A Key to Rapid Methane Reductions: Keeping Organic Waste From Landfills

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Methane is an even more potent greenhouse gas (GHG) than carbon dioxide (CO_2): Over 20 years, it has more than 80 times the atmospheric warming potential of CO_2.[1] But it is also much shorter-lived, breaking down in just 12 years on average rather than centuries.[2] That means, in the urgent effort to reduce GHGs fast enough to avoid the most severe consequences of climate change, **taking action on methane emissions is the fastest way to reduce global warming**. The Global Methane Assessment says keeping global warming below 1.5°C – the global goal identified in the Paris Agreement – could hinge on how much we reduce methane emissions in this decade.[3]

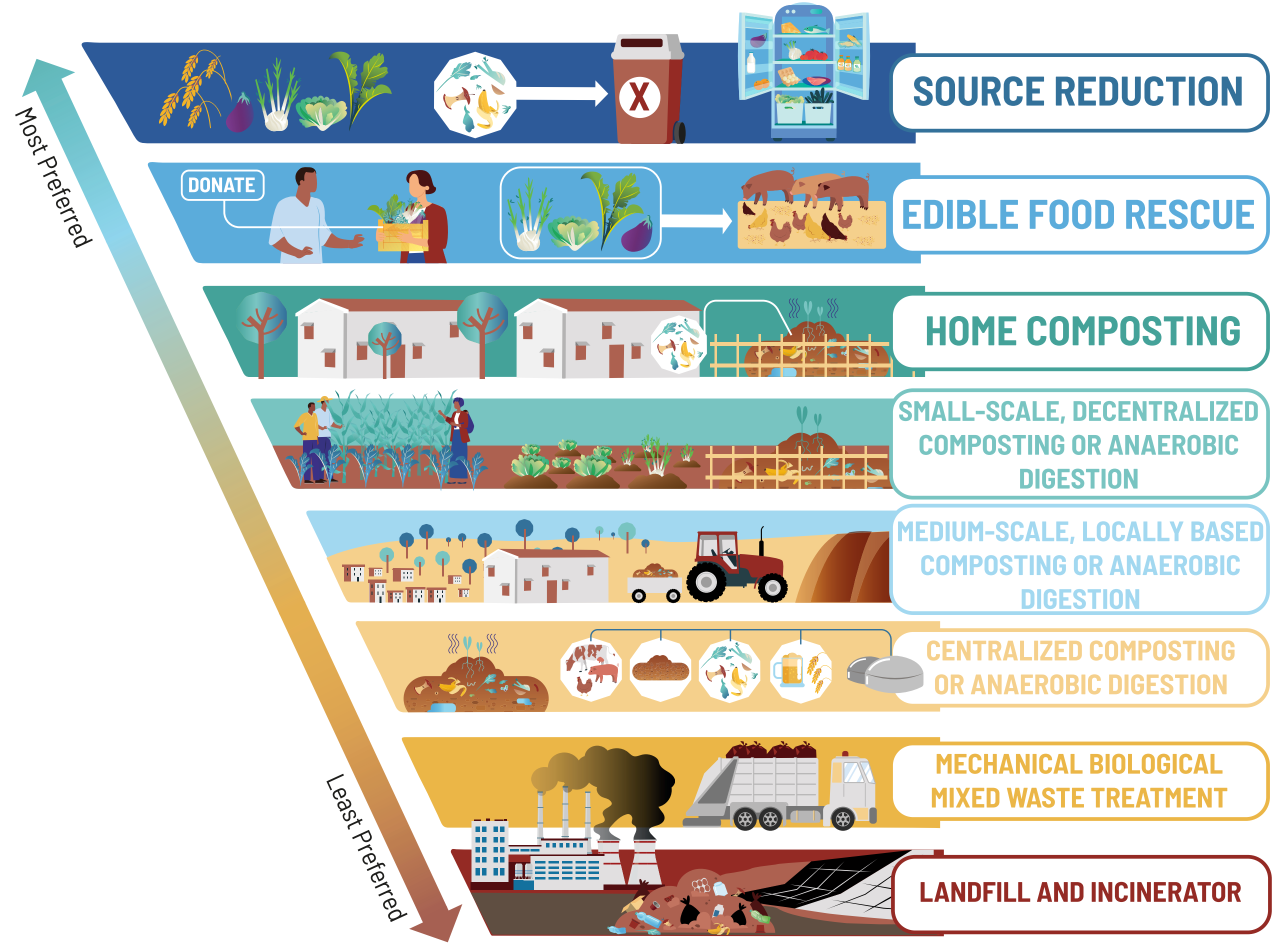
Under current policy scenarios, anthropogenic methane emissions are projected to increase by more than 15% by 2030.[4] More than 120 countries have pledged to reduce global methane emissions by 30% by that date.[5] But that is not enough to stall climate catastrophe: to stay below 1.5°C warming, the UN Environment Programme says methane emissions must drop by at least 45% by 2030.[6]

After agriculture and energy, the third largest and fastest-growing source of human-linked methane emissions – 20% of the total – is the waste sector,[7] and the largest proportion of the solid waste stream is landfilled organic waste, mostly food and yard clippings. The fastest and most economical way to reduce emissions from organic waste is to simply **stop putting the waste in landfills**, where it off-gasses methane into the atmosphere.

Keeping organics out of landfills is a central component of the zero waste movement,[8] which empowers towns, cities, and regional governments to play a leading role in countering the climate crisis. It is already yielding results in hundreds of diverse locales worldwide, and carries an array of co-benefits: creating more and better jobs, building stronger communities, improving public health, reducing environmental pollution, fostering better governance, and addressing inequalities and societal injustices.

This briefing provides an overview of effective strategies for keeping organics out of landfills. It gives examples of communities successfully deploying these practices to reduce emissions and improve lives. It looks at possible interim strategies to limit methane emissions from the billions of tonnes[9] of organic waste already in landfills. It also explains why sending organic waste to incinerators is an inefficient, expensive, and polluting approach that would lock in long-term GHG emissions.

The Hierarchy of Waste Solutions



Source: Institute for Local Self-Reliance

Strategies for keeping organic waste from landfills

As with other waste streams, **waste prevention or avoidance** has the greatest impact on organic waste.

One-third of all food produced is wasted and is responsible for as much as 10% of global GHG emissions, including methane.[10] Each tonne of food waste prevented reduces GHG emissions by almost 1 tonne to more than 4 tonnes. Globally, comprehensive food waste reduction could lower emissions by up to 5%.[11] Meat and dairy companies and food processors and packagers can be incentivized or required to set science-based targets to reduce waste and curb emissions.

After prevention of waste during food production and distribution, the next priority should be **recovery or rescue** of food otherwise headed for the landfill.

Food rescue and redistribution programs, through networks of food banks, food pantries, grocery stores, restaurants, and other food retailers, can both alleviate hunger and yield significant emissions reductions. France and California[12] are among a growing list of places that require groceries and restaurants to donate unsold edible food to local food recovery organisations. The Food Waste Hub program in Milan, Italy, diverts 130 million tonnes of food waste from landfilling annually, putting the city on track to cut food waste in half by 2030.[13]

Inevitably, some organic waste cannot be prevented or rescued. To keep it from landfills, the best strategy is **separate collection and treatment**, and the key component of that is **composting**.

Separate collection of organic waste from households and businesses is critical to avoid cross-contamination of different waste streams, which lowers the utility and value of both organic and non-organic materials. Milan has used a sophisticated ongoing communications campaign to educate the public on proper source separation, with impressive results: Today, less than 5% of organic waste collected in the city is cross-contaminated.[14] In Dar Es Salaam, Tanzania, a pilot project for 32,000 people achieved 95% compliance in source separation in just two years, reducing the amount of solid waste disposal by 75%.[15] San Francisco (USA), Ljubljana (Slovenia), Seoul (South Korea), and many other cities have seen similar successes.

Composting is readily scalable: it can be done centrally, or in backyards or neighbourhood hubs, which reduces the costs and public health impacts of heavy truck traffic. High-quality, well-run composting, which does not attract vermin or create odours, prevents an average of 78% of methane emissions that would otherwise be emitted from landfills.[16]

The compost must be sufficiently aerated to prevent anaerobic digestion and wastewater and methane formation. As the organic waste breaks down, it emits water vapour, biogenic CO_2, and small amounts of nitrous oxide. The final product is a nutrient-rich soil amendment, which can be used for agriculture, stormwater management, and landscaping.

Other treatment methods for source-separated organics include anaerobic digestion and use as animal feed.

Anaerobic digestion, in which organic waste is broken down in an air-tight vessel, produces methane-rich biogas, which can be burned on site for heat or to generate electricity. This practice is well suited for densely populated areas that generate lots of organic waste but have little room for composting, although it requires technical training and can be costly. Cheaper, small-scale anaerobic digestion units have also been successful in countries including Bangladesh, China, and India.[17]

After mismanagement forced the closure in 2011 of the only landfill in Thiruvananthapuram, capital of the Indian state of Kerala, the city (also known as Trivandrum) subsidised households to set up home and community waste-management systems. Within five years, 80 percent of households were practising source separation.[18] Today the city has nearly 4,000 decentralised anaerobic digestion facilities, complementing a network of 87,000 household composting pipes.[19] This success has become a model for the entire state of Kerala, shaping waste policy for the state's 34 million people.

Diverting food waste to feed livestock can displace conventional, energy-intensive feed crops.[20] In the European Union, most food waste cannot be used for animal feed, because of disease control concerns. However, food waste can be made safe through heat treatment, and in Japan and South Korea, about 40% of food waste is recycled as animal feed. Estimates of the methane reduction potential of using organic waste for animal feed are lacking, but one lifecycle analysis, on the potential of turning food waste into pig feed in the United Kingdom, found it could deliver greater overall GHG reductions than either composting or anaerobic digestion.[21]

The virtuous circle

Keeping organic waste from landfills, as part of a comprehensive zero waste strategy, carries with it an impressive array of economic, environmental, and societal co-benefits – elements of a just transition to a sustainable food system in which production, consumption, and waste management are symbiotically linked for the betterment of individuals, communities, and the planet. This creates a **'virtuous circle'** across sectors that reinforce each other.

Composting has low start-up costs, takes up less land than landfills, and finished compost can be sold to defray costs. Decentralised treatment saves money spent on waste pickup and transportation. **By contrast, landfills are expensive** to build and maintain, making waste management the single greatest expense of many municipalities. By reducing organic waste sent to landfills, waste prevention and source separation avoid the costly construction of new disposal infrastructure.

Diversion of organic waste also **creates jobs**. A recent global meta-analysis of the job creation potential of different waste management practices found that diverting 80% of recyclable and compostable waste from landfills and incinerators could create more than 18,000 jobs in both Dar Es Salaam, Tanzania, and Ho Chi Minh City, Vietnam, and 36,000 jobs in São Paulo, Brazil.[22]

Separate organic waste management offers an opportunity to integrate and **support waste pickers**, the informal workers who have provided valuable waste management services to their communities for decades. New jobs in collection, outreach and education, compliance monitoring, and processing can provide stable livelihoods at higher rates than conventional disposal methods.

In Mumbai, India, the Stree Mukti Sanghatana cooperative of waste pickers trained hundreds of women, known as 'neighbourhood sisters,' in the principles of zero waste: how to sort and handle waste and composting and biogas plant management.[23] The waste pickers cooperative SWaCH in Pune, India, organised a composting project that now manages 7,000 kilograms of organic waste a day in 121 locations. In São Paulo, the São Paulo Composta, Cultivo campaign employs waste pickers to operate **five composting plants** that manage organic waste from street fairs and markets.

Zero waste strategies not only reduce GHG emissions but deliver great **additional environmental benefits**. They reduce air pollution and toxic residues, protect biodiversity and natural resources, reduce littering, and improve soil quality. Source separation reduces contamination in recycling waste streams, increasing recycling rates and driving further GHG savings. Finished compost sent to gardens and farms returns organic matter and nutrients to the soil, boosting its carbon sequestration capacity, increasing its resistance to flood and drought, and reducing irrigation and tilling needs.[24] When compost replaces synthetic fertilisers, the impact is even greater, saving energy and reducing emissions of nitrous oxide, a powerful GHG.

Mitigation of remaining emissions – and mistakes to avoid

Even after careful source separation and treatment of organics, some discards will remain in residual waste streams. This residual waste should first undergo **biological stabilisation** before being landfilled. This can include simple mixing and aeration techniques or more complex material recovery and biological treatment systems. In this way, bio-stabilisation provides a final screen for organic material, including contaminated or 'dirty' organics still in the residual waste stream.

Even when complete diversion of organics is achieved, ongoing methane emissions from past discards buried in landfills must still be addressed, as landfills can continue to emit methane for decades after they have stopped accepting new waste.[25] Fortunately, active landfills are responsible for most emissions, with legacy emissions from closed landfills only contributing about 9% of the total.[26]

A growing body of research suggests that a **biocover** – a layer of compost or other organic material over landfills – can greatly reduce these emissions. By fostering communities of microbes that digest methane as it rises up from the landfill below, biologically active cover can reduce landfill emissions by 63% on average.[27,28,29,30] Depending on environmental conditions, a biocover can even generate 'negative' emissions by drawing down methane from the atmosphere.[31,32] Biocovers are inexpensive compared to other landfill engineering techniques like gas capture systems. They can be deployed easily using unskilled labour, standard farm machinery, and locally sourced organics. Moreover, the use of biocovers supports compost markets and helps to turn a problem – organic waste – into a solution. Finally, unlike landfill gas capture, biocovers do not reward operators for generating, then capturing, excess methane. As a result, biocovers make for a sound final step in a well-aligned waste stream. Denmark is a leader in biocovers, having invested in their widespread deployment through a national subsidy scheme.[33]

A zero waste strategy for curbing methane emissions from organic waste is efficient, environmentally beneficial, and values people and community above profit. None of that can be said for **landfill gas capture**, the method most often promoted by the profit-driven waste management industry.

Landfill gas capture uses tubes to collect a fraction of the gas generated by waste, of which up to half is methane. After it is piped to the surface, it can either be flared or burned for energy. Landfill gas is not the same as biogas produced from source-separated organics through anaerobic digestion: it is much more contaminated and has lower energy value. Most importantly, leakage rates are much higher, and vary widely.[34,35] A landfill gas system may require years to be built and does not provide the immediate reduction in methane generation that can be achieved through organics collection and treatment, coupled with landfill biocover.

Landfill gas capture should only be deployed as a last option, once organics collection and treatment systems have been fully implemented. But in some cases, financial incentives to collect landfill gases have motivated waste management companies or municipalities to redirect organic discards from diversion programmes back to landfills to increase gas production.[36] This is obviously counterproductive, not only for the potential to increase GHG emissions, but also by ignoring the myriad co-benefits of the zero waste model. Bioreactor landfills are an extreme form of landfill gas capture, where liquid is added to landfills to generate more methane, some of which inevitably escapes to the atmosphere.[37]

Finally, **incineration (or "waste to energy") is a polluting and expensive approach** that should never be used to manage organic waste. Building out incineration to reduce methane emissions would result in long term infrastructure that locks in CO_2 pollution for decades. Electricity produced by incinerators is more carbon-intensive than electricity generated through the conventional use of fossil fuels such as gas, and has twice the carbon intensity of the US and EU electricity grid averages.[38,39] Incineration generates huge amounts of CO_2 especially from the plastics and synthetic textiles in mixed municipal waste.[40] In Europe, where decarbonization of the energy grid is an important policy commitment, countries like Denmark are closing down incinerators to meet their decarbonization goals.[41] In 2022, Copenhagen announced it would not reach its ambitious carbon neutral goal due to the city's incinerator emissions.[42]

Although burning organics to reduce methane is counterproductive, most climate finance dedicated to waste sector methane abatement has gone to incineration.[43] So-called 'waste-to-energy' incineration projects tend to be built for other reasons and later labelled as climate interventions. The fact is that incineration is highly polluting, expensive, and carbon-intensive, with large capital costs and high operating costs for pollution control, air quality monitoring, wastewater management, and ash disposal. These costs often lead to the closure of incineration facilities and have drained municipal budgets of hundreds of millions of dollars to more than $1 billion in some cases, whereas composting tends to have lower waste management costs and has very low capital costs.[44 45 46 47]

Source separation and treatment of organic discards is always preferable to landfill gas capture and incineration. Climate finance should stop funding incineration and support effective approaches.

Acknowledgements

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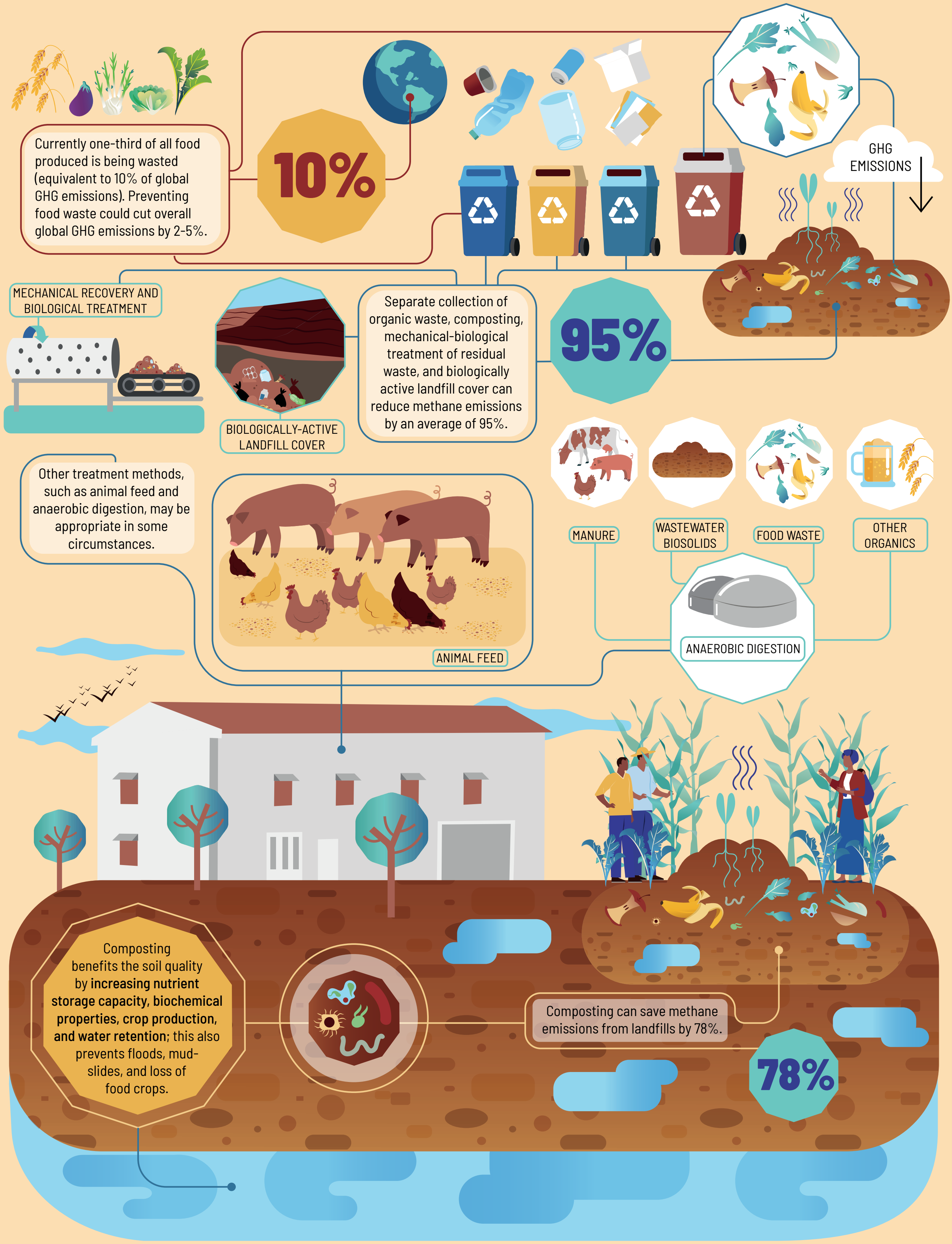
THE UNTAPPED POTENTIAL OF ORGANIC WASTE

TO COOL THE PLANET



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