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TOWARDS A CIRCULAR AND SUSTAINABLE UKRAINE: LIFE CYCLE ASSESSMENT PROGRESS IN POLICY, TECHNOLOGY, AND ACADEMIA

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Abstract

This paper presents an overview of the rapid development of Life Cycle Assessment (LCA) in Ukraine as of 2025. It outlines how regulatory reforms, EU integration, post-war reconstruction, and academic efforts have accelerated the adoption of LCA in national policy, technology, and practice. Key milestones include the adoption of ISO standards, integration of LCA in public procurement and building codes, and creation of data infrastructure and expert capacity. Ukraine's journey toward sustainability is supported by LCA as a guiding methodology for green growth, emissions reduction, and circular economy development.

Key words: *Life Cycle Assessment (LCA), Sustainability Policy, Post-war Reconstruction, Ukraine, Environmental Regulation.*

Introduction

Life cycle assessment (LCA) has become a central tool for assessing the environmental impacts of products and processes, quantifying inputs, outputs and emissions at all life cycle stages to support sustainable development decision-making. Ukraine's post-war reconstruction following the unprovoked Russian invasion in 2022 highlights the importance of rebuilding infrastructure and the economy with sustainability in mind. This situation provides a strong impetus for introducing life cycle thinking into national planning. This article reviews the development of LCA in Ukraine as of spring 2025, focusing on the evolution of regulatory and policy frameworks, technological and practical innovations, academic contributions and capacity building. Particular attention is paid to convergence with European Union (EU) environmental standards and how LCA supports Ukraine's EU alignment and sustainable development goals. Key milestones are highlighted, such as new legislation on green public procurement and waste management, integrating LCA into construction and production standards, and creating LCA infrastructure. The context of Ukraine's post-war reconstruction is intertwined throughout, where the principle of "rebuild better" drives reconstruction projects to improve environmental performance and sustainability. LCA is presented as a framework that ensures long-term sustainability in the choice of reconstruction, aligning it with Ukraine's climate commitments and the EU Green Deal. Ukraine's status shapes the current development trajectory as an EU candidate country, which is driving reforms and the integration of LCA and life cycle into

policy, industry, and academia. The following sections review the political context, technological implementation, academic potential, and future challenges and prospects.

Regulatory and Policy Frameworks for LCA in Ukraine

Since the mid-2010s, Ukraine's environmental governance has undergone rapid modernization, reflecting both internal policy reforms and external alignment with the EU. A turning point occurred in 2014 with the EU-Ukraine Association Agreement, which committed Ukraine to harmonize environmental standards with EU directives [1]. This commitment initiated a sequence of reforms providing the foundation for LCA uptake.

Green Public Procurement (GPP)

Public procurement served as an early vector for life-cycle criteria. The Law of Ukraine "On Public Procurement," last updated in 2019, introduced provisions for incorporating environmental criteria into technical specifications [2]. Article 22 mandates the inclusion of energy efficiency, waste reduction, and lower greenhouse gas (GHG) emissions. This reform, in line with the EU Association Agreement, introduced life-cycle cost assessment into tenders, indirectly promoting LCA by evaluating not only upfront price but also environmental impacts. As a result, government procurement can favour products with eco-labels or superior environmental performance, encouraging suppliers to conduct LCAs to compete. Early examples include requirements for Type I eco-label certification for computers, which led to procurement of energy-efficient, low-toxicity products at no additional cost [3].

National Environmental Strategies and EU Alignment

The "Basic Principles of State Environmental Policy of Ukraine until 2030," adopted in 2019, and the National Action Plan for Environmental Protection 2021–2025, explicitly prioritize resource efficiency, recycling, and the use of lifecycle-based indicators [4]. These strategies lay the groundwork for broader LCA adoption and reinforce convergence with the EU Green Deal, which uses LCA as a foundation for product and climate policy. Ukraine's observer status in the European Green Deal, and participation in related platforms, signal intent to adopt LCA-based approaches.

Waste Management and Circular Economy Legislation

The Law "On Waste Management" (No. 2320-IX, June 2022) [5] represents a major advance, aligning Ukraine with EU Directive 2008/98/EC [6]. The law introduces the EU waste hierarchy and Extended Producer Responsibility (EPR), obliging producers to address the full life cycle of products and packaging. This shift effectively mandates lifecycle considerations, requiring companies to design for recyclability and recovery. Technical regulations on waste sorting and packaging have been updated accordingly. These reforms drive LCA use for identifying optimal waste management options and developing eco-design strategies, supporting significant increases in recycling rates and reductions in landfilling.

Integration of LCA in Construction Standards

The State Standard DSTU 9171:2021 "Guidelines for ensuring the balanced use of natural resources in the design of structures" (effective 2022) aligns with EU sustainable construction principles and requires at least 70% of materials in a building project to be recyclable or reusable. The standard introduces methods of economic and environmental LCA for buildings, requiring simplified LCA at the preliminary design stage and full LCA at detailed design. These requirements have been integrated into the building code, obliging architects and engineers to consider lifecycle carbon and energy footprints during design. This approach brings Ukraine in line with EU practices and ensures that post-war reconstruction incorporates sustainability from the outset.

Product Environmental Footprint (PEF) and Eco-Labelling

Steps have been taken to adopt the EU's Product Environmental Footprint methodology, an LCA-based approach for product environmental performance across 16 impact categories. Supported by the EU4Environment program, a PEF pilot initiative has prepared Ukrainian industries for the Single Market for Green Products [7]. A legal framework regulates environmental claims, prohibiting misuse of "eco," "bio," and "organic" labels without certification, and has harmonized many ISO 14020-series standards. While PEF is not yet mandatory, Ukrainian exporters face requirements to report product carbon footprints under measures such as the EU Carbon Border Adjustment Mechanism (CBAM), driving the adoption of LCA methodologies in industry [8].

Integration of ISO Life Cycle Assessment Standards

Since 2014, Ukraine's national standards body has systematically adopted ISO LCA standards, including ISO 14040:2006 (Principles and Framework) and ISO 14044:2006 (Requirements and Guidelines) as national DSTU ISO standards. Supplementary guidelines such as DSTU ISO/TR 14047:2016 and DSTU ISO/TR 14049:2016 support practical implementation, while DSTU ISO/TS 14071:2018 clarifies critical review processes. Standards for EPDs (DSTU EN ISO 14025:2022), water footprint (DSTU ISO 14046:2018), and organizational carbon accounting (DSTU ISO 14064 series) have also been adopted. The adoption of these standards supports compliance with EU Green Deal requirements and enhances the credibility of environmental claims, underpinning Ukraine's sustainability strategy.

Technological Innovations and Implementation

Robust LCA practice depends on the availability of data and analytical tools. In Ukraine, recent technological advances and support mechanisms are making LCA more accessible.

Software and Data Infrastructure

Following the war, a support program by One Click LCA in 2024 made advanced building LCA software freely available for reconstruction projects, removing financial barriers to LCA tool access [9]. This enables project teams to assess the life-cycle impacts of materials and designs for schools, hospitals, housing, and infrastructure. Material-specific environmental profiles allow comparison of design alternatives, supporting implementation of new standards such as DSTU 9171. Broader use of these tools is expected to seed longer-term adoption of LCA software in Ukraine's construction sector and beyond.

Innovative Analytical Approaches

Ukrainian researchers are adopting advanced methods such as hybrid LCA (combining process and input-output data) and applying artificial intelligence (AI) for scenario modelling. For example, hybrid LCA applied to the water sector identified major contributors to environmental impacts, providing actionable insights for policy and infrastructure upgrades [10].

Training and Knowledge Transfer

Training workshops under EU4Environment and UNIDO have equipped Ukrainian specialists with skills in LCA and PEF, using both international and Ukrainian-language materials [11][12]. Academic centres, such as the LCA Hub at Sumy State University, develop and disseminate algorithms, models, and training materials, ensuring technological advances are effectively adopted [13]. Ukraine is rapidly acquiring the technological means, software, databases, analytical techniques to support mainstream LCA practice.

Academic Contributions and Capacity Building

The development of LCA in Ukraine is underpinned by a growing academic and research base.

Centres of Excellence

The establishment of specialized research centres, notably the LCA Hub at Sumy State University, has provided a focal point for LCA problem-solving, research, and capacity building. The Hub's interdisciplinary team addresses practical issues in LCA, supports businesses and government with sustainability analysis, and promotes life-cycle thinking in education and policy. Fundamental research includes bibliometric studies, sectoral LCA applications, and analyses of carbon management and circular economy policy [14].

Research and Knowledge Dissemination

Academic studies in Ukraine have analysed the evolution and current state of LCA, with conclusions that the field remains in an "awareness-raising" phase but is advancing through increased recognition, standardization, and dissemination. Academic recommendations include strengthening knowledge exchange, creating specialized platforms, and integrating LCA into business and government decision-making.

International Collaboration

Ukrainian universities and experts participate in EU-funded projects (Horizon Europe, Erasmus+) focusing on sustainability and circular economy, often including LCA components. Joint research with European partners addresses barriers to the circular economy and links LCA findings to policy recommendations [15]. International collaborations integrate Ukraine's academic community with the global LCA network.

Education and Training

LCA has been incorporated into environmental science and engineering curricula at Ukrainian universities, and short courses and workshops, often supported by international organizations, broaden practical knowledge. The publication of Ukrainian-language LCA textbooks and courses has lowered language barriers and improved training for students and professionals.

NGOs and Professional Communities

NGOs such as "Living Planet" [16] and the Resource Efficient and Cleaner Production Centre (RECP Centre) [10] have played roles in certification, awareness-raising, and introduction of life-cycle thinking in industry. Partnerships between academia and these groups reinforce the practical application of LCA concepts.

LCA, EU Integration, and Sustainable Reconstruction

Ukraine's path toward EU integration and post-war recovery provides both a challenge and an opportunity for mainstreaming LCA. EU candidate status accelerates the adoption of environmental acquis, making life-cycle perspectives central to product, construction, and industrial policy. Implementation of an Emissions Trading System (ETS), convergence with EU regulations on product footprinting, and participation in initiatives such as PEF pilots and EPDs are moving Ukraine toward EU standards. These changes require robust LCA capacity, standardized methodologies, and the establishment of verification bodies for LCA-based declarations.

Reconstruction efforts are guided by the principle of "green recovery," emphasizing modern, efficient, and low-carbon solutions. LCA serves as the analytical tool for optimizing design choices—comparing materials, energy options, and waste strategies to avoid locking in unsustainable practices. Reconstruction funding by international partners increasingly requires demonstration of sustainability, including LCA-based criteria for infrastructure and building projects.

Life-cycle thinking supports Ukraine's commitments under the Paris Agreement and the UN Sustainable Development Goals, ensuring that progress on reconstruction and EU integration delivers

measurable environmental benefits. LCA guides circular economy strategies and identifies priority investments in cleaner technologies and materials.

Challenges and Future Directions

Despite rapid progress, challenges remain. Data quality and availability continue to limit comprehensive LCA, especially in sectors without prior experience. Capacity is concentrated among a small group of experts. The following steps are proposed:

- Enhancing knowledge exchange through networks and annual conferences for LCA practitioners.
- Developing specialized platforms and guidance for businesses and policymakers, including repositories of emission factors and case studies.
- Integrating LCA into business and government decision-making via pilot projects and outreach.
- Strengthening the academic-policy interface by involving researchers in drafting sectoral methodologies and standards.
- Securing funding and international support for LCA capacity building in reconstruction and EU alignment programs.

The continuation and expansion of these efforts will determine the pace at which LCA becomes a standard component of policy and industry in Ukraine.

Conclusion

The development of LCA in Ukraine has reached a critical juncture, catalysed by the combined needs of post-war reconstruction and EU integration. Policy frameworks, technological capacity, and academic expertise have advanced rapidly, compressing a developmental trajectory that elsewhere unfolded over decades. LCA now supports procurement, construction, waste management, and export policy, and is being integrated into educational and research programs. The coming years will require continued capacity building, collaboration, and political support to fully institutionalize LCA in decision-making. With sustained effort, Ukraine is poised to become a regional leader in life-cycle thinking and a model for sustainable reconstruction and green growth.

References

1. European Union. (2014). *Association Agreement between the European Union and Ukraine* (CELEX: 22014A0529(01)). Retrieved October 26, 2025, from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A22014A0529%2801%29
2. Verkhovna Rada of Ukraine. (n.d.). *Law of Ukraine "On Public Procurement" (No. 922-VIII).* Retrieved October 26, 2025, from https://zakon.rada.gov.ua/laws/show/922-19#Text
3. Ministry of Environmental Protection and Natural Resources of Ukraine. (n.d.). *Eco-labelling and public procurement.* Retrieved October 26, 2025, from https://mepr.gov.ua/en/biznesu/ekologichne-markuvannya/ekologichne-markuvannya-ta-publichni-zakupivli/
4. Verkhovna Rada of Ukraine. (n.d.). *Law of Ukraine "On Information for Consumers on Food Products" (No. 2639-VIII).* Retrieved October 26, 2025, from https://zakon.rada.gov.ua/laws/show/2697-19#Text
5. Verkhovna Rada of Ukraine. (n.d.). *Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine on Improving Waste Management" (No. 2320-IX).* Retrieved October 26, 2025, from https://zakon.rada.gov.ua/laws/show/2320-20#Text

6. European Parliament and Council. (2008). *Directive 2008/98/EC on waste (Waste Framework Directive)* (CELEX: 32008L0098). Retrieved October 26, 2025, from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098

7. EU4Environment. (2024). *Product Environmental Footprint (PEF) Executive Report – Ukraine.* Retrieved October 26, 2025, from https://www.eu4environment.org/app/uploads/2024/09/PEF-Executive-Report-Ukraine.pdf

8. Green Deal Ukraine. (n.d.). *CBAM report.* Retrieved October 26, 2025, from https://greendealukraina.org/assets/images/reports/cbam.pdf

9. One Click LCA. (n.d.). *Stand with Ukraine: Ukrainian Reconstruction Projects.* Retrieved October 26, 2025, from https://oneclicklca.zendesk.com/hc/en-us/articles/11510273345180-Stand-with-Ukraine-Ukrainian-Reconstruction-Projects

10. Afifi, A. S., & Kim, A. S. (2025). A 21-Year study of virtual water trade in Ukraine's agricultural sector: Crop production and water use. *Water, 17*(8), 1231.

11. United Nations Economic Commission for Europe (UNECE). (n.d.). *Second training workshop on current issues in the SEA procedure in Ukraine: Practical aspects.* Retrieved October 26, 2025, from https://unece.org/environmental-policy/events/second-training-workshop-current-issues-sea-procedure-ukraine-practical

12. Sumy State University, BIEM Institute. (n.d.). *SumDU and RTU collaborate on virtual academic mobility program.* Retrieved October 26, 2025, from https://econ.biem.sumdu.edu.ua/en/sumdu-and-rtu-collaborate-on-virtual-academic-mobility-program

13. Sumy State University, BIEM Institute. (n.d.). *LCA Hub – Laboratory of Socio-Economic Systems Life-Cycle Assessment.* Retrieved October 26, 2025, from https://econ.biem.sumdu.edu.ua/en/lca-hub-laboratory-of-socio-economic-systems-life-cycle-assessment

14. Global Ecolabelling Network. (n.d.). *Green Crane (Ukraine).* Retrieved October 26, 2025, from https://globalecolabelling.net/organisation/green-crane/

НА ШЛЯХУ ДО ЦИРКУЛЯРНОЇ ТА СТАЛОЇ УКРАЇНИ: ПРОГРЕС В ОЦІНЦІ ЖИТТЄВОГО ЦИКЛУ В ПОЛІТИЦІ, ТЕХНОЛОГІЯХ ТА НАУЦІ

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Анотація

У статті подано огляд динамічного розвитку оцінювання життєвого циклу (ОЖЦ, LCA) в Україні станом на 2025 рік. Показано, як регуляторні реформи, інтеграція з ЄС, післявоєнна відбудова та зусилля академічної спільноти прискорили запровадження ОЖЦ у національну політику, технології та практику. До ключових віх віднесено прийняття стандартів ISO, інтеграцію ОЖЦ у систему публічних закупівель і будівельні норми, а також формування інфраструктури даних і експертного потенціалу. Рух України до сталого розвитку підтримується ОЖЦ як провідною методологією для забезпечення «зеленого» зростання, скорочення викидів і розвитку циркулярної економіки.

Ключові слова: оцінка життєвого циклу (LCA), політика сталого розвитку, повоєнне відновлення, Україна, екологічне регулювання.