Composting in cities as a way to reduce greenhouse gas emissions

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photo by Nadiya Kuhuk

Urban waste and climate change

Waste is a significant source of greenhouse gas emissions, particularly methane, especially in cities where energy sector alone is causing greater volumes of emissions. However, technologies already exist now that can reduce most methane emissions from waste management in a cost-effective manner[1].

> **Methane has a strong greenhouse effect – ten times greater than that of carbon dioxide – and its concentration in the atmosphere continues to grow. .**

In addition, methane has a relatively short life cycle in the atmosphere, so a rapid reduction in its emissions can rapidly reduce the impact of this greenhouse gas on climate change[2].

In 2021, the Global Methane Pledge was launched, which Ukraine also joined, and its aim is

> **to reduce methane emissions by 30% by 2030 compared to 2020[3].**

Achieving this goal requires a significant reduction in methane emissions from all major sources, including methane emissions from waste management, which account for about 20% of global greenhouse gas emissions.

At the same time, the amount of waste generated in cities will increase significantly by the middle of the century, so there is a risk of further growth in emissions.

> **Considering this, and given the key role of cities in waste management, it is important for cities to develop strategies to reduce emissions from waste management and develop a relevant infrastructure..**

Improved waste management systems will also increase the efficiency of material and energy use and reduce air pollution. Collaboration with communities and other stakeholders will help achieve these benefits not only in cities but also beyond, for example, by reducing the amount of waste in landfills and improving soil quality after compost is used as a fertilizer. In addition, improved waste management practices can create additional sources of revenue for cities, including by incorporating the informal sector into the urban economy, selling new products, and reducing costs.

Avoiding the production of organic waste through changes in eating habits, better planning, food leftovers distribution programs and other measures is the best way to reduce methane emissions. At the same time, for waste that has already been generated, composting can significantly reduce greenhouse gas emissions and create additional benefits for city residents.

Composting station in Lviv

In 2020, a composting station for organic waste was opened in Lviv, which reduced the amount of waste taken to landfills and dumps by thousands of tons per year. The station accepts food waste, green waste from city parks and Christmas trees after the New Year holidays. Waste is collected using special containers located in all districts of the city, from food outlets and other commercial facilities, and is also accepted directly at the station. In 2021, the composting station accepted 7,464 tons of organic waste.

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Once organic waste is received, it is sent to temporary storage sites where gardening waste (branches and most parts of trees) is shredded and organic waste from households is further sorted,

> **about 10% of the waste collected from households is not organic and is removed.**

photo by Nadiya Kuhuk

From the temporary storage sites, the prepared waste is sent to compost production in the ratio of about 60% food waste and 40% garden waste (grass, leaves, Christmas trees and branches depending on the season). As more garden and park waste is received, some of it is accumulated at the storage sites.

> **In 2021, 431 tons of compost were produced.**

The compost is additionally sieved to remove any impurities that have not been removed during previous stages. In general, about 300 kg of compost can be produced from 1,000 kg of prepared waste (shredded and cleaned of non-organic impurities).

Initial costs for the launch of the composting station amounted to 26.8 million UAH (about 1.1 million USD)[4], but additional significant investments were made in the years following the launch. At the same time,

> **the composting station allows the city to reduce the cost of solid waste removal and disposal (1,024 UAH per ton in 2020), as well as generate additional revenue from the sale of compost (309-840 UAH per ton in 2021).**

The Sustainable Energy and Climate Action Plan of Lviv City Territorial Community until 2030 envisions further development of the organic waste composting system as part of the separate waste collection and reusage.

Improving the waste management system will have an impact on increasing resilience to climate change, but will also help reduce greenhouse gas emissions.

The Green City Lviv Action Plan for 2020-2035 also envisions the development of an organic waste composting system and the construction of two composting plants

> **that will allow for the processing of 25% of the collected organic waste. The total composting capacity of organic waste could reach 35,000 tons per year.**

The required investment is estimated at 2-3 million euros[5].

photo by Andriana Syvanych

Reduction of greenhouse gas emissions

photo by Nadiya Kuhuk

Composting can significantly reduce greenhouse gas emissions by reducing the amount of organic waste that ends up in landfills and decomposes there to produce methane. Composting also produces methane and nitrogen oxide emissions, but in much smaller quantities than decomposition without access to oxygen in landfills[6]. The composting process also releases carbon dioxide, which is of biogenic origin and therefore is not taken into account in the calculation of greenhouse gas emission reductions.

> **The organic waste composting station in Lviv will be able to reduce the amount of waste sent to landfills by almost 266,000 tons over twenty years of its operation and reduce greenhouse gas emissions by 77,400 tons of CO_2 equivalent.**

This forecast assumes a rapid increase in composting volumes to 14,800 tons of organic waste per year and maintaining this level over the coming years.

The positive impact of composting organic waste increases over time, as emissions from the decomposition of waste in a landfill would occur gradually. The organic waste that went to the composting station in 2020 would have been emitting methane to landfill for decades in the absence of the composting station.

Approach to calculating reductions of greenhouse gas emissions

Emission reductions due to composting of organic waste in Lviv were estimated using international methodologies by comparing emissions in the baseline scenario and in the scenario of construction and use of a composting station.

In the baseline scenario, organic waste is sent to a landfill, where it gradually decomposes under anaerobic conditions to produce methane. The annual methane generation potential is calculated according to a first-order decomposition model. For the purposes of the calculations, it is assumed that anaerobic decomposition begins at the beginning of the year following the year of waste disposal. The calculation results are presented for a period of 20 years.

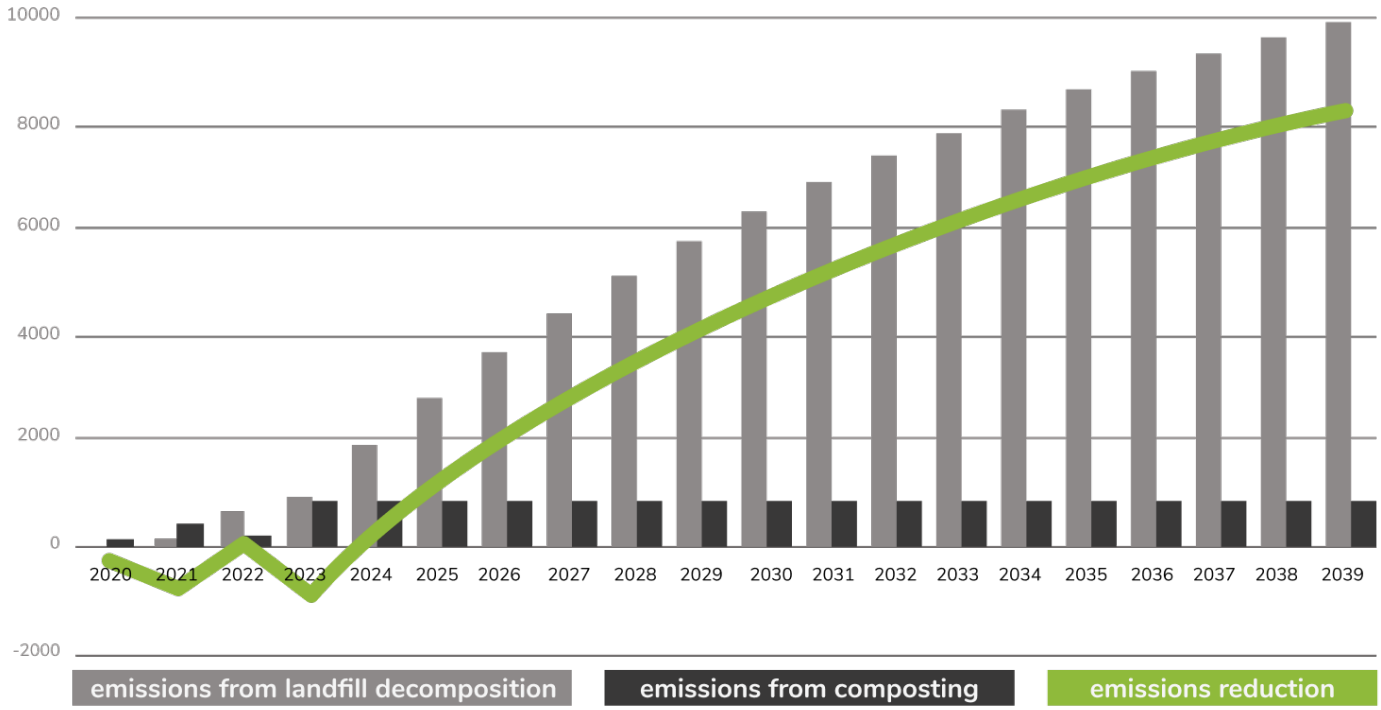
In the project scenario, compost is produced and applied to the soil as an organic fertilizer. Emissions of methane (CH_4) and nitrogen oxide (N_2O) generated during composting, as well as emissions associated with the consumption of electricity and fuel to operate the composting plant are taken into account.

The emissions associated with the transportation of waste to landfill are considered equal to the emissions associated with the transportation of waste to the composting plant and the transportation of compost to the place of use.

On average, each ton of organic waste sent to a composting station reduces greenhouse gas emissions by almost 300 kg of CO_2 equivalent over a 20-year period.

The compost produced from separately collected organic waste is of high quality and can be used as organic fertilizer on agricultural fields or private plots (about 10-15 tons per hectare). Most of the carbon in organic waste is released as carbon dioxide or methane during composting. However, the carbon that remains is in a stable state and forms soil organic matter when applied to the soil.

Reduction of greenhouse gas emissions due to composting of organic waste in Lviv, tons of CO_2 equivalent



Carbon, which makes up about half of the total wight of compost, contributes to the accumulation of organic carbon in the soil, which increases crop yields and resilience to climate change through better moisture storage and retention. However, carbon accumulation in soils depends on many factors, including compost characteristics, volume and duration of its application, climatic conditions, soil quality, agricultural practices of fertilization, crop rotation, ploughing, use of cover crops, etc. As a result, it is difficult to quantify the impact of compost use without reference to specific conditions and detailed analysis, but scientific research confirms an increase in the organic carbon content of soils with long-term compost use. According to rough estimates,

> **each ton of compost added to the soil can sequester about 60-80 kg of carbon or 215-290 kg of CO_2 equivalent.**

In addition, compost contains nitrogen (about 1-2% by weight), so it can, to some extent, replace the use of mineral nitrogen fertilizers, the production of which is associated with significant greenhouse gas emissions. The impact of this potential substitution on the overall emissions reduction due to the introduction of organic waste composting is insignificant.

The role of cities in climate policy through the example of waste composting

Cities are generally limited in implementing climate policy due to the division of powers between national and local governments. Nevertheless, cities have many opportunities to combat climate change, including by improving waste management and developing organic waste composting infrastructure, both through existing mechanisms and by creating new opportunities in cooperation with national authorities and international partners.

Opportunities for cities to reduce greenhouse gas emissions from waste management and develop organic waste composting include the following:

- Considering the potential for reducing greenhouse gas emissions through waste composting in strategic documents at the local level (e.g. sustainable energy and climate plans, environmental protection programs, etc.) and advocating for relevant measures at the regional and national levels;
- Support and encourage behavioural changes among residents to reduce the amount of organic waste, including food waste, and to divert organic waste from landfills to composting or other uses;
- Investing funds from the city budget and other sources of funding, including resources from international financial organizations, in the development of organic waste composting infrastructure (e.g. bins for separate collection of organic waste, composting stations, plants for shredding garden waste, etc.), as behavioural changes require appropriate opportunities, such as convenient and accessible infrastructure, in addition to motivation;
- Use of economic instruments, including tariff mechanisms for waste management services or subsidizing infrastructure for separate collection of organic waste, to make it more expensive to send organic waste to landfill and more affordable to compost it;

photo by Iryna Myronova

- Use regulatory tools to require the installation of separate organic waste containers and/or ban food waste in general containers;
- Conducting information campaigns to reduce the amount of food waste, engage residents in separate collection of organic waste, improve the quality of organic waste sorting, and disseminate information about the benefits of composting;
- Cooperate with the city's businesses to minimize organic waste generation through the creation of "food banks," promote separate waste collection and composting of organic waste, for example, by creating awards for establishments or other incentive mechanisms;
- Strengthening institutional capacity for the development of the organic waste composting system by approving relevant policy documents, appointing responsible specialists, and improving the system of monitoring and collecting data on organic waste generation, compost production, and greenhouse gas emissions;
- Establishing a system for monitoring information (identifying data sources, collection and processing procedures, responsible persons, etc.) on the various types, methods of waste management, and the results of the city's policy to improve the waste management system in accordance with certain indicators (e.g., the volume of organic waste composting, greenhouse gas emissions from waste management, etc.);
- Exchange of experience with other cities and joint steps to develop organic waste composting, including within the framework of international initiatives and coalitions that bring together cities and regional authorities (e.g., Covenant of Mayors for Climate and Energy, C40 Cities, Cities Mission Climate City Contract, etc.);
- Cooperation with partners at the national and international level to attract additional investments in composting organic waste: use of market mechanisms of the Paris Agreement and mechanisms of the voluntary carbon market, new projects of international financial organizations and other development partners, including projects to build links and supply chains between cities that can produce compost and the agricultural sector that can use compost as organic fertilizers to improve soil quality and increase crop production.

The most effective approach is to combine measures and implement them in a coordinated manner. As opposed to introducing separate policy instruments, this approach can more effectively contribute to solving the organic waste problem, make cities more comfortable for residents, accelerate the transition to low-carbon development, and make it easier to attract financing for organic waste composting projects.

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[1] Report of the Third Assessment Cycle Working Group 6 of the Intergovernmental Panel on Climate Change (IPCC)

[2] Global Methane Assessment. Benefits and Costs of Mitigating Methane Emissions, https://www.ccacoalition.org/sites/default/files/resources//2021_Global-Methane_Assessment_full_0.pdf

[3] https://www.globalmethanepledge.org/

[4] Lviv City Council, https://city-adm.lviv.ua/news/city/housing-and-utilities/283844-stantsiia-kompostuvannia-tse-stanom-na-sohodni-nash-naiuspishnishyi-proekt-sviatoslav-yevtushenko

[5] Action plan for the Green City of Lviv, https://ebrdgreencities.com/assets/Uploads/PDF/d4474d7c08/Lviv-GCAP-Final-UKR-merged_May-2020.pdf

[6] Methodological approaches to assessing emission reductions from composting are described in the following documents: Methodological tool Emissions from solid waste disposal sites, Version 08.0; AMS-III.F. Small-scale methodology "Avoidance of methane emissions through composting", Version 12.0; TOOL13 Methodological tool "Project and leakage emissions from composting", Version 02.0