]**.** The ministry formulates and implements state policy across the entire fuel and energy complex, including electricity generation, nuclear industry, coal mining, peat extraction, and oil and gas processing. Its leadership in policy development for renewable energy sources and alternative gas fuels supports industrial decarbonization efforts. Regulating electricity, heat, and natural gas markets provides a foundational framework enabling industries to transition to cleaner production processes.

The Ministry of Finance is the principal body within Ukraine's central executive framework that oversees comprehensive financial policy development. The ministry's formulation and implementation of state financial, budgetary, and debt policies directly influence funding mechanisms essential for clean industrial modernization. It develops fiscal instruments relevant to clean industry transition, including environmental tax structures, customs policies affecting clean technology imports, and budgetary allocation mechanisms for industrial decarbonization programs. The ministry's authority over interbudgetary relations and financial control influences how resources are allocated to green industrial development across national and local levels.

The Ministry for Development of Communities and Territories of Ukraine oversees the development of supporting infrastructure for clean industry while establishing policy frameworks for regional development, energy efficiency standards, and territorial planning. The ministry coordinates construction standards and building codes that incorporate energy efficiency requirements for industrial facilities, enabling logistics networks for circular material flows, industrial parks with clean production facilities, and waste management systems that support industrial symbiosis. Its energy security initiatives ensure a stable power supply to manufacturing operations, while reconstruction programs rebuild infrastructure with improved environmental standards. The ministry's digitalization of construction permitting through unified electronic systems streamlines approval processes for clean industry facilities and supports implementing energy efficiency requirements in industrial construction projects.

The Parliamentary Committee on Environmental Policy and Nature Management provides legislative support for clean industry development by drafting and reviewing laws on pollution prevention, circular economy, and industrial modernization. The committee recently facilitated the adoption of the Law of Ukraine "On Integrated Prevention and Control of Industrial Pollution", establishing the legal framework for comprehensive industrial permitting aligned with EU Industrial Emissions Directive requirements.

[56] Ministry of Energy of Ukraine

The National Council for the Recovery of Ukraine from Consequences of the War (the National Recovery Council), established in April 2022 by the President of Ukraine, co-chaired by the President of the Verkhovna Rada of Ukraine (VRU), the Prime Minister, and the Head of the Office of the President of Ukraine, is overseeing the development of restoration and recovery policy.[57]

Deputy Prime Minister for European and Euro-Atlantic Integration **leads the harmonization of Ukrainian industrial standards with EU requirements** and negotiates transitional arrangements for Ukrainian manufacturers under CBAM, ensuring that clean industry development aligns with Ukraine's EU integration pathway.

Despite the defined roles, the multiplicity of institutions involved frequently leads to fragmented and insufficiently cohesive policy implementation. Ministries and governmental bodies often face challenges in effective inter-ministerial communication and coordination, as evidenced by experiences during the Ukraine Recovery Conferences and inconsistencies observed in legislative drafting and policy adoption processes[58]. Addressing these inter-institutional gaps will be crucial for achieving a coherent and unified approach to clean industry development and decarbonization.

Strategic capacity

Ukraine does not have a formalized industrial policy. The primary strategic document guiding industrial and economic development is the National Economic Strategy till 2030 (adopted in 2021) [59]. The aims of the Strategy comprised creating favourable conditions for business and investment, improving international competitiveness, advancing innovation, modernizing economic sectors, developing human potential, and ensuring gender equality. The Strategy also recognizes digitalisation as a fundamental pillar for economic resilience and low-carbon development. In connection with this, the European Green Deal and Circular Economy Action Plan can guide Ukraine to accelerate the sustainability transition of its polluting industries while aligning with EU standards and practices.

The Environmental Safety and Climate Change Adaptation Strategy 2030 (adopted in 2021)[60] defines key industrial objectives, including minimizing industrial emissions, promoting sustainable resource utilization, and developing comprehensive legal and economic frameworks for effective waste management systems.

[57] About the National Council for the Recovery of Ukraine from the War

[58] Kopytsia, I., Dvornichenko, D. (2024). RE: BUILDING UKRAINE FOR ALL: Recommendations for Ukraine Recovery Conference 2025. University of Oxford.

[59] Cabinet of Ministers of Ukraine, Resolution "On Approval of the National Economic Strategy for the Period up to 2030"

[60] Ministry of Environmental Protection and Natural Resources of Ukraine (2022). Environmental Security and Climate Adaptation Strategy until 2030 adopted

In response to Russia's full-scale invasion, the Ukrainian government developed the draft National Recovery Plan, presented in July 2022 at Lugano Recovery Conference[61]. While not legally binding or enforceable, the plan provides strategic direction and introduces the 'Build Back Better' principle. It envisions a green transformation of Ukraine's industrial base by emphasizing eco-modernization, decarbonization, and alignment with global sustainability standards — mainly through hydrogen-based metallurgy, clean energy integration, and sustainable production practices that conform to European Green Deal requirements.

The Energy Strategy of Ukraine 2050, approved by the Cabinet of Ministers in April 2023, outlines comprehensive clean industry goals centred on achieving climate neutrality by 2050[62]. The strategy commits to a complete transition to carbon-neutral energy sources, expanding renewable capacity to 27% of total energy consumption by 2030 (with sector-specific targets of 25% for electricity, 35% for heating/cooling, and 14% for transport), systematically phasing out coal while implementing carbon capture technologies, modernizing energy infrastructure with best available technologies, and reducing energy intensity of GDP by 50%. Beyond domestic transformation, the strategy positions Ukraine for clean energy leadership through export-oriented development of hydrogen production, energy equipment manufacturing, and nuclear technology services – creating a framework that aligns with the National Energy and Climate Plan while supporting Ukraine's industrial evolution toward a sustainable and competitive model that integrates with European energy markets.

National Energy and Climate Plan (NECP) 2025-2030, developed under Ukraine's obligations within the Energy Community and aligned with EU Regulation (EU) 2018/1999, and adopted in 2024, represents a strategic framework aligning Ukraine's energy and climate policies to ensure sustainable development and economic recovery[63]. The NECP establishes ambitious industrial targets, including a 65% reduction in greenhouse gas emissions by 2030 compared to 1990 levels, phasing out coal generation by 2035, and increasing renewable energy sources to 27% of final energy consumption. The plan supports industrial decarbonization through comprehensive incentives for clean energy adoption, energy efficiency programs, and carbon pricing reforms while encouraging the development of hydrogen-based industry, industrial electrification, and green manufacturing practices that align with the European Green Deal's objectives.

The Law of Ukraine "On Integrated Prevention and Control of Industrial Pollution" represents a significant milestone in industrial environmental reform, fulfilling commitments under the 2017 EU Association Agreement to implement Directive 2010/75/EU of the European Parliament and the Council of November 24th, 2010, on industrial emissions". Taking effect on August 8, 2025, the Law introduces integrated permitting systems based on the best available techniques (BAT) by establishing comprehensive procedures for issuing pollution permits, setting maximum allowable emission levels, and implementing sector-specific best practices across different industrial activities. To ensure its implementation, existing regulations must be harmonised with the new requirements,

[61] National Recovery Council (2022). Ukraine's National Recovery Plan

[62] Adopted in 2023 as a response to war-related challenges, Energy Strategy remains confidential for security, with general provisions publicly available.

[63] Energy Community, 2024. Ukraine approves National Energy and Climate Plan as EU Accession Negotiations Begin

the electronic permitting system must be established, and the continuing translation of European BAT reference documents for national adoption must be completed. As of March 2024, substantial progress has been made with 10 BAT reference documents translated and several critical procedures established, including the development and approval of BAT, requirements for permit conclusions, procedures for reconciliation meetings, and guidelines for public hearings. Work continues with finalising procedures for transboundary consultations, maintaining the Unified State Register of Permits, and establishing requirements for public discussion reporting.

The Law of Ukraine "On Waste Management" adopted in June 2022 regulates waste management, including its transport, export, import, and recycling. This law supports the National Waste Management Plan until 2030, initially adopted in 2019, which lays out practical steps to transition Ukraine toward a more sustainable waste management model. Regional administrations are currently formulating regional waste management plans in line with this law, with approval processes spanning 2023–2025.

Green Industrial Recovery Programme (2024-2028)[64], developed collaboratively by the Government of Ukraine and the United Nations Industrial Development Organization (UNIDO), provides a strategic framework for revitalizing Ukraine's industry. It emphasizes sustainability, resilience, and environmental responsibility and outlines the priorities and actions required to achieve these goals.

The Global Eco-Industrial Parks Programme (GEIPP)[65]**,** funded by international donors, is helping transform traditional industrial zones into resource-efficient and environmentally sustainable production hubs. These parks focus on optimizing energy use, waste management, and circular economy practices, enabling businesses to lower operational costs while complying with global sustainability standards.

Strategy for the Recovery, Sustainable Development and Digital Transformation of Small and Medium-Sized Enterprises (SMEs) until 2027[66], approved in August 2024, focuses on industrial development through smart specialisation, creation of industry clusters and science parks[67]. The strategy supports the green transition of industrial SMEs through carbon footprint assessment tools and professional energy audits while promoting innovation and digital transformation of manufacturing processes. It aligns with the "Made in Ukraine" policy which provides grants to processing companies and supports the creation of complex value chains in the processing industry.

Action Plans for the Green Recovery and Transformation of the Ukrainian Food Industries[68] are being developed with the assistance of the United Nations Industrial Development Organization (UNIDO) and offer detailed, sector-specific implementation strategies to promote sustainable practices within Ukraine's food processing industry.

[64] UNIDO, 2024. Green Industrial Recovery Programme Ukraine 2024-2028

[65] UNIDO, Global Eco-Industrial Parks Programme, Ukraine Project

[66] Government of Ukraine, 2024. Government approves SME Development Strategy until 2027 and operational action plan for 2024-2027

[67] Government of Ukraine, 2024. Government approves SME Development Strategy until 2027 and operational action plan for 2024-2027

[68] UNIDO, 2024. Roadmap for the Green Recovery and Transformation of the Ukrainian Food Industries

Additionally, the implementation of Ukraine's National Green Reconstruction Framework integrates sustainability standards into industrial projects, establishing clear guidelines for incorporating environmental considerations into rebuilding efforts. It explicitly references international standards and certifications as benchmarks for sustainable reconstruction, creating a structured pathway for industries to follow. The government has introduced incentives for industries adopting green certifications, including tax benefits and subsidies. These financial mechanisms are designed to offset the initial costs of certification implementation, making sustainability transitions more economically viable for Ukrainian industries operating under challenging circumstances.

While Ukraine has made significant progress over the last three years in aligning its strategic framework with EU standards, the comprehensive institutional structure supporting a "clean and competitive" industry is still being developed. Addressing current gaps—including implementing circular economy strategies, improving institutional coordination, and establishing clear standards for sustainable industrial practices—is essential.

Financial capacity for clean industry

Despite challenges, Ukraine's industrial transition presents substantial opportunities. Access to EU funding programs, including the Ukraine Facility, Just Transition Fund, and Innovation Fund, provides substantial financial resources. Ukraine's candidate status enables access to specialized industrial modernization funding exceeding €3 billion through 2027.

The Ukraine Facility is a dedicated support mechanism of EU's €50 billion financial assistance through 2024-2027, aimed at bolstering Ukraine's resilience, fostering its recovery, facilitating sustainable development, and supporting progress toward EU membership.[69] Among its key priority sectors, the Facility targets explicitly the "Entrepreneurship, SMEs development, and processing industry" with substantial financial stimulus mechanisms. These include the provision of grants and soft loans, programs to support financing, expansion, and diversification of International Financial Institution (IFI) financing programs, development of investment project financing, and implementation of an affordable military insurance mechanism.

The transition toward sustainable industry requires substantial capital mobilization, estimated at €12-15 billion for priority industrial sectors through 2030. One of the primary challenges Ukraine's industrial sector faces in adopting Best Available Technologies (BAT) and certifications is the high initial investment costs, particularly for small and medium enterprises (SMEs). Despite lower lifecycle costs, advanced technologies typically require capital expenditures 30-50% higher than conventional alternatives.

[69] European Commission, Accessed in March 2025. Ukraine Facility

Several financing mechanisms should be considered:

1. **Green financing instruments**, including green bonds, sustainability-linked loans, and transition finance, are gaining traction in Ukraine.
2. **Public-private partnerships (PPPs)** create collaborative investment frameworks for large-scale industrial modernization. Notable examples include the €175 million Green Steel Initiative, which combine European Investment Bank financing with private capital to upgrade Ukraine's metallurgical facilities.
3. **Foreign direct investment (FDI)** in clean technologies has shown resilience despite geopolitical challenges, with a particular focus on export-oriented manufacturing.
4. **Multilateral development finance** through institutions including the EBRD, EIB, and World Bank provides both concessional financing and technical assistance. The EBRD's €500 million Ukraine Sustainable Industry Program combines investment support with regulatory reform assistance, offering favourable terms designed explicitly for SMEs facing high technology adoption costs.
5. **Specialized climate finance** through the Global Environment Facility supports technology demonstration and early commercialization.

Despite the diverse financial mechanisms available, the current funding scale remains insufficient. The absence of comprehensive security guarantees and war risk insurance for investors creates significant additional barriers to capital mobilization. War-related uncertainty has increased risk premiums by 8-12%, making many industrial projects financially unviable. The estimated funding gap for industrial modernization will exceed €8 billion by 2030. Strengthened financial commitments, expanded de-risking mechanisms, war risk insurance solutions for investors, and enhanced access to concessional funding will bridge this investment gap and accelerate industrial modernization aligned with EU standards.

Enablers for clean industry transformation

Circular economy principles

Ukraine faces significant shortcomings in industrial waste management, exacerbated by outdated technologies and war-related destruction. The country lacks reliable statistics on re-use, recycling, and disposal rates for industrial by-products. Reports indicate that Ukraine had no comprehensive industrial waste management system before the war. The conflict has increased levels of hazardous industrial debris, further complicating waste-handling efforts.

A significant barrier is Ukraine's low landfill tax, which is significantly below EU levels (€0.15 per tonne in Ukraine vs. €107 per tonne in the Netherlands). While raising this tax could encourage waste reduction, careful implementation is needed to prevent excessive costs for industries already struggling due to the war. Enhancing resource efficiency and minimizing waste generation represent foundational principles for Ukraine's sustainable industrial development.

A major priority is developing a secondary raw material market, which is critical for reducing and recycling waste (including industrial waste), decreasing dependence on imported raw materials, and fostering local resource efficiency. Ukraine lacks a comprehensive system for efficiently processing and reintegrating industrial by-products and waste materials into production cycles. Without a well-structured secondary raw material market, industries cannot fully transition toward circularity, missing key opportunities for cost reduction, innovation, and environmental benefits.

Market mechanisms and incentives must be strengthened to drive demand for secondary materials, including implementing circular procurement policies with targeted incentives for businesses using recycled materials and expanding Extended Producer Responsibility schemes to ensure manufacturers take responsibility for the entire product lifecycle. Developing digital trading platforms will create efficient marketplaces for secondary raw materials, improving accessibility, pricing transparency, and business engagement.

Several key factors highlight Ukraine's circular economy potential. European manufacturers are increasingly looking to relocate production closer to home, with Ukraine offering competitive energy costs and a skilled workforce. Ukraine's industrial parks, particularly those providing access to renewable energy, have attracted significant investment focused on sustainable production methods. The country also has the potential for technology leapfrogging, implementing cutting-edge solutions rather than incremental improvements, particularly in regions requiring complete industrial reconstruction.

While responding to wartime challenges, with 41% of industrial firms implementing resource-efficient strategies in 2023 alone, the transition to circular business models still faces significant obstacles. These include limited financing options due to high interest rates and strict collateral requirements, insufficient financial incentives for industrial circularity despite some progress in reducing interest rates, and the lack of standardized frameworks for industrial waste valorisation due to the lack of a unified approach to assessing circular industrial investments in terms of payback periods, risks, and environmental impact.

Regarding policy and regulatory perspectives, circular economy principles have yet to be embedded into Ukraine's frameworks. Key issues include the absence of a comprehensive national strategy for circular economy transition, lack of sector-specific circularity objectives and regulations, particularly in construction, Fragmented coordination among government ministries, agencies, and municipal bodies, and absence of a unified system for monitoring waste statistics.

Technology enabling energy efficiency, circularity, decarbonisation of industry

Technological advancement is pivotal to Ukraine's green reconstruction and industrial development, with investments in the best available technologies (BAT) playing a key role in enhancing energy efficiency, environmental sustainability, and competitiveness. The adoption of BAT aligns industrial processes with international standards and positions Ukraine advantageously in carbon-constrained markets while delivering operational cost savings. Strategic investments in energy efficiency, circular economy solutions, and decarbonization technologies are essential for enabling a circular transition. Financial support for modernizing processing facilities and technology transfer initiatives will optimize resource utilization, improve the quality of secondary raw materials, and drive long-term competitiveness in global markets.

Ukraine's industrial sector remains highly energy-intensive, with energy costs representing 15-25% of production expenses across key manufacturing segments, making the transition toward energy-efficient solutions an economic and environmental imperative. High-efficiency industrial boilers and heat recovery systems can significantly reduce energy consumption by 30-40% in energy-intensive industries such as steel production, chemicals, and cement manufacturing. For instance, implementing waste heat recovery systems in metallurgical plants can recapture up to 25% of process heat that would otherwise be lost. Furthermore, industrial electrification leveraging Ukraine's growing renewable energy capacity offers a clear pathway to decarbonization, with electric arc furnaces in steel production capable of reducing carbon emissions by up to 75% compared to traditional blast furnaces when powered by renewable electricity.

Various technologies can be employed in synergy with the energy sector to address industrial-waste-related challenges. Waste-to-energy technologies convert industrial organic waste into biofuels, syngas, and electricity, reducing landfill dependency while generating renewable energy. Additionally, biomass cogeneration facilities at food processing and agricultural facilities generate heat and electricity, improving energy self-sufficiency.

Green hydrogen integration in industrial processes presents transformative potential, particularly in steel production, ammonia synthesis, and other chemical manufacturing. Pilot projects in Ukraine's chemical sector have demonstrated 40-60% reduction in emissions through hydrogen substitution in conventional processes. **Green hydrogen production potential leveraging Ukraine's renewable resources and existing gas infrastructure positions the country as a possible European hydrogen hub.** Pre-feasibility studies indicate the capacity to produce up to 8

GW of green hydrogen by 2030, serving both domestic industrial needs and export markets[70]. The growing market premium for low-carbon industrial products driven by EU CBAM creates competitive advantages for early adopters of sustainable technologies. Ukrainian steel producers implementing decarbonization measures report securing 5-10% price premiums in European markets.

Despite its potential high capital costs (€11.5–€20 billion by 2030), green hydrogen production hinders profitability and international competitivenes[71]. Hydrogen remains viable only as an export commodity produced from electricity residues, yet current production technologies and green electricity supply fail to[72]. Technical barriers include the need to adapt Ukraine's extensive gas pipeline infrastructure for hydrogen transport, with ongoing research required to determine blending limits and system modifications. Resource constraints in the renewable energy sector—such as a shortage of 2 GW in flexible generation capacity and 200 MW in electrical storage—have already stalled RE expansion. Finally, regulatory uncertainties regarding government policy, transit regulations, and underdeveloped hydrogen markets create significant investment barriers, with project initiators explicitl[73].

For hard-to-abate industrial sectors like cement, chemicals, and steel, Carbon Capture, Utilization, and Storage (CCUS) technologies offer critical pathways to emissions reduction. Post-combustion capture systems integrated with cement kilns and power plants can capture up to 90% of carbon emissions from flue gases. Technology assessments for Ukraine's largest cement facilities indicate potential capture capacity of 1.2-1.5 million tons CO_2 annually.

While direct air capture (DAC) technologies that remove CO_2 directly from the atmosphere, are currently at demonstration scale globally, Ukraine's renewable energy resources make it a promising location for future DAC facilities. Carbon utilization pathways convert captured CO_2 into commercial products including construction materials, synthetic fuels, and chemical feedstocks. Ukrainian research institutions have developed innovative carbon mineralization processes that permanently sequester CO_2 in building materials while improving their performance characteristics. Geological storage capacity in depleted gas fields and saline aquifers provides secure, long-term CO_2 storage options. Preliminary assessments indicate Ukraine possesses storage capacity exceeding 2.5 billion tons CO_2, sufficient for decades of industrial emissions.

Education and skills

The industrial sector, heavily impacted by war-related destruction and economic shifts, will require a strategic workforce transition to meet the demands of greener, more technologically advanced industries. This transformation necessitates targeted investments in labour upskilling, workforce reintegration, and the alignment of education systems with emerging green job market needs.

[70] German Energy Agency, 2021. Green Hydrogen in Ukraine: Taking Stock and Outlining Pathways
[71] German Energy Agency, 2021. Green Hydrogen in Ukraine: Taking Stock and Outlining Pathways
[72] IKEM, 2023. Roadmap for a climate-neutral, sustainable Ukrainian energy sector and its role in an integrated EU energy market.
[73] Ukraine Energy, 2020. DiXi Group: the energy concept does not give the topmost priority to hydrogen power

Challenges and opportunities in the Industrial Workforce

The war has resulted in the loss of an estimated 3.5 to 4.8 million jobs, while large-scale displacement has further disrupted Ukraine's labour market. Many traditional industrial sectors, including metallurgy, energy, and manufacturing, face workforce shortages and skill mismatches. The shift toward green industries introduces new requirements, yet many workers lack expertise in sustainable production methods, renewable energy, and modernized industrial processes. Additionally, limited access to vocational training and low labour mobility hinder the ability of workers to transition between sectors.

One of the main challenges is the disparity between labour market demands and available skills. Many industrial workers are trained in traditional methods that do not align with green technologies. Ukraine's education system also requires modernization to provide specialized training in energy efficiency, digital transformation, and sustainable industrial practices. Furthermore, the country's workforce exhibits relatively low labor mobility, meaning that many workers find it challenging to shift from declining industries to emerging sectors with higher growth potential.

Despite these challenges, the transition to greener industries presents a significant opportunity for job creation. Estimates indicate that adopting green recovery strategies across key sectors — such as energy, transportation, and water supply — could generate significant amount of jobs. In the industrial sector, employment opportunities will be concentrated in areas such as renewable energy, circular economy initiatives, energy-efficient manufacturing, and electrification of transport. The expansion of solar, wind, and bioenergy industries will require skilled technicians and engineers. At the same time, sustainable resource management and eco-friendly production processes will create new roles in waste reduction, recycling, and environmental compliance.

The modernisation of infrastructure and industrial processes will also drive demand for green construction and energy efficiency specialists. Jobs in retrofitting factories, developing smart grid systems, and producing low-carbon building materials will be essential in meeting sustainability targets. Additionally, the electrification of transport and the shift towards digitalized, automated manufacturing will require new technical competencies, creating further employment opportunities in logistics, engineering, and digital transformation.

The workforce must enhance its adaptability and mobility across sectors, in addition to technical skills. Reskilling initiatives should equip workers with cross-disciplinary competencies, allowing them to transition between traditional and green industries. Training in environmental regulations, workplace safety, and sustainable project management will also ensure compliance with international sustainability standards.

Workforce Development Strategies

Ukraine must invest in comprehensive workforce development strategies to bridge the skills gap. Vocational education and technical training programs should be modernised to incorporate green technologies and sustainable industrial practices. Government and private sector partnerships will be essential in designing employer-led training initiatives, apprenticeships, and on-the-job learning opportunities.

The industrial workforce requires substantial upskilling to operate advanced manufacturing and environmental technologies effectively. Retaining and attracting talent in cleantech and engineering is a priority. Key initiatives include supporting the return of skilled professionals from abroad and fostering entrepreneurship in green industries**. These skills-building actions should be vital to Ukraine's industrial modernization strategy**, ensuring that clean technology solutions are developed, tested, and scaled effectively.

Ukraine should build capacity and knowledge infrastructure to ensure a systemic approach to workforce development. This includes establishing specialized training programs for policymakers, industry professionals, and MSMEs; creating regional knowledge hubs focused on sustainable industrial practices; developing partnerships with EU institutions for technical assistance; and implementing demonstration projects that showcase circular economy principles in key sectors.

Policy Recommendations for a Just Transition

Targeted policy interventions are required to ensure that the green transition incorporates social justice principles. Vocational and higher education reforms should align curricula with the needs of the green economy. Financial incentives should be introduced to encourage companies to train and hire workers in sustainable industries. Sector-specific workforce transition programs should support industries such as metallurgy, manufacturing, and logistics adopting cleaner technologies.

Labor mobility policies should be enhanced to facilitate smooth transitions between declining and emerging sectors. Social protection mechanisms, including reskilling grants, wage support, and employment transition assistance, will safeguard workers affected by industrial shifts. Furthermore, efforts should be made to ensure that green jobs provide decent wages, safe working conditions, and opportunities for career growth.

Reskilling programs should be prioritized for displaced workers, returning migrants, and veterans to facilitate their reintegration into the labour market. Fast-track training in high-demand green skills can accelerate employment opportunities and support economic recovery. International collaboration and funding should also be leveraged to support large-scale industrial training programs, knowledge exchange initiatives, and technology transfer agreements.

Digitalisation

The digitalisation of Ukraine's industry has accelerated significantly, driven by the country's European integration efforts and the necessity of economic resilience amid wartime challenges. Before 2022, Ukraine prioritized digital transformation to boost production automation, enhance labour productivity, and increase global competitiveness. The Ukrainian IT industry's export value has shown consistent growth (Figure 7), bringing 4.5% of total GDP to Ukraine's economy at the end of 2022. Today, digital technologies are crucial for maintaining economic stability, ensuring continuity in key sectors, and laying the foundation for post-war recovery with more sustainable and environmentally responsible industrial practices.

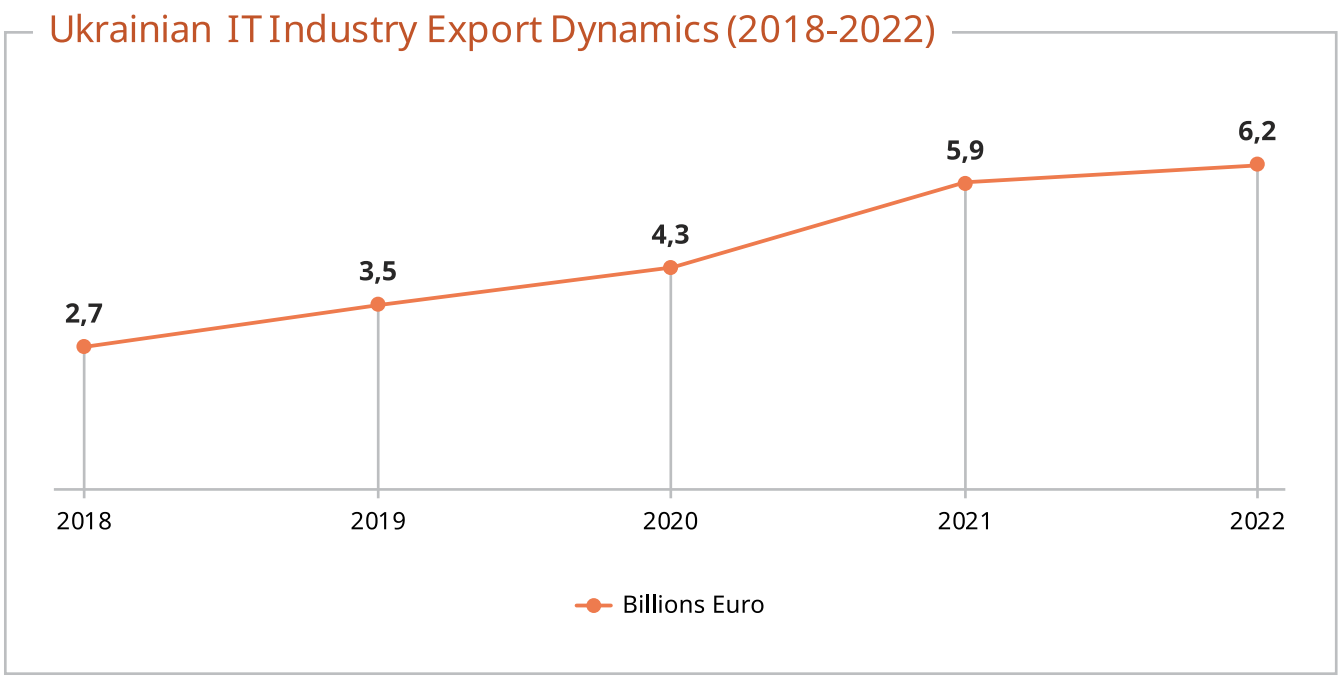


Figure 7. Ukrainian IT industry export dynamics. Source: Ministry of Digital Transformation of Ukraine

The Ukrainian IT industry remains the country's largest exporting sector. It has great potential to play a vital role in the green transition by enhancing industrial process efficiency and enabling sustainable practices.

The adoption of artificial intelligence (AI), automation, and Industry 4.0 solutions is expected to enhance manufacturing productivity, energy optimization, and industrial monitoring. Policies promoting smart manufacturing and digitalization are being integrated into Ukraine's industrial recovery roadmap, ensuring that technological advancements contribute to both economic resilience and environmental sustainability.

Ukraine's progress in digital governance provides a strong foundation for supporting green transition initiatives in Ukrainian enterprises. For example, the **Diia.Business** platform, launched by the Ukrainian government, provides SMEs with access to digital tools, financial resources, and business advisory services to help them adopt eco-friendly technologies. In general, SMEs, which form the backbone of Ukraine's economy, demonstrate how digital technologies can enable transformative practices even in heavy industry towards more sustainable business models.

In 2023, Ukraine introduced the National Decarbonization Platform (NDP), a multifunctional digital tool designed to facilitate the country's energy-efficient transformation[74]. Developed by the State Agency for Energy Efficiency and Energy Saving in partnership with American Uprisun Technology, the NDP aims to connect municipalities, businesses, and households with modern energy-efficient and green solutions. Users can access a range of options from home energy storage to large-scale solar panel installations, heat pumps, and fuel cells from leading global manufacturers, all with preferential terms and state support.

Stimulating digital transformation and reviving Ukraine's economy will be facilitated by applying for funding for digital global gateway projects under the EU's Connecting Europe Facility programme[75]**.** This funding is strategically divided into four key areas: high-performance computing (€2.2 billion) for large data computation in decision-making; AI and cloud services (€2.1 billion) to create products that facilitate work across enterprises and institutions; digital technologies in the economy and society (€1.1 billion) for business, healthcare, environment, and Smart City technologies; and digital skills development (€580 million). These investments will be instrumental in developing a cleaner, more sustainable industrial base that aligns with European standards as part of Ukraine's post-war recovery efforts.

Research, Innovation, and Development (R&I&D)

Strategic investment in research, innovation, and development (R&I&D) is a fundamental requirement for Ukraine's transition to a clean industry. Ukraine has identified green hydrogen, industrial digitalization, and circular economy innovations as top R&I&D priorities. In particular, the Ukrainian government is actively seeking partnerships with international investors and research institutions to accelerate the development of green hydrogen infrastructure, which is expected to play a key role in decarbonising industrial production. Meanwhile, the Global Environment Facility supports Ukraine's R&D in eco-friendly materials and energy-efficient production techniques.

For effective implementation, these priorities should be supported by stable funding mechanisms, collaborative research networks, and policy frameworks that enable rapid commercialization and deployment of innovations across industrial sectors tailored to regional industrial strengths.

[74] EcoPolitic, 2023. A National Decarbonization Platform will appear in Ukraine

[75] European Climate, Infrastructure and Environment Executive Agency, Accessed in March 2025. Connecting Europe Facility

Creating industrial symbiosis networks in Ukraine could be a powerful enabler for the green industrial transition. By encouraging collaboration among industries to exchange by-products as raw materials, Ukraine can create closed-loop systems where waste from one sector becomes valuable input for another. Implementing Resource-Efficient and Cleaner Production methodologies, particularly in energy-intensive sectors, will further optimize resource utilization across industrial processes. Pilots in Ukraine's industrial parks have demonstrated a reduction of up to 60% in waste through coordinated resource management.

Research priorities for industrial decarbonization must target the highest-impact sectors. Heavy industry accounts for approximately 30% of global greenhouse gas emissions, with steel, cement, and chemicals representing the largest shares. Ukraine's R&I&D strategy should focus on transformative technologies with the greatest potential for decarbonisation and resource efficiency.

The government is working on strengthening supply chain resilience by promoting domestic production of low-carbon industrial inputs, particularly in steel, chemicals, and advanced manufacturing components. By diversifying supply sources and expanding R&D capabilities, Ukraine aims to reduce its dependence on imported materials and enhance its competitiveness in global markets.

Innovation hubs specialising in clean technologies have proven particularly effective, as seen in regions like western Ukraine where business support institutions have helped launch over 100 new green enterprises. The establishment of green technology funds providing patient capital has shown promising results, with such investments achieving commercial returns while supporting environmental objectives.

The **Global Cleantech Innovation Programme (GCIP)** is one of the key initiatives supporting the development of cleantech startups in the country. It provides funding, mentorship, and market access to entrepreneurs working on low-carbon technologies and industrial efficiency solutions.

Regional industrial clusters focused on specific clean technologies have effectively built competitive advantages. For example, the EU4Environment program documented how targeted cluster development in Ukraine helped companies reduce resource consumption by 25% while increasing exports of green products. Cross-border partnerships are increasingly critical, with international technology transfer arrangements accelerating the deployment of clean solutions. Data shows that firms engaged in international partnerships were 2.7 times more likely to commercialize their innovations than those operating in isolation successfully.

Environmental, Social, and Governance (ESG) implementation

Strategic Environmental, Social, and Governance (ESG) implementation for Ukrainian industrial companies represents compliance and a competitive necessity for participating in reconstructed value chains and integrated European markets in the post-war economy. Reconstruction needs and European integration requirements will shape the future of ESG implementation in the Ukrainian industry. As Ukraine rebuilds its industrial capacity, new and restored facilities will likely need to incorporate modern ESG standards to access international financing.

Ukrainian industrial sectors face unique challenges in implementing ESG principles amid the ongoing war. Manufacturing, energy production, mining, and other industrial operations have been particularly affected by the conflict, altering their ability to pursue sustainability initiatives. Under martial law, industrial companies have received temporary exemptions from mandatory ESG reporting requirements, allowing them to prioritize operational continuity and security concerns over documentation of sustainability practices. Despite the suspension of formal reporting requirements, export-oriented industrial producers continue to maintain ESG documentation and practices to meet the expectations of international partners and customers, particularly those in European markets.

Companies that had previously implemented ESG principles in their industrial processes have demonstrated greater adaptability to supply chain disruptions. Supply chain resilience has emerged as a cornerstone of industrial ESG practices during wartime. Ukrainian industry has been forced to reimagine procurement, production schedules, and distribution channels.

EU Approximation

The European Clean Industry context

The European Union has undergone a significant industrial paradigm shift in recent years, moving beyond previous policy frameworks to embrace a more integrated and strategic approach to industrial development. Global competitiveness challenges, climate imperatives, and the necessity for technological leadership drive this shift. Recent developments shaping this transformation include the Green Deal Industrial Plan[76], the Net-Zero Industry Act[77], the Critical Raw Materials Act[78], and the European Sovereignty Fund[79]. These initiatives aim to reduce dependency on external suppliers, accelerate industrial decarbonization, and enhance Europe's technological leadership in clean energy and strategic industries.

The Draghi report, The Future of European Competitiveness, outlines a strategic vision for strengthening the EU's industrial base amidst global economic and geopolitical challenges. It emphasizes enhanced competitiveness, resilience, and sustainability in key industries, particularly in energy transition, supply chain security, and technological leadership. These priorities directly affect Ukraine as it seeks to modernize its industrial sector and deepen economic integration with the EU. The main factors driving industry from the Draghi report are **energy costs and competitiveness**, **decarbonization and industrial policy**, **supply chain resilience and strategic autonomy**, and **financing the green transition**.

One of the most pressing challenges identified in the report is the high cost of energy in Europe, which places European industries at a disadvantage compared to their US and Chinese counterparts. To address this, the EU focuses on scaling up renewable energy projects, expanding cross-border energy infrastructure, and advancing hydrogen technologies. This presents an opportunity for Ukraine to align its energy strategy with the EU by leveraging its renewable energy potential, hydrogen production capacity, and geographic role as an energy transit hub. By actively participating in EU energy initiatives, Ukraine can enhance its industrial competitiveness while contributing to Europe's energy security.

Another key area of focus is decarbonization and industrial policy. The EU is implementing stricter climate regulations, including the Carbon Border Adjustment Mechanism (CBAM), to ensure that industries remain competitive while reducing emissions. For Ukraine, whose industries — particularly in steel and chemicals — are heavily reliant on carbon-intensive processes, adapting to these regulations will be crucial to maintaining access to the EU market. By investing in low-carbon technologies and aligning its industrial policies with EU standards, Ukraine can secure its position as a reliable trading partner while avoiding potential trade barriers.

The report also highlights the **importance of supply chain resilience and strategic autonomy**. The EU aims to reduce dependence on external suppliers, particularly critical raw materials and

[76] European Commission, 2023. The Green Deal Industrial Plan
[77] European Commission, 2024. The Net-Zero Industry Act: Accelerating the transition to climate neutrality
[78] European Commission, 2024. Critical Raw Materials Act
[79] European Commission, 2022. A European Sovereignty Fund for an industry "Made in Europe"

clean technologies. Ukraine, with its rich deposits of key minerals and growing potential in green manufacturing, can play a vital role in the EU's efforts to secure sustainable and reliable supply chains. This could translate into increased European investment in Ukrainian mining, battery production, and advanced manufacturing, provided Ukraine develops a regulatory framework supporting these industries.

Financing the green transition is another crucial aspect of the EU's industrial strategy. The Draghi report calls for greater public and private investment in clean energy and industrial decarbonization, with mechanisms such as EU funding for green projects, carbon pricing revenues, and contracts for difference (CfDs) playing a key role. Ukraine can benefit from these financing tools by positioning itself as an attractive destination for EU-backed investments in renewable energy, green steel, and sustainable infrastructure. Ukraine can accelerate its industrial transformation through these financial mechanisms while reducing reliance on fossil fuels.

Lastly, the report stresses the need for regulatory simplification and innovation-friendly policies to boost European competitiveness. Ukraine faces a strategic opportunity as the EU works to streamline investment approval processes, reduce bureaucratic hurdles, and encourage technology scaling. In rebuilding and modernizing its economy, **Ukraine should carefully assess EU regulatory frameworks, adopting their strengths while avoiding the pitfalls of excessive bureaucracy that sometimes characterize EU procedures.** Despite their intent to simplify, some EU regulations can paradoxically introduce more complexity than Ukraine's existing frameworks. Ukraine should, therefore, implement a pragmatic approach—embracing EU practices that genuinely accelerate investment and business growth while preserving or enhancing the comparative advantages of its more streamlined domestic processes. This balanced strategy will attract European investment and position Ukraine's regulatory environment as competitive and business-friendly, ensuring an advantageous entry point into the EU's economic framework rather than uncritically replicating its administrative burdens.

EU Approximation progress

The circular economy has gained policy attention in Ukraine in recent years but remains in its early stages of development, remaining significantly underdeveloped compared to EU standards. The 2014 Association Agreement between Ukraine and the EU aligned Ukraine's regulatory framework with European standards, particularly in economic and industrial cooperation. The Economic Strategy of Ukraine 2030 defines decarbonization and a circular economy by the European Green Deal, alongside the development of renewable energy sources and as one of the benchmarks for the development of the national economy.

To accelerate the circular economy transition in Ukraine's industrial sector, priority areas must focus on improving waste valorisation, circular supply chains, industrial symbiosis, and market mechanisms for secondary raw materials. The EU Circular Economy Action Plan and Ukraine's national strategies emphasize the importance of key industrial sectors, including construction, mining, manufacturing, energy, and waste management, which must integrate circular economy principles to enhance sustainability and resilience.

1. **Regulatory alignment** with EU directives, including the Industrial Emissions Directive (IED) and Best Available Techniques Reference Documents (BREFs), establishes clear environmental performance standards. Ukraine's Environmental Strategy 2030 includes comprehensive industrial permitting reform to accelerate BAT implementation.

2. **The Energy Efficiency Directive (EED)**, transposed into Ukrainian law, mandates energy audits and efficiency improvements for large industrial consumers. Industries exceeding energy consumption thresholds must implement ISO 50001 energy management systems by 2026.

3. **The National Guiding Framework for Standards and Technical Regulations underpinning the Green Reconstruction of Ukraine**[80] establishes sustainability criteria for industrial rebuilding, prioritizing resource-efficient and low-carbon technologies.

4. **Financial incentives for industrial modernization** include accelerated depreciation for clean technology investments, reduced import duties on environmental equipment, and preferential lending programs through the state-owned Ukreximbank's Sustainable Industry credit line.

5. **Carbon pricing mechanisms** under development will internalize environmental costs and incentivize emissions reduction technologies. The planned Ukrainian Emissions Trading System, designed for compatibility with the EU ETS, will cover major industrial emitters by 2027.

Ukraine progressively aligns with EU standards and certifications to facilitate access to international markets and foreign investment. This alignment process involves comprehensive regulatory updates across multiple industrial sectors. Harmonization with EU Green Deal Policies ensures industries comply with climate neutrality goals, requiring Ukrainian manufacturers to adapt production processes to meet stringent environmental standards. This alignment creates both challenges and opportunities as industries modernize their operations to remain competitive in European markets.

Standards and certifications are critical for ensuring compliance with sustainability requirements in Ukraine's industrial sector. They provide a structured approach to meeting ESG objectives, aligning with international best practices. Adopting recognized standards helps Ukrainian industries integrate into global markets, meet investor expectations, and comply with EU regulations, particularly in the context of green reconstruction.

Ukraine's deeper integration into global markets and international industrial value chains is a core component of its transition to a clean industry. This process is key to aligning the country's industrial regulations and product standards with European Union (EU) requirements, allowing domestic businesses to expand their presence in the EU Single Market.

[80] UNIDO, 2025. The National Guiding Framework for Standards and Technical Regulations: Underpinning the Green Reconstruction of Ukraine

Readiness for CBAM and ETS

The EU's Carbon Border Adjustment Mechanism (CBAM) poses a significant challenge for Ukraine's industrial sector, potentially limiting access to the European market for producers unable to meet EU environmental standards. CBAM presents substantial challenges for Ukrainian industry, as over half of its exports are destined for the EU. Amid ongoing war and blocked seaports, the EU has become Ukraine's primary trading partner. Exports are crucial for Ukrainian enterprises to sustain operations, preserve employment, and support the national economy.

CBAM could affect approximately 15-17% of Ukraine's exports to the EU, with the iron and steel sector most impacted - 93% of CBAM-regulated exports originate from this industry. The GDP impact could be significant due to the interconnectedness of various sectors. By 2026, Ukraine's GDP could contract up to $790 million due to CBAM, with potential losses escalating to $4.9 billion by 2030. CBAM implementation will create additional hurdles for Ukrainian exporters already strained by war, with a diminished domestic market and further constrained export opportunities. Losses are expected to increase over time as free allowances under the EU Emissions Trading System (ETS) are gradually reduced, leading to higher carbon prices and increased CBAM-related expenses.

Ukraine aims to implement its own ETS to adapt to European economic integration. This involves enterprises gaining ETS experience, preparing management institutions, creating decarbonization financing instruments, reducing industrial carbon intensity, and gradually aligning greenhouse gas emission prices with the EU ETS. Prerequisites for launching an ETS in Ukraine include a functioning monitoring, reporting, and verification (MRV) system and an approved updated Nationally Determined Contribution (NDC-3). Due to ongoing martial law, enterprises can defer emission report submissions, making a pilot phase unlikely before 2027.

Ukraine should design its ETS system closely based on the European model while considering its war-affected economy, enterprise capabilities, and administrative specifics. Given that Ukraine lags behind the EU by at least 18 years in carbon markets, industries must focus on aligning environmental standards and investing in cleaner technologies. This transition should be primarily industry-driven, with companies taking proactive ownership of their environmental responsibilities.

Green public procurement has emerged as a powerful tool for stimulating clean industry markets. Countries implementing green procurement requirements have seen the market share of clean solutions increase by 15-30% in targeted sectors within 3-5 years. Ukraine's alignment with EU standards is instrumental in opening new markets for its cleantech companies, demonstrating how international standardization facilitates global market access.

Main priorities for the green transition

Ukraine's progress towards green transition in the industrial sector depends a lot on whether, in the reconstruction phase, a comprehensive, strategic approach that balances economic recovery with environmental responsibility will be applied. Two main elements to fast-track toward clean industry in Ukraine are establishing renewable energy sources as the backbone of the energy supply and implementing a robust greenhouse gas emissions certification scheme to effectively guide and accelerate the path toward achieving net-zero emissions.

Establishing a Cohesive Policy Framework that aligns industrial recovery with European Green Deal objectives is essential. This should include:

- Developing a national emissions trading scheme — Ukrainian ETS with transition clauses that provide adaptation periods for industries while maintaining progressive climate action. This should start with the adoption of the ETS law and necessary secondary legislation, improving MRV infrastructure, and building the capacity of the institutions and stakeholders involved in the ETS implementation.
- Creating a comprehensive circular economy law that promotes resource efficiency and addresses Ukraine's significant gap in material intensity compared to EU standards.
- Instituting certification systems for greenhouse gas emissions that can integrate with EU mechanisms while accommodating Ukraine's unique reconstruction challenges.

Ukraine needs to prioritize Sustainable Infrastructure Reconstruction by ensuring that all infrastructure rebuilding incorporates sustainability principles:

- Rebuild damaged industrial facilities using the best available technologies that minimize resource consumption and emissions. Such technologies should include carbon capture and storage (CCS) and carbon capture and utilization (CCU), used for instance during the production of eFuels, which requires carbon-negative sources. This innovative approach can be initiated promptly to support sustainable energy development.
- Create transparent digital certification systems aligned with EU standards.

It is important to establish a Circular Economy Ecosystem through:

- Creating financial incentives for businesses implementing circular economy principles.
- Establishing industrial symbiosis networks connecting waste streams across industries.
- Developing a secondary raw materials market focusing on critical materials recovery.
- Implementing digital tracking systems for material flows to enhance transparency and efficiency.

Ukraine can leverage Green Financing and Investment, Capitalizing on Ukraine's reconstruction as an opportunity for sustainable investment:

- Align reconstruction funding with EU taxonomy requirements to facilitate access to green financing.
- Develop investment mechanisms specifically targeting circular economy initiatives and resource efficiency improvements.
- Establish a dedicated Industrial Modernization Fund combining public and private capital with technical assistance for BAT implementation.

Ukraine should develop sector-specific technology roadmaps with clear timelines and metrics for key industrial segments and develop technical education programs focused on sustainable manufacturing skills.

Integrating Digital and Green Transitions can enable a lot of extra potential for clean economic development:

- Implement digital monitoring systems for resource flows and emissions tracking.
- Develop digital platforms connecting waste generators with potential users of secondary materials.
- Utilize digital tools for optimizing energy and resource use in industrial processes.

To build a robust secondary raw material market and advance resource-efficient, circular industry development in Ukraine, a comprehensive approach is needed to address both regulatory frameworks and practical implementation strategies. The foundation must be established through enhanced regulatory and policy frameworks, including clear legal definitions, quality standards, and certification systems for secondary raw materials. This should encompass developing and implementing a National Circular Economy Strategy and Action Plan and adopting dedicated circular economy legislation aligned with EU regulations to facilitate trade and improve investor confidence.

1.4 Buildings and Renovation

Status and trends

Ukraine's building stock was essentially constructed during the Soviet era. Over 80% of multi-family buildings were built before 1991, with poor thermal insulation and high energy consumption[81]. Buildings account for 42% of all final energy usage in the country[82]. Specifically, residential buildings contribute to 17.04 Mtoe of total final energy consumption, representing 33% of Ukraine's overall energy usage. **The building stock, mainly comprising structures built before 1991, is outdated and does not meet modern energy efficiency standards. The energy landscape in Ukraine's housing sector reflects a significant reliance on non-renewable sources, with gas accounting for 57.3% of total consumption** (followed by electricity at 12.7% and heating energy at 26.3%). Coal and peat contribute 1.9%, while oil products and renewable energy sources make up 0.2% and 1.5%, respectively.[83]

Indicators show that energy consumption per unit in buildings is 2-3 times higher than in EU countries, with specific energy consumption in multi-apartment residential buildings averaging 264 kWh/m^2 per year compared to 90 kWh/m^2 per year in the EU. Residential buildings consume an average of 178 kWh/m^2 annually, while energy demands for various public buildings range from 137 kWh/m^2 for sports centers to 452 kWh/m^2 for administrative buildings.

Moreover, the household sector accounts for a substantial portion of energy consumption, amounting to 13,601 million tons of oil equivalent in 2020 (28.5% of final consumption)[84], indicating a potential for reducing energy consumption by up to 30-40%. However, limited funding for comprehensive state support programs hampers efforts to modernize housing and improve energy efficiency. Previous funding for energy efficiency programs has been insufficient, averaging around 2 billion UAH annually.

Although the annual renovation rate is currently set at 1% per building type, projections indicate the retrofitting of public buildings to reach 16% by 2030, 35% by 2040, and 54% by 2050 in the basic scenario, with more ambitious targets aiming for 50%, 81%, and 100%, respectively. Similarly, in the basic scenario, residential buildings are expected to see retrofitting rates of 10%, 23%, and 36% by 2030, 2040, and 2050, respectively, with ambitious targets aiming for 35%, 70%, and 100%.

The expected CO2 emission reductions in the building sector for 2020, 2030, 2040, and 2050 demonstrate Ukraine's commitment to environmental sustainability. Unfortunately, the achieved reduction in 2020 is not available. The anticipated reductions by 2021 are estimated at 2,937 thousand tCO2eq per year, with projections increasing to 3,439 thousand tCO2eq per year.

[81] National Council for the Recovery of Ukraine from the Consequences of the War. (2022). Draft Ukraine Recovery Plan Materials of the "Construction, urban planning, modernisation of cities and regions" working group.

[82] IEA. Ukraine energy profile

[83] Ukraine Fifth Annual Report under the Energy Efficiency Directive

[84] IEA. Ukraine energy profile

By 2030, the basic scenario targets a reduction of 4,535 thousand tCO2eq per year, while the ambitious scenario aims for a more substantial decrease of 13,089 thousand tCO2eq per year[85].

The key objective of the Renovation Wave initiative in the EU is to significantly increase the annual energy renovation rate of buildings, aiming to at least double it from the current rate of 1% by 2030. **The target includes reducing energy consumption in buildings by at least 60% through energy renovations transitioning from nearly zero-energy buildings (nZEB) to zero-emission buildings (ZEB)**. Compared to the EU, which has seen a 23% decrease in greenhouse gas emissions from energy use in buildings between 2005 and 2019, Ukraine's data on greenhouse gas emissions from building energy use is currently unavailable. Similarly, the energy performance of buildings in Ukraine is higher, with public sector buildings requiring between 137 and 452 kWh/m^2 annually and residential buildings averaging 264 kWh/m^2 - this contrasts with the EU's average specific annual energy demand of 250 kWh/m^2 for public buildings and 180 kWh/m^2 for residential buildings. **The country aims for an annual renovation rate of 1% by 2030 but has not yet defined specific targets for nearly zero-energy buildings (nZEB) or deep renovation projects. The gradual renovation strategy for Ukraine's buildings through 2050 lacks detailed (quantitative) milestones**, unlike the EU's more structured and ambitious goals. Therefore, while Ukraine's current renovation and energy performance metrics lag behind the EU's, there is a clear alignment in long-term objectives. Yet, progress will depend on the development and implementation of national policies and strategies.

The war in Ukraine has escalated construction costs, increasing energy demand across all process stages. This trend is anticipated to persist until the conflict concludes, affecting the job market as well, and continue in the post-war period as substantial funds will be allocated for reconstruction and construction as high demand will keep prices high. Since the onset of the invasion, job vacancies in the construction sector have decreased by 5%, with a significant drop from 14.3 thousand offers in 2021 to 8.2 thousand[86] in 2022. Additionally, new requirements for the construction industry have emerged, prompting considerations about housing types and modernization strategies. Prioritizing construction aligned with green standards is emphasized in approved programmatic documents amidst these challenges.

Military aggression presents significant hurdles, hindering the full development of the construction market and generating risks and uncertainty for both businesses and the population**. Given Europe's escalating energy and climate ambitions and the substantial damage to Ukraine's housing stock, a thorough reassessment and enhancement of Ukrainian plans are imperative. These revised plans should aim for greater precision and ambition, consolidating into a unified and credible thermal modernization strategy (i.e. build back better).** Priority should be given to ensuring that energy efficiency requirements are integrated into eligibility criteria for accessing these funds, especially in anticipation of Ukraine's forthcoming EU accession.

[85] National Action Plan on Energy Efficiency for the period up to 2030

[86] Analytical overview of the updated nationally determined contribution of Ukraine to the Paris Agreement. Ministry of Environmental Protection and Natural Resources of Ukraine.

A resilient construction and architecture sector is essential to facilitating Ukraine's post-war recovery and transition towards sustainability. This sector should be bolstered by highly skilled human resources, digitalization, and technological advancements. **Currently, Ukraine faces a significant shortage of qualified professionals, attributed to the decline in training systems, low remuneration, and limited attractiveness of construction professions. However, the construction sector holds immense potential for job creation, with significant opportunities for post-war recovery and green transition initiatives.**

The cost of rebuilding the damaged and destroyed building stock will be substantial. **According to the Kyiv School of Economics[87] „the housing stock remains in first place in terms of damage**. Due to hostilities and systemically shelling, the number of damaged and destroyed residential buildings is increasing every day. As of January 2024, there were almost 250,000 damaged and destroyed buildings, with 222,000 private houses, over 27,000 apartment buildings, and 526 dormitories. Direct damage to these facilities is estimated at $58.9 billion". The current total estimated amount of infrastructural damage (January 2024) is estimated at cca. $155 billion (education $6,8 billion, healthcare $3.1 billion, etc.). According to the 'build back better' principle, a deep restoration would increase rebuilding costs.

Strategic capacity

To implement the EPBD directive, the Law of Ukraine "On the Energy Efficiency of Buildings" was adopted, along with a series of subordinate legal acts, including the Concept of implementing state policy in the field of ensuring the energy efficiency of buildings and the National Plan to increase the number of nearly zero-energy buildings (Cabinet of Ministers Order dated January 29, 2020, No. 88-r). In particular, the law establishes mechanisms for setting minimum energy efficiency requirements, the procedure for energy certification of buildings and methods for determining the energy efficiency of buildings, requirements for energy auditors, priority measures to increase energy efficiency, principles of funding for these measures, and more.

The Long-term Building Thermal Modernization Strategy for the period up to 2050 was approved in December 2023 to enhance Ukraine's energy independence (including from the import of Russian natural gas) by fully decarbonizing the national building stock. This aligns with Ukraine's Second (Updated) National Determined Contribution to the Paris Agreement adopted in 2021. Besides existing laws and rulebooks that are transposing the EPBD directive, the Strategy is the key enabler in Ukraine in meeting the building sector's EDG objectives. The Strategy defines, among others, the following indicators for Ukraine's buildings sector to be achieved (among others):

[87] Kyiv School of Economics, 2024. $155 billion — the total amount of damages caused to Ukraine's infrastructure due to the war, as of January 2024

1. at least 36% of residential and public buildings meet minimal energy efficiency requirements, with at least 10% of public buildings being nearly zero-energy buildings by 2030
2. at least 90% of residential buildings meet minimal energy efficiency requirements, with at least 40% of residential buildings being nearly zero-energy buildings; at least 90% of public buildings meeting minimal energy efficiency requirements, with at least 40% of public buildings being nearly zero-energy buildings
3. the amount of investments attracted to improve the energy efficiency of buildings at the level of at least 87 mln euros
4. the amount of qualified personnel in the field of energy efficiency at the level of at least 100,000 people/year.

Ukraine's recently adopted NECP (June 2024) states that the share of renewable energy for heating and cooling purposes should increase by 3.5 times until 2030 — from 9.3% in 2020 to 32.5% in 2030. This requires the construction (modernization) of approximately 35.6 GW of heat-generating capacities.

While these strategies, laws, and action plans are a very good basis for Ukraine's Government and authorities to enable EGD goals for the buildings sector, one of the key policy gaps in Ukraine is the fact that the Long-term Building Thermal Modernization Strategy doesn't aim for a fully decarbonized building stock in its long-term indicators. Instead, it is foreseen that only 40% of the residential and public building stock is comprised of nearly zero-energy buildings. Moreover, the formulation should aim for a net zero emission building stock in 2050 (while almost zero buildings should be an intermediate objective leading towards net zero emissions), thus resulting in a higher long-term indicator for 2050 regarding the % reduction in final energy consumption in the building sector (residential and public). Another gap is that EPBD-related by-laws and regulations are outdated from an EU directives perspective, given that an EED recast has been adopted in 2023, as well as an EPBD recast that was adopted in 2024.

Governance capacity

The Ministry of Infrastructure is leading Ukraine's transposition, adoption, and enforcement of EPBD. The ministry is responsible for state policies in urban planning, construction, spatial planning, architecture, technical regulation in construction, construction control and supervision, control of housing and communal services, and energy efficiency of buildings. Ukraine's State Agency on Energy Efficiency and Energy Saving of Ukraine implements state policy on the effective use of fuel and energy resources, energy savings, and alternative fuels, with a focus on increasing energy efficiency across all sectors of the national economy, implementing energy efficiency initiatives, incentive supporting schemes contributing to improving energy efficiency in the residential sector. Another important institution is the State Fund for Decarbonization and Energy Efficiency Transformation – which generates revenues on a polluter-pays principle that will be further used to finance energy efficiency measures, the introduction of alternative energy sources, and decarbonisation.

These mandates of the key government stakeholders in Ukraine provide a good ground for planning and executing the Building Renovation Plan. In the past, several programmes have been successfully carried out by different government authorities resulting in increased energy efficiency in the public and residential building sector. This shows that the institutional capacity, effectiveness, and ability to implement programs leading toward the fulfillment of EDG objectives did exist in Ukraine. It should be noted that due to the recent changes in EPBD and EED requirements and the complexity of introducing nearly zero energy buildings/net emission buildings and embedding primary energy into the performances of buildings, there is, to a certain extent, a lack of capacities to understand and ability to reflect these requirements into Ukraine's energy performance of buildings policies and technical norms.

Given the existing aggression against Ukraine, key ministries and other government institutions currently lack the human resources. This makes it very difficult to simultaneously develop/update its legislation by the new EPBD and EED requirements and ensure its enforcement, develop and execute sustainable and continuous financial mechanisms for various building and renovation stakeholder groups, and ensure funding and deliver a large country-wide building renovation programme. Additionally, there are plans to reduce government personnel due to the war, which may result in prioritizing the remaining staff and additional understaffing for daily activities. A lack of human resources and capacities could also negatively affect Ukraine's ability to absorb and manage large amounts of funding for recovery and renovation from several different financing sources simultaneously.

The country's authorities relevant to the building and renovation thematic area are currently understaffed to achieve the goal of decarbonizing Ukraine's buildings sector by 2050. Although defined mandates exist among different ministries and government institutions, the government of Ukraine is missing clearly defined roles and responsibilities for energy efficiency implementation support for buildings from an EGD perspective (fully decarbonized building sector by 2050).

Although there is a significant potential for data collection, monitoring and reporting in Ukraine, clear roles and responsibilities among different institutions aiming for transparent

and sufficient data collection, monitoring, and reporting systems of activities and its achievements, is at its early stage of development. Thus, MRV roles among key authorities are not fully defined yet. The country is also missing a country-wide awareness-raising and communication strategy, which would communicate to the general public the benefits, financing options, and goals of decarbonising Ukraine's building sector towards zero emissions in 2050. However, focus should be given to such activities in post-war times.

Ukraine already has a very good basis for existing policies and norms, which could enable the country to enforce its building stock decarbonization. Moreover, with the adoption of Ukraine's NECP in June 2024, the "energy efficiency" dimension includes several new (WAM measures) policies and instruments which contribute to the decarbonization of the building stock, i.e. the "Implementation of the State targeted economic Programme to support thermal modernisation of buildings" measure and the "Nearly-zero energy buildings" measure. The Order „On the Approval of the Procedure for Developing Design Documentation for Construction Projects", combined with the "Law on Energy Efficiency of Buildings" and the standards on „Thermal Insulation and Energy Efficiency of Buildings", define the mandatory urban and technical conditions, obligations for energy efficiency certification and proving energy performances of buildings, and minimum technical (energy efficiency) requirements for new and reconstruction of existing buildings.

Ukraine is one of the few EU accession countries which adopted policies aimed at ensuring an increasing number of nZEB buildings already in 2017 and 2020. According to the nZEB Concept, it is planned that no later than December 31, 2027, the energy efficiency class of all buildings that are put into operation should not be lower than the requirements for energy-independent buildings in force on the date of the start of construction work. In addition, no later than December 31, 2025, the energy characteristics of state and communal buildings that are put into operation must not be lower than the requirements for energy-independent buildings in force on the start of construction work. The concept also defines the maximum indicators of specific consumption of primary energy for energy-independent buildings (new construction):

1. from 46 to 92 kWh/m^2 for residential buildings (depending on the number of floors and temperature zone);
2. from 21 to 33 kWh/m^3 for public buildings (depending on the number of floors and temperature zone);
3. from 33 to 35 kWh/m^3 for buildings and structures of educational and health care institutions (depending on the temperature zone).

As per the Long-Term Thermo-modernisation Strategy, it is envisaged that by 2030, retrofits of buildings will be carried out to bring them into compliance with minimum energy efficiency requirements, while after 2030, retrofits of buildings will be carried out to bring them into compliance with the level of nearly zero-energy consumption buildings. Additionally, the overall energy performance indicators of the housing stock will change with the implementation of measures to increase the proportion of buildings with better energy efficiency classes (classes B and C), while buildings with the worst indicators will gradually be phased out of operation.

However, there is a lack of alignment between nationally defined and local goals for building thermos-modernisation as regional and local level governments still need to reflect the Long-term thermos-modernisation Strategy's aims (future National building renovation plan's aims) on their level of governance. Moreover, to meet its renovation goals, professional maintenance companies (building maintenance companies) and Homeowner Associations should be more empowered to contribute to fulfil Ukraine's energy efficiency targets in the multi-apartment buildings sector.

A nationwide National Database of Energy and Operational Characteristics of Buildings exists and enables exchange with third-party energy management and monitoring systems software. Government bodies, enterprises, institutions, and organizations belonging to the government management sphere on various levels in Ukraine introduce and ensure the functioning of energy management systems following the Resolution from 2021 "On the Implementation of Energy Management Systems," which was adopted following the Law of Ukraine "On Energy Efficiency". Energy audits for buildings are conducted by building energy auditors following the Law "On Energy Efficiency of Buildings" and the professional standard "Building Energy Auditor".

In 2023, Ukraine enabled the uptake of e-mobility by equipping buildings with a minimum number of recharging points and ducting infrastructure. The requirements prescribed that new construction projects of multi-story residential buildings must consider the need to provide at least 50% of parking spaces for vehicles equipped with electric motors and charging stations for electric vehicles. A law on the association of co-owners of MABs exists and gives a legal basis for HOAs to invest in the energy efficiency of multi-apartment buildings. However, there are currently no mandatory requirements for existing non-residential and residential buildings which would oblige them to support the uptake of e-mobility by equipping existing buildings with certain minimum numbers of recharging points and ducting infrastructure.

The war is currently the key obstacle for Ukraine to enforce fully its regulatory policies within the building sector. **Namely**, **although strategic planning and the transposition of relevant EU frameworks and acquis, and the adoption of laws, by-laws, and norms for the building sector is possible and being progressively undertaken by the Ukraine Government, a gap (the ability to implement) to be able to enforce the legal requirements fully will remain existing during wartime**. Moreover, to ensure full alignment with EGD goals (climate-neutral building stock in 2050) and EPBD requirements, the minimum technical (energy efficiency) requirements for new and reconstruction of existing buildings should be stricter/more progressive towards reduced energy consumption, i.e. an updated pre-defined minimal energy class (on demand and primary energy level) required to be met when renovating existing and/or constructing new buildings is missing as well and should be further developed. Ukraine is also missing the adoption of a mandatory requirement stating that a valid energy certificate must be accompanied for selling, renting, and advertising purposes of buildings (issued). Besides that, Ukraine hasn't yet introduced a scheme for renovating passports. Given the 2050 goal of the EGD and its objective to have a net zero-emission building stock, the energy efficiency class scale in Ukraine should include a pre-defined minimal energy class on the primary energy level required to be met when renovating existing and/or constructing new buildings. This would ensure that the country's energy mix, buildings' energy supply, and demand are taken into account when implementing its renovation strategy.

Financial capacity

During the last few years, the country has experienced an uptake of investments in the public sector and residential building energy efficiency measures. Most of the investments' financial sources are IFI and/or donor funding (vertical funds), financing the implementation of energy efficiency/renewable energy measures primarily via grants and concessional loans. Energy modernization and green building projects in Ukraine have been financed partly from the state budget, grants from the Energy Efficiency Fund, and investments from international organizations in the form of grants and soft loans (EIB, WB, NEFCO, and various international and bilateral donor organizations).

Different Ukrainian energy sector institutions absorbed more than €2.3 billion in aid for projects from 2014 to 2018, which shows an absorption and implementation capacity for funding energy efficiency projects in the buildings sector led by authorities. From 2014 to 2021, the government supported the Warm Loans loan program for home insulation and local energy efficiency measures. The Programme implemented measures to encourage the population to implement energy efficiency measures by reimbursing part of loans taken to purchase non-gas boilers and energy-efficient equipment and/or materials. More than 865,000 families anticipated in the Program, which raised 215 million EUR for energy efficiency measures.

The Ukrainian government has developed different financial instruments for different building groups (public, residential – MABs, and individual buildings) and allocated a substantial amount of state funds to its institutions to increase the energy efficiency of its building sector and support energy poverty. In 2022, the Ukrainian government allocated state support for implementing energy efficiency measures (1% of all annual budget expenditures, which is 375 million EUR). This state support was suspended with the outbreak of the war. The Ukrainian government also established the Energy Efficiency Fund to support condominiums with energy efficiency/renewable energy investments, and thus the implementation of the Building Renovation Strategy. The Fund had two programmes (EnergoDom and Renovate Home), focusing on energy modernization and restoring war-damaged housing stock. The number of projects implemented by the Fund shows that this could be one of the key domestic institutions driving Ukraine's decarbonization within the residential buildings sector.

The current focus is on the repair and adaptation of buildings damaged by the war, and most of the projects and financial agreements between Ukraine and financing institutions are aiming to repair damage caused by Russia's military aggression. However, although in war, in April 2023 the Ukraine's Parliament adopted a Law establishing the State Fund for Decarbonization and Energy Efficiency Transformation, which was later established as a separate institution (Decarbonisation Fund of Ukraine). The Fund will work on a polluter-pays principle and generate revenue via environmental taxes, which will be further used to finance energy efficiency measures, the introduction of alternative energy sources, and decarbonization. Additionally, Ukraine has a subsidy programme in place that supports vulnerable groups.

Another key driver that enables Ukraine's financial readiness is that the NECP adopted in July 2024 defines several financial measures that directly aim to support energy efficiency

retrofits of the building stock. These include "Activities of the Energy Efficiency Fund", "Decarbonization and Energy Efficiency Transformation Fund", "Energy Efficiency Obligation Scheme", and "Implementation of the State targeted economic Program to support thermal modernisation of buildings".

Given the number of existing public and residential buildings in Ukraine, it can be stated that there is a gap between the pre-war existing funding volume and funding needs for buildings and renovation regarding EGD decarbonization objectives. Due to the relatively high investment costs and relatively low energy tariffs, citizens (residential sector) have a preferred focus on grant financing for energy efficiency/renewable energy measures; however, only a limited amount of government grants was available for end users such as Ukraine, i.e., compared to the overall building stock. Although different financial instruments and sources exist in Ukraine (with one of the most developed portfolios of domestic institutions providing possibilities/support to financing energy efficiency measures in the building sector compared to other EU accession countries), one of the key challenges after the war will be the coordination of activities and allocation of responsibilities to implement National building renovation plan, making the operationalization of the renovation programme, from financing from domestic sources, organized and systematic. Moreover, Ukraine will also have to increase its financial volume, which would support such a large-scale renovation programme and thus the fulfilment of EGD goals within the building sector.

Sectoral capacity

With the successful implementation of energy efficiency projects in the years before the military aggression, it is safe to state that Ukraine's building sector has the knowledge and skills to plan and apply energy efficiency measures in accordance with the currently required national norms and technical standards, as well as to apply nZEB enabling technologies. Ukraine has had a systematic growth of technological solutions, introduction of automation and digitalization, and its end-users/consumers had trust in innovations and investment programs. The market maturity and availability of technologies for reducing energy consumption of buildings to a nZEB level was on a sufficiently high level. Moreover, there was a sufficient supply of both domestic and international companies producing heat boilers/heating systems, energy-efficient windows, and heat-insulating materials, and renewable energy systems for buildings.

The rising interest of Ukraine in energy sustainability has resulted in a growing demand for engineers skilled to analyse, design, and develop effective solutions resulting in nZEB buildings. In the past six years, more than 13 500 energy certificates have been issued in Ukraine. Today, there are more than 3000 energy auditors in the building market, which is an excellent basis and knowledge of energy professionals that could contribute to the EGD objectives of the buildings sector in Ukraine. The Ukrainian government plans to update approaches to vocational and technical training, giving special attention to the application of modern construction technologies and environmentally sustainable building materials. There is a focus on integrating renewable energy sources and digital solutions into building engineering systems. The introduction of comprehen-

sive schemes for professional training and qualification is envisioned, combining industry-specific knowledge and skills in construction, energy, and ecology.

Currently, Ukraine (State Agency on Energy Efficiency and Energy Saving) is working on the development of the National Energy Efficiency Monitoring System with the aim of enabling the implementation of EU directives and the Law "On Energy Efficiency." The System aims to be a single centralised information system ensuring the collection, processing, storage, protection, review, and use of information in the field of energy efficiency – i.e. provide an energy monitoring and management system.

Overall, from a pre-war perspective, key non-governmental stakeholders had great potential and relevant technical resources and skills of energy professionals and workers necessary to implement and support Ukraine's decarbonization of the buildings sector. The military aggression has created numerous obstacles to implementing decarbonisation plans. It does not allow the construction market to fully develop as the war creates risks and uncertainty for both - businesses and the population.

Today, Ukraine is experiencing a significant shortage of qualified professionals who could support the green transition. The number of available specialists does not align with national goals and market demands. This situation is influenced, in part, by the decline in the professional training system, low levels of remuneration, and the current unattractiveness of construction professions. However, the potential for job creation in the construction sector remains substantial but cannot be utilised during wartime. Currently, there are numerous challenges and restrictions regarding the transportation of technical equipment and construction materials, freezing of activities of individual companies, destruction of production enterprises, reorientation of activities in war conditions, outflow of qualified performers, etc.

Given the scale of needed post-war reconstruction linked with decarbonisation of Ukraine's building stock, the migration of energy professionals from Ukraine to other countries, the participation in war activities of the population/existing workforce, and the current decline of interest for construction professions due to wartime, it can be stated that a full-scale decarbonisation of Ukraine's building stock is currently not possible to be undertaken due to lack of human resources. The most significant gap for Ukraine is not the knowledge and skill set of energy professionals and workers but the required number of energy professionals to undertake a countrywide renovation programme.

Main priorities for the green transition

To be able to decarbonize its building sector by 2050 and thus meet the EGD objectives, Ukraine would need to undertake the following immediate actions:

Increase the ability to understand and reflect new EED and EPBD requirements in Ukraine's laws and by-laws – Ukraine's Government and its institutions relevant to the buildings and renovation sector need to increase their ability to understand and reflect new EED (adopted in 2023) and EPBD (adopted in 2024) requirements into national laws and by-laws – this should be done by requiring targeted technical assistance from IFI and donor funding projects, as well as educational/capacity building support to increase the expertise of existing staff members. In this regard, from an essential technical angle - the currently existing laws and by-laws defining minimum technical/energy performance requirements of buildings need to move from required energy demand to final and primary energy as the required norm for designing new buildings, undertaking reconstruction of existing buildings, and auditing building to produce energy certificates. i.e. moving from heat demand (constructional measures) to primarily energy (including mechanical engineering/heat production measures, renewable energy, the energy required for lighting and cooling, and the country's energy mix). Therefore, updates of existing laws, regulations, and norms need to be undertaken to reflect EED and EPBD recasts (including primary energy as the new required norm when assessing the energy performance of different building types). Primary energy should also be mandatory in energy certificates of buildings' energy performances/classes. Moreover, the solar readiness of buildings needs to be reflected in technical norms and standards/requirements.

Develop the National building renovation plan & implementation/ operationalization plans - Ukraine's authorities responsible for EED, EPBD and the National building renovation plan need to quantify annual targets in order to be able to better plan, execute and track/monitor the renovation strategy (i.e. Ukraine still needs to more precisely define the expected annual number and type of buildings (public, MABs and individual housing) to be retrofitted including the number or floor area of the 43 % worst-performing residential buildings, renovation rate's annual energy saving targets (GWh/a), expected emission reduction (t C02), numerical targets for the deployment of solar energy in buildings as well as estimated investments and tentative allocation of domestic and international funding sources within the operational plan/programme of the renovation strategy; i.e. a ten year Programme with quantified annual targets should be developed and adopted; thus, based on the Programme a three year Operation Plan with clear targets and responsibilities for renovation. Moreover, the currently existing Strategy should redefine its long-term goals (between 2040 and 2050) from "nearly zero energy buildings" to "zero emission buildings".

Define clear roles and responsibilities to carry out Ukraine's National Building Renovation Plan. Given the existing portfolio of institutions and developed financial mechanisms to support energy efficiency investments in the building sector, Ukraine needs to clearly define each institution's role to delivery/support targets for the country's building renovation plan (including responsibility on the type of building, annual renovation rate per institution, coordination mechanisms and lead roles). The Government needs to clearly define roles and responsibilities and allocate a mandate to its institutions to carry out, coordinate, and financially support Ukraine's renovation plan.

Quantifying nZEB and net-emission buildings & enabling solar-ready buildings' norms. The legislation on defining minimum energy consumption for various types of public and residential buildings is being drafted. Authorities are highly advised to utilise these undertakings/activities to define/quantify i) the minimum renewable energy share required for nZEB buildings, ii) to define net-zero emission buildings for Ukraine, and iii) to enable solar-ready norms/technical requirements. Furthermore, given the revised directive and the fact that zero-emission buildings will be the new standard for new buildings, Ukraine should take this trend into account as soon as possible and ensure that their technical requirements reflect that new buildings are solar-ready buildings (which is becoming the new norm). For existing public and non-residential buildings, solar systems (photovoltaic and thermal) will need to be gradually installed (starting from 2027, where this is technically, economically, and functionally feasible; varies depending on the building type and size).

Decision on a mandatory BBB (build back better) requirement linked with deep renovation or nZEB (where possible). Ukraine should adopt a decision/rule that would make it mandatory for each war-demolished building (public and residential) to be built back on a built back better principle (deep renovation or nZEB where possible). This would also enable more accurate planning of the required funds for reconstruction.

Align the higher education curriculum as early as possible with the country's decarbonisation objectives, to ensure a long-term pool of engineers and designers capable of understanding and delivering nZEB solutions, promoting the post-war recovery, and attracting more students to technical universities.

The risks linked to not meeting the decarbonization goals of the building sector in Ukraine by 2050 will remain a high energy dependence and insecurity of energy supply for the majority of the population, a direct dependence on imported gas, expected higher number of underheated buildings and non-satisfied consumers/population, and missing out a key post-war economic driver – the generation of a significant number of green jobs and the employment of the domestic work-force to undertake the reconstruction of the building sector on a large scale.

1.5 Transport and Mobility

Status and trends

Ukraine's transport sector is crucial to the economy, contributing an average of 6.2% to GDP from 2016 to 2021, though this declined to 5.4% in 2021. The transport network includes 163,033 km of roads, 19.8 thousand km of railways (47% electrified), and 1,569.4 km of navigable waterways, along with key seaports and airports, reflecting its role as a strategic transit hub between Europe, Asia, and America. While progress has been made in integrating into the Trans-European Transport Network (TEN-T), full integration is yet to be achieved.

The sector faces significant challenges, including a heavy reliance on fossil fuels. Over the past two decades, Ukraine's share of road vehicle emissions has increased significantly. According to Ukrstat 2018 data, the Ukrainian transport sector was responsible for about 10% of all GHG emissions but accounted for 71% of total Ukrainian oil consumption[88]. Road emissions are responsible for over 70% of all transport emissions, making it a priority to tackle for future transport policies[89]. Most commercial and private vehicles in Ukraine are running on fossil fuels, with 55.7% of passenger cars running on gasoline and 24.6% on diesel in 2022[90]. As of 2022, there has been a slight shift away from gasoline and diesel vehicles toward hybrid and electric alternatives, when the share of hybrid vehicles increased from 9.8% to 12.9%, and electric vehicles saw a significant rise from 1.1% to 5.8% compared to 2021[91].

Many commercial and private vehicles in Ukraine are outdated and use fuel inefficiently, increasing greenhouse gas emissions and air pollution. The Global Fuel Economy Initiative in Ukraine (2018) report indicates that the average age of the Ukrainian vehicle fleet is about 19 years (as of 2015). The age of the fleet is an indicator of its low efficiency in terms of CO2 emissions and other pollutants[92].

The war has inflicted massive additional damage on Ukraine's transport sector. With most of the new damage concentrated along the front lines in the east and south of the country, rail, and road networks remain under significant strain across the entire country. Frontline areas face the challenge of accommodating heavy weaponry and supply vehicles, while the western border regions are under increased pressure due to higher volumes of land freight passing through them. Additionally, road infrastructure continues to deteriorate due to limited maintenance, as state funding has been primarily directed toward military needs[93]. In addition, due to Russian military aggression, public transport is suffering significant losses: At least 500 buses, 195 trams, and 155 trolleybuses have been damaged or destroyed as a result of hostile attacks[94].

[88] UkrStat (2018) "Energy Balance of Ukraine"
[89] Low Carbon Ukraine, Berlin Economics, Alexander Roth (2019) "Low-Carbon Transport Policies for Ukraine"
[90] Ukrainians prefer gasoline cars, but the share of diesel cars has increased. Results 2022
[91] UkrStat (2018) "Energy Balance of Ukraine"
[92] Low Carbon Ukraine (2021) "Low-Carbon Transport Policies for Ukraine".
[93] World Bank Group (2024) "Ukraine - Fourth Rapid Damage and Needs Assessment (RDNA4) : February 2022 - December 2024".
[94] Ministry for Development of Communities and Territories of Ukraine (2024) "Restoration Digest".

Since February 2022, amid constant attacks on critical infrastructure, Ukrainian Railways has endured daily strikes, leaving the railway network repeatedly damaged. At least 126 railway stations and over 500 km of tracks have been damaged as of November 2024. Restoring and increasing carrying capacity is vital to ensure essential goods reach both communities and businesses.

Road transport status

The total number of cars in Ukraine as of the beginning of 2023 is 11.67 million for all years of production. While Ukraine's urban motorization is still low compared to the EU countries, the rising popularity of private cars has Ukraine's cities firmly in its grip. As of 2020, the level of motorization in Ukraine was 192 cars per 1,000 inhabitants, the lowest in Europe at the time. By 2021, this figure had increased to 245 cars per 1,000 inhabitants[95]. However, the level of motorization is much higher in cities. For example, according to the report on the strategic environmental assessment of the draft City Target Program for the Development of Kyiv's Transport Infrastructure for 2024-2025[96], the number of private vehicles in the city increased by one and a half times between 2019 and 2022 (every third Kyiv resident owns a car). In January 2019, 927 thousand cars were registered in the capital; in January 2022, the number was 1375 thousand.

At the beginning of 2021, the level of motorization in Kyiv exceeded the mark of 400 cars per thousand inhabitants for the first time - 407 cars per thousand inhabitants. Other high rates are in Volyn (314 cars per thousand inhabitants), Kyiv (311), and Zaporizhzhia (300).

Insufficient development of public transportation and lack of adequate cycling infrastructure are among key factors contributing to a high level of urban motorization, leading to congestion of city streets with private cars and traffic jams, scarcity of parking spaces, and increased air pollution. These developments increase Ukraine's dependence on foreign fossil fuel (and vehicle) imports while negatively affecting the attractiveness and competitiveness of urban areas.[97]

The total length of Ukrainian roads is 169.6 thousand kilometers. According to the World Bank Group's 2019 research, more than 90% of them are worn out and require immediate repair or renewal. At the same time, **39% of roads of national importance do not meet the requirements for durability and 51% for evenness**[98]. In 2018, Ukraine scored just 2.4 out of 7 on the Organization for Economic Cooperation and Development's (OECD)'s index of perceived road quality[99].

[95] Рівень автомобілізації в Києві перевищив 400 автомобілів на тисячу мешканців

[96] Обговорення проєкту Міської цільової програми

[97] Solomakha, I. and V. Raskin (2023) "Аналіз та прогноз розвитку автомобільного парку України: відокремлення реальності від реєстрації та системний погляд на майбутнє". Проблеми і перспективи економіки та управління, (4 (36), 165–173.

[98] Better Regulation Delivery Office (2019) "Ukrainian high-quality roads require transparent processes, proper control, competition and UAH 5 trillion"

[99] Better Regulation Delivery Office (2019) "Ukrainian high-quality roads require transparent processes, proper control, competition and UAH 5 trillion"

According to the 2020 report by the Ministry of Infrastructure of Ukraine, the density of highways in Ukraine (14.3 km/1,000 km²) is comparable to the EU average (19 km/1,000 km²). However, the density of all roads is significantly lower (281 v. 1,172 km/1,000 km²), indicating insufficient regional and local connectivity[100].

Public transport and cities' mobility status

The lack of comfortable, efficient and reliable public transport in Ukraine reduces its attractiveness to the population and encourages the use of private cars. As of the end of 2018, 19 tram networks were operating in Ukraine (in comparison to 32 in 1991). Over the last 30 years, the number of trolleybus networks has decreased less markedly, from 45 to 41. There are currently three metro networks in the country – Kyiv, Kharkiv, and Dnipro. At the same time, the rolling stock is being renewed too slowly, and about 90% of tram fleets and trolleybuses have already exceeded their maximum service life.

As for positive trends in this area, in 2024, three Ukrainian cities received new urban public transport vehicles as part of the Urban Public Transport of Ukraine project of the Ministry of Communities and Territories Development and the European Investment Bank (EIB). The project managed to attract a tranche of the European Investment Bank worth €17.25 million, which supported the acquisition of new buses, trolleybuses, and trams, along with essential spare parts and maintenance equipment, ensuring reliable and efficient public transport operations. This investment includes new buses for Kyiv, Ukrainian-built tramcars for Odesa, and trolleybuses for Sumy[101]. Contracts for the supply of buses and trolleybuses were signed for three more cities. Late in 2024, EIB announced another €16.5 million in EU-backed funding to renew urban public transport in Kyiv, Mykolaiv, Ivano-Frankivsk, and Odesa[102].

Many Ukrainian cities do not have adequate conditions for safe cycling despite the potential for cycling development. More than 30 cities in Ukraine have developed cycling infrastructure concepts, strategies, or plans, which included some analysis of user needs and obstacles to their implementation. However, none of the programs have been implemented. According to the study "The need for cycling and obstacles to its implementation in cities and regions of Ukraine" conducted in 2020, the main obstacles to cycling are user insecurity and a lack of infrastructure ("no place to ride")[103].

Efforts to promote electrification, such as tax incentives, have increased the number of electric vehicle registrations from 62 in 2014 to over 51,700 electric vehicles in 2024, marking a 38% increase from the previous year. Among them: Passenger Electric Vehicles: 50,458 (+37%); Commercial Electric Vehicles: 1,264 (+64%); Electric Buses: 2[104]. However, adoption remains local-

[100] Ministry of Infrastructure of Ukraine (2020) "Technical Condition of Public Highways"
[101] European Investment Bank (2024) "Ukraine: EIB provides over €60 million to support road reconstruction and urban transport renewal"
[102] European Investment Bank (2024) "EIB provides €16.5 million for new public transport in war-torn cities of Ukraine"
[103] U-Cycle (2020) "Результати дослідження "Потреба у розвитку велотранспорту та перешкоди до її реалізації у містах та регіонах України"
[104] Better Regulation Delivery Office (2022) "Rebuilding Ukraine's transport sector – how to make it "green"?"
Ukrainian Electric Car Market Surges by 38% in 2024

ized, and broader strategies are needed to scale smart mobile solutions; EVs make up about 1% of the total number of cars. Buyers tend to prefer used cars, which account for over 80% of sales[105]. There is also a need for expansion of rail electrification (beyond the current 47%), improvement of multimodal transport, and integration of digital solutions.

Ukrainian cities are advancing sustainable mobility, with Kyiv and Lviv leading the way. Efforts focus on expanding public transport, cycling infrastructure, pedestrian zones, and cleaner vehicles. For example, Kyiv has increased its cycling lanes by 60%, building 100 km of cycle paths over the last 5 years. Public transport modernization includes electrifying the vehicle fleet in major cities, and the shift to electric vehicles is supported by the addition of more than 2000 new EV charging stations in Kyiv, Lviv, and Dnipro. Smart mobility solutions like e-tickets and intelligent traffic management systems further improve urban transport efficiency. These initiatives reflect a broader shift toward greener, more efficient urban mobility.

Railway transport status

Since the full-scale invasion in 2022, Ukraine's rail transport has become a crucial lifeline. Ukrainian Railways has evacuated millions from war zones, transported troops and supplies to the front, and facilitated diplomatic visits. With seaports blocked, trains became the primary way to export goods, especially farm products. They also deliver humanitarian aid. The railway keeps running despite constant attacks damaging stations and tracks, symbolizing Ukrainian resilience. This trend reversed the pre-full-scale invasion development of railway transport in Ukraine, manifested in a sharp decline in passenger numbers from 499 million in 2000 to 81 million in 2019, although it continues to play a central role in freight transportation. At the end of 2024, Ukraine's railways transported 174.9 million tons of cargo, 17.9% more than in 2023[106], of which exports made up 48%, up from 38% in 2023. Meanwhile, domestic transport fell from 57% to 46% of the total, and imports increased by 40.9% to 9.63 million tons.

The Ukrainian government seeks to transform the railway infrastructure in the western part of the country and adapt it to European standards. This is expected to increase the capacity of railway lines to the EU and allow local logistical hubs to gain a substantial portion of the added value from rail trans-shipment operations[107].

Between 2022 and 2024, with the support of the World Bank, Ukrainian Railways procured 18 sets of modular bridges and nearly 90 pieces of equipment, including loaders, excavators, heavy-duty truck cranes, and other tools needed to repair and maintain the railway infrastructure. This equipment was used to restore 17 destroyed railway bridges and repair more than 80 engineering structures, reconnecting communities that were cut off during the invasion and improving westward transport linkages to mitigate the impacts of Black Sea shipping disruptions.

[105] На дорогах України все більше електромобілів попри блекаути. Чому?
[106] Укрзалізниця у 2024 році збільшила обсяг перевезення вантажів на 17,9%
[107] World Bank Group (2025) "Restoring and Transforming Ukrainian Railways for a Better Future"

The inland waterways in Ukraine consist of more than 4,000 km of navigable rivers, with the main Dnipro River running through the country for nearly 1,100km. Its leading role in the country's inland waterways is supported by the Ukrainian part of the rivers Danube (more than 160km), Buh (about 155km), and Dniester (about 900km). As a critical transport hub between Europe and Eurasia, Ukraine mostly uses inland waterways for carrying commodities (agricultural and ore), iron and steel products, byproducts and river sand (mostly used for the country's constantly rising construction demands)[108].

Inland waterways, which used to show growth, need investment to unveil their capacity to play a significant role in Ukraine's transportation system. The volume of cargo transported by inland waterway transport in Ukraine fell from 60 million tons in 1990 to 12 million tons in 2006, and then to 5 million tons in 2011, and in 2021 amounted to only 2 million tons. In recent years, inland waterway transportation has accounted for about 0.8% of all transportation[109].

The inadequate infrastructure on Ukraine's rivers prevents the efficient use of the cargo transportation market. For example, the maximum service life of many locks is 70 years. Due to chronic underfunding of lock maintenance, which in recent years has not exceeded 50% of the required amount, there is a real threat of a man-made disaster and increased risks of accidents in water transport[110].

Strategic and financial capacity

Although the institutional environment governing the mobility sector in Ukraine is very complex and decentralized, the country's public policy and legislation create favourable conditions for a green transition.[111] for the period up to 2030 was developed with the support of the EU with the participation of international consultants and approved by the Government of Ukraine in 2018 under the slogan "Drive Ukraine". The Strategy sets several tasks for Ukraine directly related to the development of sustainable mobility, including stimulating the use of more environmentally friendly means of transportation; ensuring transport accessibility for the population, in particular, reducing travel time for residents of settlements; curbing the motorization of cities through the development of public transport, cycling,Table 5) provide a framework for addressing urban mobility issues focusing on sustainability and inclusiveness. However, implementing these policies remains inconsistent, often hampered by overlapping responsibilities, weak interagency coordination, and limited enforcement capacity. Municipalities often lack the financial and technical capacity to implement Sustainable Urban Mobility Plans (SUMPs), which are neither mandatory nor standardized under current legislation. This is one of the critical challenges, not only in Ukraine, but that also slows down and often hinders the preparation of comprehensive strategic plans, particularly action plans, and reduces the effectiveness of the steps taken.

[108] GMK Center (2024) "Ukrainian Railways increased export shipments in 2024 by 51%"

[109] Alekseievska, H., Kolosok, E., & Hryhorenko, O. (2023) "Potential of Ukraine's Inland Water Transport as a Factor of Sustainable Development". Economic Innovations, 25(3(88), 35-49

[110] Kasych A.O. (2018) Vodni resursy Ukrainy yak osnova zabezpechennia stiikoho rozvytku transportnoho kompleksu [Water resources of Ukraine as a basis for ensuring sustainable development of the transport complex]. Effective economy No 8. pp. 1 - 19.

[111] The National Transport Strategy of Ukraine

Table 5. The state of the Sustainable Urban Mobility Plan in Ukrainian cities

City	Status
Zhytomyr	Approved
Vinnytsia	Under development
Ivano-Frankivsk	Being implemented
Lviv	Being implemented
Mykolaiv	Approved
Poltava	Approved
Kharkiv	Approved
Kherson	Under development
Ternopil	Approved

Regulatory contradictions between the State Construction Standards and the Comprehensive Traffic Management Scheme undermine the goals of the Sustainable Urban Mobility Plan. Despite recent steps toward decentralization and joint planning, most municipal governments lack the financial and technical capacity to modernize infrastructure, integrate digital solutions, or adopt climate-friendly policies. Integrating spatial planning with transport planning is one of the most important factors in creating a convenient, efficient, and environmentally sustainable urban environment. An integrated approach to the territorial development and transport infrastructure can enhance accessibility to public spaces, workplaces, and residential areas while reducing reliance on private vehicles. This, in turn, contributes to the development of public transport, cycling, and pedestrian infrastructure, reducing congestion, improving the environmental situation, and increasing the quality of life of residents.

The Action Plan for implementing the National Transport Strategy of Ukraine until 2030 was adopted in April 2021, also with the support of the EU. It outlines the implementation of Ukraine's commitments in the transport field under the Association Agreement with the EU, in particular, the European Green Deal (EGD), the renewal of electric public transport, the development of cycling infrastructure, and electromobility. An extensive list of measures is aimed at developing infrastructure for electric vehicles. They include streamlining the legislation on them, expanding the network of electric charging stations (ECS), in particular, building a national network of high-speed ECS in cities and on international roads.

The government sees attracting funds from international financial institutions (IFIs) to purchase public electric transport rolling stock as the main incentive and means of city transition to electric transport. At the local level, city councils and their executive bodies have among their competencies "determining ways to stimulate the use of electric vehicles and other environmentally friendly modes of transport" (Articles 6, 7 of the Law of Ukraine "On Road Traffic"[112]).

There are few examples of implementing these competencies locally in Ukraine so far. Today, the legislation does not set requirements or goals for cities to develop electric mobility. Low-emission zones (LEZs), such as those in London, Milan, or Stockholm, are also impossible to implement, as local governments cannot set such restrictions without legislative regulation at the state level.

Relatively recent changes to the law focus only on incentives for the purchase and importation of electric vehicles and tax incentives for possible investments in vehicle and battery production. Unfortunately, this law does not include electric public transportation.

In July 2021, the Ukrainian Parliament adopted amendments to the Customs and Tax Codes, extending the grace period for the import of electric vehicles until the end of 2025. Until January 1, 2031, imports of several goods into Ukraine by companies that create or modernize their production facilities for producing electric vehicles and compressed or liquefied gas vehicles will be exempt from VAT and import duties. In addition, companies that manufacture electric vehicles, batteries, and charging stations in Ukraine are exempt from corporate income tax until 2035. According to the initiators of the new regulations, this should encourage the opening of electric vehicle manufacturing plants in Ukraine. The laws came into force on January 1, 2022.

In 2019, the Verkhovna Rada passed Law of Ukraine No. 10405 "On Amendments to Certain Legislative Acts of Ukraine on Creating Access to the Infrastructure of Charging Stations for Electric Vehicles"[113]. It obliged to amend DSTU 4278:2006 to provide for special license plates with green font color for vehicles driven by an electric motor and not having an internal combustion engine. Thus, starting from the end of 2020, when electric vehicles are registered and re-registered, they will receive the so-called "green" license plates, and this rule applies only to battery cars (it does not apply to hybrid cars).

In 2019, the possibility of organizing parking spaces for electric vehicles was introduced, for which purpose new road signs and plates "For electric vehicles", "Except for electric vehicles", "Electric vehicle charging station" were introduced to DSTU 4100:2014 and the Traffic Rules. According to the Code of Administrative Offenses of Ukraine, these spaces are intended for parking vehicles equipped with electric motors (one or more), including both types of hybrids.

The requirement to provide charging infrastructure at the design and construction stages is present in the state building codes of Ukraine. In particular, the State Construction Norms (SCN) B.2.3-15:2007 "Parking lots and garages for passenger cars" contains a provision for the ar-

[112] The Law of Ukraine "On Road Traffic"

[113] Law of Ukraine No. 10405 "On Amendments to Certain Legislative Acts of Ukraine on Creating Access to the Infrastructure of Charging Stations for Electric Vehicles"

rangement of at least 5% of parking spaces in garages and parking lots of the total number of parking spaces for vehicles equipped with electric motors (Amendment No. 3 of 2021). The SCN B.2.2-12:2019 "Planning and Development of Territories" contains a provision for the installation of electric charging stations on the main network of settlements, as well as on highways of national importance, where the number of charging stations should be at least one per 100 km (clause 10.8.33).

At the same time, public demand and business interest are strengthening the green transition trends. Thus, the popularization of ecological transport leads to increased demand for electric cars, scooters, and bicycles. International investors are being attracted: the EBRD, the World Bank, and the EU are financing sustainable transport projects. Business support is expressed in the transition of corporate fleets to electric transport, and the number of ecological logistics solutions is increasing. These conditions create the foundation for the ecological renewal of Ukraine's transport system, reducing CO_2 emissions, and improving the quality of life in cities.

Ukraine's financial capacity for smart mobility faces significant constraints but also presents opportunities for growth. The war has magnified existing infrastructure challenges, with reconstruction costs estimated at UAH 212.7 billion through 2026. Despite establishing mechanisms like the eco-tax-funded "State Fund for Decarbonization," the low baseline for these taxes limits their effectiveness in driving green mobility.

International aid and private sector engagement play critical roles, with the EU, EBRD, and others providing much-needed support. However, the reliance on external funding and the lack of stable domestic financial models creates vulnerabilities. Risk mitigation and regulatory clarity are essential to attract private investments, which remain underutilized.

To enhance financial capacity, Ukraine must prioritize expanding fiscal incentives—such as carbon-based vehicle taxation, congestion charging, low-emission zones, green leasing, financing support, and tax incentives for sustainable transport modes (both public and private); align international aid with sustainable mobility projects; and implement institutional reforms to improve funding governance. With strategic action, the country can rebuild its transport systems in line with European Green Deal principles, fostering long-term sustainability and resilience.

Digitalization in the smart mobility sector is advancing slowly but holds significant potential. Efforts include introducing systems like the SmartTicket for electronic passenger ticketing and the e-Cargo system for multimodal freight transport. However, the war has hindered implementation, with many projects either paused or only partially operational. In 2023, a significant step was the launch of the "e.Portal UZ-Cargo," a digital platform for cargo transport customers. Additionally, Ukraine joined the EU's Connecting Europe Facility Program, aiming to digitize transport and energy networks while implementing high-bandwidth digital technologies and 5G systems. Despite these advancements, a comprehensive national strategy for transport digitalization remains absent, and the integration of intelligent transport systems (ITS) is limited, particularly in urban areas.

Data collection in Ukraine remains fragmented, limiting the ability to monitor progress toward EGD targets and assess policy impacts. Despite the annual data collection by the State Statistics Service, available transport-related data remain superficial and insufficient for informed decision-making; existing datasets are often incomplete and not fully integrated. Open data initiatives exist but are only provided in fragments, underscoring the need for more comprehensive and accessible datasets.

The principle of a just transition in Ukraine's mobility sector is underdeveloped, with minimal focus on addressing equity and inclusivity. The war has heightened challenges, significantly impacting rural connectivity, accessibility for vulnerable groups, and the affordability of sustainable transport solutions. Rural areas and underserved regions face significant disparities in access to modern transport services, exacerbating socioeconomic inequalities. Public transport systems require urgent modernization to meet European Green Deal objectives, especially in suburban and rural areas where accessibility gaps persist. Active mobility, such as cycling, has seen some strategic planning, with national and city-level bicycle strategies developed before the war, but progress remains slow. To ensure inclusivity, Ukraine must prioritize targeted policies for equitable access, capacity building for underserved regions, and financial mechanisms to support the transition.

A lack of prioritization and funding limits research and Innovation in Ukraine's transport sector. The sector is not explicitly included in Ukraine's list of priority thematic areas for scientific and technical development despite its critical role in achieving green transition goals. Some progress has been made in adopting digital and electrification technologies, but these efforts are fragmented and heavily reliant on international aid and partnerships. Public transport modernization, such as electronic ticketing systems and electric vehicles, demonstrates potential but faces financing and infrastructure development barriers. Legislative and institutional support for transport innovation must be strengthened, particularly in integrating artificial intelligence, renewable energy, and energy efficiency technologies into transport systems.

EU Approximation

At the end of 2024, the European Commission adopted the annual Enlargement Package[114]. It contains a detailed assessment of the current state and progress of Ukraine towards accession to the EU.

Ukraine continues its commitment to implementing the priority transport rules of the EU acquis, as set out in the Association Agreement. In line with its commitments in the Roadmap for Ukraine and to drive reforms in the sector, Ukraine needs to adopt and start implementing the revised National Transport Strategy until 2030 and the Strategy for the Development and Expansion of Border Infrastructure with the EU Member States and the Republic of Moldova until 2030.

Harmonization of Ukrainian legislation and standards with European ones ensures Ukraine's effective integration into the **Trans-European Transport Network (TEN-T).**

Table 6. Key integration indicators regarding the Trans-European Transport Network (TEN-T) (2017–2024)

Indicator	2017	2020	2023	Changes
Length of TEN-T roads in Ukraine	4700 km	5400 km	6200 km	+32%
Railway electrification	44%	46%	50%	+6%
Motorway modernization	900 km	1500 km	2200 km	+144%
Number of high-speed railway routes	3	7	12	+300%
Increase in freight transit through Ukraine	135 m tons	160 m tons	190 m tons	+40%
Number of modernized border crossing points	5	8	12	+140%

Integration into the Trans-European Transport Network (TEN-T) offers improved connectivity to European markets, boosting trade and economic growth, but at the same time, requires investments in low-carbon infrastructure with the support of international donors. The introduction of intelligent transport systems (ITS) can optimize traffic management and logistics, increasing competitiveness. However, ensuring sustainability and resilience requires addressing the challenges of outdated technology, poor road safety, and limited institutional capacity while incorporating EU integration and green transition strategies to create a more efficient and sustainable transport system.

[114] Delegation of the EU to Ukraine, 2024. Commission adopts 2024 Enlargement Package

Significant regulatory reforms and legislative acts still need to be implemented in road transport, including the adoption of a law to bring road transport services up to EU standards. Transposing social and market rules for road transport is key to allowing Ukrainian carriers to compete on an equal footing with European ones and to ensuring the proper functioning and implementation of the EU-Ukraine road transport agreement.

In implementing the Road Safety Strategy, equal attention should be paid to the four pillars of a safe system, namely infrastructure safety, vehicle safety, safe road use, and post-accident care. In June 2024, the road transport agreement on temporary liberalization of bilateral and transit road transport between the EU and Ukraine was extended until June 30, 2025. The Interbus Protocol on International Regular and Special Regular Passenger Transport by Bus and Coach is in the process of ratification.

As of 2023, progress in reforming rail transport remains stalled due to incomplete legislation, despite partial alignment with EU technical standards. Ukraine also lacks an independent regulatory authority. Ukraine needs to adopt a new Railway Law to create the legal conditions for a competitive passenger and freight transportation market and to establish an institutional framework (independent regulatory authority, independent national security authority, and separation of infrastructure management from railway operations) that will allow for the implementation of the future railway law.

Maritime transport has been significantly revived by the Black Sea Corridor, which Ukraine launched in August 2023 after Russia withdrew from the Black Sea Grain Initiative. Despite the full-scale invasion, the Maritime Corridor remains crucial, transporting 73.4 million tons of cargo in the first 11 months of 2024, with over 3,000 vessels using the route since its inception and Ukrainian seaports handling a total of 91.1 million tons by December 10, 2024. Progress in harmonizing legislation with EU maritime principles, including state port control and vessel traffic monitoring, has been minimal. Ukraine's maritime sector struggles to meet regulatory and safety standards. The development and implementation of inland waterway transport regulations are ongoing to improve the safety of navigation and market functionality. Ukraine's participation in the EU Strategy for the Danube Region and bilateral agreements with riparian states reflect efforts to facilitate inland navigation. Ukraine should continue to work on fulfilling all requirements for the current process of certificate recognition on inland waterways.

Civil aviation remains grounded due to the closure of airspace. While regulatory harmonization with EU aviation rules is ongoing, revising the transposition list of the EU-Ukraine Common Aviation Area Agreement has not yet been considered.

No progress has been made in multimodal transportation. In terms of passenger rights, Ukraine has to make significant progress to harmonize its legislation with EU rules on passenger rights, in particular in the field of bus transport and the rights of persons with reduced mobility.

Challenges to a Green and Modern Transport System in Ukraine

Any transformation of Ukraine's transportation sector must consider the territorial impact of the war. The country's most industrialized regions—the east and south—are currently under occupation, disrupting domestic supply chains and reshaping Ukraine's integration into global trade networks. As a result, Ukraine's economic center of gravity has shifted westward (Figure 8), highlighting the disproportionate impact of the war on the eastern regions. Additionally, a significant portion of the workforce from these areas has been displaced, at least in the short to medium term. Transport sector reforms must address these imbalances, ensuring regional connectivity, accessibility, and economic resilience.

With trade routes shifting westward, Ukraine needs to adapt

Year-on-year change in export flows of production by oblast for May 2022 (incl. % of 2021 total)

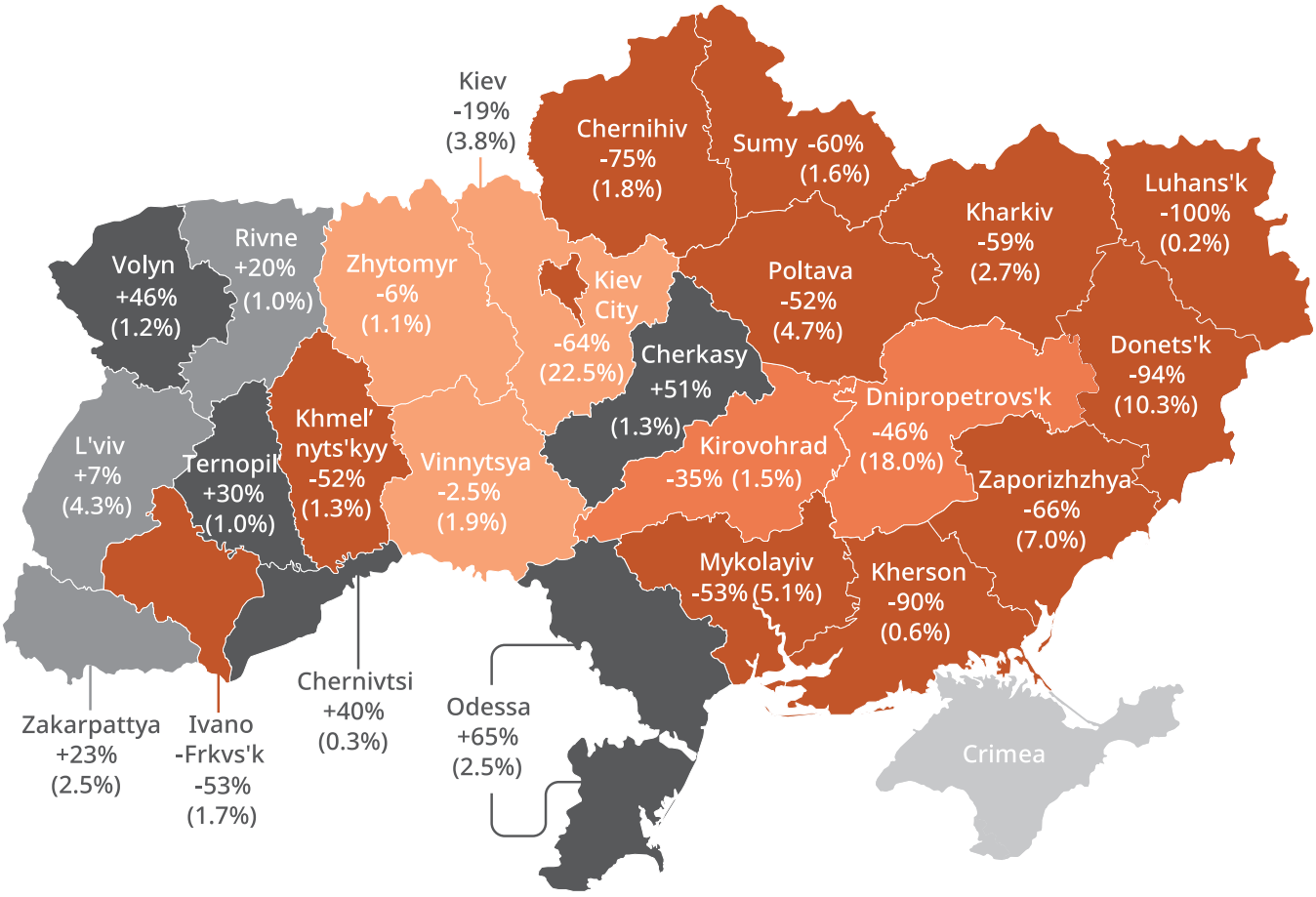


Figure 8. Analysis of the shift of trade routes to the west of Ukraine.

Source: Ukrainian National Service of Statistics, National Institute of Strategic Studies of Ukraine, BCG analysis.

Ukraine: A Sustainable Economic Recovery for People and Nature, WWF-Ukraine & BCG, 2022

Ukraine's infrastructure rebuilding efforts provide a crucial opportunity to align mobility strategies with sustainability principles, enhancing climate resilience while modernizing transport networks. This requires integrating ecological impact assessments, nature-based solutions, and policies for ecological connectivity into all infrastructure projects.

From a financial perspective, failing to implement a green transition will lead to higher CO_2 taxes in transport and raise logistics and transportation costs. For example, the EU's Carbon Border Adjustment Mechanism (CBAM), set to take effect in 2026, could increase the cost of Ukrainian transportation, as many Ukrainian logistics companies still rely on high-emission vehicles. A lack of green reforms in the logistics sector may cause European companies to cut ties with Ukrainian transport operators that continue to use outdated diesel trucks, further isolating Ukraine from key markets.

Beyond taxation, investment and international financing risks must be considered. The EU, EBRD, and World Bank prioritize funding sustainable transport projects. Without meaningful reforms, Ukraine could lose access to these funding sources, limiting its ability to modernize infrastructure and attract private sector investment. Large multinational firms may also hesitate to invest in Ukraine's transport sector if environmental standards remain outdated.

The social cost of inaction in modernizing public and private transport fleets will worsen air quality, particularly in cities where outdated public transport and high-emission private vehicles remain prevalent. This will contribute to a growing public health burden. Furthermore, insufficient investment in public transport modernization will lead to declining service quality, rising fares, and widening mobility inequality, disproportionately affecting low-income and vulnerable populations.

The **lack of digitalization in the transport sector and the absence of a CO_2 emissions monitoring system in logistics hinder effective emissions control**. Additionally, insufficient government support for charging station operators slows the expansion of charging infrastructure, delaying the transition to electric vehicles.

Main priorities for the green transition

Ukraine must continue to align its transport sector with EU legislation to bring transport services up to European standards by adopting Euro 6 and 7 standards and other relevant road transport laws, advancing alternative fuel policies, implementing safety reforms, modernizing railways, harmonizing passenger rights, and ensuring fair competition.

To accelerate the transition to low-emission and alternative-fuel transport, a comprehensive national strategy needs to be developed to expand incentives for electric and hybrid vehicles, enhance EV charging infrastructure, and promote biofuels and hydrogen in public and freight transport. Clear emission reduction targets, stricter vehicle emissions standards, and accelerated railway electrification must be established. Emphasis should be placed on shifting container transportation from road to rail and developing integrated intermodal transport hubs and

consolidation centers, including in urban settings. This approach should encompass all vehicle sizes, from trucks to cargo bikes, as well as utility services in cities, while prioritizing the construction of supporting infrastructure such as charging stations, parking, and maintenance facilities. Additionally, sectoral transport programs should be developed to ensure a balanced distribution of cargo flows across different transport modes, favoring more environmentally friendly and energy-efficient options like rail and inland waterways.

Ukraine must prioritize expanding regulatory mechanisms and fiscal incentives supporting the implementation of strategic objectives and achieving targets. These include tax incentives for switching to sustainable transport modes (both public and private) like carbon-based vehicle taxation, congestion charging, and low emission zones. Financial capacity should be enhanced through green leasing and financing support and aligning international aid with sustainable mobility projects. Institutional reforms are needed to improve funding governance. Implementing Sustainable Urban Mobility Plans (SUMPs) is key to improving urban planning by reallocating road space for public transport, cycling lanes, and pedestrian-friendly infrastructure and adopting the "15-minute city" concept.

Future digitalization and data collection development will ensure Ukraine's transportation sector remains competitive and sustainable. Expanding Intelligent Transport Systems (ITS) and accelerating the rollout of high-bandwidth digital technologies, such as 5G and secure data-sharing platforms, will enhance efficiency in urban mobility and freight transport. A centralized national transport data hub will be essential for integrating real-time datasets, improving emissions tracking, congestion management, and modal shift analysis in alignment with European Green Deal (EGD) targets. Strengthening open data policies will facilitate research and innovation, while digital solutions like SmartTicket and e-Cargo will optimize logistics. Additionally, investing in scalable and resilient digital infrastructure will support wartime continuity and post-war recovery, ensuring Ukraine's transport networks can rapidly adapt and expand to meet future demands.

To support effective implementation of sustainable mobility and green transition initiatives, administrative reforms are needed to resolve current regulatory contradictions between State Construction Standards and traffic management policies, and enable the integration of spatial and transport planning. Addressing overlapping responsibilities, weak interagency coordination, and enforcement gaps is crucial, alongside tackling corruption and personnel shortages.

Building professional capacity through higher and vocational education and retraining programs is essential for advancing Ukraine's green transition. Expanding expertise in digital governance, data management, and intelligent transport systems (ITS) will address workforce shortages and modernize reforms aligned with European Green Deal (EGD) goals.

1.6 Sustainable agriculture

Status and trends

Ukraine is widely considered to have excellent conditions for agriculture, including around a third of the world's most fertile land. Almost 70% of our territory is agricultural land, and almost 57% is arable land (2021). In some communities, the percentage of arable land can exceed almost 80%. Ukraine ranked third in the percentage of arable land (World Bank, 2021). Wheat, maize, and sunflower dominate the country's agricultural production, intended primarily for export.

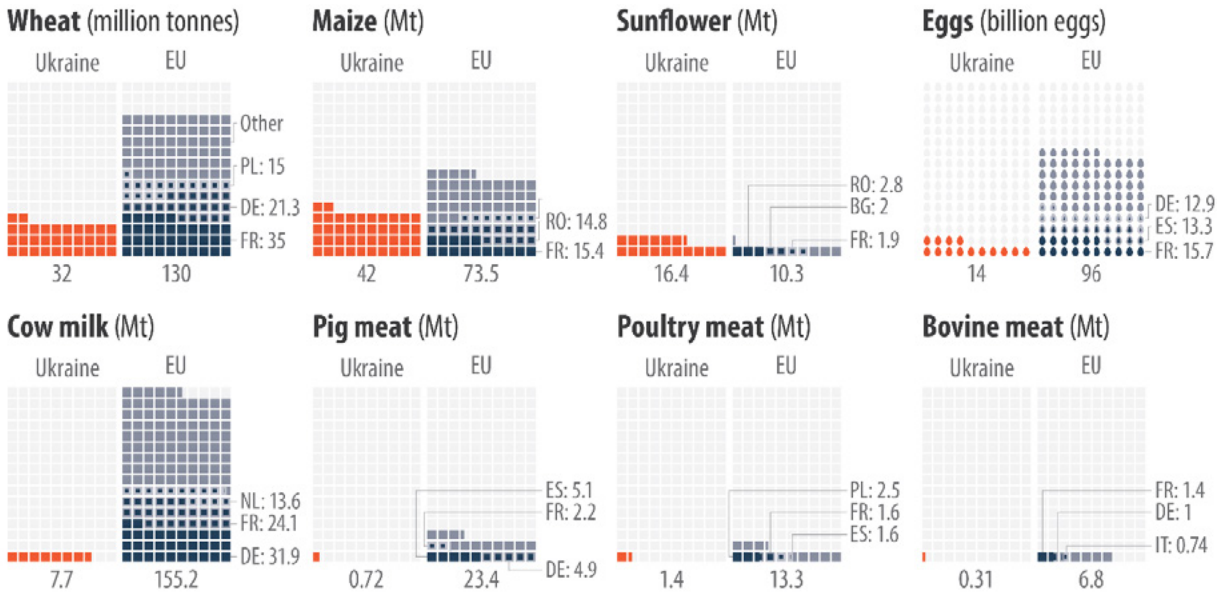


Figure 9. Comparison Of Ukrainian and EU Production of Selected Agricultural Products. Source: European Parliament Briefing "Ukrainian agriculture From Russian invasion to EU integration", European Union, 2024[115]

Compared to the EU, where smaller family-owned farms dominate, the structure of farms in Ukraine differs. Most land is concentrated in medium (500 to 5000 ha; 60% of land) and large agricultural enterprises (over 5000 ha; 25 of land)[116]. Agricultural enterprises play a prominent role in land use and agricultural production, especially crops intended for export. At the same time, smallholder farm households that correspond in size to a typical farm in the EU play a key role in the internal market, supplying a significant portion of various types of products: milk - 78%, beef and veal - 74%, pork - 35%, chicken - 17%, vegetables - 89%, and potatoes - 99%[117]. In the structure of agricultural production, there is a gradual downward trend in the production of agricultural products by these households. However, it is worth noting that in general terms, farm households are not much behind agricultural enterprises, producing a more diverse range of products[118].

[115] Antonio Albaladejo Román (2024) Ukrainian agriculture: From Russian invasion to EU integration. European Parliament Briefing

[116] Grouping of entities by the area of agricultural land owned and used in 2024

[117] Agriculture of Ukraine, 2021 Statistical collection. Kyiv: State Statistics Service of Ukraine

[118] Риковська О. Аналіз стану сільського господарства України та імплементація нормативно-правових актів ЄС, дотичних до аграрних та довкіллєвих питань / О. Риковська, О. Фраєр, О. Михайленко; за ред. М. Бєлкіна, А. Даниляк. — Київ: ГО "Екодія", 2024. — 22 с.

Approximately 1% of the land area of Ukraine is under organic production and predominantly focused on corn, soybeans, wheat and berries for the export market (Figure 9). Over 220 organic agricultural operators were certified as of July 2024.

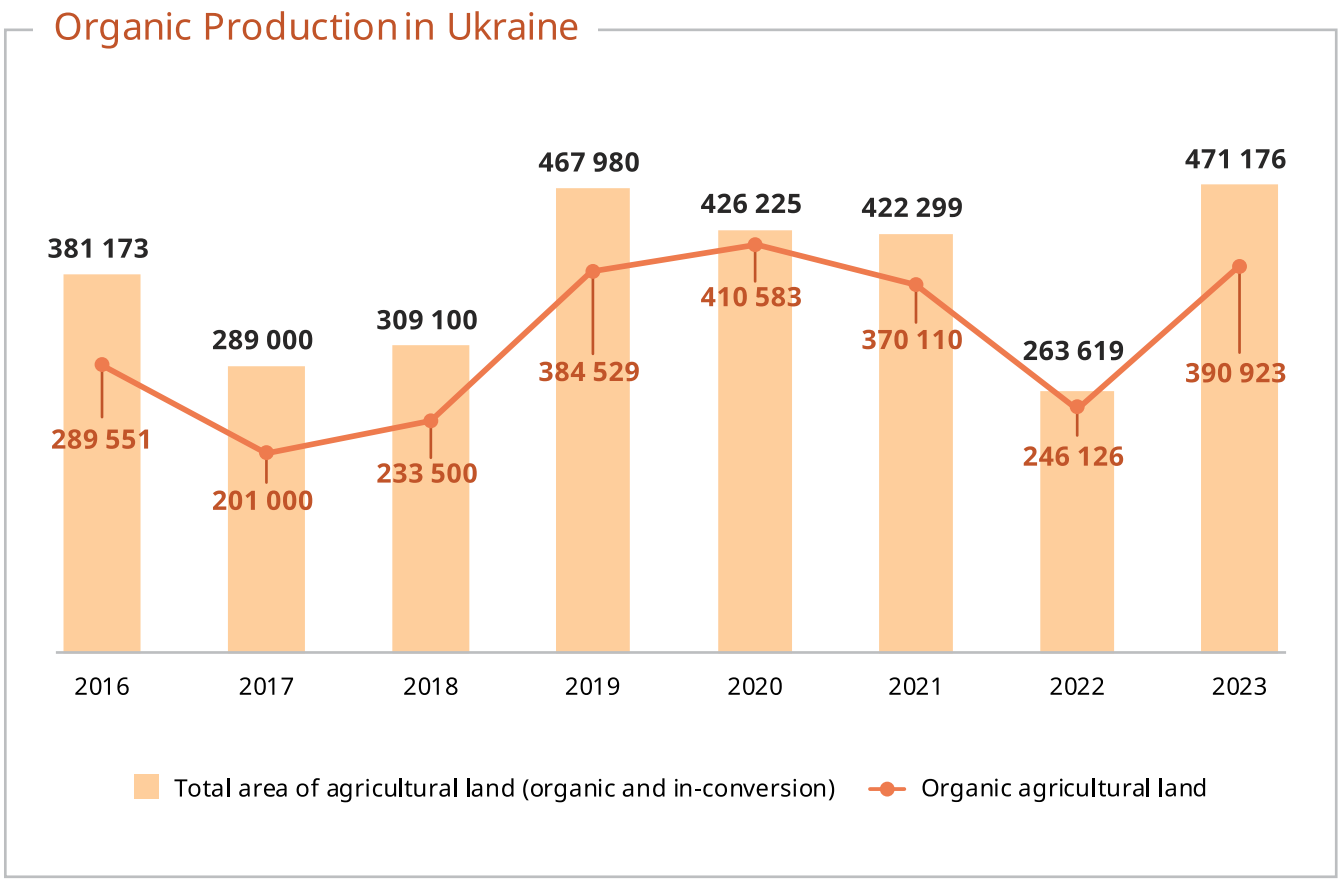


Figure 9. Organic production in Ukraine. Source: Organicinfo

The agri-food sector in Ukraine has faced substantial losses due to the war, with damages to the agricultural sector up to USD 80 billion, according to the most recent estimates (KSE 2024). The destruction of agricultural machinery represents the most considerable portion of direct losses - about 181 thousand units of agricultural machinery and equipment were partially or completely damaged due to the invasion. According to the Fourth Rapid Damage and Needs Assessment (RDNA4), total damage in the agriculture sector amounts to US$11.2 billion, while losses amount to US$72.7 billion. The damage includes the partial or complete destruction of storage facilities, fisheries and aquaculture, perennial crops, and the forced slaughter of livestock. It also encompasses the destruction and theft of machinery and equipment and the theft of inputs and outputs. Machinery and equipment damage accounts for the largest share of total damage (58 percent), followed by damaged storage facilities (17 percent) and stolen inputs and outputs (17 percent)[119].

[119] UKRAINE Fourth Rapid Damage and Needs Assessment (RDNA4) February 2022 – December 2024

Ukraine's food security faces serious consequences from the ongoing conflict, significantly affecting local and global food production. Key challenges include the severe disruption of agricultural operations, loss of crucial land to explosives and pollution, damage to infrastructure, and restricted export access. Agricultural regions in Ukraine, which have historically been major grain producers, have experienced a decline in output because of the abovementioned challenges. An estimated 7.3 million Ukrainians (20% of the population excluding those in the Russian-occupied areas) face moderate or severe food insecurity[120].

According to the RDNA4, agricultural production remains significantly below pre-invasion levels[121]. Despite these challenges, agriculture remains a key sector for Ukraine's economy and global competitiveness, particularly in the production and export of sunflower oil, sunflower meal, rapeseed, corn, barley, and rye.

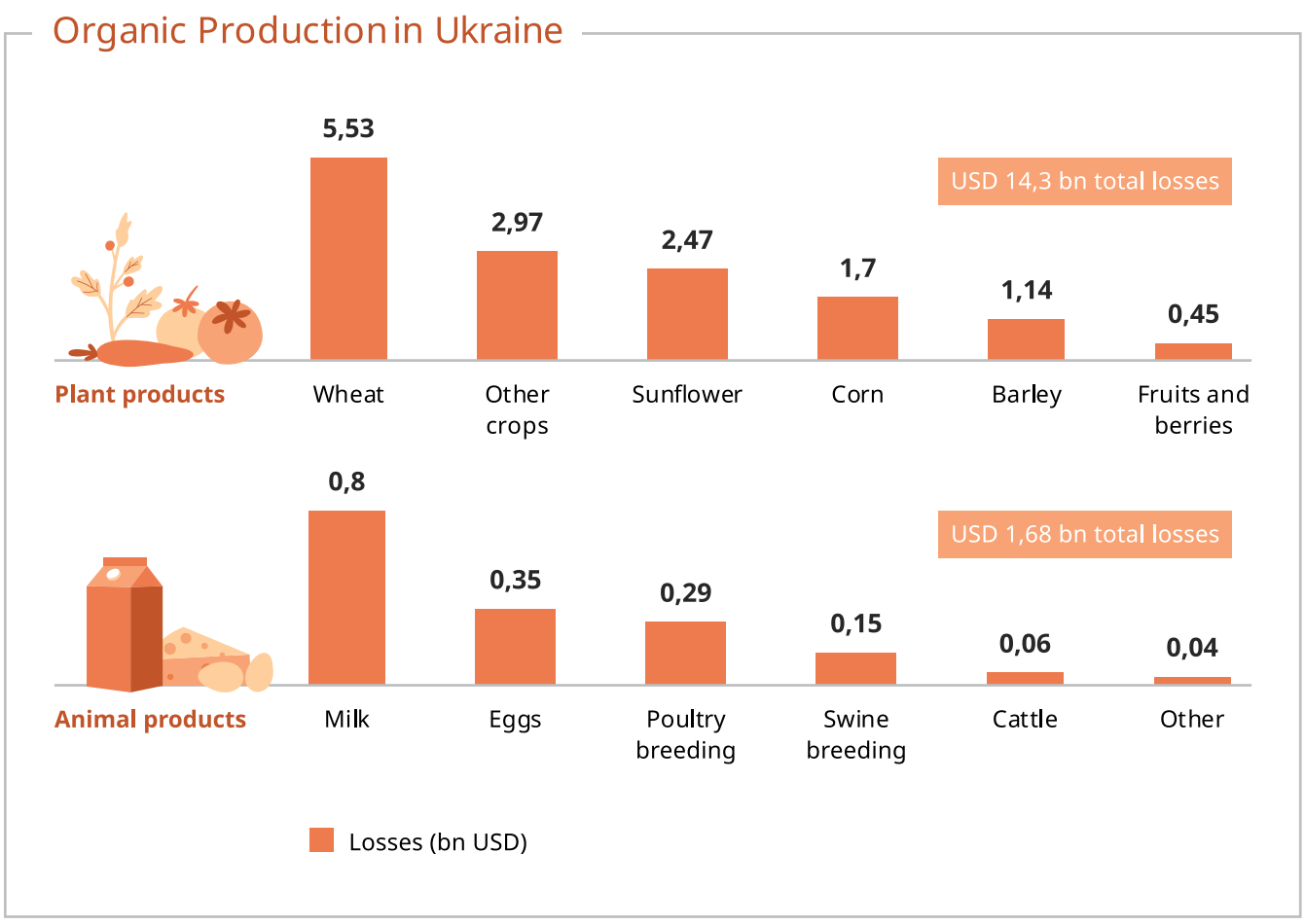


Figure 10. Damages Incurred by the Agricultural Sector by Industry.
Source: Kyiv School of Economics, 2023

[120] Ukraine Food Security & Livelihoods Cluster. People in Need 2024
[121] UKRAINE Fourth Rapid Damage and Needs Assessment (RDNA4) February 2022 – December 2024

Before the beginning of the war, there were positive economic trends in Ukraine's agricultural sector. Between 1995 and 2017, the overall level of real added value increased by 54%, and the crop production index improved by 125%. However, in general, Ukraine is developing slower than other countries in the region in the agricultural sector. During the same period, the production index in animal husbandry decreased by 26%. The reason for this decline is the lack of a systematic policy for the development of animal husbandry and the lack of incentives for modernization. As a result, the profitability of the industry is low, due to which it has lost its investment attractiveness (for example, the level of profitability of cattle meat production is -27%) (NES 2030, 2020). Since the beginning of the full-scale invasion, livestock has declined even further in specific sectors. However, it should be kept in mind that this data is generalized across the country so that other trends may be observed at the level of each region. In addition, the problem of animal by-product management and the lack of proper infrastructure remain urgent issues for Ukraine, especially given the war risks.

The sustainable transition of agriculture remains on the agenda, although development in this direction has been slow. Nevertheless, agriculture is one of the sectors which highly depends on soil quality and environmental conditions in general. According to the State Statistics Services, the use of pesticides increased before the full-scale invasion, but after 2022, the amount decreased. Concerning the use of nitrogen fertilizers, the situation is relatively the same (Table 7). In 2021, there was the maximum amount of nitrogen fertiliser used. Additionally, before the full-scale invasion, there ware estimated annual losses due to unbalanced losses of humus and nutrients - UAH 23-28 billion (~ EUR 1 billion at the rate of 2022)[122]. Despite this, the negative impact of pesticide use, particularly for bees, is often recorded in Ukraine. There are also problems with improper manure storage and illegal ploughing near water bodies, nature protection areas, pastures, slopes etc[123].

Table 7. Use of pesticides and nitrogen fertilizers. Source: Ukrstat

	2018	2019	2020	2021	2022	2023
Total use of pesticides (t)	25343,4	24326,9	24624,7	26971,5	19438,2	19360,8
	1990	**2000**	**2010**	**2015**	**2021**	**2023**
Use of nitrogen fertilizers (1000 t N)	1857,3	225,8	776,6	985	1970	1234,2

[122] Про схвалення Концепції Загальн... | від 19.01.2022 № 70-р

[123] Тєстов П. Огляд тенденцій порушень природоохоронного законодавства с/г підприємствами / П. Тєстов, , К. Гарбачук, О. Василюк; за ред. М. Бєлкіна, О. Романова, Б. Кученко, А. Клєпко — Київ: ГО «Екодія», 2024. — 15 с.

The agriculture and food production sectors have not been at the centre of the Ukrainian climate policy, but the government of Ukraine acknowledges its importance in the future implementation of the Nationally Determined Contribution (NDC) to the Paris Climate Agreement. The latest GHG emissions reporting suggests that in 2021 agriculture accounted for 14% of Ukraine's total emissions (79.92% from agricultural soils, 14.99% from enteric fermentation). Nitrous oxide (N2O) is the largest source of emissions (78% of total GHG emissions from agriculture), followed by methane (21%). A recent review indicates a 49% reduction in agricultural emissions by 2018 compared to 1990, reaching 44.2 MtCO2eq, yet sectoral emissions increased by 10% from 2015 (Figure 11). The updated version of the NDC presented in 2021 did not include any specific targets for the agriculture sector (UNFCCC, 2021), although the modelling exercises done prior to its adoption, did include the assessment of several circular economy technologies in the forecast production (EBRD, 2021). Due to extreme weather events caused by climate change, the issue of adaptation to climate change is becoming increasingly crucial for farmers in Ukraine.

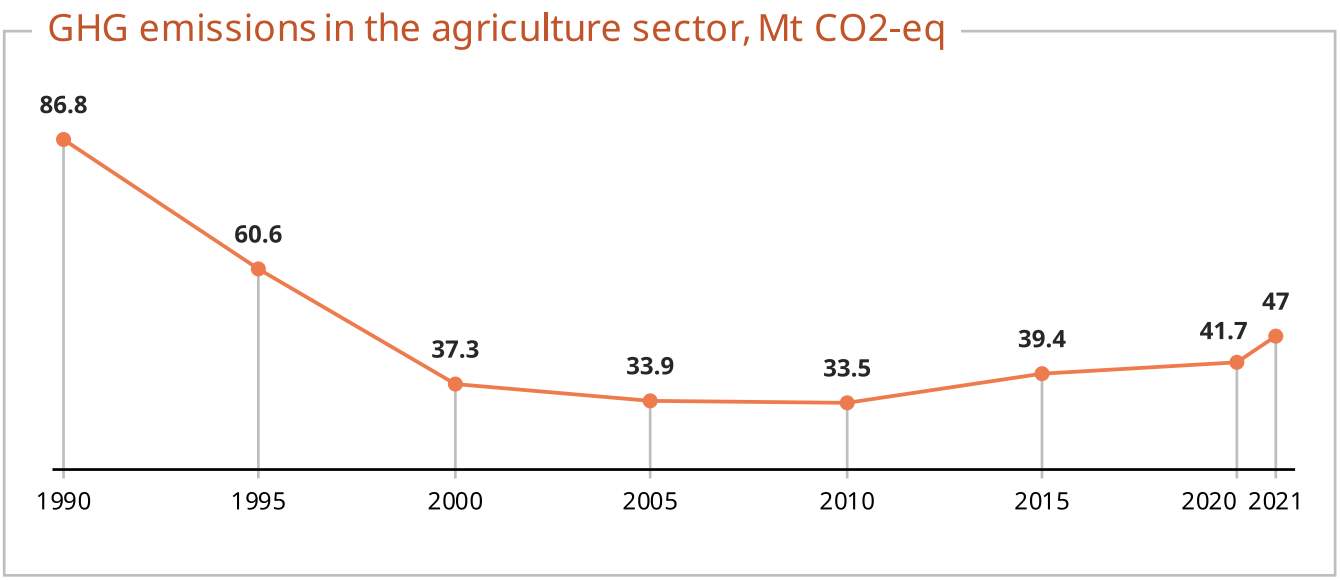


Figure 11. Greenhouse Gas (GHG) Emissions in Ukraine in the Agriculture Sector 1990-2022. Source: Ukraine's Greenhouse Gas Inventory 1990-2021, 2023

The current climate goals for 2030 aim for 44.5 MtCO2eq in sectoral emissions by 2030, requiring approximately EUR 2.3 billion in investment. To achieve that, Ukraine has started designing and implementing a number of policies, including minimized tillage, stubble burning bans, and support for other sustainable practices.

If the current trends of climate change persist in the next 20 years, the danger of the actual loss of not only the steppe zone but also more than half of Ukraine's arable land for intensive agriculture will become real. The changes are already noticeable, with the average annual temperature being 1-2 degrees above the norm every year we observe. In 2024, agriculture yields were negatively affected by adverse weather conditions and droughts in certain regions. The risks to agriculture from climate change are growing every year. According to the Climate Change Viewer, the temperature has increased by 1.6 to 2 degrees in all regions of Ukraine. The same situation is observed with a decrease in precipitation. Fluctuations in maximum temperatures during the growing season may require completely changing farming practices to more sustainable and climate-friendly ones, which will require additional investments. However, the adapted farm would become more resilient to extreme weather events in the long-term period.

In 2022, the Order of the Cabinet of Ministers of Ukraine "On Approval of the Concept of the National Target Program for Land Use and Protection" has been adopted[124]. This is the important document, in which it has been identified that excessive expansion of the arable land area at the expense of sloped land plots led to a violation of the ecologically balanced ratio of land use (arable land, natural fodder lands, forests, and water bodies), which negatively affected the stability of agricultural landscapes and caused significant human-made damage to the ecosphere. Particularly concerning is the progressive degradation and decline in soil fertility. Annual losses from the main types of soil degradation amounted to about 40-50 billion UAH; due to unbalanced losses of nutrients - 23-28 billion UAH; from shortage of products and soil losses due to erosion - 17-22 billion UAH. Additionally, this document highlighted that the key forecast indicator for solving this problem is the reduction of the level of arable land to 44 % by removing degraded, unproductive, and polluted territories.

In 2024, the National Energy and Climate Plan was adopted[125]. While the main measures relate to energy, a few of them have been identified for agriculture, in particular:

1. PM_D_WAM_05 Promote the use of information and electronic communication technologies in crop production
2. PM_D_WAM_04 Promotion of organic crop production
3. PM_D_WAM_07 National target programme for land use and protection

[124] On the approval of the Concept of the Universal ... | dated 19.01.2022 No. 70-r
[125] Ministry of Economy of Ukraine, 2024. National Energy and Climate Plan 2030

Strategic capacity

In the strategic documents related to the agriculture and food sectors before 2022, the attraction of investments, productivity improvement, and workplace creation was more often prioritised than sustainable development. But in the context of the accelerated EU accession process and the integration of the "build back better" principle, sustainability and green transition became integral and cross-cutting parts of economic recovery, including agriculture (e.g. Ukraine Plan and Ukraine Facility).

In November 2024, Ukraine adopted the Strategy for the development of agriculture and rural areas until 2030. There is a separate strategic goal #5 "Climate-smart agriculture: mitigating and adapting to climate change". Under this goal indicated two objectives:

1. Promoting climate change mitigation and adaptation. This task involves such directions as (1) water for irrigation, (2) climate-smart agriculture, (3) organic production, (4) circular bioeconomy, (5) bioenergy, (6) waste prevention.

2. Preventing biodiversity loss, improving ecosystem services, and conserving habitats and landscapes. This task involves such directions as (1) biodiversity; (2) simplified seed registration; (3) legislation on genetically modified organisms; (4) registration and use of fertilisers; (5) plant protection products.

In addition, land protection and other environmental issues are also addressed in other parts of the Strategy. For example, in strategic goal #4 Efficient use of land, demining, and land reform, where is the task "Promoting sustainable development and efficient use of soil, air, and water, in particular by reducing dependence on chemicals".

As for the Strategy's content, there is currently no systematic understanding of how to ensure the sustainable development of the agricultural sector, which will reduce pollution and emissions and increase adaptation to climate change. For example, one of the priority tasks for climate-smart agriculture is the water for irrigation. However, for the implementation of this plan, comprehensive studies will be needed to assess whether there will be sufficient water for existing and new irrigation systems, considering drinking water needs and other water use, climate change, etc. Therefore, it is important to consider that Ukraine ranks 17th in water availability among 20 European countries (The World Bank Group,2020). Additionally, due to climate change, the forecasts indicate a 25-50% reduction in water flow in major rivers[126]. In Ukraine, there is a significant focus on irrigation reform and development as a solution for climate adaptation. But irrigation can be a part of the solution but not a core. A comprehensive strategy for mitigating and adapting agriculture to climate change, including shifting farming practices to be more sustainable and less harmful to the environment, is needed.

[126] Ecoaction, 2021. Analysis of the impact of climate change on water resources of Ukraine

Additionally, in January 2025, the Concept of the State Target Economic Programme for Livestock Development for the period up to 2033 was adopted. The goal of the Concept is to create conditions for the economic development of the livestock and the agricultural sector, stimulate competitive sustainable production of livestock products to meet the needs of the domestic market, and increase exports. One of the expected results of the Programme is to ensure the progressive development of the livestock sector and the food sovereignty of the state in compliance with environmental requirements and sustainable development of rural areas. The sustainable component is a cross-cutting issue, but there is a lack of a comprehensive understanding of how this can be achieved. Thus, concrete steps are still needed to meet environmental requirements[127].

The government has put limited efforts into the promotion of healthy lifestyle and provision of dietary advice over the last years. The government adopted the strategy for reforming the school food system for the period until 2027 which aims to both increase the availability of school diners and improve the nutritional quality of the food that children eat. However, when it comes to improvement of consumption and promotion of healthy diets among other vulnerable groups, as well as the general public, no substantial progress has been achieved.

Governance capacity

Many institutions related to the implementation of EGD have the mandate of power to introduce new regulations and install the foundations of a sustainable agriculture and food strategy. They have a good level of inter-institutional cooperation, which helps minimise the impact of insufficient use of the financial or human capacity of some of the institutions. Lack of financial and human resources is the major constraint in the implementation of a range of EU agricultural and food related strategies from the institutional standpoint.

There is no concrete separation of responsibilities among the governmental institutions when coordinating the green transition in the agricultural and food sectors. Most Ukraine's obligations are fulfilled through the cooperation of several governmental institutions. However, some institutions are involved in many tasks related to the green transition, and the mandate of power of some institutions exceeds that of others. For instance, the Ministry of Economy is involved in most activities related to the green transition. While it does not always act as the main requirement, some entities lack strategic planning to execute their responsibilities under the green transition, which can slow the achievement of the policy's goals. For instance, the Ministry of Environmental Protection and Natural Resources has the largest mandate of power in terms of the green transition, but the Ministry has not updated its strategy since its creation in 2020.

Since the beginning of the full-scale invasion, the issue of the capacity of the responsible authorities to implement reforms has also become more acute. Good examples of support for sustainable reforms in Ukraine are the creation of the Climate Office to support the Ministry of

[127] Cabinet of Ministers of Ukraine. "On approval of the Concept of the State Target Economic Program for the Development of Livestock for the Period up to 2033"

Environment and the Green Transition Office to support the Ministry of Economy. Unfortunately, there is no separate body or department within the Ministry of Agrarian Policy to support sustainable reforms for the agricultural sector, although there is certainly international technical assistance that supports movement in this direction.

Other areas that require improvement are strategic planning, capacity building, implementing, monitoring, and reporting. Most strategic planning is conducted by the largest institutions, while some of the institutions do not form strategic plans regarding EGD. As for the capacity building, none of the analysed institutions are planning any expansion of their existing capacities, mainly due to the war and budget constraints. Monitoring and reporting are conducted by all the analysed institutions but require improvement.

There are many areas that require additional attention to achieve a successful green transition in the agricultural sector, particularly from the government. The absence of regulations also slows down research and development in this field as the companies are not obliged to control the use of pesticides. Another popular area of research that receives much attention abroad is alternative sources of protein. Currently, there is no information about the past or ongoing efforts to popularise alternative sources of protein in Ukraine. Meat remains the primary source of protein for Ukrainians, however, over the last years, the consumption of meat per capita has slightly reduced due to the cost, with most animal proteins consumed coming from poultry. The slow increase in the popularity of vegetarian diets is expected to eventually increase the availability of alternative protein sources.

Financial capacity

Ukraine lacks national-level investment funds and financial capacity specifically targeting sustainable agriculture and fisheries. This limits the mobilization of private capital and the private sector's involvement in financing the transition to sustainable agriculture and fisheries. Compared to EU agriculture financing (predominantly via CAP) Ukraine provides limited funding to the agriculture and fisheries sector. Between 2019 and 2021, the agricultural sector received around €600 millions of public money, a sum that could rise to over €10 billion in the event of accession.

As a result of the war, the funding of the green transition in the agricultural sector has assumed a lower priority. Even financing from other sources, such as foreign governments and international organisations, was redirected towards the support of entrepreneurs and rebuilding of damaged/destroyed infrastructure. Funding for sustainable agriculture and food production is unlikely to expand in the near future, as most of the post-war funding is expected to focus on rebuilding the country. At its current level, financial capacity is not sufficient for the transition of the sector. More efforts are needed to facilitate a just transition within the agri-food sector in Ukraine.

Since February 2022, there have been significant private investments into the agricultural sector by international financial institutions (IFIs) like EBRD, IFC, and the World Bank Group in general. Typical projects supported in Ukraine by the IFIs before the full-scale war included

predominantly a handful of the largest, often export oriented, companies[128]. Nevertheless, the IFIs in 2022 also began to provide loans to the intermediary banks in Ukraine aimed at agricultural micro-, small and medium-sized enterprises, including supporting sustainability efforts led by smallholders. Similarly, in 2023 the World Bank group-initiated Ukraine Agriculture Recovery Inclusive Support Emergency (ARISE) Project[128] aiming to reach over 90,000 farmers by facilitating access to affordable loans and grants for agricultural production. This support is supposed to reach the farmers as loans via the state programme affordable credits "5-7-9" and as grants via the state agrarian registry system. Despite the appearance of these new sources of financial support, the challenge of reaching the smallholders remains and there is a need to improve transparency and accessibility of finances via intermediary actors.

In 2022, the Fund for Partial Guarantee of Loans in Agriculture was created. The aim of this Fund is to provide support to micro-business entities, small and medium-sized business entities (up to 500 ha) operating in agriculture by partially guaranteeing the fulfilment of obligations of such entities under loan agreements[130]. Even though Ukraine has a functioning state guarantee programme, it is mainly provided to medium and large agricultural producers with a land bank of more than 500 hectares. Thus, the creation of this Fund is crucial to support small farmers. According to KSE estimates, in 2022, there were 23.1 thousand producers with a land bank of up to 500 ha (17.7 thousand agricultural producers can potentially become Fund's clients)[131]. There is potential to facilitate a sustainable transition of micro and small farmers within this Fund.

Small and medium sized farms need more targeted financial support to enable their growth and transition towards more sustainable business models and practices. At the moment, there is limited access to public and private sector finance for small and medium sized farms. Financial support and capacity need to be targeted at diversification activities, for example, opportunities to bring in income, via the support of on-farm renewable technologies (e.g., solar, biogas, agroforestry etc). Further financial support is required on infrastructure (e.g., climate-smart irrigation, cold transport infrastructure, and storage facilities), which will both improve productivity and ensure that produce gets delivered to markets in a timely and efficient manner. Financial provision for the delivery of knowledge, skills, and agricultural extension services will also be needed, particularly given the need to support farmers transition towards more climate and nature friendly forms of agriculture (e.g., organic and agroecological practices).

In 2020, legislation was amended to provide state support for organic agricultural producers. However, due to the full-scale invasion, support opportunities have been reduced[132]. In 2022, the Organic Initiative launched the grant programme "Organic Sector Support in Ukraine" to respond to Russia's full-scale invasion and support organic producers. More than 115 organic market operators in Ukraine have been supported[133].

[128] CEE Bankwatch Network. (2024). Learning from multiple crises to build resilient agri-food systems.

[129] Zorya,Sergiy. Project Information Document - Ukraine Agriculture Recovery Inclusive Support Emergency (ARISE) Project - P180732 (English). Washington, D.C. World Bank Group.

[130] Fund for Partial Guarantee of Loans in Agriculture. Accessed in March 2025

[131] Report of the Fund for Partial Guarantee of Loans in Agriculture 2023

[132] OrganicInfo, Accessed in March 2025. Milestones of organic production development

[133] Organic Initiatice, Accessed in March 2025. Support of the organic sector of Ukraine

At the beginning of the Russian invasion, the government had launched a support programme for the maintenance of cattle (from 3 to 100 cows) and announced their renewal and extension in early 2024. However, the government still does not allocate any subsidies to producers of alternative protein sources to meat. On the other hand, existing donor funding programmes usually have a smaller scale and provide funding for solving a specific problem within the industry.

As regards waste management, reduction of agricultural waste and food loss, promotion of sustainable lifestyle and healthy diets, the amount of financial support from the government and other stakeholders is very limited. The inappropriate infrastructure for managing animal by-products also remains a problem. Accordingly, within the framework of the Concept of the State Targeted Economic Programme for Livestock Development for the period up to 2033, the expected result is to create conditions for the construction of facilities for the processing of animal by-products, where residues collected from slaughterhouses, carcasses or parts of them, dead animals are utilised, which will improve the sanitary condition in communities and ensure the solution of problems with animal by-products[134].

Sustainable fisheries are currently in the early stage of development in Ukraine. As of 2023, no fisheries in Ukraine are certified by international organisations, such as the Marine Stewardship Council or Aquaculture Stewardship Council. In addition, national certification is also not widespread, especially among small fisheries. Due to the weak development of sustainable fishing in Ukraine, many fishers are unaware of its benefits and possibilities for producers. The introduction of new funding opportunities aimed at creating sustainable fisheries can stimulate the development of this field in Ukraine. However, it is worth mentioning that recent changes like e-Ryba are addressing fair access to water resources as the first step in fostering the sectors' development.

Box SEQ Box * ARABIC 1. The eRobota Project

The "eRobota" project provides grants to Ukrainians for starting a business in various industries (including agriculture, processing, food production, manufacturing and retail), developing entrepreneurship and training. The program is aimed at boosting entrepreneurship and stimulating the creation of jobs. The project includes 6 grant programs, in particular, Ukrainians will be able to receive:

- micro-grants for creating their own businesses;
- grants for the development of a processing enterprise;
- state funding for planting a garden;
- funds for the development of greenhouse farming;
- a grant for the implementation of a startup, including in the field of IT;
- funds for training in IT specialties.

[134] Cabinet of Ministers of Ukraine. "On approval of the Concept of the State Target Economic Program for the Development of Livestock for the Period up to 2033"

Within the grant for processing enterprises, the government provides compensation to the business owners based on their own contribution to business development (costs of starting a business). The size of the grant voucher depends on the number of jobs created and the economic entity's own contribution to the eRobota project. As a part of the grant programme, the government recently allocated 2 mln USD for the development of processing businesses in the Lviv region. As for the greenhouse farming grant, the government co-finances the establishment of a garden together with an entrepreneur (70% funded by the government, 30% - by the owner). Within the program, farmers can receive from 140,000 to 400,000 UAH per 1 hectare of gardens, but for this, it is necessary to own or lease land with an area of 1 to 25 hectares for 7 years. The government plans to support the creation of 10,000 hectares of gardens.

Due to the significant interest of the government and international experts in the Ukrainian agricultural sector, there are several funding opportunities for new enterprises and existing businesses of different sizes. Among the most active donors for the funding programs within the agricultural sector are the Ukrainian government, the European Commission, The United States Agency for International Development (USAID), FAO, and the World Bank.

Sectoral capacity

Before the full-scale invasion by Russia, there was a visible expansion of green infrastructure in the agricultural sector. This was mainly driven by an increased demand for organic production and an increasing uptake of renewable energy sources and waste reduction. In 2021, 9,780 tons of domestically produced organic products worth about UAH 900 million were sold in Ukraine, and big grain producers like Kernel and MHP started renewable energy production. However, Ukraine needs significant investments into green infrastructure for small and medium farmers to restore/replace capacities lost due to the war and expand them. A significant part of the existing workforce (both unskilled and skilled workers) will need to be retrained to obtain both skills required to support the green transition of the sector. Despite the existence of an extensive network of educational institutions with agricultural specialisation and multiple educational programs for agrifood and climate-related specialties, many of them need to be updated to provide knowledge and skills relevant to the labour market.

The sector is also characterised by differences in the capacity of smaller and larger companies to implement green policies. While large companies have more opportunities to invest in sustainability initiatives, many smaller agricultural producers are often in survival mode and do not prioritise sustainable development, particularly during wartime. However, due to the climate crises, they also understand the need to adapt to climate change, but they definitely have a smaller capacity and thus need more support.

The awareness regarding sustainable agriculture of the small farmers, agriculture advisory services, and population, as well as developing green skills in the workforce, also require considerable improvement. Many workers within the agriculture sector do not have sufficient knowledge and hard skills to support the sustainable development of the agri-food sector. At the same time, the educational programs that prepare specialists for SDG-related professions are often outdated and provide mostly general information to the students. This effort will also need to focus on increasing the engagement of the groups of stakeholders currently not supporting the greening of the sector, particularly the private sector.

There has been a positive development in the educational sector. For 5 years (since the 2019/2020 academic year) the number of students who studied agriculture in higher education institutions increased by 36%. In the 2023/2024 academic year, the total number of students who studied agriculture or related areas reached 93,500 (Figure 12). The growth in popularity can be explained by the increase in government funding of these specialisations and thus, a larger number of free (paid from the state budget) vacant places. However, the question remains to what extent the issues of sustainable development of the agricultural sector are included in the education of these professions, including nature-based solutions, biodiversity protection, climate change mitigation and adaptation within agriculture and food production.

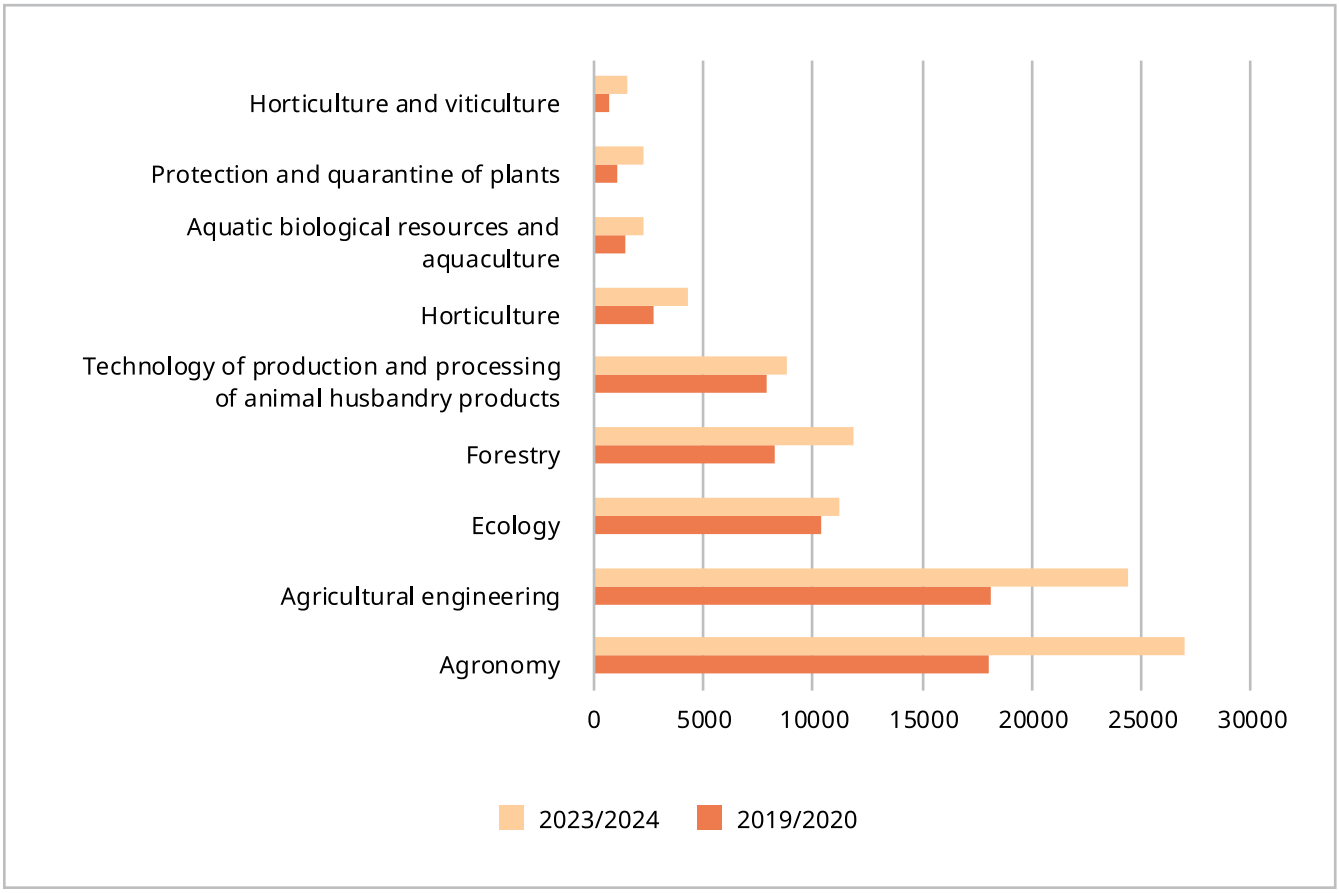


Figure 12. Number Of Students in the Higher Education Institutions With EGD-related Specialisations

One of the largest online educational platforms in Ukraine "Prometheus" launched a programme "Eco practices for agriculture and communities" aimed at the development of ecological practices in agriculture. The program is available to representatives of United Territorial communities, local self-government bodies, agricultural advisory services, agricultural producers, and students of agricultural specialties.

In recent years, there has been an increase in the number of initiatives to promote more sustainable and environmentally friendly business practices. However, it is important to scale up to reach more farmers. In particular, we can highlight:

- Code of Good Agricultural Practices – Ecodia
- PU Organic Ukraine | Organic Knowledge Platform
- Education, lectures | Green Agro Solutions
- Nature-based solutions - WWF Ukraine Platform
- AgriAcademy – A unique educational platform of the Ukrainian agribusiness community offers up-to-date agricultural knowledge in free online courses from the best teachers in the world and Ukraine

According to the national professional standards, all higher education institutions should include environmental topics to the curricula of students of agricultural specialisations, this is however still limited. For the majority of specialisations, the standards only require educational institutions to include general information about climate change, the impact of agriculture on environment and green transition. Only some of the specialisations, such as agronomy and agricultural engineering require graduates to have hard skills related to the green transition. The Educational programmes in universities and other institutions need to be updated in the future to include the most recent information about the green transition and sustainable development of agriculture and equip future professionals with relevant skills to support it.

Apart from the preparation of new specialists, it is also important to provide re-qualification and training for people already employed in the sector. In addition to providing general knowledge about the green transition and training of best green agricultural practices, it is also important to provide digital education as many workers are older people who may lack the knowledge of digital technologies. The digitalisation of agriculture plays an increasingly important role in achieving the sustainability of food systems. There are several key areas where digitalisation could positively contribute to the increased sustainability of the sector, such as sustainable farming and precision agriculture, digital traceability, data-driven decision-making, e-commerce and online platforms, food safety monitoring, digital innovation hugs for agriculture as well as ICT infrastructure for rural areas.

Supporting an agricultural just transition in Ukraine involves promoting resilience, environmental sustainability, and economic recovery within the agricultural sector. This requires a coordinated approach between the Ukrainian government, international donors, and humanitarian agencies, combined with targeted investments in infrastructure, sustainable low carbon practices, and support for more localised food systems. Supporting farmers with access to technical and financial support packages to transition to more sustainable practices (e.g. crop diversification, soil health management, and organic fertilizers) could help reduce the sector's environmental footprint while improving resilience to future climate and economic shocks. Targeted financial support through grants, low-interest loans, and subsidies for climate friendly technologies can all help. Engaging producers and local communities in policymaking can ensure that the specific needs of different agricultural areas are addressed. Policies prioritizing rural livelihoods, such as social safety nets, fair wages, and secure land tenure for small-scale farmers, are crucial elements of a just transition.

EU Approximation

The government gradually finished harmonizing the Ukrainian legal framework within the requirements of the Association Agreement, and the progress in agriculture and food production was estimated at the level of 69% as of November 2023. While the key regulatory areas related to the green transition of the agriculture and food sectors are covered by the respective regulations in Ukraine, only some of them are harmonised with the European legal framework and contribute to the achievement of sustainable development goals. Topics such as the use of pesticides and antimicrobials, animal welfare, and plant health have received significant regulatory attention over the last few years, while other issues, such as food waste, seed security and diversity, and sustainable fish and seafood production, have not seen substantial regulatory attention and require additional legislative effort. According to the EU Commission's report on the EU enlargement policy of Ukraine in 2024, Ukraine remains at an early stage of preparation in agriculture and rural development. Some progress was made in further aligning legislation with the EU acquis, including legislation on quality policy and organic farming.

There are four key regulatory documents covering agriculture and fisheries, each of which is at least partially implemented in the Ukrainian legislature framework. In implementing these documents, the Ukrainian government focuses on the economic and technological aspects of the sector's development and the development of a specific legislative environment for organic production in the country. Although currently, environmental aspects have a lower priority - the transposition of EU norms in this regard is still in its early stages - the Ministry of Agrarian Policy of Ukraine outlines at least 17 key legislative documents, which outline the framework for organic production. Some of the documents, such as a law "On the basic principles and requirements for organic production, circulation and labelling of organic products", outline the general principles of the state's policy but need the adoption of additional regulations to facilitate the green transition. In addition, the government has also adopted regulations regarding the exchange of information with EU counterparts.

Water quality regulation contains two strategic EU directives, which are not transposed into the Ukrainian legislative framework. Currently, there is a delay in identifying the nitrate vulnerable zones due to insufficient water monitoring data and a lack of capacities for responsible bodies. For example, after the full-scale invasion, the groundwater monitoring by the State Service of Geology and Mineral Resources of Ukraine was stopped because of the lack of funding. Monitoring diffuse pollution sources is a much more complex and comprehensive process than point source pollution. Additionally, one of the basic problems is the cross-cutting nature of the Nitrate Directive implementation and the lack of proactivity by the responsible authorities in addressing problematic issues.

Fertiliser use is covered by three key EU regulatory documents, which are mostly partially transposed within the Ukrainian legislation framework. Regarding the issues with the existing partial transposition, there are no regulations to control community action to achieve the sustainable use of pesticides.

Animal welfare is regulated by three EU directives and one regulation, which are mostly transposed into Ukrainian legislation. The only EU regulation not fully transposed within the Ukrainian regulatory documents, is the Veterinary Medicinal Products Regulation. Regarding the remaining directives, Ukraine currently lags in terms of the adoption of regulations required by the Association Agreement, although some of their provisions are already included in existing Ukrainian laws. On a regional level, some state administrations have adopted plans.

Food waste is regulated by two interconnected EU directives on waste management, which have been partially implemented into the Ukrainian legislation, with the adoption of new law on waste management in 2023. The government is expected to create a separate body responsible for the waste-related issues. Furthermore, some bylaws (e.g. regarding specific types of waste, development of waste registers, etc.) which should be implemented subject to the Association Agreement have not been adopted yet.

One cross-cutting issue between environmental protection and agriculture is the implementation of the Council Directive of 12 December 1991 concerning protecting waters against pollution caused by nitrates from agricultural sources (91/676/EEC). Its implementation began in 2017, but as of 2024, it has not progressed much. Currently, there is a delay in identifying the nitrate vulnerable zones due to insufficient water monitoring data, which also confirms that the water and environmental policy in general is much weaker than the agricultural policy. The Code of Good Agricultural Practices has been adopted, but no work has been done to disseminate information to agricultural advisers and farmers, therefore it is not working. The Nitrates Directive is one of the key laws protecting waters against agricultural pressures, and it forms an integral part of the overarching Water Framework Directive. Moreover, its provisions could be a base for a further sustainable transition of the agriculture system in Ukraine.

Main priorities for the green transition

Strategic planning for the achievement of sustainable development goals needs to be improved. There is currently no overarching view of how the agricultural and food sectors will go through with the green transition and how this will impact the sector. These plans are necessary not only in terms of EU accession and alignment with policies there but also to ensure the achievement of Ukraine's sustainable goals and the competitiveness of its agricultural and food sectors.

It is important to develop strategic dialogue between the public and private sector actors related to the green transition of the agricultural sector. The discussions between the ministries need to better reflect the fact that the green transition is not only an environmental topic, but an overall modernization and competitiveness effort. The same approach needs to be taken with other stakeholders and dialogue between public, private and NGO actors better framed.

Dedicated support to small and medium sized farmers to help with the transition to the EU will be crucial in reviving the rural economy after the war and make a major contribution to the decarbonisation of Ukrainian agriculture and prevention of environmental pollution. In the short to medium term, priority needs to be given to providing policy, financial, and technical support, focussed on the transition to climate and nature friendly farming practices (includ-

ing organic) and technologies. Priorities include irrigation technologies (including drip irrigation), addressing post- harvest food waste and loss, the control of pesticides and other agrochemicals (adoption of draft law No 3091), farm diversification (including on farm renewable technologies) and the expansion of integrated farmer extension services. Measures like precision farming, increasing landscape features in farmed area, biogas production, reducing fertilizer (especially based on fossil fuels), and pesticide use need to be integrated into future plans.

Agriculture has a very important effect on land use, therefore any green transition plans in this sector need to take this into account. Moving towards green transition goals in Ukraine will require land for new infrastructure development, especially in the energy sector, and an increase in protected land and sea areas to support biodiversity. Considering the effect of the war and many areas being polluted and mined because of it, strategic planning around land use to support the development of sustainable agriculture is important.

Agriculture needs to ensure long term food security and healthy and sustainable diets. There is a need to ensure agriculture focusses on healthy and nutritious affordable foods (with specific opportunities to build capacity within the horticulture sector and alternative sources of protein) to ensure production is resilient to any future climatic threats and can meet the nutritional needs of the population whilst ensuring long term food security. This will also reduce the long-term health burdens of overweight and obesity, reducing long term pressures on health services.

There are opportunities for on-farm renewable energy technologies, particularly biogas and solar. Ukraine's agricultural sector generates a significant amount of organic waste, including crop residues and livestock manure, which can be converted into energy through biomass and biogas technologies. These systems can produce both heat and electricity while generating organic fertilizers as a byproduct and, therefore, have significant potential to reduce climate emissions. For example, small-scale biogas plants on dairy farms could convert manure into renewable energy, providing a clean energy source and reducing dependency on chemical fertilizers. On-farm solar power also offers significant potential and can be used to run water pumps for irrigation, power greenhouses, and support other agricultural equipment, making it particularly valuable in Ukraine, where irrigation systems are essential. On-farm renewable technologies would require technical training and financial incentives for farmers.

To ensure an effective green transition, financing must be significantly expanded and targeted specifically toward sustainability goals. Funds allocated for rebuilding the country should prioritize the development of sustainable agriculture and food systems This will require a focus on diversifying state based financial support (introduction of subsidies and tax exemptions that promote sustainable practices) and looking for new sources of funding to support the sustainable development of agriculture. Just transition needs must also be analysed and support must be provided to smaller farms and people employed in the sector.

To ensure the required workforce and increase sectoral capacity for the transition, there must be a modernization effort in existing educational programmes. There has been positive development in this area as more students are studying in agriculture related programmes however the contents of these programmes need to be improved from a general sustainability perspective. In addition, reskilling of existing employees in the sector must also be prioritised as change will otherwise take too much time.

1.7 Biodiversity

Status and trends

Ukraine's size and specific geographical location at the crossroads of different ecoregions and its diverse climate and landscape account for circa 27,000 flora and about 45,000 fauna species. The forest areas are 15.9% of the country, and freshwater ecosystems about 4%. A large part of the country belongs to the Steppic Biogeographic Region (~40%) but only a small portion of the steppe remained unaffected by land conversion. Agricultural areas cover approximately 70%, out of which the size of arable lands is 54%[135] with an increasing trend mainly due to the conversion of pastures and hayfields (Skorobogatov& Burkovskyi, 2023). Additional pressures on nature arise from the energy production industry, commercialisation of forestry and fishery, infrastructure development, pollution, and consequences of climate change. These factors are causing loss of biodiversity through fragmentation and ecological transformation of natural areas, especially steppe grasslands and rivers, and the spread of invasive alien species. Negative trends in biodiversity are reflected in the increase in the number of species listed in the Red Data Book of Ukraine and the number of invasive alien species, as well as in the decrease in stocks of commercial species of fish and game animals.

Ukraine has made significant achievements in biodiversity conservation over the past 30 years. The Nature Reserve Fund (a national system of protected areas) has been tripled since 1991, and the Emerald Network (an ecological network made up of Areas of Special Conservation Interest under the Bern Convention) has been developed. Internationally recognised areas cover circa 11,4% of the country and include 377 Emerald Network sites, 50 Ramsar sites, 8 UNESCO biosphere reserves, and the UNESCO World Heritage Site "Beech forests and ancient forests of the Carpathians and other regions of Europe". To bridge the gap in the protected area network and ensure the connectivity of key protected and other natural areas, Ukrainian authorities established the Ecological Network (EcoNet), which aims to cover approximately 38% of the country's total territory, including forests, freshwater ecosystems, pastures, and hayfields. The number of protected species listed in the Red Data Book of Ukraine, updated in 2021, is 687 fauna and 858 flora species. The importance of the biodiversity conservation sector is increasing in the socio-economic sphere. Protected areas play an important role in raising public awareness and eco-education, promoting environmental protection and folk traditions, and developing tourist infrastructure in the regions. Increasing numbers of visitors come to enjoy protected areas and for their physical and psychological well-being.

[135] КМУ (2017). Деякі питання удосконалення управління в сфері використання та охорони земель сільськогосподарського призначення державної власності та розпорядження ними (Постанова Кабінету Міністрів України від 7 червня 2017 р. № 413).

However, the biodiversity sector faces substantial challenges, reflecting the lack of appropriate conservation goals in legislation and, at times, management effectiveness. The updated national strategy for biodiversity should aim to reflect the global ambitions of the Kunming-Montreal Global Biodiversity Framework (GBF) of the Convention on Biological Diversity (CBD), which has four overarching goals and 23 targets that are also addressed through the EU Biodiversity Strategy for 2030. Ukraine has still not submitted its updated national targets in contribution to the GBF.

Ukraine is currently not on track to reach the global goal of protecting 30% of the land and sea area until 2030. According to the World Database on Protected Areas (WDPA) estimates, terrestrial conserved areas cover 12.96% of Ukraine, and marine areas cover 9.14%. The Nature Reserve Fund (NRF), a national protected area system that plays a crucial role in biodiversity conservation in Ukraine, covers 6.9% of the country. The rate of PA coverage increase was only 1% over the last ten years, but the new national target of 15% total coverage for protected areas was set by the Law on environmental strategy till 2030. Implementation of this is complicated by the lack of understanding and the financial needs of local authorities, and trends of privatising lands for economic use. Strictly protected areas under national definition cover circa 1% of the country (the result of the desk study), while the equivalent target of the EU Biodiversity Strategy is 10% coverage under strict protection. As this EU goal aims to protect old-growth forest, Ukraine can still match this as it has adopted legislation for protecting its “virgin forests” and has an estimated 130,000 ha under old growth forest landscapes. There is no official accounting of strictly protected areas or separate statistics on terrestrial and marine protected areas, free-flowing rivers, protected forests, and restored areas. The EcoNet is not yet fully established and its principles don’t align with the Habitats Directive, so it should improve toward the inclusion of all the important habitat types. Emerald network is still lacking adaptation of special legislation, making appropriate site management very challenging. Effective management of protected and conserved areas still needs to be properly addressed in Ukraine, as management effectiveness is assessed only for national parks, nature, and biosphere reserves.

Open source data collected and analysed by CEOBS and Zoï Environment Network shows that when aggregating all available datasets of ecologically important areas, the prospective marine area coverage of Ukraine’s exclusive economic zone is 41.49%, while the prospective terrestrial area coverage of Ukraine’s landmass is 21.41%. This suggests that Ukraine is better placed to meet its 30×30 targets for marine rather than terrestrial areas (Figure 13 and Figure 14). However, this assumes that both its marine and terrestrial areas can be adequately protected and managed.

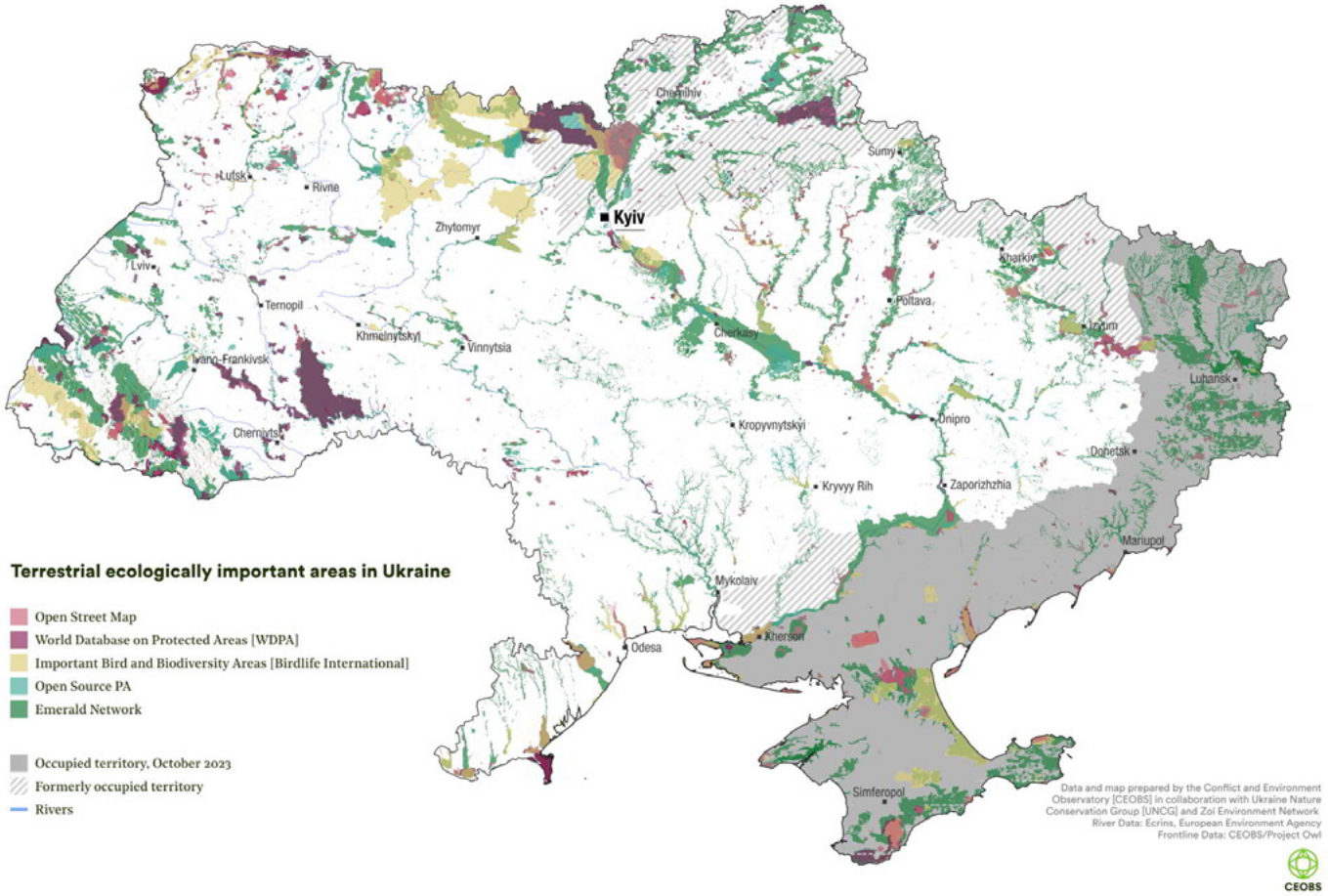


Figure 13. Terrestrial Ecologically Important Areas in Ukraine. Source: CEOBS and Zoï Environment Network, Mapping Ukraine's ecologically important areas, 2023

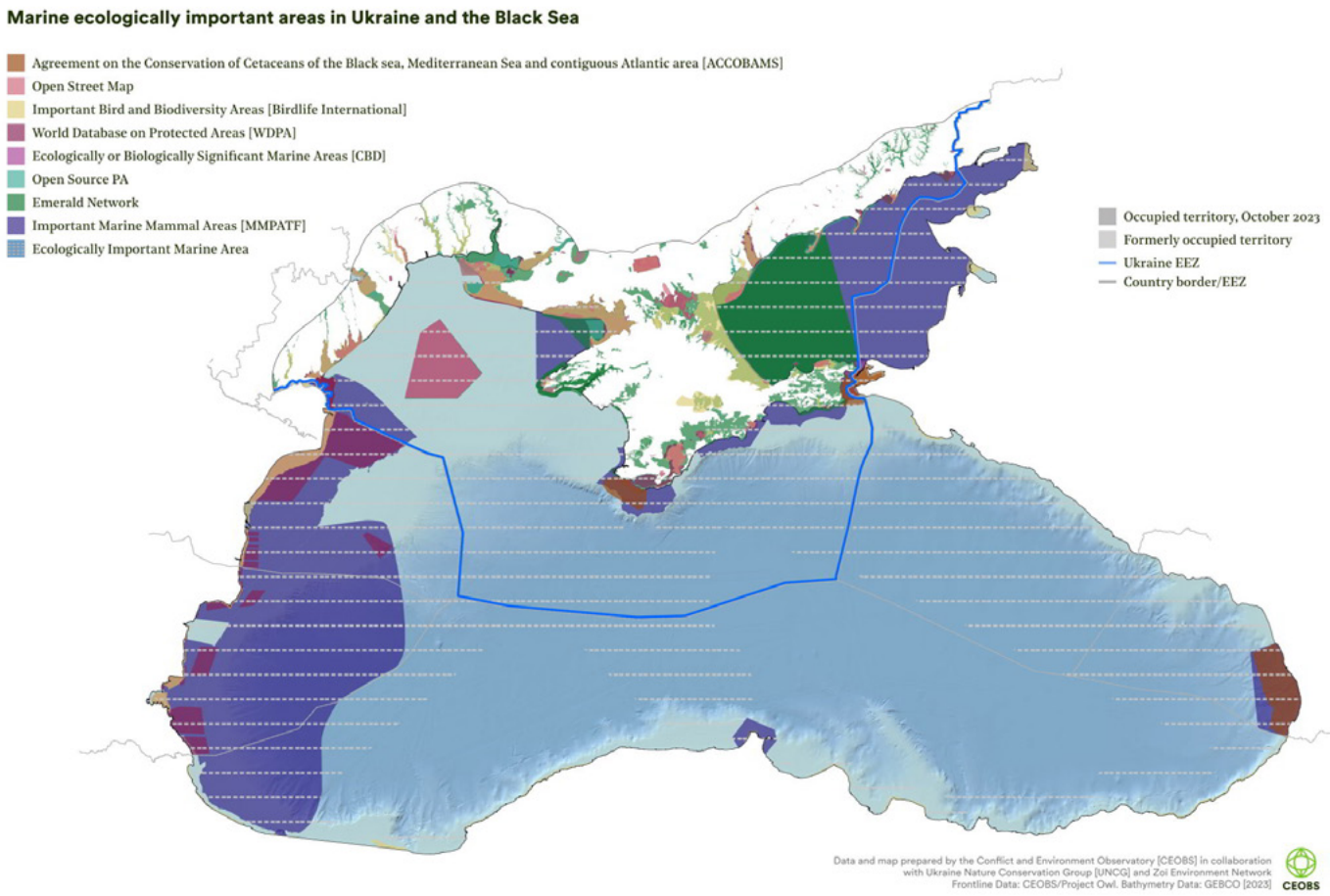


Figure 14. Marine Ecologically Important Areas in Ukraine and the Black Sea. Source: CEOBS and Zoï Environment Network, Mapping Ukraine's ecologically important areas, 2023[136]

Despite systematic reforestation in clear-cut areas and some good examples of nature restoration, restoring habitats and species is still not sufficiently developed in Ukraine. Sufficient commitments for nature restoration are not established, and statistical data is unavailable. There is a commitment to restore at least 5 kilometres of free-flowing small rivers each year starting from 2025 (State Water Strategy till 2050) and relevant targets toward increasing forest coverage by 1.6% and pastures and hayfields by 2,8% by 2030 (Law of Ukraine "On the Key Principles (Strategy) of the State Environmental Policy of Ukraine for the Period until 2030). In agricultural landscapes, reintroducing natural structures is still problematic, and the only legally defined tool is the preservation of shelterbelts (forest belts, windbreaks).

Ukraine is currently lacking a national (centralised) biodiversity monitoring system, which causes problems with assessing the state of species and habitat populations and keeping inventories of flora and fauna. This makes it difficult to assess the country's readiness to track progress and report on any indicators set to measure the success of biodiversity conservation.

[136] Conflict and Environment Observatory, 2023. Mapping Ukraine's ecologically important areas

Methodologies and tools set for data acquisition in indicators of the GBF and the EU Biodiversity Strategy can be utilised by Ukraine, providing it enables sufficient data collection on the ground.

It will be key for Ukraine to align its national restoration efforts with the recently adopted EU Nature Restoration Regulation. This would allow further alignment with the EU environmental acquis, translating international commitments under the GBF, especially Target 2, into national action and enabling the needed nature recovery. Nature-based solutions can be the approach introduced to simultaneously address societal challenges and restoration of natural structures in all types of environments, including agricultural landscapes and urban environments.

The impact of war on nature has been substantial, with long-lasting consequences of economic, social, and environmental destruction on 20% of Ukrainian territory (UNEP, 2022). Preliminary estimates for direct impact consequences include about 36% of the Emerald Network area, 67% of the Ramsar sites area, and 20% of the NRF. There has been a serious reduction in the human and financial capacity of government bodies and NGOs working with biodiversity. A potential threat is the recovery period after the war, when priorities will first be directed towards economic recovery. This will require more natural resources and lands and may become an obstacle to restoring PAs. However, many mined and devastated areas, which will be rewilding naturally, as well as large areas along Belarus and Russian borders, could have the potential to be partly recognized as OECMs and important areas for biodiversity. National security purposes for these areas will prevail over conservation management needs for one group of areas but will help to enrich biodiversity for others. Probably, up to 70% of these areas will be rewilded with a low-balanced ecological pyramid. As time passes, part of them will be rewilded areas with low-impact or absent human activities, like nature or biosphere reserves (Chornobyl Biosphere Reserve). The total impact of the war on the environment is recorded by Ukraine's government dashboard[137].

Overall, the status of nature conservation in the country could be deemed unfavourable as the environment is not one of the key priorities in the current political arena and due to pressures from specific sectors, especially those linked to land use. Issues of implementing a habitat approach to biodiversity conservation, biodiversity monitoring, control of invasive alien species, financial incentives, assessment of ecosystem services, and accounting of natural capital are absent or only at the initial stage of development. There are significant gaps in knowledge on these issues.

[137] Ministry of Environmental Protection and Natural Resources of Ukraine, Accessed in March 2025. EcoZagroza

Governance capacity

The Ministry of Environment and Natural Resources of Ukraine (MEPNR) is defined as the central government body for the formation and implementation of policies regarding biodiversity preservation. However, other ministries and agencies responsible for agriculture, fisheries, forestry, water management, land use, infrastructure, and community development often impact biodiversity sector policy and make decisions against biodiversity conservation goals. The right to make actual decisions on biodiversity use and preservation, land management, and infrastructure development that create pressure on biodiversity have been transferred to united territorial communities within administrative reform, which creates multiple risks for biodiversity due to the financial need, absence of clear biodiversity conservation goals and restrictions for the local level. The MEPNR initiates the transfer of responsibility for all the parks and reserves from different stakeholders to the Ministry. It intends to reestablish a special government Agency to improve the coordination and implementation of biodiversity conservation and PAs management.

The government institutions authorised to conserve biodiversity have sufficient jurisdiction and support from NGOs and international organizations. National and regional NGOs have freedom of action guaranteed by legislation and have proven long-term biodiversity protection results. International organisations like the EU Delegation to Ukraine, UNDP, World Bank, EBRD, the international development agencies, secretariats of MEAs, and global nature conservation NGOs like WWF and the Frankfurt Zoological Society strongly support biodiversity conservation efforts in Ukraine and adapt the international knowledge to the Ukrainian biodiversity sector.

Ukraine is a member of the primary conventions and agreements for biodiversity conservation, including the Convention on Biological Diversity (CBD), Convention on Wetlands (Ramsar Convention), Convention on the Protection of World Cultural and Natural Heritage; Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention on the Conservation of Migratory Species of Wild Animals (CMS) etc. However, there are some significant agreements, particularly the Cartagena Protocol and the Nagoya Protocol, that Ukraine has signed but not yet ratified. Ratifying these remaining protocols and conventions would enhance Ukraine's engagement in global biodiversity conservation efforts.

Ukraine's strategic objectives and biodiversity targets vary significantly compared to the goals established in the EGD and the EU Biodiversity Strategy. The strategic goals of the EU and Ukraine can be harmonised by developing and implementing a National Biodiversity Conservation Strategy and Action Plan (NBSAP), which is due to be developed with national targets submitted to the CBD in 2025. For further effective enforcement of NBSAP and reaching relevant goals, it will be necessary to make changes to the national legislation, make new laws and by-laws, and ensure the required human and financial capacity.

About 70% of Ukraine's forests are used by the State Joint Stock Company State Enterprise "Forests of Ukraine". Other 30% of forests are communally owned, while only a few are privately owned. About half of the forests have a natural origin and a status that limits their use for logging. Therefore, the state of forests and biodiversity in forests depends on state policy and support[138].

The state performs almost all functions related to regulating the use of forests and their resources, mainly wood and secondary forest resources. By the law, there are detailed requirements for the forest management system, the development, and implementation of forest management plans (forest management materials), various types of felling and use of wood, compliance with the state of the forest, fire prevention measures, afforestation and restoration of forests, implementation of state control over protection, protection, use and reproduction of forests[139]. The existing system of forest use regulation could be improved, as it does not consider some essential methods and tools inherent in market regulation systems and only declares the priority of the goals of ensuring the ecological safety of forest use. Some current unsustainable practices need to be addressed to avoid negative externalities in the future. Therefore, the modern concept of the economic regulation of forest use must be aimed at finding a successful combination of state and market regulation tools and be oriented towards the observance of the principles of sustainable forest use, which requires the improvement of the organizational-legal, systematic, institutional, administrative, financial-credit, price and customs system, innovative and investment support in the forestry sector. Prospects for further research in this regard are directly related to the need for a more detailed study of the principles of action and directions of application of various tools for regulating forest use in conditions of uncertainty of the market environment.

Financial capacity

The sector's portion of the state budget is not growing and shows a decreasing trend. The war has a substantial impact on funding and financing of the biodiversity sector. The highest level of budget line decrease (by 51%) was the "conservation management measures". Meanwhile, financial incentives for biodiversity conservation for businesses, local communities, and landowners must be created, and a difficult economic situation has blocked their development for decades. There is no accounting for natural capital or economic evaluation of biodiversity and related ecosystem services. The financing of nature conservation measures and PA activities depends on the state budget and is carried out under two main budget programs. "Distribution of expenditures of the State Budget of Ukraine for 2024" is available to the public and framed at the level of the Law of Ukraine with a total amount of ca. 212 million Euro.

The State Budget is Ukraine's biodiversity sector's most important funding source. The funding of the biodiversity sector is written in the State Budget for funding the MEPNR. "Distribution of expenditures of the State Budget of Ukraine for 2024" is available to the public and framed at

[138] Poliakova, L. and Abruscato, S. (2023) Supporting the recovery and sustainable management of Ukrainian forests and Ukraine's forest sector, FOREST EUROPE 67.

[139] Лісовий кодекс України 1994 № 3852-XII. Київ: Відомості Верховної Ради України (ВВР), 1994, № 17, ст.99, [Online] Офіційний вебпортал парламенту України.

the level of the Law of Ukraine with the total amount of 8 914 897 700,00 UA Hryvnia, which is ca. 212 million Euro[140]. However, the MEPNR budget is not a budget for biodiversity conservation alone. In addition to the Office of the MEPNR, this budget covers the State Geocadastr, the State Environmental Inspection, the State Water Agency, the State Agency of Ukraine for Exclusion Zone Management, and the State Forest Agency. Based on an assessment done during the writing of the report, the biodiversity sector (in broad scope) consists of ca. 116 million Euro, which is ca. 55% of the total MEPNR budget. The core budget lines of the biodiversity sector, like "Preservation of NRF" and "Implementation of environmental protection measures, in particular, to improve the state of the environment" and strongly linked to the implementation of EDG, consist of just over 25 million Euro, which is 22% of virtual biodiversity sector or just 12% of the total MEPNR budget. The priority financing for nature conservation and restoration in Ukraine is presented in Table 3.1, based on selected budget classification lines. The current budget does not have any budget classification lines, which are financially appropriate to EGD-related activities. The geopolitical situation of today and the ongoing conflict are reflected in the current budget lines, which indicate how the environment may not be a key priority at the moment.

The war has a substantial impact on funding and financing the biodiversity sector. The sector is not growing in the state budget but got even some reduction by 0,2% (between 2022-2023). The highest level of budget line decreased by 51% was the "conservation management measures". Protected areas support in practice covers the minimum needed for salaries and a small part of maintenance costs, while tourism income does not effectively contribute during the ongoing crisis. Most of the resource-establishing branches of the economy, like forestry, agriculture and hunting, got higher advantages during the war, and the power balance of "nature protection - industry" was shifted in favour of industry[141]. A notable exception is fisheries, as the fishing areas are not deemed safe, hence prohibiting almost completely industrial fishing. The estimates of the biodiversity sector spending needed has risen sharply during wartime, which is based on the data of the status of execution Consolidated and State Budgets of Ukraine for January - November 2022-2023 (according to the monthly report of the State Treasury Service of Ukraine from 25.12.2023). According to the consolidated budget, expenditures on environmental protection need to increase by 18.2 percent to 4.9 billion UA hryvnias (115,4 million Euro), including, according to the state budget - by 7.9 percent to 4.1 billion UA hryvnias (96,5 million Euro). The war strongly impacted municipalities' funding of nature conservation. It became unpopular as these resources were much more needed on the frontline. It is suggested to the authorities to initiate different cooperation programs and directly engage in credit agreements with international financial institutions, which is a considerable advantage for development and cooperation. The participation of Ukrainian regions in peer-to-peer recovery initiatives with EU counterparts may facilitate further integration of Ukrainian sub-national authorities into EU networks.

[140] Закон України "Про Державний бюджет України на 2024 рік". Бюджет, Розподіл, Перелік від 09.11.2023 № 3460-IX.

[141] Ukraine of the future: EU accession, post-war reconstruction, environmental challenges, and energy independence through the eyes of average Ukrainians policy brief based on a nationwide public opinion survey, February 2024.

"State policy in the field of environmental protection environment for Budget 2025-2026" will promote the formation of a clean and safe environment between 2025 and 2026, achieving "good" conditions of waters, preservation, and restoration of natural waters ecosystems by ensuring sustainable and rational development of nature management, waste management, in particular, handling of radioactive waste, prevention and adaptation to climate change. In particular, it is planned to implement measures regarding the creation and expansion of the territory of the nature reserve fund (protected areas); protection of settlements, agricultural lands, and estates from harmful effects of water; water supply to low-water regions; measurement of water quality indicators; implementation of state water monitoring for river basin areas; development of river basin management plans; preservation of animal and plant species listed in the Red Data Book of Ukraine; storage of used heat-dissipating assemblies in storage spent nuclear fuel; collection, processing, transfer (disposal) of radioactive waste. However, due to war and financial situation, it is very difficult to implement as stated.

Recently, Ukraine entered several EU Programmes, like LIFE, ERASMUS, five Interreg programmes, most suitable for the biodiversity sector are Interreg NEXT Cooperation, Interreg Europe, and Interreg Danube Region. This helped it gain experience in European territorial cooperation and shared management, including programming, sound financial management, project selection, and contracting. It is considered to be a significant step for implementing EGD-related policy. This funding provides strong opportunities for municipalities to initiate different cooperation programs and directly engage international financial institutions, which is a considerable advantage for development and cooperation. The participation of Ukrainian regions in peer-to-peer recovery initiatives with EU bodies may facilitate further integration of Ukrainian regions into EU networks.

The assessment of ecosystem services (ESS) and payments for ecosystem services are still not developed issues in Ukraine's legislation framework, which is an obstacle to the proper development of regulatory and economic instruments. Ecosystem services are mentioned in the Environmental Policy Strategy until 2030 and the Regional Development Strategy in general. The MEPNR, some NGOs, and scientific institutes are working on developing the concept of ecosystem services at the national level, introducing the concept into legislation, and using payment for ecosystem services as instruments of environmental regulation. In general, there are almost no incentive tools. Furthermore, no actual mechanisms are available for crediting nature protection measures, devise preferential taxation and price incentives for ecologically constructive activities, and to develop mechanisms for providing subsidies for forming ecological infrastructure. In particular, compensation to the landowners for preserving lands in their natural state or implementing PA management plans is absent. There are no mechanisms for accounting for natural capital, assessment of ecosystem services, or the possibility of paying for them voluntarily. Green accounting, a professional tax, has not yet been developed in Ukraine, which also makes regulatory and economic instruments weak enough to control national and international business, like dominant agro holdings. The gross domestic product ignores the environment; therefore, policymakers need a revised model incorporating green accounting.

Sectoral capacity

The interest in biodiversity is expected to be at least doubled in the process of EU accession and achieving new goals but the capacity of government bodies to work on issues of biodiversity protection is relatively low. The State Agency of Protected Areas was liquidated as a separate governmental body and merged with the MEPNR in 2011, and the number of employees working with issues of PAs decreased from 56 in 1996 to 17 people as of 2024. There is a significant difference between the capacity of government authorities and NGOs involved in biodiversity conservation and those involved in biodiversity use, which is reflected in the numbers of permanent staff and members, as well as in rights to use lands for dedicated purposes.

Many protected areas have established coordination councils for cooperation with local communities, land users, and scientists, where the use of natural resources and conservation management of species and habitats are discussed with communities, however this positive development is in danger due to the effects of the ongoing war. The government pays the 5% land tax to local communities through protected areas[142]. However, due to war, the government cannot pay the tax, which creates legal problems for the administration of national parks and reserves. This tax worked efficiently when government financial resources were available. Currently, the government of Ukraine is preparing amendments to the legislation to reduce up to 1% such a tax. The Cabinet of Ministers, as a subject of a legislative initiative, registered draft law No. 10198, "On Amendments to the Tax Code of Ukraine on Land Taxation of Nature Reserve Fund Lands", in the Verkhovna Rada. Its purpose is to support and ensure the proper functioning of NPF institutions and normalise their tax burden. In the explanatory note to the draft law, it is noted that PAs institutions, which belong to the sphere of management of the MEPNR, by tax declarations and existing decisions of local self-government bodies (taking into account benefits, land tax rates range from 0 to 5%, the average amount is 1%) for payment land tax for land plots with an area of 351.9 thousand hectares in 2023 will require UAH 139 315 600,00 (33 170 38,00 Euro). At the same time, the 2023 State Budget foresees land tax payments at the level of 2022, namely UAH 77 297 100,00 (1 840 407,10 Euro), or 55% of the need. It is a similar calculation for 2023 and 2024. At the same time, the PA institutions' funds, received from touristic activities, souvenirs, advertising publishing, and other activities, are not significant and are directed to implementing measures to protect the relevant sites. In NRF institutions, which are non-profit, and almost 80% of the territory is occupied by forests or other natural habitats, payment of land tax, according to the position of the State Tax Service, should be made in the amount established by local self-government bodies. In this regard, it is proposed that the Tax Code be amended to establish land tax rates for land plots belonging to the NRF in an amount not exceeding 0.1% of their normative monetary value. The Cabinet of Ministers of Ukraine has already approved the relevant draft law registered by the Verkhovna Rada of Ukraine. If it is approved by the Verkhovna Rada in the first half of 2024, the tax burden on NRF institutions and the expenditure part of the state budget will decrease already in 2025.

[142] Податковий Кодекс України 2011, 2755-VI, № 13-14, № 15-16, Київ: Відомості Верховної Ради України (ВВР), № 17, ст.112, [Online] Офіційний вебпортал парламенту України.

Digitisation is an important innovation issue for the government and a request of the public, particularly in the sector of biodiversity and especially during the war and post-war recovery, but there is a lack of capacities and qualified staff. Required data is only partially available and open due to the lack of a national (centralised) biodiversity monitoring system. That is linked to the Red Data Book of Ukraine's digital management. Also, the Cadastre of protected areas and the Land Cadastre are closed due to security issues during the war. The protected areas' data storage and management need to be centralised and capable of analysis but are, for now, mainly stored on paper. Digital capacities of large-scale protected areas (nature reserves, biosphere reserves and national nature parks) are still low, with few exceptions. Currently, capacity for data collection and monitoring is low. Separate data are collected by scientific institutes depending on specialization and scientific goals. Parks and reserves conduct observations and collect a fairly large amount of data on biodiversity and the environment as a whole as part of the Program Chronicle of Nature. However, data on biodiversity remains fragmented and poorly understood by decision-makers. For the preparation of reports, separate small projects are organized for summarizing and analysing data. However, the recently adopted Law on the creation of a state environmental monitoring system envisages the establishment of national biodiversity monitoring. This requires the development and preparation of by-laws and monitoring programs, software development, capacity building of organisations and mobilisation of resources.

The agenda for Ukraine in the following decades should be to adopt the best practice digital solutions and develop its national models in the biodiversity sector. Cross-sectoral interaction (e.g., transition of biodiversity finances) with other industries and sectors that use or threaten biodiversity, such as the agricultural and energy sectors, is problematic. However, EU and Ukraine R&D can be used efficiently throughout the sector to improve the green development of cross-sectoral standards.

EU Approximation

Over the past decade, Ukraine has made significant efforts within the framework of the EU accession process. The recently adopted water, forest, fishery, marine protection, biosafety, and economy strategies are considering EU objectives. EU Strategic Framework and biodiversity acquis related to biodiversity partially transposed into Ukrainian legislation. The regulatory and economic instruments framework has a complicated history, starting from the Soviet past, via the transitional economy period with oligarchy dominance, and the early democratic period. Many social equality, democracy, and sustainable development approaches entered Ukrainian legislation through international conventions, and the biodiversity sector is not exempt. Each of them filled the most critical gaps with several examples.

Currently, there is a significant difference between goals and indicators in the Ukrainian and EU strategic framework, and quite large differences and gaps in approaches to biodiversity conservation. Law of Ukraine "On the Key Principles (Strategy) of the State Environmental Policy of Ukraine for the Period until 2030" is the principal strategic document in environmental protection and biodiversity conservation. The national government considers this Law an analogue of the

National Biodiversity Strategies and Action Plans (NBSAPs) as required by the UN Convention on Biological Diversity (CBD). However, it is much broader and contains only four biodiversity-related indicators. Also, there are doubts about the possibility of achievement of set PA targets and indicators given the current land use structure, limited financial possibilities, and the impact of the war. In many cases, the goals of the national strategic documents are not reached due to the lack of human capacity, funding, and political will, difficulties in introducing amendments into legislation, business interests lobbying, and their non-fulfilment does not entail responsibility.

National legislation partially meets the requirements of the Birds and Habitats Directives. Most endangered bird species are listed in the Red Data Book of Ukraine and there is relevant legislation that regulates the use of hunting species. Monitoring of common birds and management of their populations are not established on a proper scale. The Habitats Directive was assessed similarly to the average degree of compliance. National legislation contains general provisions that allow habitat protection, however there is no corresponding list of habitats. National legislation on the preservation of plant communities, which could be considered an analogue, could be further enhanced. The crucial step for further approximation is the draft law "On the Emerald Network", which was prepared to implement the Bern Convention and aimed to facilitate the implementation of EU Habitats and Birds Directives[143]. The bill has been rejected and pending the Parliament's approval for over two years due to a lack of support from parliamentarians for establishing additional environmental restrictions.

Analysis of the EU Biodiversity Strategy and national legislation shows that the national goals are not clear enough and do not fully coincide with those in the EU. Ukraine's Eco-policy Strategy until 2030 contains an indicator of 15% for NRF and 41% for EcoNet, which generally correlates with the indicators established by the EU. However, the problem is that the current rate of establishment of NRF and EcoNet is very low and seems unlikely to reach the 15% rate due to the limited number of natural areas where nature conservation restrictions can be imposed, especially strict. Most regions have not defined the EcoNet sites, and it remains unclear what the area of the EcoNet is despite the number of 38% in official papers. There is a big gap between the requirements of legislation and the results of its implementation in practice. On the other hand, national legislation already allows the creation of ecological corridors, strictly protected areas, and other types of PAs as required by the EU Biodiversity Strategy. Also, the full protection of primaeval and old-growth natural forests legally defined in Ukraine creates certain opportunities to preserve the most valuable areas.

The EU Biodiversity Strategy's goal to bring back at least 10% of agricultural areas under high-diversity landscape features is crucial in Ukraine. The issue of returning nature to agro-landscapes, as defined in EU legislation, is complicated in Ukraine due to the continuation of land privatisation; shift of responsibility for land protection and green infrastructure in agro-landscape to the level of local communities (where there is no relevant knowledge and funds); the lack

[143] Овчинникова Юлія Юріївна, Бондаренко Олег Володимирович, Криворучкіна Олена Володимирівна, Лабунська Анжеліка Вікторівна, Задорожний Андрій Вікторович, Кривошеєв Ігор Сергійович, Прощук Едуард Петрович and Василенко Леся Володимирівна (2020) Проект Закону

of legal requirements and interest of farmers (financial incentives are absent); and big agribusiness lobbying to allow further fields consolidation. Despite national legislation declaring the need to restore degraded lands and preserve green infrastructure and areas with natural vegetation, these norms remain declarative and rarely implemented.

The goals of the EU Biodiversity Strategy regarding increasing the quality of forests and improving their health and resilience generally coincide with the Forest Code of Ukraine and are reflected in the Forest Strategy of Ukraine. In recent years, significant reforms have been carried out in forestry, the creation of an open and transparent timber market, forest inventory and accounting, and the unification of all state forestry enterprises into one large state-owned joint-stock enterprise.

The development of green energy specified in the EU Biodiversity Strategy, in particular hydropower, has a long history in Ukraine and has led to the fragmentation of all large and medium-sized rivers of Ukraine. The corresponding transformation of wetland habitats is one of the greatest threats to the aquatic biodiversity in Ukraine bringing to the point of extinction all migratory fish species. Wind and solar energy development is carried out in formal compliance with the legislative requirements regarding environmental impact assessment. But most of them are built on lands with natural vegetation and green infrastructure in agro-landscapes, compromising their role as an area of existence of biodiversity. Therefore, stricter restrictions should be introduced regarding the selection of land plots and assessment of the impact on biodiversity.

Further steps are needed to ensure compliance with EGD and align Ukraine's biodiversity sector with the EU. Based on the current situation in the legal framework development to ensure compliance with the green transition, the most key laws that need urgent regulatory and economic improvement are the Emerald Network Law adaptation, Law on Ecosystem Services and Payments development, improvement of management plan provisions for protected areas (including cadaster requirements), changes in some normative documents of the Ukrainian forestry sector linked to nature conservation measures (like methodological recommendations on the regime of forest ecosystems conservation on the areas of different categories of protected areas, biodiversity conservation in forests within and outside of protected areas, improved illegal logging framework, reducing VAT the protected areas pay for local communities, improved fishery framework (the reinforcement of the data collection framework, and the development of policies for Fishery and Aquaculture markets, management and control of fishing activities, imports by the EU's common fisheries policy). The most significant need for alignment of sectoral EGD goals is as follows: (a) development of a sectoral efficient Biodiversity Monitoring System; (b) Improvement of Environmental Impact Assessment; (c) development of the Alien Species Regulations and Management; (d) improvement for plant, animal and wood species use and protection (CITES permit/certificate, criminal liability, compensation for damage, stimulation economic mechanisms, support for restoration/rehabilitation programmes); e) improvement human and technical capacities (training on EGD goals development).

Main priorities for the green transition

While the war has postponed all "must-do" steps for an uncertain period, it is important not to lose focus on the needs of biodiversity, and "do no significant harm" principles should be applied to all investments. While both financial as well as human resources are drained by the war and biodiversity protection is less of a priority for the government, it is also very important not do make decisions that will make biodiversity protection and ecosystem restoration much more difficult in the future. All investments, especially those with large land use impacts, need to be assessed from the perspective of doing the least harm to biodiversity.

It is important to develop a National Biodiversity Strategy and ensure that it and the relevant legislation is approximated to the EU. This is particularly important in the context of setting relevant goals for national and local levels, adapting a habitat approach to biodiversity conservation, assessing biodiversity and ecosystem services, ensuring the fulfilment of obligations on the MEA, and creating new financial instruments and incentives. There is a need to adopt the draft Law "On Emerald Network" and amend other laws to implement the habitat conservation approach. Develop ecosystem services legislation framework with payments scheme.

Developing specific plans to restore nature, in line with the EU Nature Restoration Regulation, in the territories affected by military actions and the return of nature to agricultural landscapes is necessary. This will allow activities after the war to quickly focus on restoring ecosystems and allow for financial planning to ensure that funding will be available, especially through international programs and donors.

There is a need to increase capacity and create equal opportunities for NGOs to conserve and use biodiversity with the state and international support programmes. Volunteer ecological movements that support conservation management must have a special programme to expand civil society's involvement in the biodiversity sector. There is a lot of potential in NGOs to build up the expertise and resources needed after the war to restore the damaged ecosystems and set up the framework for effective biodiversity protection.

The national and regional budgets used for the biodiversity sector must be substantially improved. Develop financial incentives for biodiversity conservation. Creating a National Environmental Fund with civil society and science involvement can be a solution to improve budget use efficiency. Anti-Corruption units, like DBR, must improve activities dealing with the illegal/mismanagement use of natural resources. Dissemination of information and conducting training on fundraising and grant applications, particularly for the EU and UN Programs. Financial incentives for biodiversity conservation for businesses, local communities, and landowners must be created in addition to this to allow for more financing from the private sector to be utilized.

To ensure a green transition in the forest sector, it will be important to update forest and wildlife management plans. These should promote biodiversity conservation and address illegal hunting practices, cases of excessive illegal logging, water pollution, and other nature damage irregularities that are being reported by civil society and local communities. Forest certification

has been one of the driving issues in implementing EGD-related policies in forestry over the last 15 years. Most forests in Ukraine that are used for commercial purposes are covered by FSC certification. As of May 2024, 4.89 million hectares of forests have been certified in Ukraine; 102 FM/CoC certificates and 393 CoC certificates have been issued (FSC, 2021; 2024). FSC forest management certification confirms that the forest is being managed in a way that preserves biological diversity and benefits the lives of local people and workers while ensuring it sustains economic viability.

Law enforcement and control systems must improve activities dealing with the illegal use and mismanagement of natural resources.

Creating a special government Agency for Protected Areas and Biodiversity Conservation is essential to improve protected area management, establish the biodiversity monitoring system, and ensure biodiversity conservation in practice. The creation of a special government Agency for Nature Protection Areas and Biodiversity will contribute to improved protected areas management and to strengthening the possibilities of achieving the goals of the EGD. International training programmes are essential for public institutions, especially at the national and regional levels. Raising awareness and organising cross-sectoral interaction is needed to reduce biodiversity loss. Spreading knowledge about EGD and EU legislation and developing the skills of civil servants is necessary for biodiversity preservation.

1.8 Zero-pollution

Status and trends

Ukraine has a long-standing problem with environmental pollution due to the heavy industry in the eastern part of the country. This is partly due to the unfortunate legacy of the Soviet Union, as many of the factories built during that period were still in operation after the restoration of independence, mostly with outdated technology. The heaviest polluters have historically been located in the eastern part of Ukraine and part of the metallurgy, chemical industry, mining, and electricity generation sectors[144]. However, the Soviet legacy and limited modernization are also an issue with agriculture, forestry, water management, and other high environmental impact sectors.

Because of this, Ukraine has had serious issues with air, water and soil pollution. The National Environmental Strategy 2020 identified air pollution as one of the most serious problems and causes of health hazards in Ukraine. This has generally been the most pressing issue in major cities like Kyiv, Dnipro, and Kryvyi Rih. The Dnipro River, which is one of the longest rivers in Europe, is heavily polluted. Intensive agriculture has pushed for the heavy use of fertilizers and pesticides, leading to soil degradation and water contamination.

However, it is currently impossible to discuss environmental pollution in Ukraine without discussing the horrific consequences that the full-scale invasion by Russia has created. In the early days of the full-scale invasion, Russian troops relied on existing infrastructure for movement. As they began preparing for sustained confrontations, they established bases and fortifications, which led them to move deeper into natural areas, including forests and nature reserves. The movement of heavy equipment, construction of fortifications, and ongoing hostilities have caused damage to the soil, resulting in the degradation of vegetation and an increase in both wind and water erosion.

Since the beginning of the full-scale invasion, 79 nature conservation sites in Mykolaiv region have been affected, with 16 directly in combat zones or under occupation, including the Black Sea Biosphere Reserve and National Nature Park "Biloberezhia Sviatoslava". Damages include shelling, mining, fires, destruction of soil and vegetation, and flooding due to the Kakhovka Hydroelectric Power Plant explosion. To date, only the "Ivano-Kepyne" botanical reserve has had its damages assessed, amounting to approximately €12.5 million. In the Kherson region, a commission was established to assess the environmental damages of the right-bank area post-liberation. In 2023, the total damages exceeded €4 billion, with additional damages being assessed to be a further €27 million[145].

Since the fall of 2022, emergency and rolling blackouts have been implemented in Ukraine, and massive rocket attacks have caused power outages in certain regions. In 2022 alone,

[144] Clean air for Ukraine, 2018. Industrial Ukraine: Impact of pollution on inhabitants and the environment in five industrial cities

[145] Environment People Law, 2025. Status of fixation of damage caused to NRF objects close to the front line

nearly 670,000 generators were imported into Ukraine[146]. The internal combustion engines used in generators pollute the environment with harmful substances, including carbon monoxide, soot, nitrogen oxides, and fine dust, which negatively affect human health. The detonation of rockets, artillery shells, and mines releases various chemical compounds, such as carbon monoxide, carbon dioxide, water vapor, nitric oxide, and nitrogen. It also causes the release of toxic elements, such as sulphur and nitrogen oxides.

The state monitoring system is operated by the Ukrainian Hydrometeorological Center, which collects atmospheric air samples at 129 stationary posts, measuring air quality 3–4 times a day, six days a week[147]. Currently, in addition to this system, a public monitoring network also exists, complementing the state system by being more extensive, especially in small towns and villages. The largest public monitoring networks today are EcoCity, LUN Misto Air and Save Dnipro. Most government monitoring posts in Ukraine are outdated and require modernization, replacement, and the adoption of a unified methodology. In addition, the current equipment is not designed to capture explosive gases and other hazardous substances associated with combat operations. New equipment was installed in several cities, including Mariupol, a major industrial city with significant air quality concerns. However, in the Donetsk region, the occupiers physically destroyed these monitoring stations.

In times of war, explosions, fighter jets, tanks, and other weapons cause damage not only through direct hits and chemical contamination of the environment but also through the noise pollution they generate. This affects sleep, migration, reproduction, and the ability of wildlife to hear and track prey. The noise produced by military rifles can reach levels of about 150 decibels, and the noise from a moving tank can reach 130 decibels[148]. However, some weapons and vehicles can generate much higher noise levels. Aircraft used in military operations can produce noise bursts (e.g., sonic booms, jet afterburners, rotational pulses, etc.), which pose serious health risks to wildlife.

According to the State Ecological Inspectorate, over 280,000 square meters of soil have been contaminated with hazardous substances due to the war across Ukraine[149]. More than 59,000 hectares of forests and other plantations, including the forests of Sviatohiria, have been burned by rockets and shells. Additionally, vast areas have been mined.

The destruction of the Kakhovka dam in 2023 also caused extensive pollution of the Dnipro–Bug estuary and the north-western part of the Black Sea. On 8 June 2023, pollution reached Odesa, and by 10 June, it reached the mouth of the Dniester River. On 17 June, river water containing both chemical and biological contaminants from the sediments previously stored behind the dam and from flooded industrial facilities, landfills, sewage plants, and petroleum stations reached the mouth of the Danube River and covered an area of more than 7300 km[150].

[146] Ukraine Energy, 2023. Україна імпортувала у 2022 році майже 670 тис. Генераторів

[147] Alyona Vyshnytska, 2022. Air during the war. Why it is important to monitor pollution and talk about it

[148] EcoPolitic, 2022. The Hidden Threat of the War: How Noise Pollution "Cripples" Nature

[149] Agro-Business, 2023. More than 59 thousand. hectares of Ukrainian forests were burned by missiles and shells

[150] Viktor Vyshnevskyi, Serhii Shevchuk, Viktor Komorin, Yurii Oleynik & Peter Gleick (2023): The destruction of the Kakhovka dam and its consequences, Water International

In the east of the country, illegal dumping of chemical waste and active hostilities have caused significant soil contamination with heavy metals and oil products. The Kharkiv region showed a 200% increase in cadmium contamination; the Kherson and Zaporizhzhia regions showed a 139% and 156% increase in oil spills, respectively. These changes can create serious consequences for public and environmental health[151].

Due to the influence of the war, the process of humus loss has accelerated. Soils are losing their fertility due to changes in their physical, chemical, and physicochemical properties. The tendency to decrease the pH values in post-fire soils is explained by ash water-soluble compounds, penetrating the soil, saturate the absorbing complex with alkaline earth elements. In soils damaged by fire, there was a decrease in organic carbon, which is associated with the direct destruction of the upper horizon due to thermal exposure[152].

Environmental projects that were implemented before the full-scale invasion were tragically destroyed by the Russian army. For instance, in Mariupol, just before the war began, the infrastructure for processing and utilizing solid waste was modernized. One of the city's landfills was reclaimed, and biogas production had started. In Bakhmut, a waste sorting station was nearing completion in December 2021, with plans to recycle the waste. Now, all of this is in the past. Russia has not undertaken similar initiatives, and instead, tons of construction waste are dumped at the Mariupol landfill, causing fires and smoldering.

The ongoing full-scale invasion of Russia into Ukraine has resulted in significant environmental hazards associated with massive amounts of military waste. According to the United Nations Environment Programme (UNEP), abandoned or destroyed military equipment generates large quantities of hazardous substances including fuels, lubricants, heavy metals, and explosives, which due to the absence of proper waste management, progressively leak into the environment[153].

Additionally, the construction and demolition debris from widespread destruction across Ukraine pose a severe threat. There is a significant risk of contamination from hazardous materials contained in destruction waste, particularly asbestos, heavy metals, and chemical residues[154]. Asbestos, commonly used in older buildings, becomes airborne during destruction, causing severe respiratory health risks. In addition, improper disposal of these materials contaminates surrounding soils and water, creating prolonged environmental health hazards that require complex remediation strategies and substantial resources to mitigate effectively.

[151] Shebanina, O., Kormyshkin, I., Bondar, A., Bulba, I., & Ualkhanov, B. (2023). Ukrainian soil pollution before and after the Russian invasion. International Journal of Environmental Studies, 81(1), 208–215.

[152] Matkivskyi, M., & Taras, T. (2024). Pollution of the atmosphere, soil and water resources as a result of the Russian-Ukrainian war. Ecological Safety and Balanced Use of Resources, 15(1), 87-99.

[153] United Nations Environment Programme (UNEP), 2022. Ukraine Conflict: Environmental Risks and Impacts

[154] Environment-People-Law (EPL), 2023. Damage assessment in protected areas near frontline zones

Strategic and governance capacity

The primary government body responsible for addressing environmental pollution is the Ministry of Environmental Protection and Natural Resources. The ministry oversees ecological monitoring, policy formulation, and the implementation of environmental protection measures. Its responsibilities encompass a wide range of areas, including atmospheric air quality, preservation of the ozone layer, restoration and protection of flora and fauna, land and water resource management, and climate change.

There is currently no vision to reduce air, water, and soil pollution to levels that are no longer considered harmful to health and natural ecosystems in Ukraine. In the EU, the goal of zero pollution in 2050 is an integral part of the EU Green Deal.

Reducing air, soil, and water pollution still plays an important role in several other sectoral strategies. One of the key strategic documents in this regard is Ukraine's Environmental Security and Climate Change Adaptation Strategy until 2030, which is developed with the support of EU4Climate. This strategy sets several goals that are relevant to the reduction of environmental pollution, namely:

- reduction of industrial pollution;
- creation of an effective chemical safety system;
- ensuring the rational use of natural resources; achieving "good" ecological state of waters;
- ensuring sustainable forest management and increasing the adaptive capacity of forest ecosystems;
- creation of legal and economic bases for the introduction of a hierarchy of waste management;
- increasing the efficiency of the state system of environmental impact assessment and state supervision (control) in the field of environmental protection.

However, it is very difficult to create a viable vision during an active war as it is currently impossible to fully assess the impact of the war on the environment due to the lack of accurate information. There are two reasons for this. First, collecting this data is dangerous for experts, as active hostilities are ongoing. Second, not all information can be made public for tactical purposes. However, it is clear that the longer the war lasts, the more damage it will cause to the environment and the greater the consequences we will face in the future.

To make sure there will be relevant data for post war recovery and the process of reparations, the Ministry of Environmental Protection and Natural Resources is coordinating calculating of the environmental damage. However, while the state is actively increasing the amount of environmental data it collects in electronic databases, it is also restricting public access to this data. The Ecosystem, which integrates most electronic databases of environmental information, now requires authorization with a qualified electronic signature to access many datasets that were previously freely available (for example on EIA and SEA). Additionally, due to the war, no scheduled environmental inspections have been conducted across Ukraine for almost three years, and all re-

porting (including to the newly established PRTR) is carried out on a voluntary basis with no liability for failure to meet these obligations during martial law.

However, there is a positive development in the sector as in 2024, Ukraine adopted a law "On Integrated Industrial Pollution Prevention and Control[155]**".** The law aims to ensure the implementation of one of the key provisions of the Ukraine Facility Program and the requirements of Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control). It will introduce integrated approaches to permitting and control of industrial pollution based on the use of the best available technologies and management methods. It is foreseen that once relevant BAT conclusions are adopted in Ukraine, all new installations will be required to operate in accordance with relevant BAT conclusions. The existing installations will have a four-year transitional period and, additionally, a possible seven years derogation period after martial law is cancelled.

The Ministry of Environmental Protection and Natural Resources also approved the Procedure for the establishment of regional environmental monitoring centers in 2024 which will however only come into effect 6 months after marial law ends in Ukraine. One of the main goals of these centers is to ensure effective collection and analysis of data on the state of the environment at the regional level. This will allow obtaining up-to-date and reliable information on the state of air, water, soil, and other components of the environment. Additionally, an important aspect of the centers' activities will be the coordination of the work of various monitoring entities. They will ensure interaction between government bodies, scientific institutions, public organizations, and other stakeholders. And last but not least, the centers will play an important role in informing the population about the state of the environment. Among their tasks are to publish monitoring data and inform the public about environmental problems and risks. Monitoring data will be used to develop and implement effective environmental policies and will become the basis for making management decisions in the field of environmental protection[156].

Sectoral capacity

Following the start of Russia's full-scale invasion, the State Environmental Inspectorate established an operational headquarters to document all environmental damage. This organization was created to track and compile a list of environmental violations and calculate the damages to hold Russia accountable. However, many cases of environmental damage resulting from military actions are not recorded by the inspectorate due to mining or the prohibition of visiting certain territories. Civil society organizations, such as the Center for Environmental Initiatives "Ecoaction", also monitor the environmental harm caused by military operations.

In 2024, NGO 'Ecoaction' volunteer team recorded 450 cases of potential environmental damage caused by Russian aggression, almost one and a half times fewer than in 2023. However,

[155] Verkhovna Rada of Ukraine, 2024. ЗАКОН УКРАЇНИ № 47, ст.269, Про інтегроване запобігання та контроль промислового забруднення

[156] Ministry of Environmental Protection and Natural Resources of Ukraine, 2025. Regional Environmental Monitoring Centers: Accurate Data for Effective Environmental Solutions

the trend persists, and most cases are recorded along the contact line, as in previous years. Notably, cases recorded in regions farther from the frontline tend to have a higher rank of environmental damage, indicating more severe environmental consequences.

The number of cases ranked 2 and 3 (where the impact on the environment was clearly recorded) is comparable between both years, which generally demonstrates the ongoing impact of Russian attacks on Ukraine's environment that has not decreased as the war progresses. The reduction in numbers occurred primarily through the decrease in the number of cases ranked 1 – that is, cases with potential environmental impact. This could reflect on the one hand, methodological aspects of recording first-ranked cases (improvement in the filtering approaches of cases entered into the database). On the other hand, the decrease in recorded cases could objectively reflect the fact that many objects whose damage falls under the classification have already been destroyed earlier, in the previous years of the full-scale invasion. It also affects the fact that, for security reasons, the Ukrainian authorities often do not disclose detailed information about impacted objects and consequences, which means the team does not have enough data to record the case for the interactive map.

EU approximation

Regarding legislative documents that cover environmental pollution, Ukraine has made some progress in aligning with the EU acquis in recent years, however, based on the EU enlargement policy report on Ukraine published in 2024, the biggest issue remains the actual implementation of these regulations, which is difficult during wartime.

Air quality and noise pollution legislation are only partially aligned with EU standards, with limited progress in addressing key directives. While Ukraine adopted new legislation on air quality monitoring and fuel quality and submitted a report under the UNECE Air Convention, full compliance still requires further development. Necessary measures include setting national emission ceilings, better control of volatile organic compounds, enhanced compliance monitoring of sulphur in fuels, and improved air quality data collection. In contrast, no progress was made in aligning noise pollution legislation with EU standards during the reporting period.

Regarding water quality and wastewater management, Ukraine has made advances, particularly in implementing the Water Framework Directive. Draft river basin management plans have been published for all river basins, and changes were made to the Marine Environmental Strategy in August 2023 to prepare action plans. Additionally, secondary legislation was adopted to determine surface water quality. In wastewater treatment, the Law on Sewerage and Wastewater Treatment, which came into force in August 2023, introduced new standards. Regulations were also adopted to control the maximum permissible discharge of pollutants. However, the issue of cost recovery for water services remains unresolved.

Industrial pollution and risk management legislation are only partially aligned with EU requirements due to missing regulations and insufficient emission control measures. Some progress has been made with the adoption of a law on integrated prevention and control of industrial

pollution, alongside new reporting requirements for pollutants from stationary sources. However, full compliance with the EU Industrial Emissions Directive requires additional secondary legislation and implementation measures. Moreover, Ukraine must implement the EU Eco-Management and Audit Scheme (EMAS) and align its environmental standards with EU Ecolabel Regulations.

Environmental monitoring in Ukraine remains incomplete, with partial alignment to EU standards. A state environmental monitoring program concept was approved in July 2023, but the martial law regime has prevented its full implementation. Regarding public access to environmental information, the Law on the National Register of Pollutant Emissions and Transfers (PRTR) was adopted in October 2023, with implementing legislation following in March 2024. Additionally, no progress was made in aligning environmental liability, environmental crime, and environmental control regulations with EU standards.

Main priorities for the green transition

Ukraine must continue to develop environmental regulations to address air, water, and soil pollution, which remain serious due to outdated industrial infrastructure and war-related environmental damage. To help with this effort, a stronger vision for a zero-pollution future for Ukraine is advisable, like the EU's zero-pollution strategy. This can help create a comprehensive approach that not only focuses on pollution itself but modernizing the economy through clean energy, clean technology and sustainable business practices.

Ukraine's environmental monitoring systems are outdated and require modernization to effectively track pollution levels. The state monitoring system should integrate new technologies, expand coverage, and adopt a unified methodology for data collection. Investment in regional environmental monitoring centers, as approved in 2024, should be prioritized to ensure accurate assessments of air, water, and soil quality.

It is vital to enhance pollution monitoring and conducting a thorough assessment of post-war air pollution impacted areas to establish a baseline for the reduction of environmental pollution. While the programs currently underway for assessing environmental damage are very important to track the status of the environment, it is very difficult to get a clear view of the actual situation during the war.

Given the extensive environmental damage caused by the war, it is important to incorporate pollution reduction and ecosystem restoration into its post-war recovery strategy. This includes remediating contaminated soil and water sources, restoring forests and wetlands, and clearing toxic waste from industrial and energy infrastructure damaged by attacks. Industrial emissions should be reduced by phasing out outdated coal-fired power plants and metallurgy facilities while promoting clean technologies and best available techniques (BAT) in industrial operations.

To support businesses in adopting clean technologies and sustainable business practices, the government should establish green funding programs and increase the available expertise. Industrial companies could gain much support from green financing (including through green public procurements), workforce training, regulatory incentives, and international cooperation. At the same time, it is important for the government to strengthen regulatory agencies by allocating resources for inspections, audits, and penalties for non-compliance.

2. Financing the Green Transition

Ukraine has adhered to the European Green Deal on a strategic level and has set in motion actions to transition to a green economy. More recently, the establishment of the Ukraine Facility, a major financial mechanism for supporting Ukraine's recovery and reconstruction in 2024-2027, and the opening of the EU accession negotiations strengthened these commitments by creating concrete incentives for their realisation.

The ongoing military aggression against Ukraine has a significant impact on the Green Transition finance in Ukraine. This impact concerns both the demand and the supply of money as well as efforts to analyse financial flows. The financial needs of Ukraine related to green transition and ESG considerations are hard to disintegrate from the massive investments needed to repair damages being caused by the war in real-time. In such conditions, private investments are on the low while internal financial resources are being drained thanks to uncertainty, war risks, and inflation.

Public finance from international donors remains unpredictable: more stable support from multilateral donors is paired with volatile bilateral support. In addition, in line with government priorities, international support tends to target the most urgent needs, which sometimes creates a preference for solutions with a shorter-term vision. In such circumstances, the risk persists that ESG aspects of financing can be sidetracked despite generic pledges to "Build Back Better". For this reason, it is important to identify and strengthen the institutions critical to promoting the Green Transition finance in Ukraine.

Public and private revenues/expenditure streams for Green Transition finance

Public revenues for financing Green Transition in Ukraine come from taxes, other fiscal measures (such as fees and fines), financial inflows from official development assistance (ODA) as well as certain other sources (e.g., international charities).

Apart from general taxes on income and VAT, as of the end of 2024. a specific tax applies to emissions of certain polluting substances (including CO2) by fixed sources. The applicable tax rate remains low, the same as the collected tax revenues (linked to lowering such CO2 emissions due to ongoing military aggression). No cap-and-trade system for CO2/GHG emissions operates in Ukraine, though the development of the Emission Trading System in line with the EU approach is envisaged by the Ukraine Plan 2024-2027[157] and the National Energy and Climate Plan until 2030 (NECP).[158]

Since Ukraine is an Annex I country for purposes of UNFCCC situated in Europe, there is a relatively limited number of multilateral donors that provide funding: EBRD, EIB, World Bank/IBRD, Climate Investment Funds (Clean Technology Fund), GEF, NEFCO, as well as the Black Sea Trade and Development Bank and certain others. Bilateral donors comprise the EU

[157] European Commission, Accessed in March 2025. Ukraine Facility

[158] Ministry of Economy of Ukraine, Accessed in March 2025. Національний план з енергетики та клімату на період до 2030 року

and mainly EU member states' ministries, banks, development agencies, and the US and Canada, Australia, Japan, and Korea from outside Europe. Certain Green Transition support is provided directly by UN agencies (such as FAO, UNDP, UNEP, UNIDO) as well as by NGOs and charities. In addition, Ukraine has two Article 6.2 Paris Agreement cooperative arrangements (with Switzerland and Japan)[159], which can generate profits from the sale of ITMOs.

Public expenditure for financing green transition cannot be systematically identified without a system of budget tagging. No green/sustainable budgeting framework applies in the Ukrainian budgetary process[160]. Despite that and the austere fiscal environment caused by the military aggression exacerbated in 2022, Ukraine continues to finance programmes and provide fiscal incentives directed at Green Transition. These are streamed through the Energy Efficiency Fund of Ukraine, the newly established Decarbonisation Fund, as well as sectoral funds and individual state budget programmes of grant or low-interest debt finance. An important contribution to these efforts, especially in the energy sector, is provided by sub-national government programmes (Kyiv, Lviv, Vinnytsia, etc.).

In the absence of an official sustainable finance taxonomy, private sector revenues and expenditure for financing green transition in Ukraine are difficult to track in a consistent and reliable manner. EBRD, NEFCO, and IFC provide funding for private Green Finance initiatives through loans and technical assistance. MIGA deploys guarantees in support of Ukraine from the Support for Ukraine's Reconstruction and Economy Trust Fund (SURE TF)[161].

[159] UN Environment Programme, Accessed in March 2025. Article 6 Pipeline

[160] UNDP Ukraine, 2022. SDG budget tagging (includes methodology and report on SDG budget tagging)

[161] World Bank Group, Accessed in March 2025. Support for Ukraine's Reconstruction and Economy Trust Fund (SURE TF)

Green Transition Finance Flows in Ukraine

Official Development Assistance

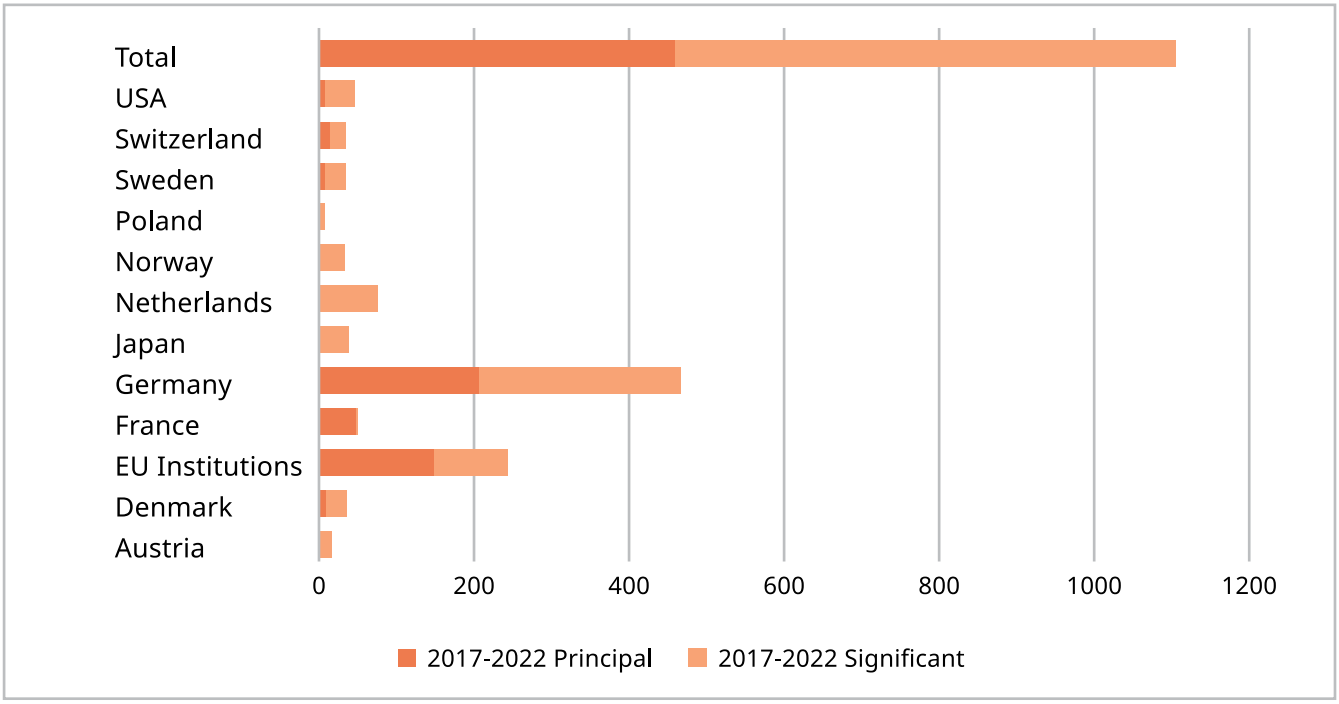


Figure 15. Bilateral climate-related development finance to Ukraine, total and major donors, 2017-2022, in million USD (2022).

Based on the OECD data, **the total bilateral climate-related finance to Ukraine in 2017-2022 was reported at approximately, USD 1.1 billion** (Figure 15)[162]. Germany contributed the bulk of this amount, followed by the EU (excluding EIB). Another major donor of bilateral finance with a principal climate element was France. In terms of finance with a significant climate element, major inflows came from the Netherlands, Japan, the USA, Norway, Denmark and Sweden. Overall, the number of bilateral donors stood at 24

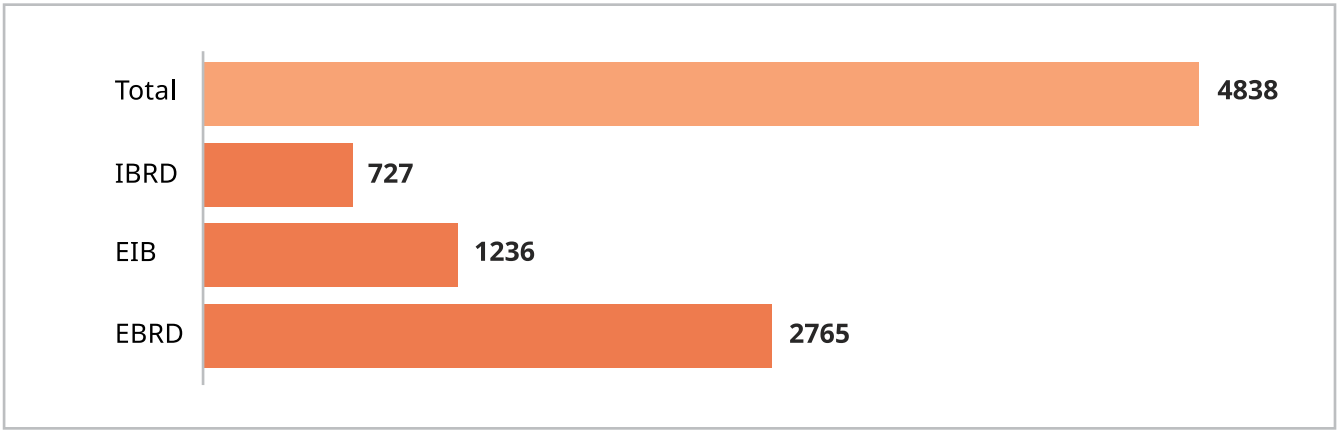


Figure 16. Multilateral climate-related development finance to Ukraine, total and major donors, 2017-2022, in million USD (2022)

[162] OECD, Accessed in March 2025. Development finance for climate and environment

The total multilateral climate-related finance to Ukraine in 2017-2022 amounted to approximately USD 4.8 billion (Figure 16), mainly constituted (97.7%) by inflows from EBRD, EIB, and IBRD (World Bank). Other multilateral donors, namely the Clean Technology Fund under the Climate Investment Funds (CIF-CTF), the Black Sea Trade & Development Bank (BSTDB) as well as the Global Environment Facility (GEF), provided substantially smaller amounts (ranging from USD 23 million to USD 51 million each). These smaller donors can be differentiated in terms of the consistency of their financial flows: while GEF provided finance throughout the indicated period (2021 being an exception), CIF-CTF reported finance to Ukraine only in 2018-2019 and BSTDB in 2020.

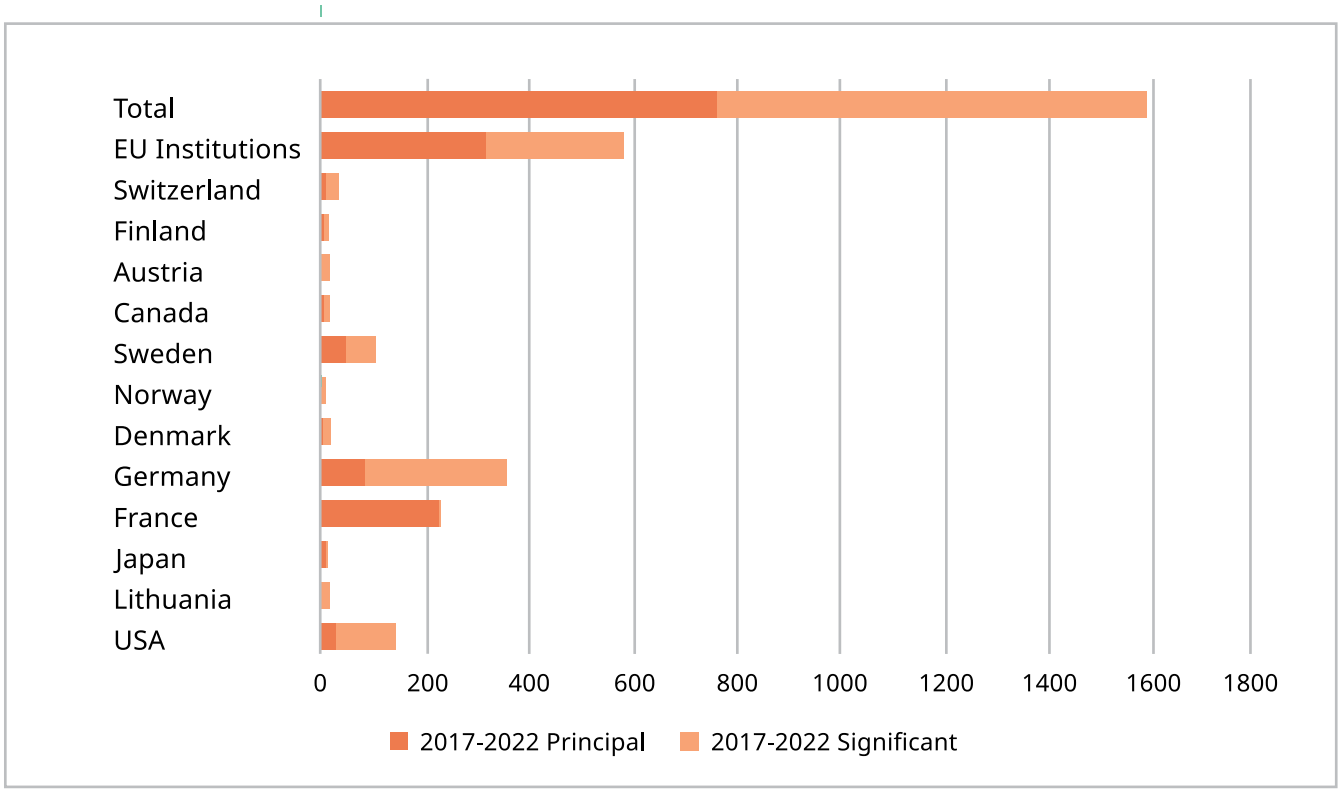


Figure 17. Environmental finance to Ukraine, total and major donors, 2017-2022, in million USD (2022)

The total environmental finance from bilateral donors to Ukraine amounts to approximately USD 1.6 billion for the period 2017-2022. The EU (excluding EIB) stands as the biggest bilateral donor overall, with a more or less even distribution of funds between principal and significant environmental elements. Following the EU, the three biggest providers of environmental finance (with the principal environmental element) are France, Germany, and Sweden, while in terms of bilateral finance with a significant environmental element, these are Germany, the USA, and Sweden. In total, in that period, environmental finance came from 29 countries, mostly from Europe and North America but also from Asia (Japan, Korea) and Australia. This includes Canada, Estonia, Greece, Iceland, Ireland, and the UK as bilateral donors (compared to climate-related finance described above). Overall, almost one-third of all bilateral environmental finance to Ukraine in 2017-2022 went to environmental objectives beyond climate change.

Concerning the sector distribution, "energy" was the leading sector in climate-related finance (33%) and total environmental finance (28%). In climate-related finance, "transport and storage" (23%), "industry, mining and construction" (7%) as well as "agriculture, forestry and fishing" (7%) were next in line to receive the most finance. Interestingly, in climate finance to Ukraine, 5% was dedicated to "banking and financial services". In environmental finance, after "energy", most environmental finance to Ukraine in 2017-2022 went to "government and civil society" (25%) and "water supply & sanitation" (18%). These sectors received only 4% and 2% in climate-related finance, respectively. "General environmental protection" as well as "agriculture, forestry, fishing" received 6% of each of the total commitments in this period.

The distribution of climate-related finance to Ukraine in 2017-2022 between climate mitigation and climate adaptation demonstrates that most financial commitments went into climate mitigation (more than 82% for most major donors) with some stark exceptions: Japan dedicated the bulk of its bilateral finance to Ukraine to adaptation while the EU institutions preferred to serve both objectives.

In 2017-2022, Ukraine recorded climate-related finance in three principal forms: grants, concessional debt, and "non-concessional debt or debt not primarily developmental". The latter mostly came from multilateral donors such as EBRD, EIB, and IBRD (the World Bank). Of the total amount of climate-related finance, 81% accounts for this latter category, with 16% of grants and only 2% of concessional debt. Of major donors, Germany provided the biggest share of concessional debt along with grants.

ODA mobilised private climate finance

OECD reports private climate finance mobilised alongside ODA on the OECD Data Explorer[163]. The classification of this financial flow is based on the general assumption that the private sector would not have invested without an official finance intervention.

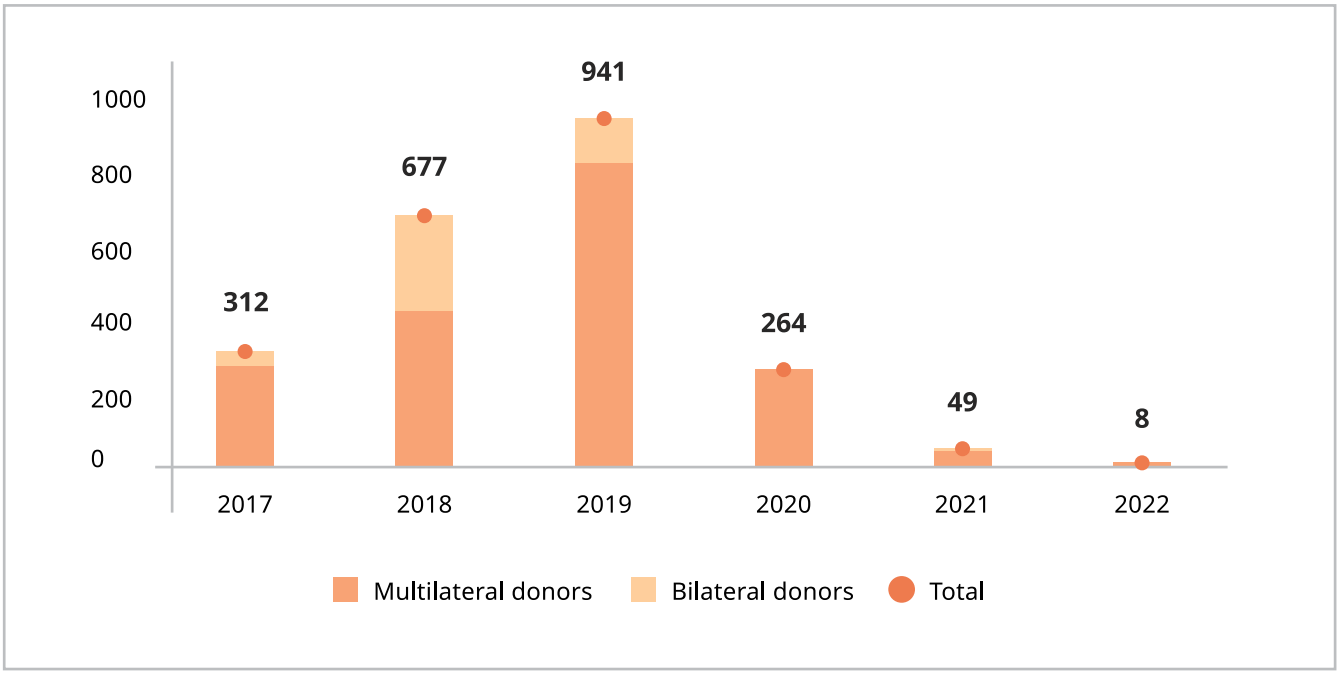


Figure 18. Private climate finance mobilised, 2017-2022, total by year and by donors, in million USD (2022)

According to OECD, in 2017-2022, the total mobilised private climate finance amounted to approximately USD 2.3 billion.[164] However, this amount is unevenly distributed over the years, with a spike in 2019 and an obvious decline in 2021-2022. Private climate finance was mobilised for Ukraine predominantly by multilateral donors.

Most private climate finance in 2017-2022 was raised in the sectors "energy" (29%), "industry, mining and construction" (23%), "transport and storage" (23%), as well as "banking and financial services" (13%). Out of the five financing modalities tracked by OECD[165], the bulk of private climate finance came to Ukraine in 2017-2022 as direct investments into companies and SPVs (50%), followed by guarantees (27%) and syndicated loans (17%).

[163] OECD Data Explorer, Accessed in March 2025

[164] Ibid.

[165] OECD, 2023. Converged Statistical Reporting Directives for the Creditor Reporting System (CRS) and the Annual DAC Questionnaire, Annex 6: Instructions for reporting on amounts mobilised from the private sector

Reported sustainable private finance

As of the end of 2024, no national climate, green, or sustainable taxonomy concept officially applies in Ukraine. This means that various classifications of what constitutes green or sustainable finance can co-exist in reporting and statistics.

Capital markets (green, sustainability, and sustainability-linked bonds): In 2021, amendments to the Ukrainian law on capital markets introduced green bonds as a specific class of debt instruments to finance "environmentally oriented projects", such as those in alternative energy, energy efficiency, waste management, clean transport, biodiversity protection, and climate change adaptation. Proceeds from green bonds must be used exclusively for financing or re-financing such projects. While the law mandates a separate procedure for selecting and supporting projects through green bonds issued by the state, this procedure has not been approved by the end of 2024. In 2021, the National Securities and Stock Market Commission (NSSMC) adopted non-binding recommendations for the issuance of green bonds[166]. In 2022, the Cabinet of Ministers of Ukraine (CMU) adopted a concept for the establishment and development of the green bonds market in Ukraine[167], while in 2024, NSSMC adopted a resolution regarding the issue and circulation of corporate bonds. The latter categorises bonds into ordinary, green, and infrastructural and contains certain other elements related to green bonds[168].

In practice, at the end of 2024, no issuing of sovereign (state or local) green bonds was recorded. There is limited experience with issuing thematic bonds by state-owned enterprises: in November 2021, the Ukrainian electricity transmission system operator Ukrenergo raised USD 825 million through the issuance of Green and Sustainability-Linked Bonds with a 5-year maturity on the London Stock Exchange,[169] with 20% coming from EBRD[170]. Proceeds from the bond issue were destined to cover debts accumulated in the chain of transactions related to the state support of renewable energy producers and featuring Ukrenergo as an intermediary[171]. In addition, major Ukrainian companies (such as state-owned Ukravtodor, Ukrzaliznytsia, Naftogaz of Ukraine, private MHP, Kernel, etc) already have experience offering bonds on foreign trading venues. Overall, experts estimate the potential volume of the Ukrainian green bonds market to reach USD 173 million in 2023.[172]

[166] National Securities and Stock Market Commission (Ukraine), 2021. Про схвалення Рекомендацій щодо реалізації або фінансування проєктів екологічного спрямування шляхом емісії зелених облігацій

[167] Verkhovna Rada of Ukraine, 2022. ЗАКОН УКРАЇНИ № 175-р, Про схвалення Концепції запровадження та розвитку ринку зелених облігацій в Україні

[168] Verkhovna Rada of Ukraine, 2024. ЗАКОН УКРАЇНИ № 28/21/1105/К03, Про затвердження Положення про порядок здійснення емісії корпоративних облігацій та їх обігу

[169] NPC Ukrenergo, 2021. Eurobond 2028

[170] EBRD, 2021. Ukrenergo Sustainability-Linked Eurobond

[171] European Commission, 2024. Ukraine 2024 Report

[172] UNDP, 2022. Supporting Green Bond Development for Ukraine

Sustainable and green lending by domestic financial institutions: The Ukrainian financial market is still underdeveloped and dominated by banks (mostly state-owned but also private with both domestic and foreign capital) with limited participation of non-bank financial institutions and private pension funds[173]. While the National Bank of Ukraine (NBU) endorses the goal of promoting sustainable finance through the gradual integration of ESG risks,[174] it does not provide statistics regarding the financial sector's sustainable or green lending, which can be partially explained by the absence of a green/sustainable taxonomy.

Under Ukrainian law, banks as issuers of shares are required to publish management reports, which, for some of them, shall include a sustainable development report (see below for more details). However, such reports are non-standardised and are often insufficiently informative. One notable exception is the state-owned Ukrgasbank, one of the biggest banks in Ukraine, which positions itself as an "eco bank". In its 2023 annual report, it describes its sustainable products with reference to sectors rather than technical criteria and provides a breakdown of its 2023 loan portfolio, where 47% is dedicated to renewable energy, 24% to energy and resource efficiency, and the rest to other sustainable initiatives, such as social and community development, medicine and health safety, waste management, eco-farming and agricultural production, environmental protection[175].

Reported Green Transition finance from government support programs

Public support programmes can only notionally be considered Green Transition finance in the absence of a green/sustainable taxonomy or relevant budget tagging. However, some of the public initiatives are specifically directed at achieving energy efficiency improvements and renewable energy development, which can qualify for Green Transition purposes.

[173] World Bank. 2023. Private Sector Opportunities for a Green and Resilient Reconstruction in Ukraine: Volume 1 Synthesis Report, pp.30-32

[174] National Bank of Ukraine, 2023. Annual Report for 2023

[175] UGB Eco Bank, 2024. Annual and Sustainability Report for 2023

Energy Efficiency Fund of Ukraine

Established in 2018 with the support of the EU and Germany, the Energy Efficiency Fund of Ukraine (EEF) is a 100% government-owned financial institution. EEF is funded jointly by the Ukrainian government and international donors (the EU and the German government) via a trust account managed by IFC. Currently, EEF has three programmes: the main programme, "EnergoDim" and "VidnovyDim", established as a response to the 2022 full-scale invasion, and a newly launched programme ", GreenDim". The "EnergoDim" programme targets housing associations and their energy efficiency measures, while the newest "GreenDim" programme set off in 2024 allows lending for renewable energy projects. EEF provides annual statistics of performance on each of the programmes, including on the energy savings and CO2 emission reduction achieved[176].

Table 8. Grants disbursed from "Energodim" and "GreenDim" programmes in 2023 and 2024

Grants disbursed	2023 (USD mln)[177]	2024 (USD mln)[178]
"Energodim" programme[179]	9.1	14.8
"GreenDim" programme	n/a	0.4

State-subsidised loans for distributed energy

There are several state-sponsored programmes directed at promoting distributed energy generation and storage[180]. These programmes target households, housing associations, SMEs, and larger businesses. For households, bank interest is compensated on the purchase of solar panels with energy storage systems as well as wind power installations[181]. For housing associations, under the "5-7-9 Affordable Loans" programme[182], lower interest rates apply on loans for the purchase and installation of generation and storage equipment using alternative energy[183]. By the end of 2024, the number of loan agreements with housing associations was 16 for a total amount of UAH 30 mln (ca USD 0.7 mln); in addition, under the same programme 133 loan agreements were concluded with businesses under energy performance contract schemes or for other energy-related purpos-

[176] Energy Efficiency Fund, 2024. Report on the Activities of State Institution "Energy Efficiency Fund" for the Year 2023

[177] Here and below for conversion in respect of 2023 the official NBU exchange rate at 29.12.2023 (UAH/USD) is used and equals 37.98.

[178] Here and below for conversion in respect of 2024 the official NBU exchange rate at 30.12.2024 (UAH/USD) is used and equals 42.039.

[179] Energy Efficiency Fund, Accessed in March 2025. Periodic Report of «ЕНЕРГОДІМ» – Програма підтримки енергомодернізації багатоповерхових будинків

[180] Ministry of Energy of Ukraine, Accessed in March 2025. Розвиток розподіленої генерації

[181] Business Development Fund, 2024. Програма «Енергонезалежність фізичних осіб – власників домогосподарств»

[182] Business Development Fund, Accessed in March 2025. Програма "ДОСТУПНІ КРЕДИТИ 5-7-9%"

[183] Ukrainian legislation employs two terms: "alternative energy sources" and "renewable energy sources", with the former being wider than the latter. In the context of households and housing associations, the former term closely mirrors the latter one.

es with the total amount of UAH 1.6 bln (USD 39.6 mln)[184]. Businesses can also access finance from newly created Decarbonisation Fund of Ukraine[185]. In 2024, 17 projects were financed related to renewable and alternative energy as well as energy performance contracts for the total sum of UAH 180.1 mln (USD 4.3 mln)[186].

Anticipated finance needs for Green Transition targets

The latest Ukraine information on financial needs related to the implementation of UNFCCC and the Paris Agreement is based on the calculation of its financial needs to implement the NECP (under the "with additional measures", WAM scenario) as well as additional needs related to agriculture, waste, and LULUCF. According to this data[187], the overall investment needs based on NECP are USD 98.4 billion by 2030, broken down by sectors as follows:

Sector	Investment needs, USD billion
Energy sector	22.8(1)
Industry	16.4(2)
Transport	26.8(3)
Buildings	17.9(4)
Supply sector	4.9(5)
Agriculture	4.3
Waste	2.1
LULUCF	3.2
Total	**98.4**

These figures are complemented by the following graph showing investment needs by sector under two scenarios of the Ukrainian NECP.

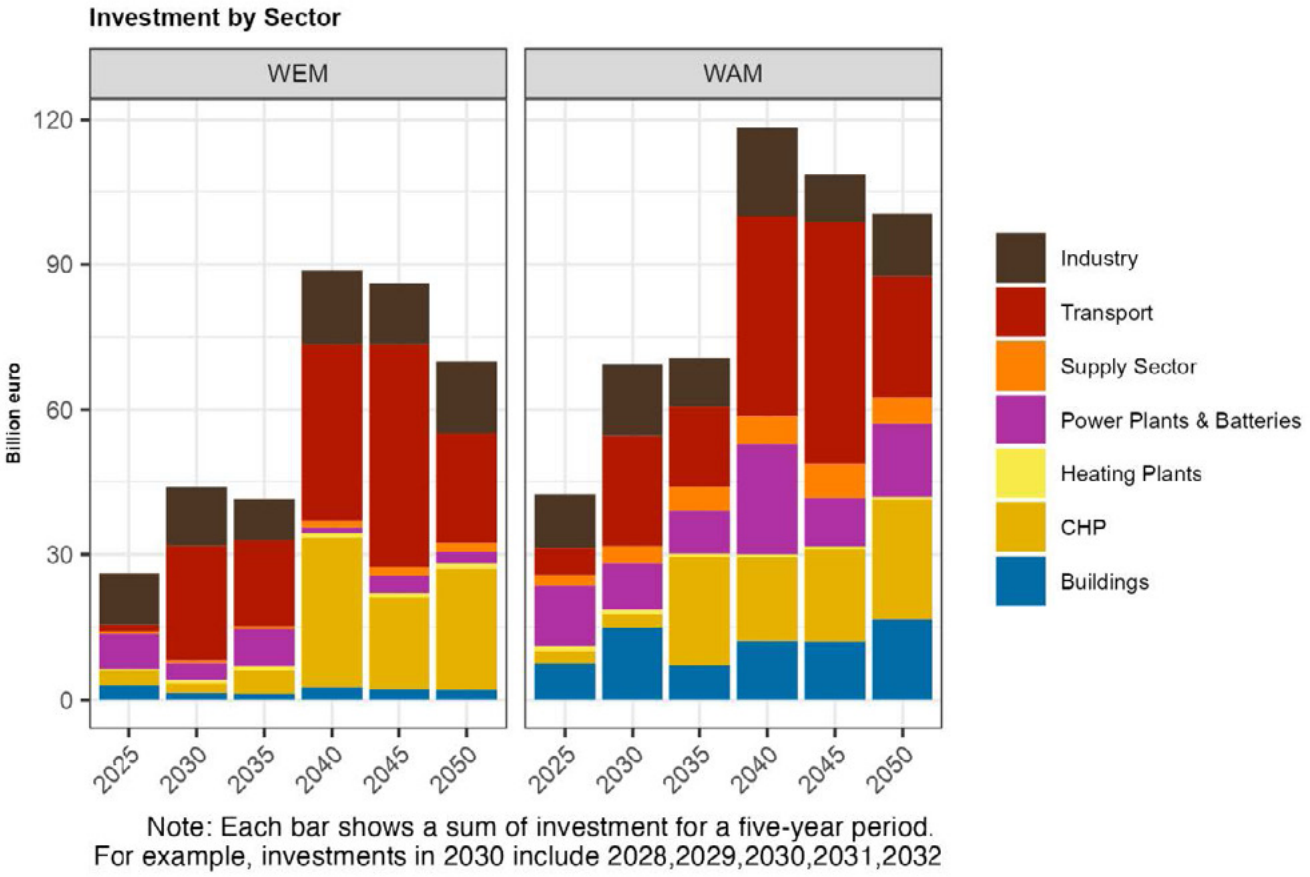
It should be noted that these figures do not include financial needs for climate adaptation (which were not costed by Ukraine) and are likely to require re-evaluation considering the added need to repair impacts of the war (e.g., in the case of agricultural land, forests, other lands contaminated with remnants of war).

[184] Business Development Fund, Accessed in March 2025. Щотижнева інформація про результати Державної програми Доступні кредити 5-7-9

[185] The Decarbonization Fund of Ukraine Joint Stock Company, Accessed in March 2025. Кредитування

[186] The Decarbonization Fund of Ukraine Joint Stock Company, Accessed in March 2025. Діяльність

[187] United Nations Framework Convention on Climate Change, 2024. Information and data from Ukraine for the preparation of the 2024 Report on the determination of the needs of developing country Parties related to the implementation of the Convention and the P



Source: Ministry of Economy of Ukraine, Institute for Economics and Forecasting of National Academy of Sciences of Ukraine

Anticipated finance needs for the management of risks from natural hazards

As a result of global warming, Ukraine is prone to experience warmer temperatures and more volatile precipitation patterns (especially in the east and southeast), leading to a higher likelihood of draughts and floods[188]. Floods are estimated to affect the annual average population of 600,000 and the annual average GDP of USD 1 billion[189].

However, according to Ukraine's official submission to UNFCCC in 2024, no quantification of climate adaptation needs has been performed and is expected at a later stage. This can be explained by a logical dependence of estimations on the scope of war damages and reconstruction needs. In the meantime, other sources can provide relevant estimates. IMF experts rely on the estimated fiscal costs of adaptation investments as amounting to 0.3% of GDP annually allocated as 0.22% related to strengthening existing assets, 0.06% for new assets, and 0.06 % related to costal protection against sea level rise[190].

[188] Geoffrey Keim and Mariia Sydorovych, Policies to Address Climate Change, Ukraine. IMF Selected Issues Paper (SIP/2023/001). Washington, DC: International Monetary Fund

[189] Global Facility to Disaster Reduction and Recovery, 2017. Disaster Risk Profile: Ukraine

[190] Geoffrey Keim and Mariia Sydorovych, Policies to Address Climate Change, Ukraine. IMF Selected Issues Paper (SIP/2023/001). Washington, DC: International Monetary Fund

Funding gap related to Green Transition

The current Ukraine's long-term low-emission development strategy (from 2017), the same as the updated NDC (from 2020)[191], does not estimate the Green Transition funding gap. Ukraine is currently working on an updated strategy[192] and an updated NDC. Overall, reliable information on the Green Transition finance gap is difficult to generate, considering the fluctuating private and public investments (directly linked to the continuation of hostilities) and unpredictable international inflows from donors. In addition, projected needs are constantly increasing in response to war-inflicted damages. Under these circumstances, "finance needs" and "finance gap" are often synonymised, which is also the perception of local stakeholders.

Importantly, finance in the form of investment can come both from private and public sources. As part of the Extended Fund Facility for Ukraine, the IMF has estimated that private investments in 2024-2027 will amount to three-quarters of all investments. The World Bank has projected how much private finance could be attracted to fill the finance gap identified in the RDNA 3 for 2023-2033[193]; however, such analysis is not aligned with the dimensions of the European Green Deal and does not address the gap in public finance.

Institutional gap assessment for Green Transition Finance

While the institutional gap assessment for the transition towards a green economy and society – in line with the targets and goals of the European Green Deal – encompasses a wide spectrum of layers and perspectives, the following analysis of institutional gaps focuses on those institutions that predominantly enable Green Transition finance flows. Two components constitute this analytical framework:

1. sector-specific institutional gaps for Green Transition finance identified for Ukraine;
2. institutional gaps based on the EU Sustainable Finance Governance Framework put in place to steer finance into more sustainable purposes and relevant for Ukraine in the EU accession process.

The following major sector-specific institutional gaps have been identified for Ukraine which impacts on Green Transition finance:

[191] United Nations Framework Convention on Climate Change, Accessed in March 2025. Updated Nationally Determined Contribution of Ukraine to the Paris Agreement

[192] UNDP Ukraine, 2024. UNDP supports Ukrainian government in developing updated Low Emissions Development Strategy until 2050

[193] World Bank. 2023. Private Sector Opportunities for a Green and Resilient Reconstruction in Ukraine: Volume 1 Synthesis Report

European Green Deal sector or theme	Institutional Gaps for Green Transition Finance
General	• Challenges in quantification of Green Transition financial needs are exacerbated by the war. This prevents a proper identification of the finance gap and the design of a tailored strategy to address it. • No green / sustainable budgeting or expenditure tracking policies for public finances exist at present. • A comprehensive and robust green Public Investment Management (PIM) system is yet to be developed.
Climate change	• Current carbon pricing is not stimulating GHG emission reduction, due to a low taxation level focusing on CO2. An emission trading system (ETS) is absent. • The relaunch of a comprehensive and robust monitoring, reporting and verification (MRV) system for GHG emissions is a prerequisite for an EU-model aligned ETS. • There is no system of tracking, monitoring and controlling of public fossil fuel subsidies at the national, sub-national, or SOE level. • A tracking and accounting mechanism and reduction incentives for CH4 emissions are yet to be designed with a potential to attract more mitigation finance. • Climate adaptation and disaster risk management suffer from the lack of adequate financial instruments related to the ongoing war risks.
Circular economy & waste management	• A clear circular economy / waste management strategy is yet to be formulated and supported by proper incentives building on, inter alia, the Law of Ukraine "On waste management".[194] • The insufficient use of green public procurement is a missed opportunity for public expenses increasingly aiming at the procurement of sustainable goods, works and services.
Environment protection	• The system of environmental monitoring and emission control needs to be improved to provide a solid basis for results-oriented finance. • The environmental tax needs an overhaul in line with the EU approach. • Existing war-time exceptions from mandatory Environmental Impact Assessment and Strategic Environmental Assessment procedures (especially for infrastructure and certain energy facilities) potentially increases the risk of public and private commitments in major non-sustainable projects and investments.

[194] Verkhovna Rada of Ukraine, 2023. ЗАКОН УКРАЇНИ № 47, ст.269, Про управління відходами

European Green Deal sector or theme	Institutional Gaps for Green Transition Finance
Nature and biodiversity	• The biodiversity strategy supported by proper incentives must be formulated. • The comprehensive, reliable and digitalised data on the full scope of biodiversity activities and the analysis of their actual impact on nature conservation are not available, which circumvents further expansion of financial flows into the sector. • The legal and organisational framework of the Emerald Network areas is yet to be established. Overall, only a small part of the national territory was designated as nature conservation areas. Designated sites may attract more finance into biodiversity conservation, including through generation of income from visitors. • Lacking sustainability criteria for biofuels, bioliquids, and biomass fuels, sustainable origin tracking for wood and similar systems disables private investments into greener businesses.
Energy and buildings	• Subsidy schemes for RES and distributed generation lack a sustainable and predictable source of finance leading to accumulation of debts along supply chains and circumventing further RES support attempts. • There are cumbersome and complex permitting procedures for RES. • Regulated utility prices are set at non-cost-reflective levels, which combined with absent energy efficiency obligation schemes, other regulatory barriers and the lack of predictable public finance prevent new investments into energy efficiency improvements (including in the heat sector) and result in a stagnating ESCO market.
Sustainable food systems	• A clear Farm-to-Fork strategy must be formulated and supported by proper incentives, as well as control and verification mechanisms building on, inter alia, the Law of Ukraine "On Main Principles and Requirements to Organic Production, Circulation and Labelling of Organic Products".[195] • The State Agrarian Register should become fully functional and cover the full agrarian value chain to be used for provision of all agricultural and rural development support. • An independent body to manage and control public support to the sector needs to be established, as well as its administrative and control capacity ensured as a necessary step to unlock further EU public support. • A Farm Sustainability Data Network (FSDN)[196] needs to be deployed as a precursor for effective distribution of support for agriculture and tracking its impact. • There is an urgent need to improve the efficiency of and integrate sustainability into various forms of public support to agriculture.

[195] Verkhovna Rada of Ukraine, 2018. ЗАКОН УКРАЇНИ № 36, ст.275, Про основні принципи та вимоги до органічного виробництва, обігу та маркування органічної продукції

[196] Ministry of Agrarian Policy and Food of Ukraine, 2024. Мінагрополітики запускає пілотний проєкт мережі збору сільськогосподарських даних FADN/FSDN

European Green Deal sector or theme	Institutional Gaps for Green Transition Finance
Urban planning and smart mobility	• A complex approach to infrastructure development is yet to be implemented, anchored in Trans-European transport networks and targeting synergies with energy networks and decarbonisation in transport. • Competition and independent regulatory supervision are yet to be ensured in railway passenger and cargo transport capable of attracting more private finance into the sector and setting decarbonisation targets. • More sustainable investments into ports, new roads and multimodal transport can be expected with relevant regulatory reforms in line with the EU acquis.
Digitalization	• Fully functional digital solutions are necessary in the energy, nature and biodiversity, sustainable food systems (e.g., implementation of geoinformation system, Spatial Data Infrastructure[197] and Integrated Administration and Control System[198]), as well as for urban planning and smart mobility (e.g., European Rail Traffic Management System and eFTI) to ensure the adequacy of current spending and attract more public and private finance into innovative businesses.
Research and Innovation	• Wider participation in Horizon Europe governance and projects is yet to be promoted. • Further development of regional smart specialisation strategies is necessary to attract finance into innovations at sub-national levels.

[197] European Commission, Accessed in March 2025. INSPIRE Knowledge Base

[198] European Commission, Accessed in March 2025. Integrated Administration and Control System (IACS)

The above institutional gaps can be complemented and viewed against the implementation status, progress and prospects as regards key elements of the EU Sustainable Finance Governance Framework. Overall, the latter has been developed around the 2018 Sustainable Finance Action Plan,[199] based on which various legal acts have been adopted and are still being developed. The following table summarises such key aspects:

EU Sustainable Finance Governance Framework's key elements	Implementation status[200]	Implementation efforts and outlook
Official classification of economic activities as sustainable (from the ESG perspective)	No visible progress	While some work reportedly started on developing the classification of sustainable economic activities and respective technical criteria by the State Agency for Energy Efficiency of Ukraine before 2022, there is no record of it progressing further. The concept paper for the establishment and the development of the green bonds market adopted by CMU in late February 2022 indicates that the taxonomy is a precondition for green bonds market but does not go further than that.[201] Under the new Financial Sector Development Strategy announced in 2023 (hereinafter – new FSDS), NSSMC is in charge of preventing greenwashing. The adoption of corporate bonds standards which refer to ICMA or CBI taxonomies as applicable to green bonds can be seen in this context. Importantly, the adoption of the Ukrainian taxonomy requires an appropriate legal basis capable of making it binding on public and private actors as well as subject to supervision and enforcement, where necessary.
Disclosure of non-financial (ESG) information / sustainability reporting[202]	On track	Several laws of Ukraine[203] require companies to submit management reports (alongside financial statements and annual issuer's reports) containing, among others, non-financial information related to company's activity prospects and risks. Micro and small enterprises are exempt from this requirement while medium enterprises may choose not to disclose non-financial data. Recommended guidance for the content of management reports indicates the need to disclose ESG

[199] European Union, Accessed in March 2025. Action Plan: Financing Sustainable Growth

[200] Categories: No visible progress / Some progress / On track. Implementation status as at 31.12.2024.

[201] Verkhovna Rada of Ukraine, 2022. ЗАКОН УКРАЇНИ № 175-р, Про схвалення Концепції запровадження та розвитку ринку зелених облігацій в Україні

[202] Relies on three interrelated acts: Directive 2014/95/EU of the European Parliament and of the Council of 22 October 2014 amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large undertakings and groups; Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting ("Corporate Sustainability Reporting Directive"); Commission Delegated Regulation (EU) 2023/2772 of 31 July 2023 supplementing Directive 2013/34/EU of the European Parliament and of the Council as regards sustainability reporting standards. All of them amend the crucial legal act on financial accounting and reporting, i.e. Directive 2013/34/EU.

[203] Verkhovna Rada of Ukraine, 1999. ЗАКОН УКРАЇНИ № 40, ст.365, Про бухгалтерський облік та фінансову звітність в Україні; Verkhovna Rada of Ukraine, 2006. ЗАКОН УКРАЇНИ № 31, ст. 268, Про ринки капіталу та організовані товарні ринки

EU Sustainable Finance Governance Framework's key elements	Imple-mentation status	Implementation efforts and outlook
		aspects.[204] When submitted by the issuer, the report must cover its corporate governance and, in case of some issuers, contain a sustainable development report.[205] Such reporting however remains non-standardised. In the Ukraine Plan, Ukraine committed to develop legislation for corporate sustainability reporting. In October 2024, CMU adopted the Strategy for the implementation of sustainable development reporting by companies as well as its operational plan for 2024-2026.[206] The Ministry of Finance is the responsible entity for monitoring the implementation of the strategy. In addition, under the Ukraine Plan by Q4 2025 an official study will be published regarding the current state of ESG reporting for the extractive industry.
Green Bonds[207]	On track	2021 - amendments to the Law on capital markets introducing green bonds; NSSMC adoption of non-binding recommendations for the issuance of green bonds;[208] 2022 - CMU concept paper for the establishment and development of the green bonds market in Ukraine;[209] 2024 - NSSMC resolution regarding the issue and circulation of corporate bonds[210] (see more above). In addition, the new FSDS envisages the creation of social bonds and "sustainable development bonds".[211]

[204] Verkhovna Rada of Ukraine, Ministry of Finance of Ukraine, 2018. НАКАЗ № 982, Про затвердження Методичних рекомендацій зі складання звіту про управління

[205] Verkhovna Rada of Ukraine, Національна комісія з цінних паперів та фондових ринків сприяє розвитку ринків капіталу, 2023. РІШЕННЯ № 608, Про затвердження Положення про розкриття інформації емітентами цінних паперів, а також особами, які надають забезпечен

[206] Verkhovna Rada of Ukraine, Cabinet of Ministers of Ukraine, 2024. РОЗПОРЯДЖЕННЯ № 1015-р, Про схвалення Стратегії запровадження підприємствами звітності із сталого розвитку

[207] Relies on the EU Taxonomy and Regulation (EU) 2023/2631 on European green bonds and optional disclosures for bonds marketed as environmentally sustainable and for sustainability-linked bonds.

[208] National Securities and Stock Market Commission (Ukraine), 2021. Про схвалення Рекомендацій щодо реалізації або фінансування проєктів екологічного спрямування шляхом емісії зелених облігацій

[209] Verkhovna Rada of Ukraine, 2022. ЗАКОН УКРАЇНИ № 175-р, Про схвалення Концепції запровадження та розвитку ринку зелених облігацій в Україні

[210] Verkhovna Rada of Ukraine, 2024. ЗАКОН УКРАЇНИ № 28/21/1105/К03, Про затвердження Положення про порядок здійснення емісії корпоративних облігацій та їх обігу

[211] National Bank of Ukraine, Accessed in March 2025. Стратегія розвитку фінансового сектору України

EU Sustainable Finance Governance Framework's key elements	Imple-mentation status	Implementation efforts and outlook
Other label-based instruments in financial markets (e.g., Green Benchmarks,[212] ESG rating providers,[213] sustainability-focused funds or products[214])	Some progress	In late 2024, NSSMC presented a draft law "On Investments Funds" which seeks, among others, to transpose EU acquis on EuSEFs and ELTIFs.[215] The new FSDS[216] envisages for NSSMC a task related to "the introduction of ESG-rating" without providing details on the future framework. It may be facilitated by the recent adoption of the generic Law of Ukraine "On Rating".[217]
Integration of ESG factors into banking supervision[218]	On track	In 2021, NBU formally adopted the Sustainable Finance Development Policy until 2025.[219] Under the new FSDS,[220] this policy needs to be updated given the ongoing full-scale war, the policy's inconsistency with current EU acquis as well as its inability to meet new challenges facing the financial community and the NBU as the sector's conditions change.[221] The current NBU's approach envisages the development of the ESG policy White Paper (to determine the current state of the sector's ESG risk management, its vision going forward, as well as a detailed plan of regulatory actions to transition the sector to its envisaged state and an intermediate stage before a new policy is drafted), the NBU Internal Policy (to shape the NBU's work as an organization) as well as the NBU's ESG Risk Management Policy for Financial Institutions.[222] The World Bank and SIDA are assisting NBU in the sustainable finance track, including as regards the implementation of the updated Capital Requirements Directive / Capital Requirements Regulation.[223]

[212] Regulation (EU) 2019/2089 of the European Parliament and of the Council of 27 November 2019 amending Regulation (EU) 2016/1011 as regards EU Climate Transition Benchmarks, EU Paris-aligned Benchmarks and sustainability-related disclosures for benchmarks.

[213] Regulation (EU) 2024/3005 of the European Parliament and of the Council of 27 November 2024 on the transparency and integrity of Environmental, Social and Governance (ESG) rating activities, and amending Regulations (EU) 2019/2088 and (EU) 2023/2859.

[214] Regulation (EU) No 346/2013 of the European Parliament and of the Council of 17 April 2013 on European social entrepreneurship funds; Regulation (EU) 2015/760 of the European Parliament and of the Council of 29 April 2015 on European long-term investment funds.

[215] National Securities and Stock Market Commission (Ukraine), 2024. European integration of investment funds: the NSSMC presents new draft law to market participants

[216] National Bank of Ukraine, Accessed in March 2025. Стратегія розвитку фінансового сектору України

[217] Verkhovna Rada of Ukraine, 2024. ЗАКОН УКРАЇНИ Про рейтингування

[218] This covers the integration of ESG risks into the exercise of prudential control and the banks' risk management strategies and policies, relying on the European Central Bank's Guide on climate-related and environmental risks, as well as key prudential supervision legislation (as amended): Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms, amending Directive 2002/87/EC and repealing Directives 2006/48/EC and 2006/49/EC ("Capital Requirements Directive") and Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012 ("Capital Requirements Regulation").

[219] National Bank of Ukraine, 2021. Політика щодо розвитку сталого фінансування на період до 2025 року

[220] National Bank of Ukraine, Accessed in March 2025. Стратегія розвитку фінансового сектору України

[221] National bank of Ukraine, 2024. Sustainable Finance Development Policy

[222] Ibid.

[223] National Bank of Ukraine, Accessed in March 2025. Відновлення та стійкість фінансового сектору в Україні

EU Sustainable Finance Governance Framework's key elements	Imple-mentation status	Implementation efforts and outlook
Integration of ESG factors into capital markets supervision	Some progress	NSSMC is the capital markets regulator in Ukraine. Many of its past and ongoing initiatives have been directed at promoting practices based on consideration of ESG factors. In addition to what is already described in this chapter, in December 2021 NSSMC published a separate ESG chapter[224] to the Corporate Governance Code adopted previously as a best practice document for domestically listed companies. Under the new FSDS, NSSMC is tasked with countering greenwashing, introducing social and "sustainable development bonds", "ESG reporting" and "ESG rating". However, such efforts need to come under a comprehensive strategic umbrella to be better understood by the market and serve the underlying causes.
Sustainability disclosure in the financial services sector (esp. as regards financial products with environmental or social characteristics and sustainable investment products).[225] Disclosure on ESG factors in investment decisions and advice. Identification and accounting for sustainability preferences in investment and insurance advice.[226]	No visible progress	Under current regulations, banks are required to include in their management reports the analysis of economic, environmental and social aspects of their activities, their change over time and their future impact or risk potential.[227] In practice, such reports are heterogenous and non-standartised. The new FSDS[228] envisages in the future the adoption of "norms which enhance the transparency of instruments to finance ESG-projects". There is however no detalisation of the applicable format or framework of such norms. In addition, the same document envisages the introduction of "ESG reporting" by NSSMC without specifying whether this should apply to issuers or financial institutions under its supervision.

[225] Relies on: Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector; Commission Delegated Regulation (EU) 2022/1288 of 6 April 2022 supplementing Regulation (EU) 2019/2088 of the European Parliament and of the Council with regard to regulatory technical standards specifying the details of the content and presentation of the information in relation to the principle of 'do no significant harm', specifying the content, methodologies and presentation of information in relation to sustainability indicators and adverse sustainability impacts, and the content and presentation of the information in relation to the promotion of environmental or social characteristics and sustainable investment objectives in pre-contractual documents, on websites and in periodic reports.

[226] Relies on: Commission Delegated Directive (EU) 2021/1269 of 21 April 2021 amending Delegated Directive (EU) 2017/593 as regards the integration of sustainability factors into the product governance obligations; Commission Delegated Regulation (EU) 2021/1253 of 21 April 2021 amending Delegated Regulation (EU) 2017/565 as regards the integration of sustainability factors, risks and preferences into certain organisational requirements and operating conditions for investment firms; Commission Delegated Regulation (EU) 2021/1257 of 21 April 2021amending Delegated Regulations (EU) 2017/2358 and (EU) 2017/2359 as regards the integration of sustainability factors, risks and preferences into the product oversight and governance requirements for insurance undertakings and insurance distributors and into the rules on conduct of business and investment advice for insurance-based investment products. The first two acts relate to MiFID II while the latter relates to the Insurance Distribution Directive.

[227] Verkhovna Rada of Ukraine, National Bank of Ukraine, 2011. ПОСТАНОВА № 373, Про затвердження Інструкції про порядок складання та оприлюднення фінансової звітності банків України

[228] National Bank of Ukraine, Accessed in March 2025. Стратегія розвитку фінансового сектору України

Importantly, the EU Sustainable Finance Governance Framework rests on the foundation of key regulatory frameworks targeting specific aspects of financial services[229] such as: Capital Requirements Directive / Capital Requirements Regulation (for credit institutions, including banks), MiFID II / MiFIR (for capital markets), the Investment Firms Directive / Investment Firms Regulation (for investments firms, i.e. asset managers), the Solvency II framework (for insurance firms) etc. This also includes the Shareholder Engagement Directive.[230] Progress still needs to be made in the finalisation of basic financial sector regulatory frameworks.[231]

Main priorities for the green transition

Based on the institutional gap assessment presented in section 5, the following specific recommendations for institution and capacity building, as well as policy development can be made directly aiming at the facilitation and mobilization of domestic/international public and private financial flows supporting green transition in Ukraine.

Ukraine needs a dynamic methodology to identify and quantify Green Transition finance needs and respective finance gaps despite the state of war. The analysis to be carried out based on this methodology should be used to develop **a tailored Green Transition finance strategy** which will comprehensively cover the variety of sources of finance and assign appropriate institutional capacity to implement it.

Ukraine can benefit from progress on green budgeting. It needs to improve the rule of earmarking revenues for Green Transition which should help build trust with market players. It may consider promoting budget/expenditure tagging, both at the national and sub-national levels, to enable better tracking of Green Transition finance. Fossil fuel subsidy tracking system should also be in place to trace, inform public decisions and steer them towards sustainability. Ukraine should also develop a system of Public Investment Management where the consideration of ESG factors and the "do-no significant harm" (DNSH) principle will be engrained. Finally, it needs to consider expanding and improving the use of green public procurement.

Ukraine must develop and adopt a national taxonomy of sustainable activities in line with the EU approach. Without such a methodology, other efforts at promoting Green Transition finance are easily undermined. It is important that this taxonomy is used and further refined in relations with key international donors of Ukraine.

Carbon pricing in Ukraine should be overhauled. The EU-aligned emission trading system should be launched backed by a robust MRV system. Current environmental tax should be brought in line with the EU rules. In addition, tracking and controlling other GHG gases (such as methane) should be promoted.

[229] European Commission, Accessed in March 2025. Overview of financial services legislation: Capital markets union and financial markets

[230] European Union, Accessed in March 2025. Directive (EU) 2017/828 of the European Parliament and of the Council of 17 May 2017 amending Directive 2007/36/EC as regards the encouragement of long-term shareholder engagement

[231] European Commission, 2024. Ukraine 2024 Report

The current implementation of the EU's Sustainable Finance Governance Framework may seem sporadic and devoid of the strategic vision of its benefit for the local economy and markets. **A Sustainable Finance strategy common for all financial services sector regulators can be helpful** to clearly set out key objectives and elements of this framework to be applied in Ukraine and the necessary adjustments to be made, given the current state of the Ukrainian financial services sector, its potential, challenges and opportunities of recovery and reconstruction. This strategy could promote the integration of ESG factors into the new regulatory frameworks in the financial services sector (e.g., for investment firms and funds, pension funds, insurers and re-insurers, etc). It could also prioritise measures which encourage investors and financial intermediaries to promote sustainability.

More regulatory attention should be paid to analysing specific issues with supply and demand and designing solutions for the wider issue of **green and other thematic bonds, the offer of retail financial products marked with sustainability, and disaster risk management financial products**.

National sector strategies form the starting point not only for reforms in respective sectors of the European Green Deal but also for promoting Green Transition finance in these sectors. In this connection, **circular economy/waste management, biodiversity, Farm-to-Fork and transport strategies should be refined detailing the objectives and scope of relevant policies as well as concrete financial tools for their achievement**.

Modern ICT provides opportunities to expand Green Transition finance flows and strengthen their impact. Digital solutions should be used to track sector progress with reference to past and future finance, which is particularly relevant for areas where such progress is difficult to trace (biodiversity) or where there is a significant number of potential beneficiaries and associated risks of fraud (agriculture). Digital solutions can also be part of regulatory reforms directed at increasing sustainable private investments (e.g., multimodal transport). Finally, digital solutions should be put in place to build up and improve existing infrastructures supporting the implementation of the European Green Deal (such as tracking of sustainable products and services).

3. Cross-Cutting Green Transition Topics

This section contains the cross-cutting areas related to the green transition in Ukraine, which, if implemented properly, can support the achievement of green transition goals. In all topics, the report aims to capture the most relevant information available in Ukraine at the time of writing.

3.1 Just transition

In the context of the EU policy, Just Transition is a term used to describe the transition to a climate-neutral economy while securing the future and livelihoods of workers and their communities. A just transition to a climate-neutral economy provides and guarantees better and decent jobs, social protection, more training opportunities and greater job security for all workers affected by climate change policies.

Although this framing of Just Transition is applicable and useful for Ukraine, whose economy still heavily relies on extractive industries and fossil fuels, **the approach to Just Transition in this chapter of the National Assessment highlights the importance of a broader framework.** This framework should incorporate social justice components within the context of the green transition, focusing not only on workers in the fossil fuel industries but also on aspects such as poverty, social equity, and other forms of social vulnerability. In light of the Russian full-scale invasion of Ukraine and its devastating consequences for Ukrainians, discussions around Just Transition must consider the overall damage inflicted on Ukrainian society by the war.

A just transition and the streamlining of social justice priorities are crucial for Ukraine in the context of the green transition and recovery process. These should be strongly emphasized as fundamental cross-cutting components in green transition- and recovery-related policies and projects.

Current status and trends

There is no established system for monitoring social justice indicators in Ukraine, nor any methodology that defines the scope of social-justice-related topics to be tracked. However, there are a number of indicators, specifically those included in Sustainable Development Goals (SDGs) reporting, that allow tracking progress on topics related to poverty, equality, education, skills, and other relevant areas.

Until 2022, prior to Russia's full-scale invasion of Ukraine, Ukrstat collected data as part of SDG reporting, and progress had been made in relation to most of the relevant SDG indicators in the years leading up to 2022. Since the invasion and the imposition of Martial Law, Ukrstat has temporarily stopped collecting most of the essential data[232].

At the same time, it is evident that during the last three years, from 2022 to 2025, the level of social damage in Ukraine has been tremendous. The scope of problems ranges from Ukrainians being displaced, trapped in occupied territories, imprisoned, abducted, or having lost their property, health, jobs, or means of living. Therefore, any discussion related to the justice aspects of green transition and recovery in Ukraine cannot be disconnected from the overall demographic and humanitarian damage in Ukraine.

[232] Ukrstat, Sustainable Development Goals, Accessed in March 2025. Показник 1.1.1: Частка населення, чиї середньодушові еквівалентні сукупні витрати є нижчими за фактичний (розрахунковий) прожитковий мінімум, %

According to the recent Rapid Damage and Needs Assessment report[233], from February 2022 until the end of December 2024, almost 12,456 civilians in Ukraine lost their lives, and 28,000 were injured. During this period, **13.5 million people—approximately one-third of Ukraine's population—were forcibly displaced**, with 6.8 million being displaced outside Ukraine.

The overall poverty level during this time has increased, with likely very high rates in regions currently occupied by Russia. With official data sources unavailable due to restrictions on statistics, other sources have been used to estimate poverty rates for 2023 and 2024; these sources show that rates are now much higher than before February 2022.

13 percent of Ukraine's housing stock has been damaged or destroyed. Overall, livelihoods and living conditions continue to deteriorate in Ukraine; access to basic services is severely disrupted, and different societal groups experience different adverse impacts.

In most regions, they were subject to just transition policies and activities related to coal regions, specifically, any policy implementation action is impossible at the moment. In terms of regional distribution, the most economically vulnerable regions, such as Donetsk and Luhansk regions, in Ukraine would need to receive special support and attention in the context of green transition and the associated need for extractive industries workers' communities' support and re-skilling programmes are the same regions that have either been partially occupied by Russia, were severely damaged by the war events, are located close to the frontline, or have the highest numbers of IDPs among their population. Some cities and villages in Donetsk and Luhansk regions have been completely erased and ceased to exist as a result of the Russian full-scale invasion. In this regard, the Just Transition Target Programme for Coal Regions until 2030[234] approved by the Cabinet of Ministers of Ukraine in 2021, remains a relevant framework but need to be amended considered a new reality in Ukraine.

For the regions in Ukraine where just-transition-related activities are feasible, one of the key objectives is ensuring that workers have access to education, training, and lifelong learning opportunities. With the structural economic changes, including the closure of coal mines or other industrial enterprises representing heavy-polluting extractive sectors, new skills will be essential for integrating workers into emerging industries, including those who have experienced previous or ongoing displacement. Although Ukraine has initiated significant reforms in secondary, vocational, and higher education, further transformation is needed to align workforce skills with the demands of a sustainable economy. In addition, expanding access to digital skills and broadband connectivity will be vital in facilitating this transition. **It is crucial that the transformative changes are addressed in a systems-thinking way and designed as an inclusive process where workers, businesses, local authorities, and funders are actively involved.**

Both in terms of the post-war recovery as well as the green transition for Ukraine, the energy sector will play a critical role in shaping the nation's economic stability, environmental sus-

[233] World Bank; Government of Ukraine; European Union; United Nations. 2025. Ukraine Fourth Rapid Damage and Needs Assessment (RDNA4), February 2022 – December 2024

[234] Cabinet of Ministers of Ukraine, 2021. Concept of the State Target Program for Just Transition of Coal Regions of Ukraine for the period up to 2030

tainability, and long-term resilience. Ensuring energy independence, transitioning to renewable sources, and securing stable, clean energy supplies are not just immediate priorities—they are essential for rebuilding a stronger and more sustainable future.

While Ukraine has a strategic goal to ensure equal rights and opportunities for all, gender equality is not explicitly prioritized in the National Economic Strategy[235]**.** The country has taken steps to narrow the wage gap and increase female employment, but without targeted policies, the transition to a greener economy may reinforce existing inequalities. The need for better inclusion of women is further amplified by men increasingly having to stop their civilian employment to join the military and a tendency for considerable health implications among male war veterans. A just transition must incorporate gender-sensitive policies to guarantee that both men and women benefit equally from new job opportunities and economic restructuring.

One of the positive counter-intuitive effects of the ongoing war has been the abolition of restrictions on women in certain professions, which represents a step forward for Ukraine to combat labour market discrimination. At the same time, income inequality remains a challenge. The just transition requires a more comprehensive approach to equal opportunities, ensuring that wages are fair and employment policies do not disproportionately disadvantage specific social groups. The current NES does not contain strong new targets for tackling income disparity, which could slow progress toward a fairer labour market. In the context of green transition, which incorporates social justice principles, the gender factor is very important, considering that a lot of skills development will be needed in STEM disciplines, which have a smaller share of female representation.

A key component of just transition is ensuring strong employment support systems for those affected by economic shifts. The Ukrainian government is actively increasing monitoring in this area through the State Employment Service, aiming to provide better access to social services and job opportunities. However, long-term unemployment and labour market participation still require stronger policy alignment with European standards to enhance job security and adaptability in a rapidly changing economy.

Promoting social entrepreneurship is seen as a viable strategy for addressing social problems arising from economic transformation. The government has introduced policies[236] to encourage microfinance incentives and tax benefits for social enterprises, aiming to support vulnerable communities and drive social change. However, broader adoption and institutional support for these models are necessary to ensure long-term success.

Despite being crucial for a just transition, issues such as fair wages, employment conditions, and protection in cases of dismissal are not currently prioritized in Ukraine's NES. This gap could leave workers vulnerable to economic instability, especially as industries transition away from fossil fuels. Strengthening labour rights and wage policies will be essential to ensuring improved economic security for all.

[235] Ministry of Economy of Ukraine, 2023. The Government has approved the National Strategy for Bridging the Gender Pay Gap until 2030 in Ukraine for the Period Until 2030

[236] Ministry of Economy of Ukraine, 2022. The government launches a system of grants for entrepreneurship development

A well-functioning just transition depends on a strong social dialogue between workers, employers, and policymakers. However, in Ukraine, trade unions play a relatively weak role in negotiations, and corporate social responsibility initiatives remain fragmented. Encouraging greater worker involvement in decision-making will be critical for ensuring fair labour policies during the transition process.

Protecting children from economic hardship is a vital aspect of Ukraine's just transition. Prior to the full-scale invasion, the government had made progress in monitoring child poverty and ensuring access to social services, but further reforms are needed to meet the basic needs of vulnerable children, including shelter, adequate nutrition and hygiene, access to healthcare and education, safe physical environment, including minimising risk of explosive ordnance, etc. As part of the broader social equity agenda, investments in education, healthcare, and child protection will help safeguard future generations from the negative impacts of economic restructuring.

Ukraine's ageing housing stock, as well as its outdated and inefficient district heating system, presents a significant challenge in the transition to a sustainable economy. The government estimates that $120 billion is needed by 2030 to renovate existing housing and improve energy efficiency. While the NES emphasizes housing construction through deregulation and affordability programs, there is limited direct tracking of homelessness, highlighting a gap in social protection measures for the most vulnerable populations. Considering the additional massive damage to the housing stock in Ukraine due to the war, addressing this problem through green rebuilding policies and projects is very important.

Although Ukraine has made progress in social protection, key areas such as healthcare, disability inclusion, and long-term care remain underfunded and under-prioritized. The NES aligns with European healthcare goals, but the sector continues to struggle with financial constraints. Additionally, infrastructural accessibility improvements for people with both physical and mental disability require stronger monitoring and policy enforcement to enable their participation and inclusion in Ukraine's recovery and green transition.

While efforts are underway to support displaced workers, address income inequality, and invest in social protections, many key areas lack direct policy prioritisation. Strengthening labour rights, ensuring gender and income equity, and expanding social services will be essential to making the transition fair and inclusive. By aligning these efforts with broader sustainable development goals, Ukraine can build a resilient economy and reduce the risk of leaving the most vulnerable persons behind.

Main priorities for the green transition

The framing of Just Transition in Ukraine must expand beyond a narrow definition of the Just Transition of Coal Regions. Ukraine's overall just transition strategy remains too narrow from the social justice agenda perspective. A broader approach is needed to incorporate other key areas such as sustainable mobility, energy efficiency, agriculture, and transition to clean industry and modern economy. Additionally, the legislative transposition of EU policies is progressing too slowly, which hampers Ukraine's ability to align fully with the European Green Deal (EGD). To overcome

these challenges, Ukraine must accelerate policy alignment and broaden its just transition strategy to ensure a more holistic and inclusive transition

Regulatory and Policy Mechanisms Require Strengthening for Effective Implementation. Ukraine's regulatory landscape currently lacks a unified framework for just transition implementation. While some initiatives have been launched—such as those by the State Employment Service and the Ministry of Digital Transformation—the Ministry of Social Policy lacks a strategic vision for necessary reforms. Furthermore, regulatory mechanisms are inadequate, and there is no clear reporting structure or legislative transparency. To ensure success, Ukraine must re-establish and improve a comprehensive data collection and monitoring system based on SDG criteria, introduce mandatory environmental, social, and governance (ESG) reporting for companies, and provide targeted subsidies to industries affected by the transition. Utilizing dormant assets and passive capital to fund social entrepreneurship will also be key in mitigating transition risks.

Financial Readiness Must Be Strengthened to Support Just Transition Goals. Ukraine's current financial mechanisms are insufficient to support a just transition, particularly in coal-dependent regions. While the country aligns with EGD objectives, the absence of targeted policies and coordinated funding weakens its ability to mitigate economic disruptions for vulnerable populations. Competing national priorities, including war-related expenses, further constrain financial support. To address this, Ukraine needs to develop stronger regulatory and economic mechanisms to ensure equitable and resilient recovery of war-affected regions. Establishing specialized funds and state-targeted programs, alongside prioritizing blended finance strategies, will help secure sustainable development funding.

Institutional Capacity Gaps Must Be Addressed Through Better Coordination. One of the major barriers to effective just transition implementation is the absence of a central oversight body to coordinate policies and ensure their enforcement. Government institutions operate within defined roles, but there is no singular authority responsible for cross-sectoral coordination. Additionally, human resource shortages exacerbated by war-related displacement hinder the ability to implement policies effectively. Inadequate data collection, weak monitoring frameworks, and limited engagement between government and non-government stakeholders further complicate policy execution. Ukraine must establish a central oversight body, invest in human resource development, and improve data collection and stakeholder engagement to ensure a transparent and accountable transition process.

Green Innovation and Skills Development Need Stronger State Support. Despite having a strong research and development (R&D) sector and a growing private cleantech industry, Ukraine faces significant challenges in mobilizing state support for green innovation. War-related disruptions have shifted public attention away from just transition priorities, and there is little state planning for the return of displaced specialists. Additionally, the country has a major deficit in green skills programs, limiting the workforce's ability to adapt to a low-carbon economy. To address these gaps, Ukraine must increase funding for R&D and cleantech industries, integrate just transition discussions into the national discourse, implement workforce training programs, and encourage the return of skilled specialists. Strengthening cooperation among industries, particularly in coal regions, and providing resources for key stakeholders will be essential in fostering an inclusive and sustainable transition.

3.2 Digitalization

Digital technologies play a crucial role in supporting the green transition by providing real-time data, enhancing transparency, improving decision-making, and supporting sustainable practices. In Ukraine, digital tools are already being used to monitor and manage greenhouse gas emissions, optimise energy use, and promote sustainable agricultural practices. This highlights the potential of digital technologies in advancing the green transition. However, there are challenges across the sectors as well; the main one is that data collection and exchange tend to be uneven and limited, prohibiting the full potential of digitalisation for greening. Several initiatives are being tested and piloted (e.g., smart cities, smart grids, e-waste systems, etc.). However, these types of initiatives require further continuous effort in all sectors, including funding, expertise (IT savvy workforce) and a supportive regulatory framework (often this means alignment with EU standards).

In the EU, **the digital and green transition are viewed as combined or the 'twin' transition.** Digital technology is applicable to multiple aspects of green transitions, such as monitoring and tracking, simulation and forecasting, virtualisation, systems management, and information and communication technologies. This chapter will analyse digitalization from the perspective of a twin transition in Ukraine.

The twin transition in Ukraine

Monitoring and tracking

Digital technologies enable precise, real-time monitoring of emissions, ecosystem status, and material flows. Achieving sustainability can mean enabling reuse and recycling more easily as sensors, data analytics, and real-time solutions are used to understand and direct decisions.[237] For example, a circular economy allows for the tracking and management of resources throughout their lifecycle, which helps with resource efficiency and reuse goals. In Ukraine, such practices are currently applied to a very limited extent, and there are no state incentives for recycling waste into circular materials and selling those materials to other industries.

Digital platforms can facilitate the exchange of waste materials between industries reducing waste. An e-waste solution for this purpose is being piloted in Ukraine together with the UNDP and SIDA[238]. It will provide an accessible, transparent system for tracking the waste cycle in Ukraine. Some examples from the EU that can serve as best practices for applying digital solutions to benefit Ukraine's waste management sector are startups that provide a blockchain-based platform for tracking materials and products throughout their lifecycle (e.g. Circularise), or digital platforms that match waste or excess materials with companies that can repurpose them (e.g. Excess Materials Exchange).

[237] European Commission's Joint Research Centre, 2022. Towards a green and digital future

[238] UNDP Ukraine, Accessed in March 2025. Digital Waste Management (E-Waste Platform)

There are also automated systems for emission control of pollutants that are being implemented to monitor and analyse emissions data as required by the government regarding industrial enterprises from energy, manufacturing and heavy industry[239]. **Yet, the lack of standardised protocols for data description, storage, exchange, and analysis remains a barrier in this area that impedes ensuring compliance with environmental regulations and improving air quality.** Though there are environment monitoring databases on the regional and national levels, some parts of the country are insufficiently covered. Also, there are shortcomings in accuracy and reliability (standards are not in place), highlighting gaps regarding environmental monitoring.

Moreover, Ukraine currently lacks comprehensive biodiversity monitoring. Parts of the country are insufficiently covered with monitoring networks, leading to the absence of data on the environmental condition in some regions.

Simulation and forecasting

Digital simulation and forecasting software tools can improve efficiency by providing insights into the entire lifecycle of products and processes. This knowledge enables the identification of options to improve the environmental footprint and ways to improve reparability and upgradeability, leading to reduced waste, which means less environmental degradation. Digital Twins, for instance, can simulate the lifecycle of a product and identify potential improvements in efficiency and sustainability. Simulation and forecasting for monitoring and tracking rely on data. In all green transformation sectors, the level of data availability is uneven or limited in Ukraine for accurate simulation and forecasting. **Data is often stored in fragmented databases or managed in silos that are not interoperable which makes data analysis for forecasting difficult. Aligning data sources for greening purposes and ensuring data interoperability remains a key challenge for Ukraine.**

Some positive developments exist in Ukraine. Digital twins are being used to optimise the management of energy systems, helping to balance demand and supply in energy grids and prevent interruptions. While applications of AI and Machine Learning in climate action are currently limited, ongoing research in Ukraine explores their potential in weather forecasting, energy demand prediction, and optimising renewable energy production.

Virtualisation

Virtualisation involves using digital alternatives to analogue solutions, such as videoconferences, virtual reality experiences, e-books or digital prototypes. **Virtualisation can reduce the environmental impact by moving economic activities online.** For example, the Research Institutes of Sweden (RISE) uses digital prototyping to support sustainable innovation in recycling and construction industries. Augmented and virtual reality platforms, digital instead of physical over-the-

[239] Resolution of the Cabinet of Ministers of Ukraine № 272, 2023. Procedure for introduction of the obligatory automated control systems of emissions of pollutants

counter services lead to more online interaction that can mean more energy efficiency as more activities happen virtually. **In Ukraine, the virtualisation of public services through the Diia platform has made government services more accessible and efficient, reducing the need for physical infrastructure and travel, thus limiting emissions.** However, the overarching digital services framework is unevenly implemented resulting in fragmented delivery and management of services by public agencies.

Systems management

Digital technologies help manage complex systems and value chains more efficiently, reducing their resource loss and, therefore, causing less environmental strain. An integrated data ecosystem is a precondition for smart city or smart grid initiatives. **Overcoming data exchange and siloed management challenges is key to supporting integrated solutions and data analysis.** Integrating systems and data creates an ecosystem where data from different databases can be used to create solutions geared at efficiency and precision. Another aspect of an integrated data ecosystem is data visualisation, where dashboards help understand data and provide insights on how to improve traffic or energy flows, reducing emissions and the environmental impacts as a result. Smart cities use the Internet of Things (IoT) and AI to optimise resource management and improve urban living conditions.[240]

Smart city initiatives in Kyiv and other cities like Lviv[241] are using IoT and AI to manage traffic, reduce energy consumption, and improve public services. Altogether, 12 Ukrainian cities joined the SUN4Ukraine initiative of the EU Climate-Neutral and Smart Cities mission towards climate neutrality in May 2024.[242] In the energy sector, smart grids can be used to optimise entire grid capacities. Pilot projects for smart metering are underway in both the electricity and gas sectors, by companies like Siemens and DTEK. Data management platforms are being developed to optimise grid monitoring and energy flows, with initiatives like YASNO energy company's project for electricity distribution network. However, these developments are only in the early stages and need to be accelerated and scaled to further locations and geographies.

Information and Communication Technologies / ICT infrastructure

Connectivity and ICT solutions offer opportunities for information collection and dissemination. **Connectivity is a precondition for digitalisation: digital services, monitoring, virtualisation, and data analytics-driven solutions need good connectivity.** 5G offers faster data speeds and greater capacity, which means an increased ability to support more devices involved in gathering and transmitting environmental data for decision-making that can increase sustainability through transparent monitoring and tracking.

[240] European Commission's Joint Research Centre, 2022. Towards a green and digital future

[241] Interreg Europe, 2024. Smart City Lviv

[242] SUN4Ukraine, 2024. Twelve Ukrainian cities join the SUN4Ukraine initiative of the EU Climate-Neutral and Smart Cities Mission

5G is not yet in place in Ukraine while existing networks have been under attack. There are 29.64 million internet users in Ukraine, representing an internet penetration rate of 79.2%. Ukraine has 24.30 million social media users, which is 64.9% of the total population. There are 55.64 million cellular mobile connections in Ukraine, equivalent to 148.7% of the population.[243] This shows that there is potential for 5G uptake, and it can further increase internet coverage and use. Before deployment of 5G, cyber security measures need to be defined and developed as (sensitive) data needs to travel securely.

Blockchain technology represents another type of infrastructure, for instance, in agriculture. Covantis is pursuing This for wheat and maize exports from Ukraine to increase transparency in the grain supply chain[244]. Blockchain can further enhance transparency and accountability when it comes to fulfilling environmental and sustainability goals.

Digital divide

An important aspect of accessing virtual services and implementing ICT solutions for sustainability goals is the digital skills of the population. In 2023, 53% of Ukraine's population (18-70) have a level of digital literacy below the basic level mark.[245] 7% have no digital skills.[246] Therefore, it is important to provide citizens with digital competencies to make maximum use of services and digital solutions. For this purpose, the Diia.Education platform and Mriia were launched, both aimed at increasing digital literacy among Ukrainians. Overall, digital skill levels have improved over the years as more than half of the population notes positive changes in their digital skills. The share of internet users has increased from 2019 to 2023 by 8% and stands at 94%. The younger groups are more active users (in the 18-29 group, 96% use the internet daily).

All regions have made progress in reducing the digital divide by increasing internet access, still the progress is uneven across territories with Kyiv's 84% of internet access compared to Rivne where only 49% have access to internet.[247] A solid provision of public e-services was in place before the war which now poses challenges as Russian hackers aim to destroy administrative data and the lack of employees at service providers. Though digital literacy has greatly improved in Ukraine in the past years, there are still regional and age-related gaps.

[243] DATAREPORTAL, 2024. Digital 2024 Ukraine

[244] Prikhodko, D., Sikachyna, O., Pedersen, E., Sylvester, G. and Rybchynshyi, R. (2022) "Digital technologies in the grain sector of Ukraine"

[245] Ministry of Economy of Ukraine, Accessed in March 2025. Ukraine Plan 2024-2027

[246] Ministry of Digital Transformation of Ukraine, 2023. Дослідження цифрової грамотності в Україні

[247] OECD, 2022. Digitalisation for Recovery in Ukraine

More environment-friendly information and communication technology

For the green transition, the full footprint of the ICT sector itself also needs to be examined in more detail. While ICT solutions have a positive impact on greening the economy, the ICT equipment and intangible assets, such as software and databases, have an environmental footprint of their own. To balance the two, the impact of the ICT sector needs to be assessed.

Assessment and monitoring methodologies of ICT impacts on greening

The footprint of Ukraine's ICT sector is currently unknown. Increased digitalisation brings energy intensive IoT, big data and AI solutions that rely on powerful data centres that significantly increase energy consumption. However, there are no exact calculations on the impact of ICT sector complementing the green transition of different sectors in Ukraine. The calculation of this impact should be undertaken. In the next paragraphs we list examples of existing methods developed by various international organisations that can be used in Ukraine as well.

Firstly, there is the Greenhouse Gas (GHG) Protocol by the World Resources Institute and the World Business Council for Sustainable Development. It is a comprehensive framework to measure GHG, including those associated with the ICT sector. This Protocol follows a life cycle approach considering emissions from all stages of a product's life cycle from manufacturing to use to disposal. It also addresses complex supply chains by providing methodologies for boundary setting and data collection, and allocation of emissions across different stages and components. In addition, the protocol considers the enablement effect which is the potential of ICT products to reduce emissions in other sectors. Finally, it emphasises the importance of data quality and provides methods to assess uncertainty in emissions calculations.[248]

Secondly, there is the World Bank and the International Telecommunications Union (ITU) Protocol Emissions and the Energy Footprint of the ICT Sector that emphasises the need for precise data on energy usage and emissions[249]. The recommendations include collecting data from telecommunications, connectivity networks, data centres, and consumer devices. Comprehensive tracking of subsectors like telecommunications and data centres is crucial. Collaboration between the digital and energy sectors can significantly cut ICT emissions and encourage sustainable energy use. Examples include regulatory and financial incentives that promote the use of clean energy in the digital sector. The report addresses the policy and regulatory implications of the data collected. It highlights the importance of creating policies that support the reduction of emissions and energy consumption in the ICT sector. To align with global climate objectives, emissions from the broader digital sector must be reduced significantly. It also confirms the need to address the rising volume of e-waste and promoting circular economy models to lower environmental impact.[250]

[248] Greenhouse Gas Protocol, Accessed in March 2025.Product Life Cycle Accounting and Reporting Standard

[249] The World Bank and ITU, 2024. Measuring the Emissions & Energy Footprint of the ICT Sector: Implications for Climate Action

[250] The World Bank and ITU, 2024. Measuring the Emissions & Energy Footprint of the ICT Sector: Implications for Climate Action

In addition, the OECD and the EU outline in different documents how ICT technologies can be used to assess and monitor climate and GHG. They propose a methodology that is being tested regarding the assessment of emission reduction in different sectors via digital means: construction/ buildings, energy, transport, agriculture, smart cities and manufacturing. It was published by The European Green Digital Coalition (EGDC). It is an initiative of "companies, supported by the European Commission and the European Parliament, based on the request of the EU Council, which aims to harness the enabling emission-reducing potential of digital solutions to all other sectors".[251] Secondly, there is a science-based methodology to assess the net carbon impact of ICT solutions.[252] The latter quantifies both the positive contributions (handprint) and the direct environmental footprint (footprint) of the ICT solutions in terms of CO2e (carbon dioxide equivalent) emissions. The exact steps and considerations can be accessed here. To refine the Net Carbon Impact Assessment Methodology, the EGDC has developed Case Study Calculators. These calculators were used to conduct assessments of the net environmental impact of real-life ICT solutions.[253]

Finally, the EGDC has also published Deployment Guidelines to provide recommendations for green digital transformation in each of the six sectors. These guidelines offer practical advice on how to deploy digital solutions to maximize their net positive impact (e.g., emission avoidance) and minimize negative impacts (e.g., solution footprint, rebound effects). These guidelines and methods can be used to calculate the ICT sector's environmental handprint and footprint.

Ukraine Facility

The Ukraine Facility is a financial assistance program established by the European Union to support Ukraine's recovery, reconstruction, and modernisation from 2024 to 2027. The program allocates up to €50 billion in grants and loans to help Ukraine stabilise its economy, rebuild infrastructure, and implement necessary reforms.[254] Digital transformation is one of the cross-cutting areas of the Ukraine Facility plan. By integrating digital transformation into its recovery and development strategies, Ukraine can build a more resilient, innovative, and sustainable economy.

In the Ukraine Facility plan increased interaction with the EU members regarding transport, energy and digital sectors (Connecting Europe Facility Fund) is foreseen. Largest potential is seen in the sectors of energy, agriculture, transport, critical raw materials and IT. The digital transformation agenda includes:

- measures supporting the digitalisation of institutions;
- regulatory convergence with the EU;
- bolstering cybersecurity standards.

[251] European Green Digital Coalition, Accessed in March 2025

[252] European Green Digital Coalition, Accessed in March 2025. Net-Carbon Impact Assessment Methodology

[253] European Green Digital Coalition, Accessed in March 2025. Deployment Guidelines

[254] European Commission, Accessed in March 2025. Ukraine Facility

The digital sector is becoming an important economic driver and should be central in the green transition, as it has the **potential to accelerate sustainable development, promote circular economy practices, stimulate economic growth and promote inclusion by providing equal access.** Among other priority areas like defence tech, bio tech and agro-food tech are mentioned.[255] Ukraine is also a leading AI provider in Eastern Europe and can leverage this position in employing AI solutions for different digitalisation functions in all sectors.

Main priorities for the green transition

Create regulatory and policy frameworks that support the integration of digital technologies for sustainability purposes while ensuring alignment with international and EU standards. The Ukraine Facility foresees digitalisation as a cross-cutting measure to drive sustainability in different sectors. Each ministry responsible for sectors such as energy, circular economy, agriculture, transport, buildings, and environment/climate should, in an inclusive manner (i.e., involving a broad spectrum of stakeholders), identify and set up roadmaps for how digital technologies will be deployed to support the green transition. The opportunities of digital technologies - through functions illustrated in this chapter - need to be reflected and followed in regulations and policies. Policy objectives should be SMART (Specific, Measurable, Achievable, Relevant and Time-bound). Critical areas such as emerging technologies (e.g., AI, blockchain, cloud) and IT ecosystem thinking should receive special attention in nationwide strategies and policies for their potential for sustainability. Private companies in the respective sectors should also be encouraged and incentivised to assess how digital technologies help to green their activities and take practical steps towards implementing such solutions.

Data collection, storage and management is currently limited and uneven across sectors and regions. When different sectors operate in silos, data cannot be easily exchanged and seamlessly analysed to create comprehensive systems to track and reduce emissions, monitor environmental degradation or increase efficiency. **To improve data-based decision-making, there needs to be an integrated data ecosystem where the exchange of data across sectors is seamless. The first step would be to ascertain what data and in which format are needed to achieve sustainability goals.**

Comprehensive and interoperable data management and exchange systems for monitoring, tracking, simulation and forecasting in all sectors are needed to make best use of digital tools. Putting in place standards for data interoperability across public sector authorities and different private sector actors is the first step

Investments in digital infrastructure, particularly in rural areas, to further bridge the digital divide are preconditions for sustainable digitalisation in Ukraine, so continued cooperation with international organisations and the private sector is needed. This is an important enabler for the twin transition.

[255] European Commission, Accessed in March 2025. Ukraine Facility, p 272

Cybersecurity enhancements are needed as data needs secure handling. Therefore, alignment with the NIS2 directive and other EU cyber security standards and protocols is needed. Enhanced cyber security is also needed for the future deployment of 5G. A National Cybersecurity Strategy needs to be implemented, and compliance with GDPR needs to be achieved to ensure the protection of personal data.

Approach digitalisation as an integral part of greening different sectors, keeping in mind the environmental impact of ICT and, therefore, setting up regular ICT footprint monitoring frameworks, methods, and tools. One option is to use the GHG protocol to account for emissions from ICT products. Additionally, public and private sector actors could require product providers to follow the Ecovadis sustainability ratings in their tenders.

Improve digital services provision by creating an overarching digital services framework, so the delivery and management of services can be improved across services. Additionally, alignment with the Digital Services Act, the European Interoperability Framework (2017) and the Interoperable Europe Act (2022) should be achieved.

Provide training and capacity-building programs to equip professionals with the skills needed to use digital technologies effectively in their respective sectors.

3.3 Research and Innovation

The uptake of green R&I[256] in Ukraine is hindered by structural issues that the R&I sector faces in Ukraine, including underfunding, gaps in human capital, obsolete infrastructure and low innovativeness of the private sector. In fact, in 2023, the Gross Domestic Expenditure on Research and Development (GERD) in Ukraine reached its historic low of 0.33% of GDP, six times lower than the average in the EU[257]. This decline was accompanied by a decrease in the number of researchers (R&I representing 0,95% of total employment in 2010 and 0,5% in 2020), the degradation of R&I infrastructures due to lack of funding, and the continued trend in R&I staff ageing as science failed to attract youth (in 2022, only 40% of researchers and scientists were under 44 yr.)[258]. The private sector investment in R&I stood as low as 0.17% of GDP in 2021, demonstrating Ukraine's low absorptive capacities for innovation, even if there are some positive examples in the IT sector, defence tech and govtech exist and Ukraine demonstrated its high innovation capacities as the full-scale invasion began in February 2022. Finally, the **European Green Deal (EGD) related areas are not emphasised in R&I policy and cross-sectoral integration of R&I is lacking to make sure R&I becomes a real driver of Ukraine's green transition**.

Since 2015, Ukraine has been addressing the above-mentioned challenges through the reform of its R&I sector in the view of the EU integration. The reform includes improving regulatory and legislative frameworks (e.g., the adoption of the Law "On Scientific and Scientific and Technical Activity" in 2015), introduction of new policy mechanisms to enhance the R&I system performance (e.g., the establishment of the National Research Fund responsible for provision of competitive R&I funding in 2018, fostering the network of business incubators and accelerators, as well as industrial parks; the Science and Business platform to facilitate science-business linkages for technology commercialisation), and implementation of measures to enhance Ukraine's readiness to integrate the European Research Area (ERA) (e.g., adoption of the Roadmap on integration in 2021). The latter emphasises improving research careers, consolidating research institutions, streamlining R&I governance structures, and introducing performance-based funding for its R&I institutions.

The ongoing Russian aggression since February 2022 has had a significant negative impact on the R&I sector in Ukraine, which hinders the sector's capabilities to support the green transition. The data as of March 2023 shows that 35% of research infrastructure was damaged or destroyed in Ukraine due to the war, and a quarter of researchers and scientists left abroad[259].

[256] The Research, development, and innovation cross-cutting thematic area is referred to as research and innovation (R&I) in the GUMA project, as this is the current form used on the EU level in the context of the Green Deal. The key terms of R&I used in this report are aligned with those used in the OECD Frascati Manual and Eurostat-OECD Oslo Manual of "R&D" and "Innovation".

[257] Ukrainian Institute of Scientific and Technical Expertise and Information (2024). Scientific and scientific and technical activity in Ukraine in 2023

[258] Ukrainian Institute of Scientific and Technical Expertise and Information (2023). Scientific and scientific and technical activity in Ukraine in 2022

[259] Ukrainian Institute of Scientific and Technical Expertise and Information, 2023. Scientific and scientific and technical activity in Ukraine in 2022

The recent estimates of the total cost of restoring public research infrastructure stand at USD 1.3 billion[260]. Furthermore, the mobilisation of state resources to sustain the war shock led to sequestration of the funding for R&I projects under the National Research Fund in 2022, contracting the already limited R&I budget. For instance, the budget allocated to the National Academy of Sciences has dropped by 48% since 2021 with scientists receiving 39% less in salaries[261]. At the same time, the war catalysed innovation across several sectors of the economy, including IT, military technologies, and government technologies, as the state had to respond to the increasingly urgent needs of its population and economy. International partner support in the R&I sector, particularly that of the EU, was crucial to sustain the sector and reform efforts. In fact, the EU offered major support to Ukraine's researchers under Marie Skłodowska-Curie Actions and European Research Council Actions for Ukraine, as well as other programs, but also by opening a New Horizon Europe Office in Kyiv in Dec 2023 to facilitate Ukraine's participation in "Horizon Europe" projects[262]. The Office could play an important role in supporting Ukraine's participation in EGD-related Horizon Europe projects, amongst other things. This support was complemented by initiatives to support local tech start-ups, e.g., through EUR 20 million under European Innovation Council Action to support Ukraine, and the launch of the European Institute of Innovation and Technology (EIT) Community Hub in Kyiv[263] to provide the Ukrainian innovators remaining in Ukraine with access to partners, markets, testbeds, training and investment.

In addition**, Ukraine's R&I sector is struggling with the availability and development of necessary green skills**[264], as the curricula and training programmes are yet to integrate EGD-relevant focus. Finally, the R&I policy framework suffers from policy fragmentation, weak policy coordination and insufficient monitoring and evaluation complemented by weak public sector capabilities to implement an effective R&I policy. This impedes the development of a strong R&I system able to effectively accompany green transition. The **R&I sector is not mentioned among the priorities under the Ukraine Facility Plan**[265] – a key document guiding Ukraine's recovery and reconstruction with the financial support of the EU, **which reflects the overall lack of strategic long-term vision for the R&I as a driver of Ukraine's recovery and EU integration, including on green transition and climate goals**.

[260] UNESCO, 2024. Analysis of war damage to the Ukrainian science sector and its consequences

[261] UNESCO, 2024. Analysis of war damage to the Ukrainian science sector and its consequences

[262] European Commission, 2023. Commission launches three new initiatives to support Ukrainian researchers and innovators

[263] European Institute of Innovation and Technology, 2023. New Innovation Hub opens in Ukraine: EIT continues to strengthen support for Ukrainian Innovators

[264] As defined by the European Classification of Occupations, Skills and Competences, green skills are skills needed across all sectors and levels to adapt to climate change and comply with environmental regulations (or skills needed for the green transition). These include skills for the green jobs and transversal thinking (critical thinking, systems thinking, problem solving and innovation, but also communication, collaboration, adaptability, and digital literacy).

[265] Government of Ukraine, 2024. 'Plan for Ukraine Facility 2024-2027'

Policy and legal framework capacity

The R&I sector has seen significant improvements to its legislative framework since 2015, including the introduction of the Law "On Scientific and Scientific and Technical Activity" (2015), the establishment of the National Research Fund (2018)[266] and the introduction of support mechanisms for innovative enterprises (e.g., the establishment of the Ukrainian Start-Up Fund[267] in 2018 and introduction of innovation vouchers in 2016). Furthermore, recent amendments to the legislation on the priority areas in R&D and in innovation activity (introduced in January 2024)[268] reflect the national security and defence priorities adding to the list of R&I areas defence technologies. **However, R&I legislation and regulatory framework currently lacks coherence (i.e., over 200 different acts and regulations) and requires better alignment with national strategic priorities (e.g., the National Economic Strategy 2030) and the EGD-related priorities (as reflected under relevant legislation).**

When it comes to policy framework, the State Strategy for Development of Innovative Activities in Ukraine until 2030[269] has been the main strategic document guiding R&I policy development and implementation up until January 2025. The efforts on R&I sector reform were complemented by the Strategic Plan of Activities until 2027 of the Ministry of Education and Science (MoES)[270], as well as the Roadmap on ERA integration and Roadmap on the use of R&I for achieving the Sustainable Development Goals (SDGs)[271]. Despite the war, the MoES managed to advance on Strategy implementation, including through continued assessment of R&I and higher educational (HEI) institutions based on the new unified methodology, the launch of the Science & Business platform connecting businesses and research organisations for R&I commercialisation, finalisation and approval of the "Roadmap for the use of science, technology, and innovation to achieve the Sustainable Development Goals (SDGs)", etc.

On 14 January 2025, the new Digital Innovations Development Strategy of Ukraine until 2030 was adopted by the Government of Ukraine[272]. The Strategy[273] aims to support innovative activity across all sectors of the economy and strengthen Ukraine's innovation ecosystem with the ambitious goal of making Ukraine the most comfortable digital and innovative country in the world. The Action Plan for 2025-2027 for the implementation of the Strategy outlines 79 measures across 18 strategic objectives with specific integration of 14 priority areas for innovation and technology development. Among the priority sectors, the EGD-related areas feature prominently including medtech, biotech (incl. tech for sustainable agriculture and for quality of life), govtech, agrotech (incl.

[266] National Research Foundation of Ukraine

[267] Ukrainian Startup Fund

[268] Official web portal of the Parliament of Ukraine, 2024. On Amendments to Certain Laws of Ukraine Regarding Priority Areas of Development of Science and Technology and Innovative Activities (In Ukrainian)

[269] Decree of the Cabinet of Ministers of Ukraine dated 10 October 2019, N526-p "On Approval of the Strategy of Innovative Development until 2030"

[270] Ministry of Education and Science of Ukraine, 2024. 'Strategic Plan of Activities of the Ministry of Education and Science of Ukraine until 2027'

[271] Ministry of Education and Science of Ukraine, 2023. Roadmap on Science, Technology and innovation to Achieve the SDGs

[272] Diia. Business, 2025. The Government approved the Digital Innovation Development Strategy until 2030

[273] Ministry of Education and Science of Ukraine and Ministry of Digital Transformation of Ukraine, 2024. Ukrainian Global Innovation Strategy 2030: Full version (presentation)

addressing the degradation of soils, phytoremediation), edtech, greentech (incl. decarbonisation of energy sector, energy saving and energy efficiency, green energy transition, biomethane production, green metallurgy), and fluid economy (incl. fostering digital infrastructure and seamless connectivity, AI-ready education). **The effective implementation of the newly adopted Strategy has strong transformative potential for the Ukrainian economy placing innovation in the centre and facilitating Ukraine's green transition.**

However, **as the Strategy for Development of Innovative Activities in Ukraine until 2030 and other policy documents on R&I lack effective implementation mechanisms, robust KPIs and sufficient funding, these documents have not been able to generate expected R&I policy outcomes** with the effect of slowing down Ukraine`s ERA integration. If the outlined weaknesses are not addressed when implementing the new Digital Innovation Development Strategy of Ukraine 2030, there is a high chance the Strategy will not deliver on its ambitious objectives. The overall slow progress on R&I reform also has negative consequences for the R&I sector's capacity to accompany the **green transition**.

In addition, **the R&I sector faces challenges in the implementation and lacks specific policy mechanisms to catalyse innovative activity in Ukraine and make innovation a true driver of economic transformation, including green transition**. For instance, the MoES plans to increase the financial and administrative autonomy of universities and state R&D organizations in Ukraine (e.g., regulations enhancing cooperation with and attraction of funding from private sector and non-state actors) and to catalyse science-industry collaboration for competitive high-quality innovations (e.g., incentivising private sector co-financing of R&I). In addition, a change in the remuneration system of R&I workers, the introduction of a fully-fledged performance-based research funding system, and the establishment of additional financial incentives for young and prospective scientists and researchers are envisaged for implementation until 2027. However, these measures fall short of adequate funding in the context of the ongoing war and related fiscal constraints and, therefore, may not bring expected benefits for Ukraine's R&I system if the funding and adequate capacities are not allocated for their implementation.

Furthermore, **existing tools to support R&I lack sufficient funding and do not contain focus or dedicated incentives to foster green R&I**. For example, the National Research Fund (NRF), the only state institution providing grants to innovative R&D projects, saw its funding sequestrated in 2022 due to the outbreak of the war with donor funds playing a crucial role in supporting R&I projects in the aftermath of 2022. In addition, while some programmes funded by NRF are relevant for green transition, e.g., "Science for security and sustainable development of Ukraine", which focuses on sustainable use of nature, energy efficiency, new substances and materials, there is significant room for better integration of green transition into the calls it launches.

Finally, **existing instruments for R&I support, such as industrial, technological, and science parks, lack effectiveness in supporting green R&I.** Many of these support infrastructures are not operational in practice due to a lack of funding and human capacities. Improving fiscal incentives and addressing the related capacity constraints could help support the uptake of R&I tackling the EGD challenges.

Instruments for policy implementation

The current policy instruments for R&I implementation are not well-adapted to assist the transformation in EGD areas, lack effective implementation and adequate funding, and are quite limited in scope. The funding for R&I has been on a declining trend since the 1990s and exacerbated by the invasion, with the Government aiming to address this gap through measures to increase R&I investment from the private sector and tools to enhance the quality of R&I system, including the transition to performance-based funding of public R&D organisations, revising the remuneration to attract talent and internationalisation of Ukrainian science. However, additional measures are needed to support green R&I as the focus on EGD areas is now largely missing.

Over the last couple of years, the Government introduced economic and regulatory instruments to support R&I in Ukraine, but they remain rather limited in their scope and marked by several implementation challenges. In terms of regulatory tools, the main achievements are legislation setting the priority areas for R&I activities, enabling R&I funding through the NRF, the Ukrainian Start-Up Fund (USF), and access to Horizon Europe.

The economic instruments to promote R&I include:

- allocations of state budget for Ukraine's participation in the "Horizon Europe" projects
- grants for technology and innovative start-ups available through the USF, supported by EU and international donors
- incentives for innovative start-ups and R&I organisations to conduct their activities in science, technology and industrial parks, including import tax exemption on R&I equipment, full or partial interest payment compensation, profit tax and property tax exemptions
- loans, guarantees, credits and co-financing mechanisms provided through the State Innovative Financial and Credit Institution
- grants for innovative ideas provided under the Presidential Fund for Support to Education, Science and Sport.

However, these economic instruments have struggled to produce expected results. For instance, many of the science and technology parks are not operational in practice due to issues with funding and lack of skilled personnel – out of 16 officially registered technoparks, only three are operational, while the results of the activity of the 26 science parks are unknown[274]. In addition, the State Innovative Financial and Credit Institution's activity has been limited and encountered some operational challenges[275]. It is, however, worth noting that private initiatives in the field of support to R&I (e.g. UNIT.City, UNIT.Kharkiv, Promprylad. Renovation, Lviv.Tech.City, etc.) showed good results in terms of residents, raised finance for innovative R&I, international cooperations, etc., covering the gap left by the state initiatives in the field.

[274] Ministry of Education and Science of Ukraine and Ministry of Digital Transformation of Ukraine (2024) Ukrainian Global Innovation Strategy 2030: Full version (presentation)

[275] 'Credit institution of the Ministry of Strategic Industries incurred 10.9 million in losses for the first half of 2021', 2021. Marlin

Generally, the available R&I regulatory and economic instruments do not fully address the EGD areas, do not contain focus on green R&I and lack effective incentives for business sector investments in R&I and green R&I in particular. An increase in state investments in R&I together with deployment of incentives and instruments to enhance R&I quality could send a powerful signal to the private sector to increase their investments in R&I and will help catalyse green R&I.

When it comes to R&I funding, the R&I sector in Ukraine has been suffering from declining investment over several decades, with GERD in 2023 reaching 0.33% of GDP, leaving science to perform only a socio-cultural function[276]**.** The state funding is the main source for the R&I activity funding in Ukraine (almost 65% in 2023) with most of the resources directed towards fundamental research performed at the National Academies of Sciences of Ukraine (i.e., the National Academy and the five Sectoral Academies). After a significant decline in 2022, the share of the R&I projects funded from foreign sources increased nearly to 2021 levels to stand at 16,4% of all R&I expenditures in 2023 due to an increase of international support to Ukrainian science and innovative activities. However, state support to international cooperation on R&I remains very limited, even if it saw an increase compared to 2022, reaching 1,3% of all state R&I expenditures in 2023 (for comparison, it was at 0,5% in 2022)[277]. **The engineering and technology field has a strong track record in receiving the highest shares of state funding (51% in 2023) and boasts of the highest share of experimental R&D**[278]**.** In addition, enterprise sector organizations represented 11.5% of total R&I expenditures in 2023 with a recorded increase in expenditures on engineering and technologies development in the context of the increased demand in technologies and innovations from the Armed Forces of Ukraine. Competitive grant funding represents only 8% of the total R&I state funding in 2023 – an increase, compared to the 5% in 2022, the NRF responsible for almost all of the resources allocated in this category.

The available data does not allow to provide a comprehensive view on funding of the EGD-related areas. However, there are several projects financed by the NRF (e.g., "Science for security and sustainable development of Ukraine" through its focus on sustainable use of nature, energy-efficiency, new substances and materials) and also specific calls launched by the Academies of Sciences, Ministry of Health, Ministry of Environment, Ministry of Education and several other ministries.

Donor funding has been the main source of green R&I funding in Ukraine. Noteworthy projects include UNIDO`s project "Low-carbon economy of Ukraine for climate change prevention"[279], the Global Green Chemistry Initiative (GreenChem) financed by Global Environment Facility under UNIDO, the UpSHift Ukraine[280], a UNICEF programme for youth with focus on eco-innovation projects, and Climate Innovation Vouchers funded by EBRD and the EU[281].

[276] Ukrainian Institute of Scientific and Technical Expertise and Information, 2024. Scientific and technical activity in Ukraine in 2023

[277] Ukrainian Institute of Scientific and Technical Expertise and Information, 2024. Scientific and scientific and technical activity in Ukraine in 2023

[278] Refers to R&D produced through practical testing, trials, and experiments.

[279] Global Environment Facility, 2021. Low-carbon economy of Ukraine for climate change prevention: Facilitating investment to scale-up innovative cleantech solutions for low-carbon economy and climate action

[280] UPSHIFT – Ukraine. Innovative program for youth

[281] Greencubator, 2017. 'Climate Innovation Vouchers'

Overall, insufficient funding of R&I and the lack of dedicated funding for EGD-related areas is a major obstacle to ensuring that the R&I sector in Ukraine can be effective in accompanying the green transition. In this regard, several challenges need to be addressed:

- Increasing funding for priority R&I projects that are in line with EGD, such as energy, sustainable use of resources, agritech, medtech and greentech (e.g, in the framework of projects financed through NRF, leveraging the opportunities provided by international cooperation projects in this regard);
- Introducing dedicated instruments to support EGD-specific R&I projects through additional funding or co-funding mechanisms (donor/ business sector);
- Facilitating access of Ukrainian researchers to funding opportunities in the framework of Horizon Europe that specifically address EGD areas by providing tailored support to applicants and related awareness-raising activities through the Office of Horizon Europe Ukraine and its National Focal Points network;
- Introducing fiscal incentives for businesses to engage in green R&I (e.g. tax exemptions for investment in R&I in EGD areas) and supporting participation of innovative firms from Ukraine (e.g. covering consultancy/advisory fees) in various European projects such as EGD Data Space programme under the Digital Europe, grants for R&D in agrifood technology by Impact Funding Framework by EIT Food, the GRAINS project (European Cluster Collaboration Network) and STAGE Grant Programme for Sustainable Development.

Finally, in the context of the ongoing war and security challenges, the defence sector has attracted significant investments, both from the state and private companies, which allows the development of military technologies for Ukraine's enhanced defence capabilities. For instance, the Ministry of Defence launched its own accelerator programme for innovative military technologies, and drone technology and production have grown significantly (e.g., from around 10 companies in 2021 to more than 200 companies in 2024 with more than 60 certified types of drones; Drone Hackathon conducted in 2022 by MinDigital[282]). As defence-tech and related fields are attracting and absorbing state and non-state funding, capitalising on developments in this sector to enhance technology transfer for dual-use technologies, R&I in dual-use, replicating successful industry-science cooperation frameworks in non-military R&I fields could substantially boost the capabilities of Ukraine`s R&I system. Moreover, incentivising, to the extent possible, the military tech to propose green solutions (e.g. tax reductions/exemptions, matching funding mechanisms, provision of loans and guarantees, etc.) would make a solid contribution to R&I system's capacities in EGD implementation.

[282] Ministry of Digital Transformation, 2022. The Ministry of Digital Transformation launches Drone Hackathon to find new solutions in the field of military technology

Institutional capacity

The existing institutional set-up in R&I policy in Ukraine, or innovation policy governance, is marked by a high level of fragmentation in policy formulation and implementation, weak coordination mechanisms, and gaps in policy monitoring and evaluation. Together, these characteristics weaken the effectiveness of the R&I policy initiatives, leading to weak implementation, duplication of efforts, and lack of tailored approaches to specific challenges facing R&I sector[283]. **Inefficiencies in R&I policy governance complicate the integration of EGD areas into the R&I as green R&I measures would face high risks of not getting the expected results, i.e., supporting Ukraine's climate and green transition goals**.

In Ukraine, there is no single central executive body responsible for innovation policy with responsibilities distributed across several major ministries including the Ministry of Education and Science (MoES), the Ministry of Economy (MinEconomy), the Ministry of Digital Transformation (MinDigital), the Ministry of Strategic Industries, and several others (Ministry of Health and Ministry of Environments overseeing the R&I aspects in their policy areas). Each ministry formulates and implements the goals related to the R&I in their respective field which results in significant policy fragmentation.

The Government's efforts to harmonise policy implementation resulted in the establishment in 2017 of the National Council on Science and Technology Development under the Cabinet of Ministers as an advisory body. However, the effectiveness of the Council's operation leaves much room for improvement as the meetings are rare and not systematic. The reporting and monitoring of R&I policy implementation is fragmented as it is carried out by responsible ministries based on their strategic plans[284]. In addition, effective monitoring mechanisms of R&I policy implementation are missing, e.g., a comprehensive and systematic monitoring system based on robust KPIs was not developed for the Innovation Development Strategy until 2030 and timely data availability for monitoring indicators is an issue[285].

Furthermore, in the absence of effective R&I policy coordination body, the implementation of R&I policy measures by different ministries and the development of new strategic documents does not benefit from strategic steering and robust monitoring, misses out on regular contributions from business sector, academia and civil society representatives, and faces risks of duplication of efforts thus leading to R&I policy failures.

To address several of the outlined innovation governance challenges, the new Digital Innovation Development Strategy of Ukraine until 2030' was prepared by the MoES and MinDigital and adopted by the Government on 14th January 2025. Among other things, the strategy sets out the creation of the State Innovation Agency to optimise and enhance innovation policy implemen-

[283] For instance, incentives for private sector investments in R&D as outlined by the respective legislation in the framework of technoparks, industrial parks and science parks have not been consistently implemented, hence, these support infrastructures have so far failed to deliver on expected effects on the economy.

[284] For instance, the MoES gathering reports from and monitoring the activities carried out by subordinated implementing bodies such as National Academies of Sciences, HEIs, public R&D organisations, IP Office, etc.

[285] UNECE, 2021. Sub-regional Innovation Policy Outlook 2020: Eastern Europe and the South Caucasus

tation, re-invigorating the work of the Innovation Development Council for effective and inclusive innovation policy development, and ensuring that Chief Digital Transformation Officers (i.e., responsible for digital development, transformation, and digitization) within ministries and central executive bodies oversee innovation in their portfolio to enhance R&I policy implementation and monitoring. The Strategy also puts the Vice-Minister for Innovation, education, science and technology development as responsible for cross-sectoral coordination on innovation and places the formulation of innovation policy onto the MinDigital. The implementation of the Strategy has the potential to significantly boost R&I activity in Ukraine and make a strong contribution to Ukraine`s green transition.

However, for this to be realised and to increase R&I sector readiness to support green transition, several challenges with regards to institutional capabilities should be addressed, including:

- Missing anchoring of R&I policy in Ukraine's economic development and recovery policies with focus on green transition aspects;
- The overlaps in mandates between ministries responsible for R&I policy, i.e. MoES, MinDigital, MinEconomy and Ministry of Strategic Industries, with negative impact on R&I policy effectiveness;
- Insufficient financial resources allocation for R&I policy implementation (e.g., the National Innovation Strategy 2030 and its Action Plan were heavily underfunded, with some measures not having any funds attributed for their implementation);
- Lack of qualified human resource for the R&I policy in the context of population outflow due to the war[286], and the ongoing public administration reform (e.g., downsizing of the state administration apparatus);
- Lack of systematic use of evidence derived from thorough studies and analysis to inform policymaking together with gaps in monitoring of R&I policy implementation;
- Insufficient capacity-building of public servants in R&I and in the area of green transition, with ad hoc projects in place (e.g., the IMF's Ukraine Capacity Development Fund (UCDF)) but more comprehensive mechanisms missing;
- Expanding on the progress achieved through the digitalisation reform for increased transparency and accountability of the R&I policymaking and promotion of Open Science principles for enhanced research quality and integrity.

[286] According to the National Agency on Civil Service, in 2022, more than 4000 civil servants moved abroad, around 3,500 were drafted into the army and another 4000 remained in the occupied territories.

Sectoral capacity

While Ukraine's R&I support infrastructure is quite diverse, comprising such elements as science parks, technoparks, industrial parks, Industry 4.0 Centres, innovation hubs, and regional technology transfer centres, it currently falls short of meeting the demands of the green transition. In fact, only a small share of registered infrastructures is operational and R&I infrastructure is often not easily accessible to non-state actors. Out of 16 techno parks only three are operational, around 10 industrial parks out of 75 are demonstrating results, and the activity of the 26 science parks is unclear due to the lack of data. There are two Industry 4.0 Centres functioning on the basis of the National Polytechnical University in Kyiv and the Kharkiv Aviation University, while the ambition has been to have such centres in all regions of Ukraine to support the cluster development (as of 2023, 25 clusters in operation). The effect of the ongoing war should not be underestimated when assessing the performance of this infrastructure as at least a third has been damaged or destroyed since 2022.

The MoES is working to enhance collaboration with the business enterprise sector on R&I and make available some of the infrastructures of the HEI, public R&D organisations to the private sector and other stakeholders for R&I activity (e.g., through centres of shared equipment use that can be established), for example through Science. City initiative[287] and the Open Science[288] implementation. However, limited access to quality research infrastructure for knowledge-intensive start-up, scientists and inventors remains a challenge. The newly adopted Digital Innovations Development Strategy of Ukraine until 2030 foresees a set of measures to address the outlined bottlenecks.

Private sector support infrastructure for the R&I activity saw an important boost due to the burgeoning Ukrainian IT sector and its start-up ecosystem over the last couple of years. For instance, Ukraine has a set of successful private innovation parks such as UNIT.City, UNIT.Kharkiv, Promprylad.Renovation and Lviv.Tech.City, which provide infrastructure and funding for innovative enterprises and R&I projects. Venture capital initiatives, such as Angel One Fund and Flyer One Ventures, invest in Ukrainian innovative start-ups at early stages of their development, and the funding under USF and WES NIS, Creative Europe, Horizon Europe, Visa, and Good programmes offer financing for innovative projects. In addition, **support services for private sector "greening", i.e., resource efficiency and cleaner production (RESP) services, are provided by the Resource Efficient and Cleaner Production Centre**[289] (funded by the EU), with 170 companies benefitting from the Centre's services. The UN Global Compact initiative also contributed to enhancing companies' environmental, societal and governance (ESG) compliance with 149 Ukrainian companies, mostly multinationals or large business having joined so far and thus contributing to building foundation for the green transition of Ukraine.

[287] Science.City is an online platform with information and services for all R&I actors and is currently under development.

[288] Open Science is an approach to research based on open cooperative work that emphasizes the sharing of knowledge, results and tools as early and widely as possible. It follows FAIR principles for data sharing and storage (Findable, Accessible, Interoperable, Reusable data), is mandatory under Horizon Europe, and operates on the principle of being 'as open as possible, as closed as necessary'.

[289] Resource Efficient and Cleaner Production Centre

The overall awareness of the green transition, its components, rationale and implications across sectors is relatively weak, except for a few businesses and CSOs that attach great attention to green transition and realise its importance for competitiveness of Ukrainian economy and its EU integration.

Awareness raising activities are funded by the EU, for instance, under the project on "Integration of sustainable development in Ukraine in line with the European Green Deal", which allowed to develop and run an online platform on EDG "greentransform.org.ua" in Ukrainian. Other EU-funded projects, such as the Interreg Danube Region projects on energy-efficiency and greening of the Danube region and broader projects of EU4Energy and EU4Climate, disseminate information on the green transition, contributing to the overall awareness of the public and stakeholder groups of the EGD. Several NGOs described below are undertaking awareness-raising campaigns, workshops and seminars on topics related to environmental protection, energy efficiency, and decarbonisation. The media communications and capacity-building activities conducted by industrial associations (e.g., Chamber of Commerce and Industry, Association of Industrial Automation of Ukraine and Ukrainian Cluster Alliance, Association of Manufacturers of Ukraine, Association of Start-ups, etc.) do not seem to prioritise green transition which is limited to ad hoc events on Industry 4.0, circular economy principles and energy efficiency[290]. This mirrors the lack of prioritisation of green transition in sectoral policies and the insufficient understanding of green transition and its role in the competitiveness and growth of the Ukrainian economy.

When it comes to green skills, the 2024 report by Resource Centre "Society and Environment" estimates that Ukraine's green post-war reconstruction can create 4.2 million green jobs across transport, education, healthcare, energy, water supply, and irrigation sectors[291]. This shows not only the huge potential of a green transition for the Ukrainian economy but also the future demand for green skills.

Currently, the Ukrainian education system cannot provide the required number of green skills for the future. The higher education institutions count approximately 636 courses in EGD-related areas, with a total of 110,734 students out of one million students[292]. Furthermore, STEM education at the university level would be crucial for green transition and, in the case of Ukraine, with its strong record in STEM graduates, could make an important contribution to higher-skilled green employment[293]. However, this potential is hampered due to the emigration of students and prospective students following the war and the ongoing destruction of the educational and R&I institutions and infrastructures.

Reskilling programmes and on-the-job training for green jobs are not on the government's policy agenda for now and have not yet been integrated at scale by the business sector

[290] Based on the study of the webpages of these organisations, incl. events and key communication materials over 2022-2024.

[291] Razom We Stand and Resource and Analysis Centre "Society and Environment", 2023. Green jobs and reconstruction of Ukraine

[292] Estimates based on the National Agency for Higher Education Quality Assurance, 2023. Report on the quality of higher education in Ukraine, its compliance with the objectives of sustainable innovative development of society in 2022 and Universities of Ukraine, Directory of Ukrainian universities - universities, institutes, academies – osvita.ua

[293] Based on the World Bank Education Statistics, in 2019, a quarter of graduates in Ukraine's tertiary education were in STEM.

despite some businesses providing such training to their employees and taking steps towards ESG compliance.

The green transition agenda in Ukraine is supported by several sectoral NGOs, including CSOs and analytical centres, most of them fully donor-funded. DixiGroup, EcoAction and the Resource Centre Society and Environment are major actors in this respect with the necessary weight to influence policy decisions and contribute to effective implementation of the donor projects on green transition in Ukraine. The work of the abovementioned organisations is amplified through their membership in international CSOs, such, as for example, the well-established environment-focused NGO CEE Bankwatch Network where EcoAction is a member. **Integration into European networks of NGOs that comes with the international donor funding these organisations benefit from allows for the exchange of knowledge, expertise, and better collaboration on EGD-related topics between Ukrainian organisations and international organisations while increasing the capacities of Ukrainian NGOs to advance and support the green transition agenda in Ukraine.** For instance, DixiGroup and Resource Centre Society and Environment, together with a few other NGOs, produce the annual "Ukraine and European Green Deal Monitoring Report," which is invaluable in the context of lacking systematisation and cross-sectoral approach to EGD in Ukraine[294]. **Such reliance on donor funding is a strength but also a weakness for these organisations, as their activities are contingent on the availability of sustainable donor funding.**

When it comes to the private sector, **large businesses, such as DTEK, a major energy company, and Neo-Eco Ukraine, a waste management company, implement initiatives to support the greening of their relevant sectors of operation through investments into innovation, renewable energy projects, and development of waste management solutions.** In addition, several prominent business associations in Ukraine, such as the Association of Industrial Automation of Ukraine and Ukrainian Cluster Alliance, the Association of Manufacturers of Ukraine, and the Association of Start-ups, conducted ad hoc discussions at national and international levels on EGD-related topics, e.g., decarbonisation, energy efficiency, circular economy principles, etc. However, since the invasion and its significant negative effect on the economy, the main topics of discussions and capacity-building relate to building resilience in wartime, exporting under transport, tariff barriers and other constraints, **putting the EGD-related issues down in the list of priorities**. At the same time, as Ukraine advances in its EU integration, particularly Single Market requirements, EGD will become more pressing for understanding and operationalising on the side of the Ukrainian business. Engaging with the EU professional networks, such as the European Enterprise Network where Ukraine is a member, on issues such as EGD compliance could help better prepare Ukrainian businesses for EU integration and foster the green transition in Ukraine.

[294] Dixi Group and Resource and Analysis Centre "Society and Environment", 2024. Ukraine and European Green Deal monitoring report 2023

R&I in other EGD areas

While there is generally a growing understanding in the Government of the importance of innovation for resilience and economic recovery and development of Ukraine, **the R&I is not systematically reflected and consistently integrated into other sectoral strategies.** When reflected in the sectoral policy documentation, **the focus is often on the adoption of readily available technologies and technology upgrading with no mention of R&I**, reflecting the systemic underfunding and overall low innovativeness of the Ukrainian private sector.

In addition, the seven priority areas for R&I outlined in the legislation are overall aligned with EGD areas but the focus on green R&I across sectoral policies is currently lacking. While the role of R&I in achieving EGD is reflected in the recently adopted National Energy and Climate Plan, the R&I is largely missing from the Ukraine Facility Plan[295] – a key document outlining priority government actions until 2027 to be supported by the EU funds. There is a pressing need to streamline and prioritise R&I across the sectors of the economy to ensure the transition to a more "demand-driven" innovation system in Ukraine and to integrate more EDG focus to facilitate Ukraine's green transition.

Main priorities for the green transition

A focus on EGD-related areas such **as energy, industry and circularity, building and renovation, and zero pollution, in particular waste management**, would help to accelerate Ukraine's green transition while simultaneously responding to the country's most pressing challenges in the context of war and reconstruction.

First, the **energy sector** has been the most associated with the "green transition" in Ukraine, and important progress was achieved in enhancing energy efficiency and fostering renewable energy sources over the last decade[296]. The R&I in the energy sector contributes to meeting the objectives in several EGD areas, including climate, building and renovation, industry and circularity, and smart mobility, while also helping to achieve objectives set out in relevant national sectoral strategies, national development goals and hence could accelerate Ukraine's progress across at least five sectors. Furthermore, the sector's strong capabilities and revealed interest in investments in new technologies, such as hydrogen, biofuels, and RES, create a demand for R&I in energy with favourable conditions for fostering local R&I and strong potential contribution to energy sector transformation in line with EGD. The need for R&I in the energy sector that would advance reliance on renewable energy sources and de-centralised energy generation is further amplified by ongoing targeted military attacks on Ukraine's energy infrastructure.

Second, the R&I could support the **greening of industry and promotion of circular economy** to facilitate EU integration, in particular when it comes to compliance with EU's carbon border adjustment mechanism (CBAM). Furthermore, green technologies and circular economy principles can

[295] Government of Ukraine, 2024. 'Plan for Ukraine Facility 2024-2027'
[296] IKEM, 2023. Roadmap for a climate-neutral, sustainable Ukrainian energy sector and its role in an integrated EU energy market

help to decarbonize Ukrainian steel and cement industries, enhance industrial waste recycling and reduce waste generation. The pressing need to ensure the transformation of Ukrainian industry for it to remain competitive in the view of EU Single market integration and the availability of financing from local private sector and donors can facilitate the uptake of the R&I in the sector.

Next, **reducing pollution through waste management** is one of the major challenges for Ukraine, given the country's long-standing track record in landfilling (over 90% of household waste is landfilled, and industrial waste recycling was 3% in 2020)[297] and a significant amount of demolition waste due to war-related destructions and the scale of reconstruction ahead. R&I in waste recycling technologies should be accompanied by robust waste management policy implementation and can have a significant positive impact on Ukraine's GHG emissions reduction contributing to progress on Ukraine's commitment under the Paris Agreement.

Finally, given the level of destruction caused by the war and infrastructure reconstruction plans and outdated housing stock, **innovation in the building and renovation sector** is crucial to set Ukraine's reconstruction process and construction industry on a more sustainable path and contribute to achieving climate neutrality objectives[298]. The R&I in this sector could also help contribute to the social sustainability of infrastructure and just transition as housing and social infrastructure construction and renovation are in the focus of the Ukrainian government and donors' efforts in the context of the ongoing war. In addition, green infrastructure reconstruction has positive spillovers for preserving the ecosystem and reducing pollution – one of the areas of EGD of high importance for Ukraine.

[297] SEI GUMA, 2023. Thematic report on Industry and circularity in Ukraine
[298] World Bank, 2023. Ukraine - Third Rapid Damage and Needs Assessment (RDNA3)

ANNEX I.

Overview of current sources of revenue and direction of investments related to Green Transition in Ukraine

Sector/theme	Public/private	Revenue/funding source	Expenditure/investment
Climate change	Public sector	• General taxes, fees and fines (state / local budgets) • Specific taxes (environmental tax) • ODA (bilateral, multilateral) provided to government and SOEs (IBRD, EBRD, EIB, NEFCO, US, EU, KfW, GIZ, SIDA etc) • ITMO trade (Switzerland, Japan) • Sovereign and municipal green bonds (possible but not in use)	• State & local budget programmes • Energy Efficiency Fund of Ukraine • Decarbonisation Fund of Ukraine • Fiscal incentives (lower or zero rates for customs, VAT and other taxes and duties) directed at RES, energy efficiency and biofuels • Investments by SOEs
	PPP	*e.g., low carbon cement and green concrete production demonstration plant (Neo-Eco, Mission East with support from the Danida Green Business Partnerships)* [299]	
	Private sector	• Private profits and earnings • Borrowings (intra-corporate, from domestic banks, from multilateral banks and other financial institutions such as EBRD, NEFCO, IFC) • Equity (sale of shares) • Capital markets (issuing of thematic bonds, esp. green bonds)	• Payments of general and specific taxes, fees and fines • Investments into new production technologies, renewable energy, energy efficiency improvements
Circular economy / waste management	Public sector	• General taxes, fees and fines (state / local budgets) • ODA (bilateral, multilateral) provided to government and SOEs (GEF, UNIDO, UNECE, EU etc) • Waste management service fees • Sovereign and municipal green bonds (possible but not in use)	• State & local budget programmes • Investments by SOEs
	PPP	–	
	Private sector	• Private profits and earnings • Borrowings (intra-corporate, from domestic and multilateral banks, other financial institutions) • Equity (sale of shares) • Capital markets (issuing of thematic bonds, esp. green bonds)	• Payments of general and specific taxes, fees and fines • Investments into circular economy / waste management

[299] Danida Green Business Partnership, 2023. Circular Economy Demonstration of Low Carbon Cement and Green Concrete Production

Sector/theme	Public/private	Revenue/funding source	Expenditure/investment
Environment protection, including chemicals management	Public sector	• General taxes, fees and fines (state / local budgets) • Specific taxes (environmental tax) • ODA (bilateral, multilateral) provided to government and SOEs (GEF etc) • Sovereign and municipal green bonds (possible but not in use)	• State & local budget programmes • Investments by SOEs
	PPP	–	
	Private sector	• Private profits and earnings • Borrowings (intra-corporate, from domestic and multilateral banks, other financial institutions) • Equity (sale of shares) • Capital markets (issuing of thematic bonds, esp. green bonds)	• Payments of general and specific taxes, fees and fines • Investments into environmental protection
Nature and biodiversity	Public sector	• General taxes, fees and fines (state / local budgets) • ODA (bilateral, multilateral) provided to government (GEF, UNEP, UNDP, EBRD, EU, Germany, US, France, Sweden etc) • Tourism income (negligeable) • Funds from international charities (WWF, Frankfurt Zoological Society etc) • Sovereign and municipal green bonds (possible but not in use)	• State & local budget programmes
	PPP	*e.g., WWF Digital Platform for Ukrainian Forest Restoration (collaboration between WWF, private and public partners)*[300]	
	Private sector	• Private profits and earnings • Borrowings (intra-corporate, from domestic and multilateral banks, other financial institutions) • Equity (sale of shares) • Capital markets (issue of bonds, esp. green bonds)	• Payments of general taxes, fees and fines • Investments into biodiversity

[300] WWF CCE, 2024. Forests for the Future: WWF-Ukraine and SoftServe restore a hectare of forest in Lviv region in Ukraine

Sector/theme	Public/private	Revenue/funding source	Expenditure/investment
Energy and buildings	Public sector	• [see Climate change section above] • Funds from international charities (Greenpeace etc) • State-owned electricity TSO's income (transmission tariff and income from congestion management at electricity interconnectors)[301]	• [see Climate change section above]
	PPP	• *Feed-in tariff scheme* • *RES support (feed-in premia/contracts for difference) through tenders* • *New generation capacity support through tenders* • *Long-term contracts for energy storage capacity through tenders with Ukrenergo* • *Energy performance contracts for public buildings*	
	Private sector	• [see Climate change section above] • Income from the sale of guarantees of origin of renewable energy	• [see Climate change section above] • Investment into RES, energy efficiency improvements and energy storage • Investment into distributed energy generation (including fast-dispatchable gas-fuelled generation units)
Sustainable food systems	Public sector	• General taxes, fees and fines (state / local budgets) • ODA (bilateral, multilateral) provided to government and SOEs (IBRD, EBRD, GEF, FAO, EU, US, UK, Switzerland etc) • Sovereign and municipal green bonds (possible but not in use)	• State & local budget programmes • Ukrainian State Fund for Support to Farmers[302] • Fund for Partial Guarantees in the Agricultural Sector[303] • Investments by SOEs
	PPP	–	
	Private sector	• Private profits and earnings • Borrowings (intra-corporate, from domestic and multilateral banks, other financial institutions) • Equity (sale of shares) • Public subsidies • MIGA-backed insurance[304] • International charities (Mercy Corps etc.) • Capital markets (issuing of thematic bonds, esp. green bonds)	• Payments of general taxes, fees and fines • Investments into sustainable food systems

[301] Currently, the electricity TSO of Ukraine (Ukrenergo) is required to procure services related to the increase of electricity from RES. The payment for these services is included into its transmission tariff. However, the accumulating debts of Ukrenergo to such service providers signifies the insufficient level of tariff for these purposes. Provisionally, Ukrenergo can use proceeds from congestion management at interconnection points with other systems to repay such debts.

[302] Ukrainian State Fund for Supporting Farmers

[303] Ukrainian Fund for the Agriculture Credit Guarantees

[304] World Bank Group, 2024. MIGA's Ukraine Response

Sector/theme	Public/private	Revenue/funding source	Expenditure/investment
Urban planning and smart mobility	Public sector	• General taxes, fees and fines (state / local budgets) • Fuel excise duty • ODA (bilateral, multilateral) provided to government and SOEs (IBRD, EBRD, EIB, EU, UK etc) • Sovereign and municipal green bonds (possible but not in use)	• State and local budget programmes • Fiscal incentives (zero or lower rates for customs, VAT and excise duties) directed at low-carbon transport fuels, vehicles and infrastructure • Investments by SOEs
	PPP	*e.g., concessions for the Kherson and Olvia ports (granted before 2022)*	
	Private sector	• Private profits and earnings • Borrowings (intra-corporate, from domestic banks, from multilateral banks and other financial institutions such as EBRD, IFC) • Equity (sale of shares) • MIGA-backed insurance • Capital markets (issuing of thematic bonds, esp. green bonds)	• Payments of general and specific taxes, fees and fines • Investments into transport and infrastructure repairs and upgrade, sustainable vehicles and charging infrastructure
Digitalization	Public sector	• General taxes, fees and fines (state / local budgets) • ODA (bilateral, multilateral) provided to government and SOEs • Sovereign and municipal green bonds (possible but not in use)	• State and local budget programmes • Ukrainian Startup Fund[305] • Fiscal incentives (special regulatory and tax regime of Diia.City, tax subsidies for industrial parks) • Investments by SOEs
	PPP	–	
	Private sector	• Private profits and earnings • Borrowings (intra-corporate, from domestic and multilateral banks, other financial institutions) • Equity (sale of shares, esp. venture capital) • Capital markets (issuing of thematic bonds, esp. green bonds if related to projects of environmental direction)	• Payments of general taxes, fees and fines • Investments into digitalisation

[305] Ukrainian Startup Fund

Sector/theme	Public/private	Revenue/funding source	Expenditure/investment
Research and Innovation	Public sector	• General taxes, fees and fines (state / local budgets) • ODA (bilateral, multilateral) provided to government and SOEs (e.g., Horizon Europe) • Sovereign and municipal green bonds (possible but not in use)	• State and local budget programmes • National Research Fund • Ukrainian Startup Fund • State Innovation Financial and Credit Institution[306] • Fiscal incentives (special regulatory and tax regime of Diia.City, tax subsidies for industrial parks) • Investments by SOEs
	PPP	–	
	Private sector and civil society	• Private profits and earnings • Grants (e.g., EBRD, USAID, European Innovation Council, Horizon Europe) • Borrowings (intra-corporate, from domestic and multilateral banks, other financial institutions) • Equity (sale of shares, esp. venture capital) • Capital markets (issuing of thematic bonds, esp. green bonds if related to projects of environmental direction)	• Payments of general taxes, fees and fines • Investments into R&D

[306] State Innovation Financial Credit Institution

ANNEX II.

Qualitative impact assessment of omitted polices on green transition finance

The assessment in the previous section has revealed several policies that are essential to facilitate Green Transition finance. This section briefly describes in a qualitative way the expected impacts of certain policy omission (not introducing selected policies) in the short-term and medium-term perspective. It provides a rational for the relevance of institutional development in Ukraine and informs the formation of recommendations to be integrated into a green transition roadmap (GUMA work package 2).

Policy measure	Affected sectors / themes (*)	Qualitative impact assessment of policy gaps
Adoption of the Ukrainian taxonomy of sustainable activities in line with the EU Taxonomy	(1)-(9)	The taxonomy of sustainable activities is the alphabet of Sustainable Finance. Without its mandatory application, financial flows are deprived of a clear direction, green-washing risks augment and there could be limited expectations of the positive impact of such financial flows onto actual ESG factors. This, in turn, can circumvent the international commitments of Ukraine under international environmental agreements as well as in relations with the EU. The absence of a sustainable taxonomy in Ukraine which is, per the EU model, based on technical criteria creates the need to link evolving Sustainable Finance instruments (such as green bonds) to other, voluntary standards (e.g., ICMA or CBI). This creates a missed opportunity for the market to practice the application of EU rules, develop necessary supporting infrastructures within the country and create a genuine link between finance and actual improvements on ESG factors. The EU Taxonomy contains several important aspects: quantifiable criteria for environmental sustainability, the DNSH principle as well as social safeguards. Before acceding to the EU, Ukraine can avail itself of the possibility to expand these with wider social and governance factors to better match the needs of its society. In any event, the EU Taxonomy provides a practical starting point for non-EU countries. For practical reasons, the Climate and the Environmental Delegated Acts can and should be transposed alongside the EU Taxonomy. At the same time, the Disclosures Delegated Act relies on the scope of non-financial information disclosure / sustainable reporting obligations as applied to financial and non-financial undertakings; thus, for practical reasons it should be transposed in consonance with the establishment of clear corporate sustainability reporting obligations.
Implementation of key elements of the EU Sustainable Finance Governance Framework (other than the EU Taxonomy)	(1)-(9)	Sustainability reporting by companies feeds information into the rest of the financial services sector and thus allows to implement other elements of the Sustainable Finance Governance Framework. In Ukraine, several requirements are already in place which reflect the EU sustainability reporting. What is needed is the standardisation of such reporting which can be achieved in a relatively cost-effective manner (i.e. to avoid excessive burden on companies). If the coverage or the standards for such reporting diverge significantly from the EU rules, this will create a missed opportunity to test the rules as well as to develop local supporting infrastructure which can in the future compete on the EU market. Domestic institutions most active in terms of ESG (such as NBU) currently tend to concentrate on integrating ESG risks into the risk management of financial institu-

		tions. This is an important step; however, its impact is commensurate with the level of risks characteristic to Ukraine (especially climate risks). At the same time, much could be lost if regulation is foregone which streams more finance into trusted sustainable activities. Due to current stringent currency control rules in Ukraine, there are financial resources inside the country which can be mobilised and at least partially directed towards sustainable activities. The reputation of green (e.g., renewable energy, energy efficiency, energy storage) investing is on the rise (as proven by a recent case of Inzhur Energy[307]). Sustainable product governance may be one example of such regulation as it could serve to build trust and prevent fraud and greenwashing among investors. Development of the local bonds market outside of the EU Green Bond standards risks creating regulatory fragmentation and missing opportunities as Ukrainian companies wishing to place their bonds on EU trading venues will still be required to apply the EU Green Bond rules (rather than ICMA or CBI standards).
Policy measure	**Affected sectors / themes (*)**	**Qualitative impact assessment of policy gaps**
Establishment of an ETS based on the EU model	(1)-(3), (5)-(7)	The cap-and-trade system represented by an EU-model ETS is an instrument to ensure compliance of Ukraine with its international commitments and to achieve that in a cost-efficient manner. The current environmental tax does not effectively curb emissions but rather provides unlimited emission allowance. In addition, the tax rate itself and the associated rate revenues are low. This means that while Ukraine undertakes strenuous commitments related to climate change abatement, the government has limited tools to meet them from a regulatory perspective. Curbing these emissions becomes particularly topical considering that as part of the reconstruction and recovery GHG emissions are expected to rise. In the absence of an ETS with a sufficiently comprehensive coverage, the government may be inclined to use corporate control over SOEs to achieve emission reductions. This practice would distort the level-playing field between private and public companies. Increasing the environmental tax and then reallocating the collected revenues to decarbonisation activities could have at least two negative consequences: first, given the ongoing war and a complex geopolitical environment, tax revenues would be diverted to other needs; second, even where not diverted, the disbursement of significant funds could surpass the operational capacity of existing public institutions (e.g., Energy Efficiency Fund, Decarbonisation Fund) to disburse finance. In addition, the establishment of an ETS is part of the available alternatives for Ukraine not to be subject to EU's CBAM. According to available estimates, CBAM-covered exports from Ukraine to the EU will amount to 2.4% of the Ukrainian GDP. [308]

[307] Inzhur Energy Fund

[308] Geoffrey Keim and Mariia Sydorovych, Policies to Address Climate Change, Ukraine, (2024). IMF Selected Issues Paper (SIP/2024/001). Washington, DC: International Monetary Fund, p.8

Policy measure	Affected sectors / themes (*)	Qualitative impact assessment of policy gaps
Establishing a robust and comprehensive PIM system with ESG factors properly integrated	(1)-(9)	The Public Investment Management Diagnostic Assessment finalised by the World Bank in 2023 concluded that in Ukraine "clear roles and responsibilities exist in PIM, but institutional arrangements open up a "bypass" route that allows state budget funded investments to legitimately circumvent the PIM procedures"; this "allows for established procedures to be circumvented in many investment projects"; "no organization is performing the "gatekeeper" role to prevent projects that have not been positively appraised from getting funding" and, on top of that, "[d]ifferent PIM streams exist with their own specific procedures: (1) direct budget financing (state capital investments); (2) state budget support (state guarantees, budget lending); (3) PPPs; and (4) corporate sector investments (SOEs' investments of own funds)".[309] To address these shortcomings and as part of cooperation with the IMF, CMU adopted a Roadmap in 2023 and an Action Plan in mid-2024. These are being implemented as part of IMF structural benchmarks,[310] which means that the reversal of the reform would cause issues in IMF cooperation. In addition, the PIM reform is engrained in the Ukraine Plan which seeks to make sure that no project would receive budget funding without previously being assessed and selected according to the established PIM procedures. According to the European Commission, "planning capacity [should be improved] to ensure the development of a strategic vision for Ukraine's economic recovery and reconstruction" which "will help to inform the development of strategic plans and documents defined in the PIM action plan and guide the prioritisation of projects in sectoral pipelines and the Single Project Pipeline". Apart from improved strategic planning, the new PIM system would allow for the proper monitoring and audit of public spending, including from the EU side. Overall, the PIM system is key to the delivery of funds from the Ukraine Facility. The connection with the Ukraine Facility provides a good opportunity to integrate ESG factors and the DNSH principle in the new PIM system's architecture. The latter principle is explicitly promoted by the Ukraine Facility Regulation.[311] At the same time, while the Ukraine Plan contains numerous references to this principle, it often takes its application for granted (e.g., due to the nature of certain economic activities such as renewable energy or energy efficiency) whereas in reality its implementation critically depends on how it is operationalised in the policy design, project selection, monitoring and control procedures. Without such an integration, the new PIM system will miss out on an important dimension of the European Green Deal.

(1) climate change, (2) circular economy and waste management, (3) environment protection, (4) nature and biodiversity, (5) energy and buildings, (6) sustainable food systems, (7) urban planning and smart mobility, (8) digitalization, (9) research and innovation, (10) disaster risk management

[309] World Bank Group, 2022. Ukraine: Public Investment Management Diagnostic Assessment Report

[310] IMF, 2024. Sixth Review Under the Extended Arrangement Under the Extended Fund Facility, Requests for Modification of a Performance Criterion, and Financing Assurances Review—Press Release; Staff Report; and Statement by the Alternate executive Director for Ukraine

[311] Regulation (EU) 2024/792 of the European Parliament and of the Council of 29 February 2024 establishing the Ukraine Facility, preamble para (30)

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