The Waste Methane Toolbox: Policy Solutions for a Low Methane Future

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CLEAN AIR TASK FORCE

Acknowledgments

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Clean Air Task Force (CATF) is a global nonprofit organization working to safeguard against the worst impacts of climate change by catalyzing the rapid development and deployment of low-carbon energy and other climate protection technologies. With 25 years of internationally recognized expertise on climate policy and a fierce commitment to exploring all potential solutions, CATF is a pragmatic, non-ideological advocacy group with the bold ideas needed to address climate change. CATF has offices in Boston, Washington, D.C., and Brussels, with staff working virtually around the world. For more information, visit www.catf.us.

Abbreviations

AD	anaerobic digestion
CO_2e	carbon dioxide equivalents
EPA	Environmental Protection Agency (U.S.)
EPR	extended producer responsibility
EU	European Union
EUR	euros
GBP	British pounds
GHG	greenhouse gas
GHGRP	Greenhouse Gas Reporting Program (U.S.)
GMP	Global Methane Pledge
Gt	Gigatons
IPCC	Intergovernmental Panel on Climate Change
LMOP	Landfill Methane Outreach Program (U.S.)
MSW	municipal solid waste
NDC	nationally determined contribution
OECD	Organisation for Economic Co-operation and Development
PAYT	pay as you throw
SWM	solid waste management
UNEP	United Nations Environment Programme
USD	U.S. dollars

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Executive Summary

The waste sector, encompassing both solid waste and wastewater, is responsible for approximately 20% of global anthropogenic methane emissions — equivalent to roughly 5.4 gigatons of carbon dioxide equivalents annually. As a significant contributor to methane pollution, addressing emissions from the waste sector is critical to achieving global methane reduction targets. This guide provides a clear framework for policymakers to navigate the often-overwhelming array of classifications and taxonomies for environmental policy approaches; it's aim is to aid these decision-makers as they design and implement solutions to accelerate methane mitigation from solid waste.

Building on established frameworks from organizations like the Intergovernmental Panel on Climate Change, United Nations Environment Programme, and the Organisation for Economic Co-operation and Development — which typically classify waste policies by type — this guide introduces a novel matrix. This matrix depicts how countries can leverage a range of policy approaches within the solid waste management (SWM) chain to mitigate methane emissions effectively. Rather than endorsing a single policy approach, the guide synthesizes existing literature to offer flexible, actionable insights for national governments.

Key highlights include:

1. **Waste Sector Methane Mitigation Policy Matrix**
2. **Policy Development Considerations**
3. **Case Studies**

The guide underscores the importance of designing policies as part of a holistic strategy to build integrated SWM systems that manage all waste materials effectively. By offering a simplified and structured approach to methane mitigation in the waste sector, this guide equips policymakers to contribute meaningfully to limiting global warming to 1.5 degrees Celsius while supporting environmental and community health.

Section 1

Waste Methane Mitigation Is Essential to Meeting Climate Goals

Why Global Methane Emissions from the Waste Sector Matter

The World Meteorological Organization warns that 2024 was the warmest year on record, with global average near-surface temperatures reaching 1.55 degrees Celsius above preindustrial baselines.[1] The evidence is clear: the world is not on track to meet climate goals and keep global temperatures within safe and manageable limits. According to the synthesis report on the first Global Stocktake of the Paris Agreement, the gap between current commitments and emissions reductions required to limit warming to 1.5 degrees Celsius is between 20 to 24 gigatons (Gt) of carbon dioxide equivalents (CO_2e).[2] That is equivalent to the total combined national greenhouse gas (GHG) emissions from China, the United States, India, Russia, and Indonesia in 2020.[3] Though much of the climate conversation centers on decarbonization and reductions of carbon dioxide, methane is a far more powerful climate pollutant that must be reduced alongside carbon dioxide in order to meet climate goals. Methane is a harmful pollutant that has over 80 times the warming potential of carbon dioxide over a 20-year period. Altogether, methane is responsible for nearly half a degree Celsius of the human-caused warming we have experienced since 1900.[4]

1 World Meteorological Organization. (2025). WMO confirms 2024 as warmest year on record at about 1.55°C above pre-industrial level [Press release]. https://wmo.int/news/media-centre/wmo-confirms-2024-warmest-year-record-about-155degc-above-pre-industrial-level

2 United Nations Framework Convention on Climate Change Secretariat. (2023). *Technical Dialogue of the First Global Stocktake: Synthesis report by the co-facilitators on the technical dialogue.* https://unfccc.int/documents/631600

3 Based on data from ClimateWatch. (2024). *Historical GHG Emissions*. https://www.climatewatchdata.org/ghg-emissions?end_year=2020&source=Climate%20Watch&start_year=1990

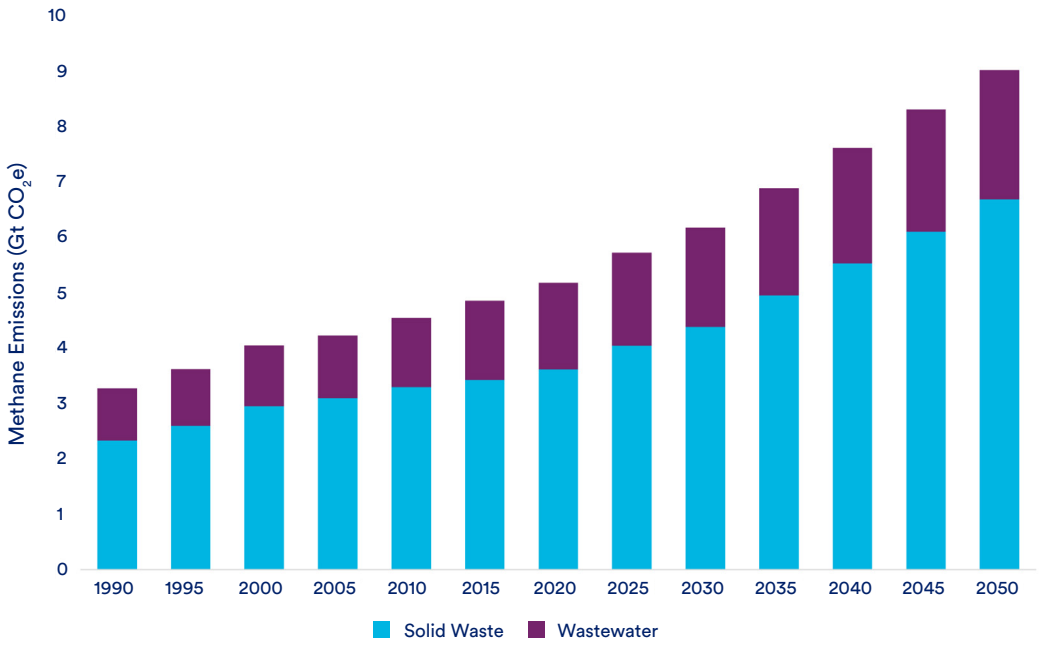
4 Intergovernmental Panel on Climate Change (IPCC). (2021). Figure 2. In *Climate Change 2021: The physical science basis, Working Group I, SPM*. https://www.ipcc.ch/report/ar6/wg1/downloads/figures/IPCC_AR6_WGI_SPM_Figure_2.png

Because of their short lifetime in the atmosphere, rapidly reducing methane emissions is a crucial solution the world needs now to slow near-term warming, while buying time for widespread implementation of decarbonization technologies. At COP26 in 2021, world leaders acknowledged the significance of methane and responded by launching the Global Methane Pledge (GMP) to collectively reduce 30% of global methane emissions by 2030. This pledge has now been signed by over 155 countries.

The waste sector (solid waste and wastewater) is responsible for approximately 20% of global methane emissions, equating to roughly 5.4 Gt CO_2e.[5] It is a significant source of methane emissions, and addressing it is critical for achieving global methane reduction targets. What's more, waste emissions are expected to increase as global waste generation rises; the World Bank estimates that solid waste generation will grow over 70% by 2050 relative to a 2020 baseline.[6] Modeling using the International Institute for Applied Systems Analysis's GHG and air pollution interactions and synergies model estimates that global waste sector methane emissions could exceed 9 Gt CO_2e by 2050 (Figure 1).

Through international initiatives (e.g., the Paris Agreement, Nationally Determined Contributions (NDC), and Methane Action Plans) along with national and subnational strategies (e.g., solid waste management plans, climate plans), governments are committing to improving solid waste management (SWM) and mitigating methane pollution. In most cases, doing so will require improvements to existing institutional frameworks for waste management.

Figure 1. Global waste sector emissions are expected to grow by over 70% by 2050



Note: Values based on modeling from Höglund-Isaksson et al., 2020.[7] Methane emissions are converted to CO_2e using a 20-year non-fossil global warming potential of 79.7.

5 Based on data provided in the United Nations Environment Programme (UNEP) Global Methane Assessment and the IPCC AR6 non-fossil global warming potential 20-year value of 79.7.

6 Kaza, S., Shrikanth, S., & Chaudhary, S. (2021). *More Growth, Less Garbage*. World Bank. https://openknowledge.worldbank.org/entities/publication/ba7feea4-0abe-59fb-bc60-ce6b60eb1ceb

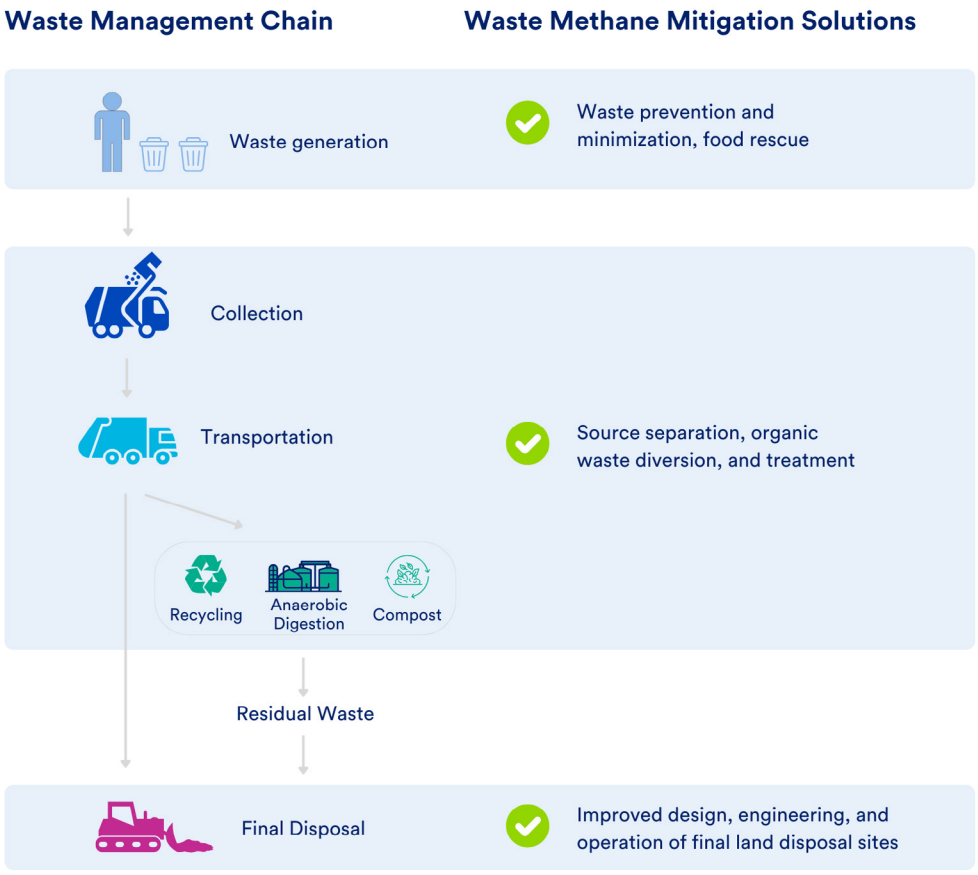
7 Höglund-Isaksson, L., Gómez-Sanabria, A., Klimont, Z., Rafaj, P., & Schöpp, W. (2020). Technical potentials and costs for reducing global anthropogenic methane emissions in the 2050 timeframe: results from the GAINS model. *Environmental Research Communications*, 2(2). https://iopscience.iop.org/article/10.1088/2515-7620/ab7457

Solutions for Waste Sector Methane Mitigation Already Exist

Solid waste emissions from landfills and dumpsites represent the majority of methane from the waste sector. Methane from solid waste is generated from the decay of organic waste — food and yard waste, as well as paper, cardboard, and wood — in the oxygen-free environments found in disposal sites. Globally, up to 80% of solid waste emissions can be mitigated using readily available technologies.[8] Methane mitigation solutions across the SWM chain are well known, technologically feasible, and relatively cost-effective. Opportunities for proven emission reductions from solid waste are second only to the oil and gas sector's abatement potential for major methane-emitting sectors.

The solid waste management chain, as shown in Figure 2, is the series of steps by which materials become "waste" and are then subsequently managed, treated, and disposed of in final disposal sites, including engineered sanitary landfills or dumpsites with little or no environmental controls in place. Municipal solid waste (MSW) typically includes household waste, such as kitchen scraps, paper, glass bottles, etc., as well as commercial and institutional waste.[9] MSW does not typically include industrial or construction and demolition waste, which are managed separately.

Figure 2. Solid waste management chain



8 Ocko, I. B., Sun, T., Shindell, D., Oppenheimer, M., Hristove, A. N., Pacala, S. W., Mauzerall, D. L, Xu, Y., & Hamburg, S. P. (2021). Acting rapidly to deploy readily available methane mitigation measures by sector can immediately slow global warming. *Environmental Research Letters*, 16(5). https://iopscience.iop.org/article/10.1088/1748-9326/abf9c8

9 There is no universally accepted definition of MSW, and the definition often differs between countries. MSW can be categorized by source (household, commercial, institutional) or by the amount of waste produced by a generator. For example, institutions that generate waste below a certain amount are considered municipal, but those that produce more waste are categorized as "bulk" or "special" generators and are required to manage their waste privately.

Waste methane mitigation solutions can be separated into three categories, each addressing a different stage in the SWM chain:

1. **Waste prevention and minimization, along with food rescue**, aim to reduce the amount of organic waste generated at the household, commercial, and industrial levels to subsequently reduce the need for collection, treatment, and disposal. Examples of prevention and minimization depend on the material and source of waste, including food waste and paper-based packaging.
   - For food waste, policy and technology options such as improving consumer awareness, standardization of food date-labeling, proper transport, storage, and cooling of food and other agricultural products, and direct to consumer sales of imperfect or surplus produce can limit the amount of food that is lost or wasted between the farm and kitchen. For more information on technological and policy solutions for food waste prevention, explore ReFED's Roadmap to 2030.
   - For cardboard and other paper-based packaging materials, policy and technology options can limit materials and products and can incentivize reusable and lightweight packaging to reduce the total amount of waste generated.
   - Uncontaminated foods and other organic material, primarily from commercial and industrial sources, can be rescued for use. Edible food can be donated for human consumption, whereas food no longer suitable for human consumption can be diverted for use as livestock feed. The Global Food Donation Policy Atlas is a resource on solutions to promote food donation.

2. **Source separation, organic waste diversion, and treatment** include solutions that divert organic materials from incineration and final disposal in landfills and dumpsites. Diversion and treatment of inedible wastes rely on source separation (i.e., separating organic waste from plastics, metals, and other inorganic materials) through separated collection and transport to the relevant recovery and/or treatment facility. Treatment options include:
   - Composting, an aerobic treatment process that breaks down organic waste and produces a nutrient-rich soil amendment. Composting can be done at home, at the community level (i.e., decentralized), or at large, centralized facilities.
   - Anaerobic digestion (AD), which intentionally creates an oxygen-free environment to produce methane that can be captured and used as a heat or energy source, as well as digestate that can be treated and used as a soil amendment. AD systems can operate at both decentralized and centralized scales.
   - Other technologies include, but are not limited to:
     - Black soldier fly technology, which takes advantage of the natural reproductive cycle of these organisms to break down organic waste and generate revenue through the sale of fly larvae for animal feed and frass as a soil amendment;[10] and
     - Mechanical recycling of paper, cardboard, and some other biobased materials via existing recycling technologies.

3. **Improved design, engineering, and operation of final land disposal sites**, which include:
   - Pretreatment of residual waste, sometimes referred to as mechanical biological treatment, prior to landfilling to stabilize the waste and minimize methane generation from landfills;[11]

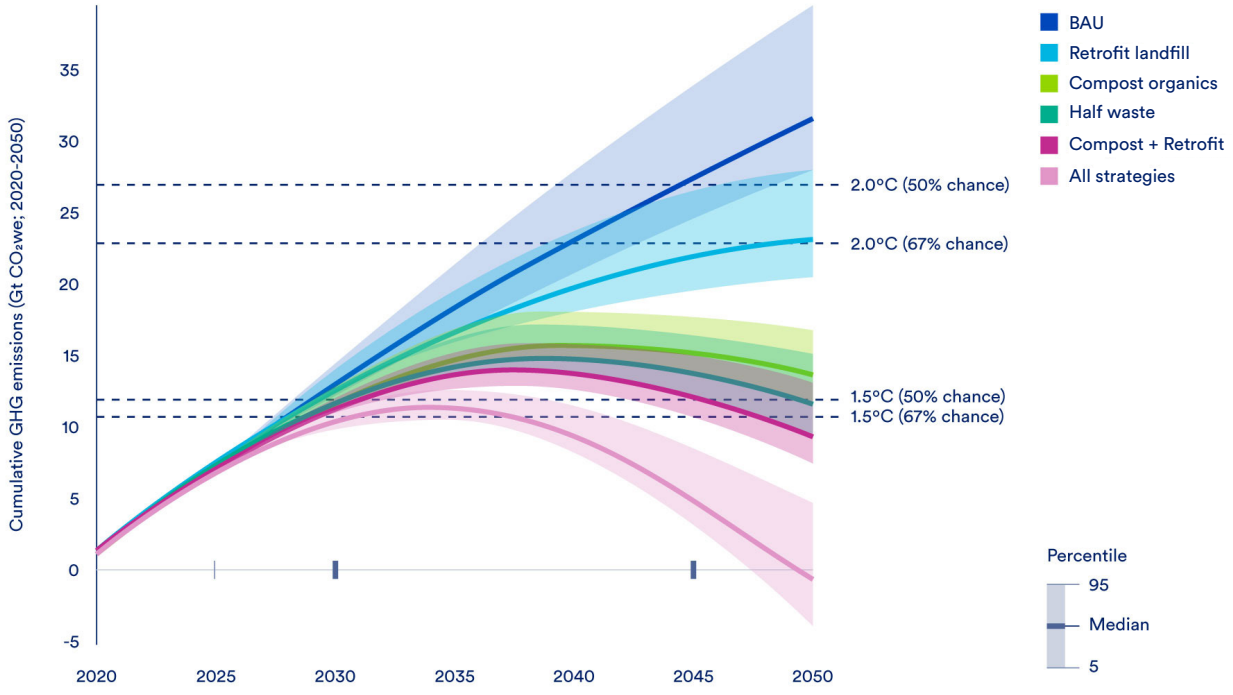
10 Climate and Clean Air Coalition. (2024). *Scaling up underfinanced SLCP mitigation solutions: Driving innovation and technology in the waste sector* [Policy brief]. https://www.ccacoalition.org/resources/brief-scaling-underfinanced-slcp-mitigation-solutions-driving-innovation-and-technology-waste-sector

11 Compost generated through this process is too contaminated for commercial use but can be used as a landfill cover material. Additionally, pretreatment helps to reduce the amount of waste sent to landfills and can minimize leachate generation along with other environmental contamination associated these sites.

- Installation and optimization of landfill gas capture and utilization systems at sanitary landfills;
- Use of biologically active soil covers, also known as biocovers, to encourage enhanced oxidation of methane as it passes through the cover layer;[12] and
- Closure of open or illegal dumpsites and conversion of open dumps to controlled dumpsites.[13] Though closure of dumpsites is primarily an environmental health and sanitation issue, it is exceedingly difficult to capture methane generated at these sites, making their closure an important climate issue as well.

Estimates show that implementing these solutions individually (i.e., only installing gas capture systems or only focusing on treating organics) could reduce 27% to 70% of GHG emissions from waste by 2050.[14] However, we cannot stay within 1.5 degrees Celsius of temperature change unless waste sector methane mitigation solutions are implemented globally across all three categories in the SWM chain (Figure 3). Countries that aim to establish leading waste management practices and reduce methane emissions need to implement a comprehensive strategy that deploys a combination of solutions.

Figure 3. Climate goals are out of reach without strong action on waste sector methane



Impacts of waste sector methane solutions on cumulative emissions compared to 1.5 and 2 degrees Celsius emissions budgets (2020-2050)
Source: Hoy et al., 2023.[14]

12 Methane oxidation is a process in which methanotrophic bacteria found in the cover soil on landfills use atmospheric oxygen to convert methane into carbon dioxide and water.

13 Closure and conversion of open dumps should also involve installation of a passive (venting) or active gas collection system. The feasibility of an active system depends on estimated gas generation volume, waste composition, and age of the waste at the site. International Solid Waste Association. (2016). *A Roadmap for Closing Waste Dumpsites*. https://www.iswa.org/closing-the-worlds-biggest-dumpsites-task-force/?v=79cba1185463

14 Hoy, Z. X., Woon, K. S., Chin, W. C., Fan, Y. V., & Yoo, S. J. (2023). Curbing global solid waste emissions toward net-zero warming futures. *Science*, 382(6672), 797-800. https://www.science.org/doi/10.1126/science.adg3177

Guidance for Policy Development and Implementation on Waste Methane Mitigation Is Limited

Legislation, policies, and plans for waste management are generally set at the national level with responsibility for implementation delegated to regional or municipal authorities. In many countries, the national waste management plan or other national waste legislation provides an overarching framework for the steps along the SWM chain and often defines responsibilities for waste management based on generator type, amount of waste produced, and type of waste. These frameworks can be complex, with responsibilities for the solid waste sector extending across various levels of government and multiple government institutions.

Waste management has historically been established as a public service through the lens of environmental health and safety. As such, public participation is critical to the success of waste management programs (e.g., waste reduction, source separation). Legislation and policies often prioritize closing open dumps; limiting air, soil, and water pollution; preventing landfill slides and fires; and ensuring the health of waste sector workers and local communities. However, countries are now recognizing the linkages between waste management and climate and aiming to improve existing institutional frameworks to address methane emissions from the sector, especially as urban areas continue to grow, making solutions even more challenging to implement.

One key challenge that countries face is insufficient understanding of the types of policies and solutions that they can design and implement to incentivize methane mitigation within existing waste management frameworks and responsibilities. Additionally, because the circumstances of each country and local government are different, decision-makers must consider their specific context; incorporate local knowledge to create feasible policies that do not have unintended consequences within the community; and set realistic time horizons for policy achievement.

How to Use This Guide

This guide aims to define policy approaches that can be used to accelerate methane mitigation in the municipal solid waste sector. It was developed **based on research and evaluation of national-level approaches** from around the world and **presents a menu of options for governments to consider for solid waste methane mitigation.** While many of these policies can be applied successfully at both national and subnational levels, this guide is **focused on national approaches.** It also does not recommend a specific combination of policy approaches for methane mitigation, as these choices will be informed by the ambition of the government — in terms of the abatement goal from the sector — as well as a variety of other local considerations.

Section 2 describes a range of policy approaches that can be considered by decision-makers, using a simplified categorization framework to advance methane emissions reductions. By using the SWM chain as a categorization framework, this guide aims to help decision-makers understand:

1. Available policy approaches to improve diversion, treatment, and final disposal;
2. How each approach can target specific steps in the SWM chain; and
3. How multiple approaches can be combined to achieve maximum reductions in methane emissions.

Note that this framework focuses on policy approaches related to organic waste diversion, treatment, and final disposal and *does not cover approaches related to waste prevention and minimization in detail.* However, many of the policies in this guide can indirectly promote waste minimization. Lastly, Section 3 summarizes key considerations that are critical to address when developing policies that seek to improve SWM and reduce methane emissions. The country case studies in the Appendix provide examples of various strategies that countries have employed successfully.

Section 2

Policy Approaches for Waste Methane Mitigation in the Solid Waste Management Chain

Existing Categorization for Environmental Policy Approaches

Policy approaches are the interventions created by governments and decision-makers to achieve a set goal or policy objective.[15] There are numerous categories for environmental policy approaches (Box 1), the diversity of which unintentionally leads to information overload that can be confusing for policymakers. Many classifications, including those of the United Nations Environment Programme (UNEP) and the Organisation for Economic Co-operation and Development (OECD), arrange waste policy approaches by type. This guide does not seek to identify a single example as the correct method of categorizing waste-related policy approaches. Rather, it builds on existing literature to create a novel matrix depicting how countries can leverage these approaches to mitigate waste sector methane within the SWM chain.

15 Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (n.d.). *Policy instrument: Definition*. https://ipbes.net/glossary-tag/policy-instrument

Box 1: Existing categorizations of environmental policy approaches

The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report includes references to the following policy approach groupings:[16]

- Regulatory instruments
- Economic instruments
- Other instruments, which include information programs, voluntary agreements, and government technology procurement policies

The OECD Policy Instruments for Waste and Materials Management use the following categories:[17]

- Regulatory instruments
- Economic instruments
- Extended producer responsibility (EPR)
- Green public purchasing
- Public information
- Monitoring and reporting
- Enforcement

The UNEP Guidelines for National Waste Management Strategies use the following categories:[18]

- Executive decision-making
- Regulation and enforcement
- Voluntary agreements
- Economic instruments
- Education and behavior change
- Monitoring, information, and performance assessment
- Technology choice

Policy Options for Waste Methane Mitigation

Acknowledging the numerous options for classifying environmental policy approaches, **this guide proposes the following simplified categories to organize tools available for governments to act on waste methane mitigation:**

- Legislative and Regulatory Approaches
- Market-Based Approaches
- Voluntary Agreements
- Information and Education Approaches

16 IPCC. (2022). National and sub-national policies and institutions. In IPCC, *Climate Change 2022: Mitigation of climate change*. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. https://www.ipcc.ch/report/ar6/wg3/

17 OECD. (2019). Chapter 4: Policy instruments for waste and materials management. In *Waste Management and the Circular Economy in Selected OECD Countries*. https://read.oecd-ilibrary.org/environment/waste-management-and-the-circular-economy-in-selected-oecd-countries_d8216b41-en#page2

18 UNEP. (2013). *Guidelines for National Waste Management Strategies: Moving from challenges to opportunities*. https://wedocs.unep.org/handle/20.500.11822/8669

Legislative and Regulatory Approaches

Traditional legislative and regulatory approaches, also referred to as **command and control regulation**, are approaches in which the government controls or directly influences or intervenes in any aspect of waste management. In broader environmental policy, command and control regulations often establish limits on how much pollution is emitted and/or what type of control equipment, technology, or best practice should be used to limit pollution. Command and control regulations usually require good implementation, monitoring and reporting for compliance, and enforcement of noncompliance.[19] Regulatory approaches that can be used for the waste sector to mitigate methane pollution include:

- **Pollution Standards.** Regulations often set thresholds or standards for pollution. In the waste sector, this could mean setting standards for landfill design and operation that limit water pollution from leachate and air pollution from methane emissions or other pollutants (i.e., particulate matter or volatile organic compounds). For example, the U.S. Environmental Protection Agency (EPA) requires certain design, construction, and maintenance standards for U.S. landfills, such as installation of impermeable liners to control leachate and covers to reduce air pollution. There are two types of pollution standards:
  - **Technology-based standards** require the use of specific methods or equipment to limit and control pollution. For instance, landfill gas capture and control systems are based on criteria such as landfill capacity, dates of construction and/or subsequent modification, types of waste disposed, and results of modeled and measured emissions.

Oregon's rules are stronger than those at the federal level.

The state of Oregon requires installation and operation of gas capture and control systems if the landfill has:[20]

- more than 200,000 tons of waste,
- modeled annual emissions rate >664 tons, and
- surface emissions monitoring result >200 parts per million by volume of methane.[21]

  - **Performance-based standards** set levels or thresholds for emitters to meet but do not require a specific control technology. For example, legislators may set methane emissions limits from landfill sources.

Canada, for example, proposed a performance standard requiring surface methane concentration limits in areas of a landfill with final cover or where waste has not been disposed for one year. The proposed standard does not mandate a specific technology or approach for controlling surface emissions but does assume the installation or expansion of gas capture systems for modeling purposes.[22]

19 Bengtsson, M., Hotta, Y., Hayashi, S., & Akenji, L. (2010). The four main types of policy instruments. In *Policy Tools for Sustainable Materials Management: Applications in Asia*. Institute for Global Environmental Studies. https://www.jstor.org/stable/pdf/resrep00758.4.pdf

20 Oregon Department of Environmental Quality. (n.d.) *Landfill methane emissions reduction*. https://www.oregon.gov/deq/ghgp/pages/landfill-methane-emissions-reduction.aspx

21 Surface emissions monitoring is a method for measuring concentrations of methane at the surface of a landfill. Historically, this has been done manually by technicians who walk the landfill surface with handheld devices to detect leaks and measure concentrations of methane; however, recent advances in remote sensing technologies are seeing drones and airplane flyovers used for this purpose.

22 Canada Department of Environment and Department of Health. (2024). *Canada Gazette, part I, volume 158, number 26: Regulations respecting the reduction in the release of methane (waste sector)*. https://canadagazette.gc.ca/rp-pr/p1/2024/2024-06-29/html/reg5-eng.html

- **Source separation and/or diversion requirements.** To meet a country's waste management goals and targets, regulators may set source separation and diversion requirements.
  - **Source separation mandates** state that waste materials must be separated by waste generators into various categories (e.g., organic, recyclable, and inert waste) prior to collection. This helps to reduce contamination of recyclable and organic waste streams, making processing and treatment easier. Source separation programs are often paired with changes in the frequency of waste collection: organic wastes that break down quickly need to be collected at least once per week, but inorganic wastes can be collected less frequently.

Thailand's National SWM Plan (2022-2027) requires that 80% of community waste is properly managed by increasing source separation and recycling of household waste by 35% and reducing food waste to 28% of total waste by 2027.[23,24]

  - For **diversion requirements or quotas**, decision-makers set a target percentage of material (e.g., recycled, organic, or total) to be diverted from landfills. Diversion requirements also incentivize treatment, providing organic waste treatment project developers with a steady stream of feedstock.

Chile's National Organic Waste Strategy aims to increase organic diversion from 1% to 66% by 2040.[25]

- **Bans** include material disposal bans, bans on open dumping, and bans on use of unmanaged dumpsites. Bans are often phased in over a number of years to allow for implementation of alternative treatment infrastructure or to allow product alternatives time to develop. Phase-ins also allow waste generators time to adapt to necessary behavior changes required to properly implement the ban.
  - **Material disposal bans** can be used to limit food waste, other organic materials, or untreated waste from being disposed in landfills or sent to incineration facilities, thereby directly or implicitly requiring diversion by donation and/or treatment. Banning materials and products from landfills is often accompanied by a requirement for specific parties to collect and treat waste, which may be subject to technology and performance standards to limit pollution.

Scotland banned biodegradable MSW, including food and garden waste, paper, and cardboard, from entering landfills in January 2021.[26]

23 Thailand Pollution Control Department. (2022). *The Ministry of Natural Resources and Environment is preparing to submit to the Cabinet after the National Environment Board approves the second National Waste Management Action Plan (2022-2027)*. https://www.pcd.go.th/pcd_news/26688/

24 Chotthong, B. (2024, September 14). Getting to the root of the term "food waste." *Bangkok Post*. https://www.bangkokpost.com/opinion/opinion/2865328/getting-to-root-of-the-term-food-waste

25 Ministerio del Medio Ambiente. (2021). *Estrategia nacional de residuos organicos Chile 2040*. Gobiero de Chile. https://economiacircular.mma.gob.cl/wp-content/uploads/2021/03/Estrategia-Nacional-de-Residuos-Organicos-Chile-2040.pdf

26 Scottish Environment Protection Agency. (2024). *Biodegradable municipal waste landfill ban*. https://www.sepa.org.uk/regulations/waste/landfill/biodegradable-municipal-waste-landfill-ban/

- **Bans on illegal dumping** apply to the act of disposing waste in areas not designated as final disposal sites. Citizens resort to illegal dumping of waste when adequate collection services are not provided or to avoid collection fees. This dumped waste ends up in empty lots in cities, ditches, waterways, etc. Bans on illegal dumping prohibit this practice in order to improve environmental and public health and safety and encourage the proper collection and disposal of waste in sanitary landfills.

Nigeria's National SWM Plan established illegal dumping of waste including tires, construction and demolition waste, and chemicals as a criminal offense; and it called on the Ministry of Environment to mandate regulatory agencies to implement antidumping legislation with penalties and fines for offenders.[27]

- **Dumpsite closure** or bans apply to the continued use of existing dumpsites. As dumpsites have few environmental controls in place, it is difficult to implement systems to capture or mitigate methane emissions at these sites, though examples exist in which landfill gas capture systems have been installed in addition to environmental controls to manage stormwater and mitigate leachate generation. Bans on the use of dumpsites encourage the transition to controlled and sanitary landfills, which can be fitted with methane pollution controls as an integral part of their initial design.

Brazil's national solid waste policy (Lixão Zero) provides a deadline for the closure of dumpsites. After initial deadlines were missed, a revised deadline was set for August 2024; however, in late 2024 dumpsites continued operating around the country. Despite these setbacks, the government continues to work with states and municipalities in pursuit of reaching the zero-dumpsite objective.

27 Federal Republic of Nigeria. (2020). *National policy on solid waste management*. https://www.environment.gov.ng/download/national-policy-on-solid-waste-management/

Box 2 describes regulatory and market-based approaches targeted at plastic waste that benefit waste methane mitigation.

Box 2: Achieving methane mitigation benefits from policy approaches focused on plastic waste

The majority of household and commercial solid waste is not source-separated, leading to commingling of organic and inorganic wastes. Plastic contamination, in the form of plastic packaging and microplastics, is a major challenge to the diversion, recovery, and treatment of organic waste. Similarly, contamination of plastic waste from organic materials reduces the recyclability of diverted plastics. Improving separation and diversion of plastic and organic waste streams is an objective of integrated SWM to ensure policy and technology solutions are complementary, not competing. Methane emissions reductions and reduced plastic pollution are two goals of waste management systems that can be addressed in tandem to maximize waste methane mitigation and reach plastic pollution reduction goals and targets.

Source separation policies often require waste to be split into dry waste or recyclables (e.g., plastic, metals) and wet waste (e.g., food and yard waste). While the following approaches focus on plastics, they may offer co-benefits for waste methane mitigation:

- Product bans, such as single-use plastic bans for straws, cutlery, and plastic bags that often contaminate organic wastes.
- Product fees, which can be used to shift consumption away from certain products such as single-use plastics or other packaging, thereby incentivizing reusable products or bio-based products that can be managed through composting or anaerobic digestion.
- Incentivizing environmentally preferred products, which can be made with bio-based or recycled content to reduce production impacts or lifecycle emissions of products. Requiring the purchase of bio-based or compostable materials can further support organic waste treatment by providing additional feedstocks for these processes.
- Requiring the use of eco-labels that share information about a product's climate or environmental impact and can guide consumer decisions and encourage behavior change in favor of bio-based products that may be managed in separate organic waste streams.[28]

28 UNEP. (n.d.). *Eco-labelling.* https://www.unep.org/explore-topics/resource-efficiency/what-we-do/responsible-industry/eco-labelling

Market-Based Approaches

Market-based, or economic, approaches rely on encouraging and incentivizing behaviors that improve efficiency and **are the least costly and/or most profitable methods** of reducing pollution and mitigating GHG emissions. Because prices set by the market do not adequately reflect environmental and social impacts, market-based approaches aim to correct price signals to internalize the costs of these externalities.[29] Market-based approaches can help shift the cost burden of waste management to the polluter, a concept often known as the "polluter pays principle." They can also help to improve waste management by "providing a strong incentive to reduce waste generation and encourage source separation of waste to maximize reuse and recycling," diverting materials from disposal, and reducing costs and the budget needed by governments for waste management.[30]

Before we address approaches for methane mitigation in the waste sector, it is important to understand the most common polluter pays-based approach, as employed by municipal governments around the world. **A flat rate fee, or user fee**, may be set by income level, household type, or another socioeconomic factor. Flat rate fees are levied regardless of total waste collected from each household or commercial business and are not designed specifically to mitigate methane emissions but do offer a starting framework to build on. Because households or commercial entities can throw away any quantity of waste, flat rate charges do not increase awareness of the volume or weight of waste generated, nor do they directly incentivize waste minimization and diversion. However, these fees can be set to effectively cover the costs of providing waste management services and to invest in new collection and treatment infrastructure.

Other approaches that can be paired with the flat rate fee and used to specifically address methane mitigation include:

- **Taxes, charges, and fees** can be used to correct price signals, cover waste management costs, and incentivize behaviors that reduce waste generation, reduce landfilling of waste, and increase diversion and treatment of organic and inorganic wastes.[31]
  - **Landfill taxes** raise the cost of the polluting activity while providing additional revenue streams that can be used to monitor industry activity or invest in alternative treatment options. They can be designed to reduce the amount of waste sent to landfills by raising the price, thereby shifting materials to cheaper, less-polluting diversion and treatment options.[32] Generally, taxes are paid by landfill operators, though the added costs may be passed on to waste generators in the form of higher gate or tipping fees.

In the United Kingdom, landfills have been taxed since 1996 at rates determined by type of waste. The rates have risen over the years and are currently around GBP 99 (USD 124) for active or biodegradable waste and GBP 3 (USD 4) for inert waste.[33]

29 Bengtsson et al., 2010.

30 UNEP, 2013, *Guidelines for National Waste Management Strategies.*

31 OECD, 2019, Chapter 4.

32 Plastic Smart Cities. (2023). *Landfill tax.* https://plasticsmartcities.org/landfill-tax/

33 United Kingdom Department for Business, Energy & Industrial Strategy and Department for Energy Security & Net Zero. (2022, November 15). *United Kingdom methane memorandum.* https://www.gov.uk/government/publications/united-kingdom-methane-memorandum/united-kingdom-methane-memorandum#uk-progress-to-date

Tipping fees can also be used to influence a similar change in the way waste is managed, with differentiated fees placed on materials designed to drive recoverable materials away from disposal at landfills and incinerators and toward material recovery facilities or other types of treatment.[34] In the European Union (EU) where incineration of municipal waste is common, taxes are also levied on this form of disposal. Nine EU member states levy taxes on each metric ton of waste incinerated, with the average tax set at around EUR 24 (USD 25) per metric ton.[35]

- **Pay as you throw (PAYT)**[36] is a model that builds on the flat user fee described above and charges households or businesses based on the amount of waste disposed. Systems may be volume-based (pay a set amount for a trash bag of a certain volume) or weight-based (amount charged is based on the weight of the waste). In many cases, the payment for waste that must be sent to landfills is higher than payment for recyclables or organics, which may be free of charge to incentivize diversion. As acceptance of these systems depends on the public's perception of their fairness, the operational design and fee structure must consider impacts on users at all income levels and ensure revenues target waste reduction and recycling efforts.

The Republic of Korea introduced a volume-based waste fee in 1995, requiring citizens to use prepaid bags for waste disposal; recyclables are collected free of charge. In 2014 Korea adopted a weight-based fee for food waste collection and requires households, restaurants, schools, and supermarkets to pay based on the amount of food waste produced. In larger cities, radiofrequency identification equipment is often used to automatically measure and charge households for food waste, eliminating the need for bags.

- **Subsidies and incentives** can support faster uptake and implementation of cleaner and more efficient practices and technologies.[37]
  - **Grants and subsidies** (i.e., direct cash payments) help reduce costly barriers to entry for waste management initiatives and technologies. These payments can support methane mitigation initiatives when used to spur development of the infrastructure required to treat organic waste and detect and capture methane emissions. Alternatively, subsidies can be provided for purchase of compost and digestate, as well as biogas to offset reliance on fossil fuel-based fertilizer and energy sources, respectively.

34 Tipping fees are paid by the entity disposing of waste at the landfill or material recovery facility to the operator (either private or municipal) based on the quantity of waste to be disposed (e.g., $/ton).

35 Overview of taxes on the incineration of municipal waste used in EU Member States, European Environment Agency, 2023.

36 NRDC and the Environmental Law Institute have developed a model ordinance for a PAYT system with other resources for interested governments.

37 Bengtsson et al., 2010.

Colombia's Ministry of Housing, Tourism, and Cities provides funds and incentives for pre-feasibility and feasibility studies to develop and expand solid waste treatment and recovery activities.[38] Funds available each year are based on the amount of waste generated; in 2019, approximately COP 74 billion (USD 22 million) was available to conduct these studies.[39]

- **Tax breaks and incentives** promote preferred behavior by reducing taxes or other charges. Examples can include reduced fees for source-separating waste or minimizing overall generation. Tax breaks may be applied to the purchase of certain types of waste management technologies. For example, the U.S. Inflation Reduction Act includes an investment tax credit for renewable energy that allows businesses to deduct a percentage of the cost of biogas production equipment.[40] Tax breaks can also be used to incentivize food donation by businesses such as restaurants and grocery stores. In the EU, value-added tax guidelines facilitate donation of surplus food, while in France 60% and Spain 30% of the value of donated food can be claimed as a corporate tax credit.[41]
- **Low interest loans, green loans, and climate bonds** reduce the barrier to entry for mitigation solutions, including infrastructure costs for composting and biogas facilities and investments in landfill gas monitoring and capture technologies, by reducing financing costs (interest rates) over the lifetime of the investment. Colombia offers an example of green lending with more than 80 lines of credit focused on a wide range of sustainability and climate investments including several that call out solid waste specifically.[42] Climate bonds offer an emerging alternative finance instrument for waste methane activity investments although they present challenges to municipalities that don't have the financial and technical capacity to secure this source of investment capital.

- **Emissions markets**, also known as emissions trading or cap and trade, can be compliance-based or voluntary. In these schemes, emissions credits are bought and sold to compensate for GHG emissions from a facility, organization, corporation, etc.[43] Current in-force national compliance-based trading systems that place caps on emissions from waste disposal sites (e.g., landfills and incinerators) are present in Australia, Germany, Korea, and New Zealand.[44] International and domestic schemes also allow for the sale of credits generated from emission reduction projects. These are often developed using Clean Development Mechanism methodologies, which are technically robust, but may be beyond the capacity of many municipalities and small project developers to implement, hindering access to the emissions markets.

38 Función Pública. (2015). *Decreto 2412*. https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=76153

39 MAG Consultoría S.A.S. (2021). *Tratamiento de residuos sólidos en el marco del servicio público de aseo*. https://www.minvivienda.gov.co/sites/default/files/documentos/20210806-entregable-1-v5-definitiva_0.pdf

40 See 26 U.S.C. § 48(a), (c) (including and defining qualified biogas property as energy that may be subject to an energy credit).

41 European Commission. (n.d.). *Financial Rules on Food Donation*. https://food.ec.europa.eu/document/download/b915c933-3cbe-4d8b-8b5a-df86417b-fc84_en?filename=fw_factsheet_fd_financial-rules_en.pdf

42 AsoBanCaria, Direccion de Sostenibilidad. (n.d.) *Corredor de financiamiento climático.*

43 United Nations Development Programme. (2022, May 18). *What are carbon markets and why are they important?* [Blog post]. https://climatepromise.undp.org/news-and-stories/what-are-carbon-markets-and-why-are-they-important

44 International Carbon Action Partnership. (2024). *International Carbon Action Partnership ETS map*. https://icapcarbonaction.com/en/ets

- **Procurement incentives or requirements** build demand for products by encouraging use of environmentally preferred products or renewable energy sources. They can be leveraged to incentivize or require the use of organic fertilizer and compost for public green spaces or the purchase of renewable energy from anaerobic digestion and landfill gas-to-energy projects. Additionally, procurement may focus on the ease of end-of-life management — for example, purchasing products that can be recycled or composted within the local or regional waste management system. As large quantity purchasers, governments may set procurement guidelines or requirements for these purchases, supporting the market.

In Mexico City, the Distrito Federal (now Mexico City) Waste Law establishes that mayorships should prioritize the use of compost in parks, gardens, green areas, protected natural areas, and areas that require regeneration. In addition, the law promotes generation of markets for the commercialization of compost and requires criteria be set for compost to enter different markets.[45] The criteria for compost are set in the standard NADF-020-AMBT-2011, and compost has been used on approximately 47 hectares of green areas or areas under reforestation.[46,47]

While all approaches to methane mitigation in the waste sector should consider principles of environmental justice, market-based approaches are particularly pertinent in promoting a just transition for informal recyclers (Box 3).

Box 3: Ensuring a just transition for informal sector recyclers

The informal recycling sector is the cornerstone of waste collection and recycling services in much of the world. However, improvements in waste management and privatization of waste sector services can threaten the livelihoods of these communities. Many policy approaches can and should be designed in such a way as to recognize the important work of the informal sector, improve these individuals' working conditions, and incorporate their expertise into decision-making. Market-based approaches can provide a clear avenue for ensuring a just transition for informal sector workers and cooperatives as waste management systems are adapted to limit their climate impacts. By ensuring these groups are afforded access to incentives created by market approaches (e.g., governments set up programs to pay the informal sector for separating and collecting organic waste, or cooperatives have access to low interest loan programs or subsidies that are offered to other private sector waste operators), policymakers can support these communities.

For more information on supporting informal sector communities and prioritizing environmental justice in the waste sector, see GAIA's Environmental Justice Principles for Fast Action on Waste and Methane.

45 Congreso de la Ciudad de México. (2023). *Ley de residuos sólidos del Distrito Federal*. https://www.congresocdmx.gob.mx/media/documentos/5e9cfdc1fa63fdf6120fd92f434a3e407d58af30.pdf

46 Secretaría del Medio Ambiente, Gobierno de la Ciudad de México. (2012). *Norma ambiental para el Distrito Federal NADF-020-AMBT-2011, que establece los requerimientos mínimos para la producción de composta a partir de la fracción orgánica de los residuos sólidos urbanos, agrícolas, pecuarios y forestales, así como las especificaciones mínimas de calidad de la composta producida y/o distribuida en el Distrito Federal.* https://sedema.cdmx.gob.mx/storage/app/uploads/public/577/290/22c/57729022cdb18069720357.pdf

47 Secretaría de Obras y Servicios, Gobierno de la Ciudad de México. (n.d.). *Residuos sólidos urbanos en la Ciudad de México*. https://www.obras.cdmx.gob.mx/storage/app/media/RSU/RSU%20CDMX%20.pdf

Voluntary Agreements

Voluntary policy agreements are nonregulatory, nonbinding tools used by governments and nongovernmental organizations in partnership with industry to achieve stated policy goals and outcomes. Voluntary agreements can be viewed as a form of self-regulation, allowing entities to achieve policy goals without the risk of penalties for noncompliance.[48] Adequate incentives or benefits for participation can encourage action, but ultimately the success of voluntary programs depends solely on the collective willingness to participate. Examples of voluntary policy agreements include international commitments, pledges, partnerships, and agreements to reduce emissions or other environmental impacts coupled with incentives that reward compliance and continuous improvement.

- **Agreements between national and/or subnational governments** can spur action including meeting agreed-upon targets. National or subnational governments commit to addressing climate and environmental goals and agree to share best practices, capacity-strengthening efforts, and other resources to accelerate action toward shared goals. Private industry may benefit from these pledges and agreements, but do not individually join the arrangement. Examples include the GMP, COP29's Declaration on Reducing Methane from Organic Waste, the Global Covenant of Mayors for Climate & Energy, or C40 Cities' Towards Zero Waste Accelerator. Signatories to C40's Accelerator initiative pledge to reduce MSW generation per capita by 15% by 2030, reduce total MSW sent to landfill and incineration by 50% by 2030, and increase diversion rates from landfills and incinerators to 70% by 2030.

- **Public-private partnerships or agreements** convene governments and industry to agree on targets, goals, and incentives for nonregulatory action. These programs are often less burdensome on industry partners than regulatory approaches and allow greater flexibility in meeting goals.

In 2020, South Africa's Department of Forestry, Fisheries, and the Environment, Consumer Goods Council of South Africa, and Department of Trade, Industry, and Competition launched the voluntary Food Loss and Waste Initiative to reduce food loss and waste in the country by 50% by 2030.[49] To support the voluntary agreement, a web-based food waste reporting system was developed to support monitoring for signatories and create a knowledge hub to share best practices. Signatories, including food and drink producers and manufacturers, retailers, and food services businesses, receive benefits such as access to the reporting portal, working groups, technical support, and publicity for their achievements.[50]

48 OECD. (2000). *Voluntary Approaches for Environmental Policy: An assessment*. https://www.oecd-ilibrary.org/environment/voluntary-approaches-for-environmental-policy_9789264180260-en

49 Republic of South Africa Department of Forestry, Fisheries, and the Environment. (2020). *Food loss and waste voluntary agreement launch* [Address]. https://www.dffe.gov.za/food-loss-and-waste-voluntary-agreement-virtual-launch-word-support-address-delivered-minister

50 Consumer Goods Council of South Africa. (n.d.). *Food Loss and Waste (FLW) Initiative Signatory Benefits* [Report]. https://www.cgcsa.co.za/CGCSA-FS-SI-Signatory-Benefits.pdf

Information and Education Approaches

Information and education approaches can be used to strengthen implementation of policies, increase transparency of the environmental impacts of waste sector operations, improve market access of byproducts through standards for quality and safety, support decision-making, and change attitudes and behavior regarding resource consumption and waste management. In the waste sector, public awareness, buy-in, and participation are key to the success of broader waste management efforts (including household and commercial source separation), which impact methane mitigation efforts to reduce, divert, and treat organic waste. Many of these approaches can be **structured as either voluntary or mandatory**, depending on the goal of the policy.

- **Technical assistance** is a hands-on approach to **capacity-strengthening** in institutions, organizations, and communities by providing tailored guidance to meet stated or observed needs.[51] Technical assistance can take the form of professional development, training and workshops, access to consultants, referral to informational resources, and site visits or study tours to observe best practices with the goal of improving implementation and overall system capacities. By enhancing implementation of regulatory and legislative approaches, technical assistance can thereby reduce methane emissions. Assistance can be provided by government agencies implementing the regulations or by third parties. Technical assistance programs should include an evaluation step to better understand the most successful types of assistance.

The Government of India provides technical assistance to municipalities through trainings and workshops conducted by designated centers of excellence.[52] Its efforts are augmented by international government agencies such as the German Society for International Cooperation, which has assisted cities around the world to improve organic waste management.[53]

- **Information disclosure.** Governments can require facilities to report information to a centralized platform or have information made public through other means. Data can include emissions or toxic release data, waste in place at final disposal sites, or characterizations of the waste stream. Emitters may also voluntarily disclose information for a variety of reasons, including public pressure and corporate targets. Pressure to disclose information can drive changes, including improvements in operations, process, and product design. Box 4 highlights examples of voluntary and required disclosure programs for landfills in the U.S.

51 Scott, V. C., Jillani, Z., Malpert, A., Kolodny-Goetz, J., & Wandersman, A. (2022). A scoping review of the evaluation and effectiveness of technical assistance. *Implementation Science Communications*, 3(70). https://doi.org/10.1186/s43058-022-00314-1

52 *Memorandum of Understanding between the Ministry of Housing and Urban Affairs, Government of India and the Indian Institute of Management in Indore.* (2022). https://mohua.gov.in/upload/uploadfiles/files/MoU-CoE-IIM-Indore-28th-Nov.pdf

53 Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ). (2021). *India: Protecting the environment and climate with innovative technologies.* https://www.giz.de/en/worldwide/93150.html

The Government of India fosters healthy competition among cities and towns to improve their cleanliness under the Swachh Bharat (Clean India) Mission. The Swachh Survekshan, or cleanliness survey, collects information on cities and ranks them for their cleanliness each year. The ranking is based on provision of services for SWM and includes indicators such as source segregation of waste, waste treatment capacity, and reduction of waste disposal. The information is used to provide each city with a star rating of one, three, five, or seven, with only three of 4,477 cities achieving a "seven-star" rating in 2023.

- **Environmental certifications and quality standards** are developed to serve as benchmarks for quality and safety; they can also signal climate and environmental attributes of products to consumers to aid preferred decision-making. Certifications and quality standards can be developed and maintained by governments or nongovernmental organizations.

For example, EN 16723, developed by the European Committee for Standardization in response to EU Commission Mandate M/475, defines technical specifications for biomethane to be injected into the natural gas network or used as an automotive fuel.[54]

Another example is the ASTM D6400 standard that applies to products made from plastics designed to be composted in municipal and industrial aerobic composting facilities; the Biodegradable Products Institute is a nonprofit organization that reviews and certifies that compostable products meet the ASTM D6400.[55]

- **Education and behavior change** programs are specific communications and outreach efforts to inform the public or other stakeholders about an issue. These programs can be leveraged to promote education on methane abatement benefits and incentivize behavior change, but should be tailored to the local context and be inclusive to all community members within the specified audience.
  - **Education and behavior change campaigns** can utilize community-based social marketing to increase efficacy of the outreach. The U.S. EPA's social marketing toolkit provides resources on how to develop impactful behavior change campaigns, as well as a food waste prevention social marketing toolkit. Chile's Reciclo Organicos program includes materials to educate the general public about the benefits of source separation of waste and how to compost at home. Case studies, education infographics, posters, and factsheets are available in Spanish on the program's website.
  - **Educational programs at schools** have proved to be successful in educating younger generations. For example, the World Wildlife Fund Food Waste Warriors initiative worked in nine cities on student-led food waste audits and developed a conservation curriculum focused on reducing food waste across grade levels, with teaching resources available in English and Spanish.

54 GreenMeUP. (2024). *Development of Standardisation Processes for Biomethane.* https://www.greenmeup-project.eu/wp-content/uploads/2024/07/D1.4.pdf

55 BPI. (2024). *Mission*. https://bpiworld.org/bpi

Box 4: Voluntary and required information disclosure for landfills in the U.S.

The U.S. EPA's Landfill Methane Outreach Program (LMOP) is a voluntary partnership working with industry and waste management decision-makers to reduce landfill methane and promote recovery and beneficial use of biogas from MSW. In addition to providing technical assistance and informational materials on the benefits of biogas, LMOP maintains a national landfill gas energy project database comprised of voluntarily reported data.[56] The LMOP database promotes transparency and information exchange among partners, which can accelerate adoption of methane mitigation strategies. LMOP aims to foster partnerships and create networking opportunities with peers and renewable energy experts.

In a different type of program, the U.S. Greenhouse Gas Reporting Program (GHGRP) requires MSW landfills that generate more than 25,000 metric tons of CO_2e to report their emissions and other data annually, which are then published and made available online. In 2022, 1,123 municipal landfills, representing over 90% of industry emissions, reported to GHGRP.[57] In May 2024, the EPA finalized updated reporting requirements for MSW landfills through the GHGRP. The updates require additional reporting on gas collection system characteristics to include the percentage of recovered methane sent to a destruction device annually. In August 2024, the EPA further requested public comments on advanced and emerging technologies used for quantifying methane emissions in the MSW and oil and gas sectors to evaluate the need for further rulemaking on use of these technologies to increase transparency and the accuracy of measurements.[58] According to the EPA, GHGRP data can be used to track and compare facility emissions, identify opportunities to mitigate pollution, and develop "common-sense" climate policies.[59]

56 U.S. EPA. (2024). *Voluntary data collection from LMOP partners.* https://www.epa.gov/lmop/voluntary-data-collection-lmop-partners

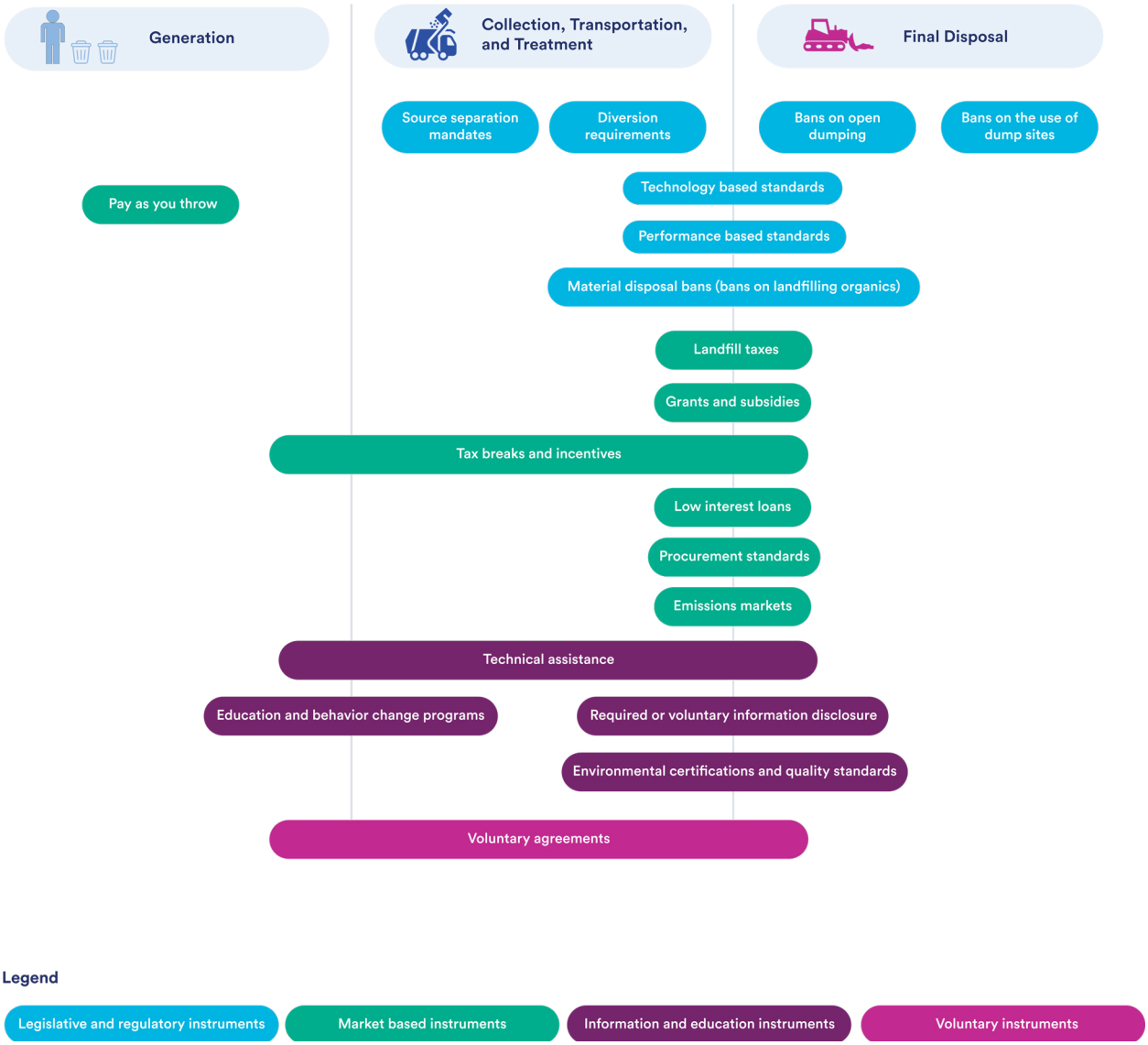
57 U.S. EPA. (2024). *GHGRP waste.* https://www.epa.gov/ghgreporting/ghgrp-waste

58 U.S. Federal Register. (2024, August 29). *Use of advanced and emerging technologies for quantification of annual facility methane emissions under the Greenhouse Gas Reporting Program* [Notice]. https://www.federalregister.gov/documents/2024/08/29/2024-19403/use-of-advanced-and-emerging-technologies-for-quantification-of-annual-facility-methane-emissions

59 U.S. EPA. (2023). *Learn about the GHGRP.* https://www.epa.gov/ghgreporting/learn-about-greenhouse-gas-reporting-program-ghgrp

The approaches discussed in this section are organized by the four simplified categories outlined in this guide and according to the steps of the SWM chain that they directly impact (Figure 4). For example, PAYT programs are often implemented with the aim of directly encouraging waste generators to reduce their total waste and raising revenues for municipal waste management operations. They further indirectly influence the management chain by reducing the amount of waste that must be collected, treated, or disposed and encouraging source separation of waste depending on the structure of the program. Therefore, for purposes of this guide, PAYT is classified as a market-based approach that is most applicable at the point of waste generation.

Figure 4: Categorization framework of solid waste methane mitigation policy approaches along the solid waste management chain



Section 3

Policy Development Considerations

The range of policy approaches and tools available to governments aiming to mitigate methane emissions from the waste sector indicates that no single approach or universal set of policies can be applied across all countries. The appendices to this report provide detailed examples of how various nations have combined and layered different policy approaches to address this challenge in distinctive ways.

While the deepest cuts in methane pollution can only be achieved through a complete ban on organic waste disposal in landfills, complemented by policies that promote waste treatment and minimize emissions from final disposal sites, not all governments will prioritize such stringent measures. Many will need to balance these efforts against other pressing priorities, such as economic development and public sanitation.

This section presents a list of considerations to guide policy development and design. These considerations highlight the importance of adaptability, ensuring that each country sets goals and chooses policies aligned with its specific capacities, priorities, and waste management realities, as it seeks to increase its ambition to mitigate methane. Considerations to keep in mind are the following:

Coordinate and align multilevel governance and institutional frameworks.

Most importantly, when crafting an institutional framework that adequately addresses SWM's role in climate change, decisionmakers must ensure that efforts are coordinated and aligned across all levels of government. This process includes the need for champions at all levels who align governance and institutional frameworks, laws, policies, and strategies to meet both waste management and climate goals. Without incorporating climate change mitigation into the main objectives of their approaches, governments risk continuing systems that ignore the critical impact of waste management on climate, environment, and public health. Coordination is imperative to ensure municipal waste management and climate plans correspond to their national counterparts.

Consider the current realities of the national waste management system.

Policy design must consider the existing waste management infrastructure to define realistic and attainable goals and develop strategies to achieve them. For example, countries starting with only open dumpsites and limited or no collection services must first invest in the basics of waste collection, hauling, and proper sanitary treatment. Further, national policies must be supportive of action at the local and municipal levels and integrate clear mechanisms for driving regulated entities toward compliance.[60] For example, bans on landfilling organic waste cannot be implemented by municipalities without an accompanying enabling framework to promote treatment of this waste stream. This framework can take the form of streamlined permitting and subsidies for facilities that treat organics, source separation mandates, and increased fees imposed on disposal sites that accept organics, among a host of other actions.

Utilize a combination of policy approaches to achieve goals.

Most often, countries that have found success have layered approaches — often over time — to target different aspects of the SWM chain and different challenges that arise. The IPCC has stated with high confidence that "low-emission technological innovation is strengthened through the combination of technology-push policies, together with policies that create incentives for behavior change and market opportunities."[61] Countries choosing approaches and designing policies should bear this combination in mind as they evaluate the environmental benefits, cost-effectiveness, distribution of costs and benefits, and institutional feasibility of policy options that suit national circumstances.[62]

Implement policy approaches across the entire solid waste management chain.

To effectively manage waste and reduce emissions, policies must address both the upstream separation of waste and downstream landfill emissions. Mandating source separation of organic waste and inorganic waste is a foundational step in creating a system that values and utilizes organic materials, but this transition, and the resulting drop in methane emissions, takes time. Robust mitigation solutions at new and existing landfills — and the corresponding monitoring and enforcement protocols — are essential as they mitigate climate pollutants in the near term, while supporting policies and infrastructure development that enable broader, more effective methane reduction through upstream organic diversion over time.

Identify and address potential roadblocks or competing policies.

Early identification and mitigation of roadblocks or misalignment with other policies are essential to ensure the successful implementation of waste management and valorization initiatives. This need may mean repealing, or otherwise amending, current policies that inhibit the goals of improved waste management and methane mitigation. For example, policies to promote development of compost treatment technologies may be hindered by subsidies for use of chemical fertilizers. Similarly, waste management frameworks that only promote or prioritize disposal in sanitary landfills limit funding and development of organic waste treatment projects that extend landfill life.

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60 Giles, C. (2022). *Next Generation Compliance: Environmental regulation for the modern era*. Oxford University Press. https://static1.squarespace.com/static/631e3d07bc567e7e9a19c191/t/635e952f7272f54fa91aad9e/1667142986113/9780197656747.pdf

61 IPCC. (2023). *Climate Change 2023: Synthesis report*. pp. 35-115. https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_LongerReport.pdf

62 Gupta, S., Tirpak D. A., Burger N., Gupta J., Höhne N., Boncheva, A. I., Kanoan, G. M., C. Kolstad, Kruger, J. A., Michaelowa, A., Murase, S., Pershing, J., Saijo, T., Sari, A. (2007). Chapter 13: Policies, instruments and co-operative arrangements. In *Climate change 2007: Mitigation.* Contribution of working group III to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg3-chapter13-2.pdf

Ensure adequate funding is available for infrastructure and service improvements.

Governments should impose fees on waste generators that cover the costs incurred along the entirety of the SWM chain, reflective of the polluter pays principle. Lack of access to funding for services and infrastructure is a key barrier to scaling methane mitigation solutions in the solid waste sector. Subnational governments that implement these solutions need sustainable sources of funding for upfront capital expenditures and long-term operational and maintenance costs. Raising revenues through taxes or tariffs, increased tipping fees, or PAYT is needed to help governments cover these costs. Increased waste management revenues also make these services more attractive to climate and development banks and encourage private investment. Nevertheless, governments must consider social equity when implementing these programs, providing subsidized services through a fee reduction or offset.

Support development of business models that facilitate scaling of collection and treatment of organics.

Effective waste management requires scalable, sustainable business models that support the collection and treatment of organic waste. Governments can play a crucial role in fostering these models by creating incentives that encourage investment and innovation in organic waste-processing and other decentralized waste management infrastructure. By helping to generate demand for organic waste services and their end products, governments can drive revenue streams essential for the long-term viability of these facilities. This process involves more than simply establishing infrastructure; it requires carefully crafted incentives that support the financial sustainability of organic waste collection and processing. For example, tax incentives, grants, and low-interest loans can encourage businesses to enter the organic waste management sector. Furthermore, establishing policies that foster partnerships between local businesses and waste management services can create a steady demand for organic waste end products, such as compost or biogas.

Establish coordinated, multifunctional reporting requirements and regular data collection.

Many countries lack high-quality, accurate data for use in monitoring and reporting on waste management despite this data being useful for tracking progress toward national or MSW management plans and national climate commitments. Regular standardized waste audits and waste characterizations can help national and subnational governments understand the quantity and types of materials in the MSW stream.[63] This information is critical for GHG emissions modeling as well as scoping and scaling mitigation solutions. Information collection at landfills, including waste in place, management practices, the presence of a flare or capture system, and the end use of collected landfill gas, is not currently a standard practice.

Invest in public education, awareness, and behavior change programs.

Not only do these programs help citizens and businesses understand the importance of the changes being made to their waste management systems and create public will, but they explain expected behaviors moving forward such as how to separate food waste from the rest of household waste or how to follow new collection schedules. A robust public education and awareness campaign will also help ease concerns and complaints and, ideally, provide a feedback mechanism wherein citizens can support governments to make these programs more effective and efficient.

63 UN-Habitat has developed the Waste Wise Cities Tool to help governments collect data on municipal solid waste. Additionally, the Global Methane Initiative has published guidance on conducting waste characterizations.

Section 4

Conclusions

The aim of this guide is to clarify and simplify the myriad of policy approaches that can be employed to accelerate methane mitigation from the municipal solid waste sector. When we consider examples of countries that have successfully used these approaches to improve waste management and reduce climate impacts (see the Appendix for Country Case Studies), it becomes clear that there is no silver bullet or single solution to achieve this goal. Nevertheless, decisions made with the aim to reduce waste sector methane pollution should be viewed as part of a holistic strategy to create and enhance integrated SWM systems that adequately address all waste materials, while improving environmental and public health and adding value to local communities.

The road to achieving climate goals and reduced methane emissions does not end with policy design, but with strong implementation, sustained enforcement, and periodic evaluation of programs.

While this guide seeks to fill one significant gap in that chain of events, strong international cooperation, increased access to sustainable funding for infrastructure costs and operations, improvements in measurement and monitoring technologies, and political will all need to be addressed to effectively mitigate methane pollution from the solid waste sector and limit warming to 1.5 degrees Celsius.

Appendix

Country Case Studies

This appendix provides an overview of how seven countries have used the policy approaches discussed in this guide to craft an enabling environment that mitigates methane pollution from SWM. A government's choice of policy approach(es) will depend on various factors including waste composition, geography, and socioeconomic and cultural factors. To improve waste management and reduce its climate impacts, a mix of approaches is needed.

Country examples are provided for **Colombia, Germany, India, Italy, Perú, the Republic of Korea, and the United States of America.** These examples are not meant to be inclusive of every waste sector or climate change policy that exists in a particular country, but rather to highlight the approaches discussed in this guide and showcase real-world examples of their implementation. These countries were chosen due to their political leadership and incorporation of a variety of policy approaches related to waste sector methane mitigation. A summary of the approaches utilized in these countries is provided in Table 1.

Methodology

Research conducted for these case studies was conducted primarily in English-language sources; therefore, some relevant information may have been overlooked.

All units are reported in metric tons. Annual waste generation refers to data on MSW generation in the country and does not include construction and demolition waste or hazardous waste.

All information on methane emissions was taken from countries' official communications to the United Nations Framework on Climate Change (National Inventory Reports, National Communications, Biennial Update Reports). Where methane emissions were reported in CO_2e, the appropriate global warming potential (the one used by that country in its inventory) was used to convert emissions to metric tons of methane to more accurately compare across countries; change in emissions was calculated based on this value. Methane emissions from solid waste include emissions reported from landfills as well as biologic treatment of solid waste where available, and in the case of Germany emissions from mechanical biological treatment. Time frames over which the change in emissions is calculated vary by country. In the cases of Colombia, India, and Perú, the earliest inventory year was used, but regardless of the period analyzed, methane emissions were always found to have increased. In the cases of Germany, Italy, Korea, and the U.S., the time frame was selected based on when certain policy approaches were enacted to highlight the impact of the policy framework.

Table 1: Summary of policy approaches in country case studies

Policy Approaches													
	Legislative and Regulatory			Market-Based				Voluntary Agreements		Information and Education			
	Pollution Standards	Source Separation and/or Diversion	Bans	Taxes, Charges, and Fees	Subsidies and Incentives	Emissions Markets	Procurement Incentives	Government Agreements	Public-Private Agreements	Technical Assistance and/or Training	Information Disclosure	Environmental Certifications and Quality Standards	Education and Behavior Change
Colombia	x	x	x	x	x			x			x	x	x
Germany	x	x	x	x	x		x	x		x		x	x
India	x	x	x	x	x					x			x
Italy	x	x	x	x	x		x	x		x	x	x	x
Perú	x	x		x	x			x			x		x
Republic of Korea	x	x	x	x	x	x	x	x		x			x
U.S.	x	x	x		x		x	x	x	x	x		x

Colombia

National Policies, Strategies, and Plans

Colombia's National Environmental Policy (CONPES 2750), established in 1994, is the foundational policy for environmental programs in the country's National Development Plan, which includes SWM. CONPES 3874 of 2016, the National Policy for Integral Management of Solid Waste, complements CONPES 2750, and further identifies four strategic objectives for adequately managing waste:[68]

1. Reduce the amount of waste generated at the source;
2. Minimize the amount of waste arriving at final disposal sites;
3. Promote reuse, recovery, recycling, and treatment of solid waste to further reduce landfilling rates; and
4. Avoid the generation of GHGs.

CONPES 3530 of 2008 was created to encourage the regionalization of sanitary landfills to promote final disposal in authorized sites and improve SWM in urban and rural areas. Regional landfills facilitate waste management in smaller municipalities that do not always have access to disposal facilities.

At a Glance

Population[64]

52.3M

Annual Waste Generation[65,66]

14M tons

70% organic

Methane Emissions from Solid Waste[67]

CH_4 380 thousand tons

Change in Methane Emissions: 2010 to 2018

26% increase

GMP Signatory

Yes

GMP Waste Sector Commitment

No methane action plan

64 ELADE—Population Division of CEPAL and United Nations, Department of Economic and Social Affairs, Population Division. (2022). *World population prospects 2022.* https://www.cepal.org/es/subtemas/proyecciones-demograficas/america-latina-caribe-estimaciones-proyecciones-poblacion/estimaciones-proyecciones-excel

65 Hub de Residuos Sólidos y Economía Circular. (2023). *Base datos regional 150523 descargar*. https://hubresiduoscirculares.org/gestion-del-flujo-de-materiales/

66 Caicedo-Concha, D. M., Sandoval-Cobo, J. J., Stringfellow, A., & Colmenares-Quintero, R. F. (2021). An evaluation of final disposal alternatives for municipal solid waste through life cycle assessment: A case study in Colombia. *Cogent Engineering* 8(1). https://doi.org/10.1080/23311916.2021.1956860

67 Gobierno de Colombia. (2022). *Tercer Informe bienal de actualización de cambio climatico de Colombia (BUR3) dirigido a la Convención Marco de las Naciones Unidad sobre Cambio Climaático*. https://unfccc.int/documents/424157

68 MinAmbiente. (2016). *CONPES 3874: Política nacional para la gestión integral de residuos sólidos*. República De Colombia, Departamento Nacional de Planeación. https://www.minambiente.gov.co/documento-normativa/conpes-3874-de-2016/

Other national-level policies that refer to waste management include:

- **CONPES 3934 of 2018: Green Growth Policy.** Ensures sustainable development by establishing a green growth model that safeguards natural capital and climate security.
- **CONPES 3918 of 2018: Strategy for implementation of the Sustainable Development Goals (SDGs).** Defines targets and indicators to ensure environmental conservation through a roadmap for implementing Agenda 2030 and the SDGs in Colombia. Regarding waste, the policy sets a national recycling target of 17.9% by 2030 in its SDG target 12 to increase recycling rates and reuse of solid waste.

Colombia's National Climate Change Policy was developed to reduce GHG emissions and serve as the foundation of Colombia's first NDC.[69] The policy incentivizes the reduction, reuse, recycling, and utilization — including energy generation — of solid waste prior to its final disposition, as well as utilization of landfill gases. Solid waste mitigation actions included in the revised 2020 NDC are increased organics separation, collection and treatment via mechanical biological treatment systems, increased biogas collection from sanitary landfills, and increased landfill gas use to generate electricity, primarily in the Doña Juana landfill in Bogotá. These actions are estimated to lead to a 1.31 Mt CO_2e reduction, equivalent to 5% of total emissions from the waste sector.[70]

Legislative and Regulatory Approaches

- **Pollution standards**
  - Resolution 938 of 2019 established minimum guidelines for the design and operation of disposal sites, as well as guidelines for closure, decommissioning, and the post-closure phase of facilities. The following minimum standards are defined for operation of all disposal sites: gas capture and flaring, measurement of gases such as methane and hydrogen sulfide, and flammability limits using sensor equipment.

- **Source separation and/or diversion requirements**
  - Resolution 2184 of 2019 established a color code for the separation of solid waste at source at the national level: green for organics, white for recyclables, and black for nonrecyclables.

- **Bans**
  - Resolution 1390 of 2005 defined guidelines for closure of inadequate final disposal sites of waste that do not comply with environmental standards
  - Decree 838 of 2005 works to prohibit uncontrolled dumping and burning of waste by allowing landfills as a final disposal alternative.
  - Resolution 1890 of 2011 prohibits uncontrolled dumping, burning, and storage of waste in temporary cells by stating final disposal alternatives for municipal solid waste, approved by the environmental authorities.

Market-Based Approaches

- **Taxes, charges, and fees**
  - Resolution 720 of 2015 established the tariff regulation regime for landfill operators with monthly final disposal of more than 300 tons of waste and public waste service providers in municipalities with more than 5,000 subscribers in urban areas. Also established waste treatment alternatives to landfilling that are covered under the tariff as long as they do not exceed the cost of final disposal plus the cost of leachate treatment

69 MinAmbiente. (2017). *Política nacional de cambio climático.* https://www.minambiente.gov.co/wp-content/uploads/2022/01/9.-Politica-Nacional-de-Cambio-Climatico.pdf

70 Gobierno de Colombia. (2020). *Actualización de la contribución determinada a nivel nacional de Colombia.* https://unfccc.int/sites/default/files/NDC/2022-06/NDC%20actualizada%20de%20Colombia.pdf

- Decree 1784 of 2017 updated Resolution 720 by establishing guidelines for waste treatment activities and empowers operators and providers of public waste management services to charge fees for these activities. Also provided a tariff for the public sanitation service for landfill gas capture and utilization technologies.
- Resolution 853 of 2018 established the tariff regulation regime for landfill operators with monthly final disposal of less than 300 tons of waste and public sanitation service providers serving municipalities with fewer than 5,000 subscribers in urban areas.

Subsidies and incentives

- Decree 2412 of 2018 provides funds and incentives for pre-feasibility and feasibility studies to develop and expand solid waste treatment and recovery activities. The funds available each year are based on the amount of waste generated.
- Law 2099 of 2021 defines biomass within the Colombian energy matrix as a nonconventional source of renewable energy, allowing such projects to obtain tax benefits.

Voluntary Agreements

Agreements between national and/or subnational governments

- Colombia is a signatory to the Paris Agreement, the GMP, and COP29's declaration on Reducing Methane from Organic Waste.

Public-private partnerships or agreements

- Colombia is a founding member of the Global Methane Initiative, an international public-private partnership focused on reducing barriers to the recovery and use of methane as an energy source.

Information and Education Approaches

Required or voluntary information disclosure

- Law 689 of 2001 created the Unified Information System, a platform to collect and process information reported by public service companies on final disposal of waste at landfills and dumpsites and established the Superintendent of Residential Public Utilities as administrator of this system.

Environmental certifications and quality standards

- Colombian Technical Standard 5167 of 2011 established guidelines and tests that organic products must meet to be used as soil conditioners or soil improvers.
- Resolution 240 of 2016 established standards for domestic public gas utilities concerning biogas and biomethane.

Education and behavior change

- Colombia established a "Communication and Environmental Agenda" at all grade levels.

Sources

Lavola, A. (2021). *Estructuración y formulación de la NAMA de residuos sólidos municipales.* https://www.minvivienda.gov.co/sites/default/files/documentos/resumen-ejecutivo-nama-rsm-colombia_final.pdf

INERCO. (2018). *Valorización energética de residuos: Proyecto WTE Colombia.*

MAG Consultoría S.A.S. (2021). *Tratamiento de residuos sólidos en el marco del servicio público de aseo.* https://www.minvivienda.gov.co/sites/default/files/documentos/20210806-entregable-1-v5-definitiva_0.pdf

Germany

National Policies, Strategies, and Plans

As an EU member state, Germany implements the EU legal framework on waste, including the EU Waste Framework Directive (2008/98/EC) and Landfill Directive (1999/31/EC). Germany's legal framework for waste management dates back to the 1970s. Regarding methane mitigation in the waste sector, Germany took its most decisive action in 1993 with the Technical Ordinance on Municipal Waste that banned the landfilling of untreated MSW from June 2005 onward. This ban is an integral part of all subsequent German legislation on landfills and ensures that MSW landfilled in the country emits minimal amounts of methane.

In the 1970s, Germany closed around 50,000 uncontrolled landfills and built large centralized engineered disposal sites with gas capture systems. Following that, the EU Landfill Directive (1999/31/EC), amended by Directive (EU) 2018/850, came into force and required member states to reduce the amount of biodegradable municipal waste landfilled to 35% of 1995 levels by 2016 (for some countries by 2020)[75] and stipulated that 10% or less of municipal waste is landfilled by 2035. For primary waste treatment, Germany exceeded this target by landfilling less than 1% since 2016 and had already implemented the ban on disposing untreated organic waste as mentioned above.[76]

At a Glance

Population[71]

84.4M

Annual Waste Generation[72,73]

46M tons

40-50% organic

Methane Emissions from Solid Waste[74]

CH_4 117 thousand tons

Change in Methane Emissions: 1990 to 2022

91% decrease

GMP Signatory

Yes

GMP Waste Sector Commitment

No methane action plan

71 World Bank Group. (2023). *Population, total: Germany.* https://data.worldbank.org/indicator/SP.POP.TOTL?locations=DE

72 German Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection. (2023). *Waste Management in Germany 2023: Facts, data, figures.* https://www.bmuv.de/fileadmin/Daten_BMU/Pools/Broschueren/abfallwirtschaft_2023_en_bf.pdf

73 German Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection. (n.d.) Organic waste. https://www.bmuv.de/en/topics/water-management/circular-economy-overview/overview-types-of-waste-and-waste-flows/organic-waste

74 German Environment Agency. (2024). *National Inventory Document for the German Greenhouse Gas Inventory 1990-2022.* https://unfccc.int/documents/637995

75 European Commission. (n.d.). Biodegradable Waste. https://environment.ec.europa.eu/topics/waste-and-recycling/biodegradable-waste_en

76 European Environment Agency. (2022). *Early Warning Assessment Related to the 2025 Targets for Municipal Waste and Packaging Waste: Germany.* https://www.eea.europa.eu/publications/many-eu-member-states/germany#:~:text=In%20Germany%20there%20is%20no,introduced%20through%20an%20administrative%20regulation.

Waste management infrastructure has continued to evolve in Germany in response to these regulations, with prevention and separate collection and treatment as the most important measures. However, residual wastes in the country (e.g., diapers, sanitary products, ashes from fireplaces, non-recyclable plastics) continue to be high in organic waste (39% by weight) and pretreatment prior to disposal curbs methane emissions from landfills.[77] Residual waste is treated through mechanical biological treatment or incineration with energy and heat recovery, after which the residues are landfilled.

The Circular Economy Law of 2012, and amended in 2020, mandated separate collection and treatment of biodegradable waste since 2015.[78] The waste hierarchy specified therein is ordered as prevention, preparing for re-use, recycling, other recovery (particularly energy recovery), and disposal. Germany has a clear color-coded system for collection bins that increases the efficiency of both recycling and resource recovery from organic waste. Resource recovery from biowaste is achieved by composting or anaerobic digestion systems to produce soil amendments and biogas.

Finally, The German Federal Ministry of Food and Agriculture and associations representing the agricultural sector, the food and nutrition industry and the catering and hotel sector signed an agreement to reduce food waste by 30% by 2025 and by 50 % by 2030 at the retail and consumer levels relative to 2015 levels.[79]

Legislative and Regulatory Approaches

- **Pollution Standards**
  - The Landfill Ordinance of 2009, amended in 2024, specifies the criteria for construction, operation, closure, and post-closure maintenance of landfills.[80]

- **Source separation and/or diversion requirements**
  - The Circular Economy Law of 2012 mandated separate collection of biowaste from private households from January 2015. Most biowaste and residual waste are collected through a door-to-door system, while recyclables may be collected similarly or at community collection points. Paper and Cardboard are collected separately, and often free of charge as the value of the material covers the costs for collection and recycling. The packaging share of paper and cardboard is financed by EPR, a legal requirement according to German and EU law. However, separate collection of biowaste has not been implemented evenly across Germany by municipalities.[81]

- **Bans**
  - The Landfill Directive (1999/31/EC), as amended by Directive (EU) 2018/850, obligated member states to landfill 10% or less of municipal waste generated by 2035.
  - The German Technical Ordinance on Municipal Waste issued in 1993 banned the disposal of organic waste with total organic carbon greater than 3%; in the case of waste that undergoes bio-mechanical treatment, total organic carbon of 18% and a calorific value of 6000 kJ/kg (dry matter) should not be exceeded and the respiration activity AT4 of less than 5 mg/m3 and a gas formation rate GB21 of less than 20 ml/g should be attained.

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77 Anja Schwetje. (2024). German experience in methane mitigation in the waste sector [Presentation]. https://www.ccacoalition.org/sites/default/files/resources/files/Presentation%20%233_%20German%20Experience%20in%20Methane%20Mitigation%20in%20the%20Waste%20Sector%2C%20Ms.%20Anja%20Schwetje%2C%20UBA.pdf

78 German Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection. (2012). Circular Economy Act. https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Abfallwirtschaft/kreislaufwirtschaftsgesetz_en_bf.pdf

79 German Ministry of Food and Agriculture. (2020). General Agreement on the Reduction of Food Waste. https://www.bmel.de/SharedDocs/Downloads/EN/_Food-and-Nutrition/general_agreement-reduction_of_food_waste.pdf?__blob=publicationFile&v=1

80 German Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection. (2009). Ordinance on landfill sites and long-term storage facilities (landfill ordinance – DepV). https://faolex.fao.org/docs/pdf/ger126682E.pdf

81 German Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, 2023, Waste Management in Germany 2023.

Market-Based Approaches

- **Taxes, charges, and fees**
  - 100% of the population pays waste management fees and has access to waste services. Collection and treatment for paper and cardboard packaging is financed by EPR schemes. Domestic waste management is the exclusive competence of the legal persons responsible under Land law (public bodies responsible for waste management), which are generally the municipalities. Therefore, municipalities are in charge of residual waste, bulky waste and separated biowaste waste; they set waste fees (sometimes PAYT) based on the principle of cost-coverage. To encourage separate collection, the biowaste collection is often less expensive than collection of residual waste.
  - Germany does not have a landfill tax. Waste collection fees or PAYT fees are set by some local municipalities and not across the country. Only 30% of the population is covered by collection fees for residual waste. Recyclables and separated biowaste waste are collected without a charge.

- **Subsidies and incentives**
  - The National Climate Protection Initiative provides funding for a diverse range of climate related projects. Through this initiative, the German government has provided EUR 62 million in funding to support ventilating legacy landfills (i.e., those that continue to produce small quantities of methane) with air to prevent the formation of GHGs.[82]

- **Purchasing and Procurement**
  - The German Environment Agency has developed guidelines to help administrative bodies move towards being greenhouse gas neutral.[83] These guidelines include green procurement practices.

Voluntary Agreements

- **Agreements between national and/or subnational governments**
  - Germany is a signatory to the Paris Agreement, the GMP, and COP29's declaration on Reducing Methane from Organic Waste.

- **Public-Private Partnerships or Agreements**
  - Germany is a partner country of the Global Methane Initiative, an international public-private partnership focused on reducing barriers to the recovery and use of methane as an energy source.

Information and Education Approaches

- **Technical Assistance**
  - Associations provide a platform for technical assistance and information exchange in Germany (e.g., the German Association of Local Public Utilities of municipally determined infrastructure undertakings and economic enterprises (Verband kommunaler Unternehmen e.V.), Fachverband Biogas, ITAD, Bundesgütegemeinschaft Kompost e.V, and ASA).

82 German Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection. (2019). BMU and waste management agree on achieving 2030 climate targets. https://www.bmuv.de/pressemitteilung/bmu-und-abfallwirtschaft-einig-ueber-erreichen-der-klimaziele-2030/

83 Umwelt Bundesamt. (2020). *The Path to Greenhouse Gas Neutral Administration: Stages and guidelines.* https://www.umweltbundesamt.de/sites/default/files/medien/3521/publikationen/fb_path-greenhouse-gas-neutral-administration_bf.pdf

- **Environmental certifications and quality standards**
  - The Ordinance on Biowastes of 1998 specifies the requirements regarding the quality of compost and digestate from anaerobic digestion facilities. These address contaminant and hygiene properties, allowable biowaste input, monitoring requirements, processes, and limitations on soil application.[84] On a voluntary basis, the Bundesgütegemeinschaft Kompost e.V. and the German Institute for Quality Assurance and Certification support voluntary product certification for manufacturers of fertilizers and soil improvers. The label is independent and is trusted by the population and relevant actors in Germany.

- **Educational and behavior change**
  - An annual German Organic Waste Campaign is run by a coalition of policymakers, business and associations and promoted by German Environment Agency and the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection. The campaign is directed at municipalities to improve their organic waste collection and reduce the amount of contamination in the organic waste bins.[85]

84 Umwelt Bundesamt. (2016). Organic-waste treatment. https://www.umweltbundesamt.de/en/topics/waste-resources/waste-disposal/organic-waste-treatment#composting-and-fermentation-

85 Umwelt Bundesamt. (2022). Aktion Biotonne Deutschland (German organic waste campaign) launches a "28-day organic waste bin challenge" for citizens. 2022 [Press release]. https://www.umweltbundesamt.de/en/press/pressinformation/aktion-biotonne-deutschland-german-organic-waste

India

National Policies, Strategies, and Plans

The Solid Waste Management Rules, 2016[90] govern waste management in India. The SWM Rules are comprehensive in that they address all aspects of waste management, including:

1. Responsibilities: Waste generators are responsible for providing segregated waste for collection. Urban local bodies (e.g., municipal governments) are responsible for developing and implementing action plans in their jurisdictions that comply with the national rules. State urban development agencies are responsible for developing state-level policies and strategies that are in line with national rules. National government ministries are responsible for implementation and creating an enabling environment.
2. Waste minimization: Local and state government agencies are responsible for developing information, education, and communication campaigns to reduce waste generation, including through home and community composting.
3. Collection: Waste generators are required to segregate their waste as dry (primarily recyclables), wet (primarily organic waste), and hazardous and to make it available for urban local bodies that are required to collect the segregated waste.
4. Recycling: Local government agencies are required to incorporate the informal sector into collection activities and increase recycling through materials recovery facilities.

At a Glance

Population[86]

1.4B

Annual Waste Generation[87,88]

62M tons

50% organic

Methane Emissions from Solid Waste[89]

CH_4 791 thousand tons

Change in Methane Emissions: 2011 to 2019

19% increase

GMP Signatory

No

GMP Waste Sector Commitment

N/A

86 World Population Dashboard India, Department of Economic and Social Affairs, Population Division. (2022). *World population prospects 2022*. https://www.unfpa.org/data/world-population-dashboard

87 Central Pollution Control Board. (2023). *Annual Report 2021-22 on Implementation of Solid Waste Management Rules, 2016*. https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2021-22.pdf

88 Government of India, Ministry of Housing and Urban Affairs. (2021). *Circular Economy in Municipal Solid and Liquid Waste*. https://mohua.gov.in/pdf/627b8318adf18Circular-Economy-in-waste-management-FINAL.pdf

89 Government of India, Ministry of Environment, Forest and Climate Change. (2023). *India Third National Communication and Initial Adaptation Communication to the United Nations Framework Convention on Climate Change*. https://unfccc.int/documents/636235

90 Government of India, Ministry of Environment, Forest and Climate Change. (2016). *Solid Waste Management Rules, 2016*. https://cpcb.nic.in/uploads/MSW/SWM_2016.pdf

5. Treatment: Organic waste is to be composted or processed through anaerobic digestion. Waste to energy systems include both biogas projects and the use of refuse-derived fuel from nonrecyclable combustible waste products.
6. Disposal: Residual waste from processing facilities and inert waste are required to be disposed in sanitary landfills.

India has other additional national-level policies and initiatives that create an enabling environment for improved SWM. These include:

1. **The Swachh Bharat Mission** or Clean India Mission was initiated in 2014 to eliminate open defecation and to implement waste management in cities and villages across India. A key initiative is an annual cleanliness survey (Swachh Survekshan) that collects information from participating cities. Cities are assigned a star ranking for being a garbage-free city to indicate their level of cleanliness based on waste management. The star ranking created a healthy competition, with cities striving to improve their ranking. Improved ranking not only raises the profile of a city, but also unlocks financial assistance from the central government for waste-related projects.
2. **Sustainable Alternatives Toward Affordable Transportation** was announced in 2016 by the Ministry of Petroleum and Natural Gas to promote the development of compressed biogas (CBG) from urban and agricultural waste and reduce the country's dependence on imported fossil fuels. This initiative encourages entrepreneurs to develop CBG projects and supply the CBG for sale as automotive and industrial fuel to traditional oil marketing companies such as the Indian Oil Company Limited, Bharat Petroleum Limited, and Hindustan Petroleum Limited. State governments across the country are working with local governments to set up large-scale biogas plants to process organic waste and produce CBG under this program.

Legislative and Regulatory Approaches

- **Pollution standards**
  - The Central Pollution Control Board in the Ministry of Environment Forests and Climate Change sets pollution standards for ground water, ambient air, noise, and leachate in waste-processing and disposal facilities.

- **Source separation and/or diversion requirements**
  - The SWM Rules require waste generators to source-segregate waste into three categories at a minimum: dry, wet, and household hazardous waste. Urban local bodies are required to collect the waste in a segregated manner.
  - Bulk waste generators (more than 100 kgs per day) are responsible for managing their waste by separating dry and wet wastes, recycling the dry waste, and treating the wet waste on their premises or through vendors approved by the local government agency.

- **Bans**
  - The SWM Rules do not allow disposal of material in landfills other than unusable, nonrecyclable, nonbiodegradable, noncombustible, and nonreactive inert waste and preprocessing rejects and residues from waste-processing facilities.
  - Waste generators are not allowed to throw, burn, or bury their waste in public spaces.

Market-Based Approaches

- **Taxes, charges, and fees**
  - The SWM Rules require waste generators to pay fees for waste management services and fines for noncompliance. Fees and fines are set by local government agencies in their bylaws.

- **Subsidies and incentives**
  - The Ministry of Chemicals and Fertilizers developed a policy to promote compost from city waste through a Market Development Assistance subsidy of INR 1500/MT (USD 18).[91]
  - The Ministry of New and Renewable Energy provides financial assistance to project developers for waste to energy plants, including biogas, CBG production, and power production from biogas.[92] For example, it provides a capital expense subsidy of INR 40 million (USD 480,000) per 4,800 kg/day from new CBG plants capped at INR 100 million (USD 1.2 million) and a subsidy of INR 7.5 million (USD 90,000) per MW power generation from a new plant with a ceiling of INR 50 million (USD 600,000).
  - The Ministry of Agriculture announced a scheme in 2015 to provide 100% financial assistance with a ceiling of INR 19 million (USD 227,500) to government agencies and 33% financial assistance with a ceiling of INR 6.3 million (USD 73,600) per unit to individuals or private agencies as capital investment for setting up mechanized compost plants for fruit and vegetable market waste.[93]
  - Local governments, including those of New Delhi and Mumbai, have instituted incentives such as tax rebates to improve source segregation.

Voluntary Agreements

- **Agreements between national and/or subnational governments**
  - India is a signatory to the Paris Agreement.

- **Public-private partnerships or agreements**
  - India is a founding member of the Global Methane Initiative, an international public-private partnership focused on reducing barriers to the recovery and use of methane as an energy source.

Information and Education Approaches

- **Technical training**
  - The SWM Rules tasks the Ministry of Urban and Housing Affairs to provide technical training and assistance to state and local bodies for developing policies and strategies. The Central Public Health and Environmental Engineering Organisation within the Ministry of Housing and Urban Affairs developed a manual[94] for local government agencies with detailed guidance on planning, implementing, and monitoring waste management to comply with the rules, along with descriptions of technical aspects of collection, transportation, treatment, and disposal of the waste.
  - The National Institute of Urban Affairs, an autonomous body created by the Government of India, conducts trainings and develops tools for capacity-building at the local level.
  - The SWM Rules require local governments to educate workers involved in collection, transportation, treatment, and disposal on the specified requirements.

- **Education and behavior change**
  - The SWM Rules require local governments to conduct information, education, and communication campaigns directed at waste generators on waste minimization, source segregation, home composting, biogas generation, and decentralized processing of waste at the community level.

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91 Government of India, Ministry of Chemicals and Fertilizers. (2020, September 15). *Government is encouraging Urban Local Bodies to manage municipal solid waste in scientific manner including processing waste to compost and other process* [Press release]. https://pib.gov.in/PressReleasePage.aspx?PRID=1654529

92 Government of India, Ministry of New and Renewable Energy. (2024). *Waste to Energy Programme.* https://mnre.gov.in/waste-to-energy/

93 Government of India, Ministry of Agriculture & Farmers Welfare. (2015, August 4). Encouraging the production of organic manure from bio-waste [Press release]. https://pib.gov.in/newsite/PrintRelease.aspx?relid=124299

94 Government of India, Ministry of Urban Development. (2016). *Municipal Solid Waste Management Manual*. http://swachhbharaturban.gov.in/writereaddata/Manual.pdf

Italy

National Policies, Strategies, and Plans

At the national level, waste management in Italy is the responsibility of the Ministry of Environment and Energy Security, which supervises recycling and waste management activities, and the Ministry of Ecological Transition, which develops the national waste management plan. However, environmental management in Italy is decentralized, consistent with the regionalization of the country, with regional governments holding planning and regulatory roles and municipalities charged with daily operation of waste management systems. To optimize waste management, municipalities are grouped into territorial areas.

As a member of the EU, Italy must comply with targets set in the EU Waste Framework Directive and Landfill Directive. These directives set a number of targets for separate collection of biowaste, packaging waste recycling, and a cap on the amount of residual waste sent to landfills, discussed in more detail below.

Italy's National Strategy for Sustainable Development, Strategy for the Circular Economy, National Recovery and Resilience Plan, and National Waste Management Plan all highlight the country's priorities of resource recovery and circular economy.

- The **National Waste Management Plan** defines high-level objectives for waste management in Italy and provides guidelines for regional governments in developing waste management plans to meet these goals. This includes criteria for meeting targets set by EU directives and closing gaps in planning and infrastructure between regions within the country.[99]

At a Glance

Population[95]

59M

Annual Waste Generation[96,97]

29M tons

57% organic

Methane Emissions from Solid Waste[98]

690 thousand tons

Change in Methane Emissions: 2000 to 2021

18% decrease

GMP Signatory

Yes

GMP Waste Sector Commitment

No methane action plan

95 World Bank Group. (2023). *Population, total: Italy*. https://data.worldbank.org/indicator/SP.POP.TOTL?locations=IT

96 OECD. (2024). *Economic Instruments for the Circular Economy in Italy: Opportunities for reform.* https://doi.org/10.1787/33e11c28-en.

97 Ministerio della Transizione Ecologica. (2021). *Programma Nazionale Per La Gestione Dei Rifiuti.* FAOLEX Database. https://faolex.fao.org/docs/pdf/ita213142.pdf

98 United Nations. (2023). *Italy: 2023 national inventory report.* https://unfccc.int/documents/627845

99 Ministerio della Transizione Ecologica, 2021, *Programma Nazionale Per La Gestione Dei Rifiuti.*

- The **National Circular Economy Strategy** focuses on ecodesign and ecoefficiency to define a roadmap for achieving circular economy targets by 2040 and support climate neutrality objectives. The strategy calls for a transition integrating the bioeconomy and circular economy by valorizing organic wastes to convert them to high value-added products.[100]

- The **National Recovery and Resilience Plan** is part of the EU's Next Generation EU program in response to the COVID-19 pandemic. Italy's plan earmarks EUR 1.5 billion (USD 1.55 billion) for the construction and improvement of waste treatment and recycling infrastructure. It also calls for improved technical support for local governments and streamlining of permit and tendering procedures for the construction of new treatment plants.[101]

- The **Italian Bioeconomy Strategy II** set a goal to improve performance of the Italian bioeconomy by 15% by 2030. The Implementation Action Plan for the strategy for 2020-2025 calls for increased investment in local-level projects to take advantage of the full potential of urban biowaste and wastewater, including the production of biobased chemicals, materials, and energy, as well as compost.[102]

Legislative and Regulatory Approaches

- **Pollution standards**
  - Legislative Decree 36/2003 adopted the EU landfill directive of 1999 into Italian law.[103] The decree specifies construction and management criteria for landfills that accept inert waste, hazardous waste, and nonhazardous waste. All landfills that accept biodegradable waste must be equipped with a gas capture system that guarantees maximum collection efficiency and energy use (or flaring if energy use is not possible).

- **Source separation and/or diversion requirements**
  - Legislative Decree 116/2020 required that organic waste be separated and recycled at source (i.e., home composting) or collected separately and recycled at industrial biogas or compost facilities by January 2022. It also adopted the EU Waste Framework Directive targets of preparing municipal waste for reuse and recycling: at least 55% by 2025, 60% by 2030, and 65% by 2035 (by weight).[104]

- **Bans**
  - Legislative Decree 121/2020 transposed the updated EU landfill directive of 2018 into Italian law. It set a target of reducing the amount of municipal waste sent to landfill to 10% or less of total MSW by 2035.
  - Legislative decree 152/2006, the Environmental Consolidated Act, banned the "uncontrolled deposit" of waste and made it punishable with administrative and criminal fines.[105]

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100 Ministerio della Transizione Ecologica. (2021). *Strategia Nazionale Per L'economia Circolare.* FAOLEX Database. https://faolex.fao.org/docs/pdf/ita212828.pdf

101 Government of Italy. (n.d.). *Italia Domani, the National Recovery and Resilience Plan.* https://www.italiadomani.gov.it/content/sogei-ng/it/en/home.html

102 Comitato Nazionale per la Biosicurezza, le Biotecnologie e le Scienze della Vita. (2021). *Implementation action plan (2020-2025) for the Italian bioeconomy strategy BIT II*. FAOLEX Database. https://faolex.fao.org/docs/pdf/ita210073.pdf

103 Gazzetta Ufficiale della Repubblica Italiana. (2003). *DecretoLlegislativo 13 gennaio 2003, n. 36 attuazione della Direttiva 1999/31/CE relativa alle discariche di rifiuti.* FAOLEX Database. https://faolex.fao.org/docs/pdf/ita38107.pdf

104 Gazzetta Ufficiale della Repubblica Italiana. (2020). *Decreto Legislativo 3 settembre 2020, n. 116 attuazione della Direttiva (UE) 2018/851 che modifica la Direttiva 2008/98/CE relativa ai rifiuti e attuazione della Direttiva (UE) 2018/852 che modifica la Direttiva 1994/62/CE sugli imballaggi e i rifiuti di imballaggio.* https://www.gazzettaufficiale.it/eli/id/2020/09/11/20G00135/sg

105 OECD, 2024. *Economic Instruments for the Circular Economy in Italy.*

Market-Based Approaches

Taxes, charges, and fees

- Italy's landfill tax was established in Law 549/1995. The law defines the upper and lower limits of the tax at the national level but leaves the amount that landfill operators are taxed up to the discretion of regional authorities. Regional authorities also determine the types of waste subject to the tax and how to allocate revenues. The landfill tax was revised by Law 62/2005.[106]
- Italy's waste charge or *tassa sui rifiuti* (TARI) was introduced by Law 147/2013 and replaced previous charges on waste. TARI charges for MSW generators are based on the size of the house as well as the number of people living there. Law 147/2013 also allows municipalities to apply volume-based PAYT systems instead of the TARI if they have the capacity to do so.[107] About 8 million people in 1,100 municipalities were subject to PAYT systems as of 2022.[108]
- Biorepack is Italy's extended producer responsibility scheme for biodegradable and compostable plastic packaging; it was established in 2018 under legislative decree 152/2006.[109] Manufacturers of bioplastics and packaging are required to be Biorepack members and pay a fee of EUR 130 per ton of bioplastics sold, which is used to support municipalities in collecting, transporting, and treating compostable packaging waste.[110]

Subsidies and incentives

- Italy has provided economic incentives to promote the production of biomethane (biogas upgraded to natural gas quality) from organic waste (of both municipal and agricultural origin) since 2018.[111] The most recent decree from the Ministry for Ecological Transition for 2022-2026 promises a 40% capital contribution of investment costs for eligible biomethane plants (with a cap on the maximum eligible investment cost), as well as an incentive tariff for the production of biomethane for 15 years ranging from 62 to 115 euros/MWh.[112] Biomethane is injected into the national gas grid or used as a fuel for vehicles.

Purchasing and procurement

- Italy's Green Public Procurement National Action Plan was first approved in 2008 and was updated in 2023. Minimum environmental criteria are mandatory for all public contracts and have been adopted for 20 categories including paper, municipal waste and street sweeping, refreshment and vending machines, catering, and public green spaces.[113]

Voluntary Agreements

Agreements between national and/or subnational governments

- Italy is a signatory to the Paris Agreement, the GMP, and COP29's declaration on Reducing Methane from Organic Waste.

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106 European Environment Agency. (2022). *Early Warning Assessment Related to the 2025 Targets for Municipal Waste and Packaging Waste: Italy.* https://www.eea.europa.eu/publications/many-eu-member-states/italy/view

107 Ergun, M. (2022). The waste tax in Italy. SSRN.

108 Redazione. (2023, December 20). In Italia 1.117 Comuni con tariffazione puntuale, 8 milioni di persone raggiunte (ma quasi tutte al nord). *Eco dalle Città.* https://www.ecodallecitta.it/?p=33173

109 Biorepack. (n.d.). *Insieme rigeneriamo il pianeta.* https://eng.biorepack.org/about-us/consortium/about-us.kl

110 Consorzio Nazionale Imballaggi (CONAI). (2024). *CONAI: the economic situation leads to an increase in EPR fees for aluminium, paper, and plastic packaging; decrease, on the other hand, for bioplastic packaging.* https://www.conai.org/en/news/conai-the-economic-situation-leads-to-an-increase-in-epr-fees-for-aluminium-paper-and-plastic-packaging-decrease-on-the-other-hand-for-bioplastic-packaging/

111 Ministero delle Imprese e del Made in Italy (2018). *Decreto ministeriale 2 marzo 2018: Promozione dell'uso del biometano nel settore dei trasporti.* https://www.mimit.gov.it/index.php/it/normativa/decreti-interministeriali/decreto-interministeriale-2-marzo-2018-promozione-dell-uso-del-biometano-nel-settore-dei-trasporti#:~:text=Il%20decreto%20interministeriale%20del%202,dell'energia%20da%20fonte%20rinnovabile

112 Dentons. (2022). *New incentives for the biomethane sector.* https://www.dentons.com/en/insights/guides-reports-and-whitepapers/2022/november/14/new-incentives-for-the-biomethane-sector

113 OECD. (2024). *Harnessing Public Procurement for the Green Transition: Good practices in OECD countries.* https://www.oecd.org/en/publications/harnessing-public-procurement-for-the-green-transition_e551f448-en.html

- **Public-private partnerships or agreements**
  - Italy is a founding member of the Global Methane Initiative, an international public-private partnership focused on reducing barriers to the recovery and use of methane as an energy source.

Information and Education Approaches

- **Technical assistance**
  - The Consorzio Nazionale Imballaggi, the umbrella organization for EPR schemes for packaging waste, provides technical assistance to municipalities with poor recycling achievements. Similarly, the Consorzio Italiano Compostatori supports regional authorities in need of structuring separate collection and recycling initiatives for organic waste.[114]

- **Required or voluntary information disclosure**
  - The National Electronic Registry for Waste Traceability was established by legislative decree 152/2006 and launched in 2023. This registry helps the Italian government more effectively monitor and control waste management activities and make data publicly available to businesses and the public to promote the circular economy.[115]

- **Environmental certifications and quality standards**
  - The Italian Fertilizer Legislation, legislative decree 75/2010, classified compost, obtained from separately collected organic waste, as a soil improver that can be used in organic and conventional farming. It also set quality standards for the compost in terms of agronomic, environmental, sanitary, etc. factors such as pH, moisture content, and physical impurities.[116]
  - Italy uses the UNI-EN-13432 standard to ensure that compostable plastics or bioplastics collected with food and other organic waste do not contaminate compost. The standard further supports circular economy initiatives by boosting recycling rates in Italy, as it helps to improve the effectiveness of compostable plastic recycling.[117]

- **Education and behavior change**
  - The National Waste Management Plan and Bioeconomy Strategy call for improved education and awareness, for both citizens and those working in these sectors, but these activities are planned and executed at the regional level.
  - EPR schemes invest in regular awareness campaigns for households and commercial activities in national newspapers, on TV, and in social media.

114 Marco Ricci, personal communication, November 15, 2024.

115 Ministero dell'Ambiente e della Sicurezza Energetica. (2024). *Tracciabilità dei rifiuti.* https://www.mase.gov.it/pagina/tracciabilita-dei-rifiuti

116 Centemero, M., Ricci, M., & Confalonieri, A. (2024, August 6). Italy's experience with compostable plastics in organics recycling. *Biocycle*. https://www.biocycle.net/italy-compostable-plastics/#:~:text=By%20adhering%20to%20the%20stringent,sustainability%20and%20the%20circular%20economy.

117 Centemero et al., 2024.

Perú

National Policies, Strategies, and Plans

Perú's Ministry of the Environment (MINAM) develops, implements, and evaluates the country's national environmental policies, including for SWM. In 2000, Perú adopted the General Law of Solid Waste, No. 27314, establishing the framework for SWM in the country and defining responsibilities of the municipal governments. This law was enhanced by the Law on the Integral Management of Solid Waste, which shifted the focus of SWM toward a more circular economy through waste recovery and shared responsibility, including EPR. Perú's Supreme Decree on the National Environmental Policy (2021 Supreme Decree No. 023-2021-MINAM) and National Environmental Action Plan set Perú's environmental goals. The initial plan included SWM as a priority objective with goals of 100% reuse and proper disposal by 2021 and to progressively close dumpsites and convert them to sanitary landfills. However, the 2021 goals have not yet been achieved.

Perú's National SWM Plan for 2016-2024 set goals to strengthen capacity of local governments, improve student education on waste management issues, update the legal framework for SWM, improve data collection and information-sharing, promote EPR, and promote investment in waste management. A new eight-year plan is expected for 2024-2032. In Perú, each province and district develops its own SWM plan, which is then reviewed by MINAM.[121,122] Provinces and districts are responsible for budgeting and raising resources to cover waste management services, while municipalities are responsible for day-to-day management of waste.

At a Glance

Population[118]

34.7M

Annual Waste Generation[119]

8.2M tons

50% organic

Methane Emissions from Solid Waste[120]

CH_4 231 thousand tons

Change in Methane Emissions: 2010 to 2019

34% increase

GMP Signatory

Yes

GMP Waste Sector Commitment

No methane action plan

118 World Bank Group. (2023). *Population, total: Peru.* https://data.worldbank.org/indicator/SP.POP.TOTL?locations=PE

119 Perú Ministerio del Ambiente. (2022). *Indicadores RSS AÑO-2021.* https://app.powerbi.com/view?r=eyJrIjoiODI2NjU0MzgtNTQyOS00ZjM0LWI3YjAtN2YwNzcwMWY1M2IzIiwidCI6IjBlMmFiZjRlLWExZjUtNDFlZi1iOWE0LWM5YWE2ZGQ1NTE4MCJ9&pageName=ReportSection

120 Gobierno del Perú. (2023). *Tercer informe bienal de actualización ante la convención marco de las naciones unidas sobre el cambio climático.* https://unfccc.int/sites/default/files/resource/Tercer%20BUR_Per%C3%BA_Jun2023.pdf

121 Peru Law No. 27314-2000: General Solid Waste Law of 2000. (2000).

122 MINAM. (2019). 2019 Ministerial Resolution No. 100-2019-MINAM on District SWM Plans.

In 2018, Perú passed the Climate Change Framework law to establish the main principles of the country's climate policy and name MINAM as the national authority on climate standards, policy implementation, monitoring, and development of the national GHG inventory.[123] In 2020, Perú submitted its first NDC, which included measures to reduce emissions from the waste sector, specifically from organic waste. The Government of Perú, inspired by recent Chilean efforts to improve organic waste management, committed to increasing organic waste management for both compost creation and potential energy sources.

Legislative and Regulatory Approaches

- **Standards**
  - The Law of Integrated SWM requires new landfills with "high waste volumes" to install landfill gas capture.[124]

- **Source separation and/or diversion requirements**
  - The recyclers law, La Ley del Reciclador No. 29419, recognizes informal waste workers and requires local governments to include informal sector workers in waste collection efforts through "the creation of associations and cooperatives and include them in separate collection and recycling programs."[125]
  - Under the Comprehensive Waste Management Law, Legislative Decree No. 1501, Perú requires source separation of waste into color-coded containers as stated in technical standard 900.058: green containers for usable waste and black containers for non-usable waste. MINAM published an accompanying implementation guide.[126]

Market-Based Approaches

- **Subsidies and incentives**
  - The Ministry of Finance manages the Incentive Plan to Improve Local Governments Management, which uses VAT taxes to fund Peruvian municipalities to support necessary services, including SWM (Goal 3 of the Incentive Plan). In 2021, over 700 municipalities received economic incentives for collection and recovery of organic and inorganic waste.

Voluntary Agreements

- **Agreements between national and/or subnational governments**
  - Perú is a signatory to the Paris Agreement, the GMP, and COP29's declaration on Reducing Methane from Organic Waste.

- **Public-private partnerships or agreements**
  - Perú is a member of the Global Methane Initiative, an international public-private partnership focused on reducing barriers to the recovery and use of methane as an energy source.

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123 Congreso de la Republica. (2018). *Ley Marco Sobre Cambio Climático.* https://climate-laws.org/documents/climate-change-framework_7e5f?id=framework-law-no-30754-on-climate-change_688f

124 Cristobal, J., Vázquez-Rowe, I., Margallo, M., Tia-Nagy, D., Ziegler-Rodriguez, K., Laso, J., Ruiz-Salmón, I., Kahhat, R., Aldaco, R.. (2022). Climate change mitigation potential of transitioning from open dumpsites in Peru: Evaluation of mitigation strategies in critical dumpsites. *Science of the Total Environment*, 846, 157295. https://www.sciencedirect.com/science/article/pii/S0048969722043935#bb0010

125 Aparcana Robles, S. R. (2016). Approaches to formalization of the informal waste sector into municipal solid waste management systems in low- and middle-income countries: Review of barriers and success factors. *Waste Management*, 61, 593-607. https://doi.org/10.1016/j.wasman.2016.12.028

126 Perú Ministerio del Ambiente. (2021). *Ministerial Resolution No. 138-2021-MINAM*. https://www.gob.pe/institucion/minam/normas-legales/2045811-138-2021-minam

127 Perú Ministerio del Ambiente. (2022). *Indicadores RSS AÑO-2021.*

Information and Education Approaches

- **Required or voluntary information disclosure.**
  - The National SWM Plan requires local governments to track and report waste collection and management data. Data include total waste generation by organic, inorganic, non-usable, and hazardous wastes and the amount of waste valorized.[127]
  - The Environmental Evaluation and Inspection Bureau of Perú tracks and reports data on dumpsites throughout the country.

- **Education and behavior change**
  - The 2005 General Environmental Law requires the development of environmental education programs, spurring the national policy on environmental education and the ongoing Municipal Environmental Education, Culture, and Citizenship Program, which supports local governments in community engagement and behavior change toward more sustainable actions.[128]
  - MINAM promotes "Perú Limpio" across the country to public and private stakeholders through communications materials, including videos, printable materials, and audio messages. Perú Limpio promotes responsible consumption, recycling, payment of taxes, and responsibility not to litter or dirty public spaces.[129]

128 Olivera, C. A. C., Tapara, N. E. H., Lolandes, V. V. G., Torres, R. J. C., Tejeira, M. C. (2023). *Education, culture, and environmental citizenship program to raise awareness among the population of Ventanilla in Lima, Peru* [Paper presentation]. 21st LACCEI International Multi-Conference for Engineering, Education, and Technology, Buenos Aires, Argentina, July 17-21, 2023. https://laccei.org/LACCEI2023-BuenosAires/papers/Contribution_565_a.pdf

129 Perú Ministerio del Ambiente. (n.d.). *Kit Comunicacional Perú Limpio.* https://www.minam.gob.pe/educacion/kit-comunicacional-peru-limpio/

Republic of Korea

National Policies, Strategies, and Plans

Korea's Ministry of Environment (MOE) has been improving waste management practices for decades due to the country's rapid economic growth and lack of land available for final disposal. The Waste Control Act of 1986 defined waste by its source, mainly household and industrial, and allocated responsibilities for its management by local governments and businesses, respectively.[136] The act encourages recycling of waste over final disposal and created a system in which all waste generators are required to pay for the costs of collection and disposal of waste.

The current Waste Control Act upholds this focus on waste reduction and recycling, while setting standards for design and management of leachate and landfill gas. It also provides the basis for Korea's PAYT system and requires the development of subnational plans to reduce and treat food wastes.[137]

Korea has a number of other notable waste management policies that promote recycling and a circular economy, the purchase of green products, and the prevention of waste, many of which are discussed below. One notable regulation is the Act on the Promotion of Installation of Waste Disposal Facilities and Assistance to Adjacent Areas, which facilitates the development of waste disposal facilities while promoting residents' welfare.

At a Glance

Population[130]

51.7M

Annual Waste Generation[131,132]

16.8M tons

31% organic

Methane Emissions from Solid Waste[133]

373 thousand tons

Change in Methane Emissions: 2000 to 2018[134]

18% decrease

GMP Signatory

Yes

GMP Waste Sector Commitment[135]

49% methane reduction by 2030

130 World Bank Group. (2023). *Population, total: Korea, Rep.* https://data.worldbank.org/indicator/SP.POP.TOTL?locations=KR

131 Republic of Korea Ministry of Environment. (2022). *National waste generation and disposal status.* Translated version provided by Solutions for Our Climate.

132 Solutions for Our Climate, personal communication, September 2024.

133 GHG Inventory and Research Center. (2021). *Fourth Biennial Update Report on the Public of Korea under the United Nations Framework Convention on Climate Change.*

134 GHG Inventory and Research Center, 2021.

135 *Republic of Korea's 2030 Methane Emissions Reduction Roadmap.* (2023). https://www.ccacoalition.org/sites/default/files/resources/files/2030%20Methane%20Emissions%20Reduction%20Roadmap%28RoK%29.pdf

136 Yoon, S.-J. (2020). *South Korea's experience with smart infrastructure services: Integrated solid waste management.* InterAmerican Development Bank. https://publications.iadb.org/en/south-koreas-experi ence-smart-infrastructure-services-integrated-solid-waste-management

137 Republic of Korea. (2015). *Republic of Korea Wastes Control Act.* FAOLEX Database. https://faolex.fao.org/docs/pdf/kor117318.pdf

The act requires creation of a resident support fund to compensate for losses related to a planned facility and a committee to facilitate communication between residents and the government, among other measures.[138]

Further, Korea's waste management policies are incorporated into climate change planning and commitments. The 2050 Carbon Neutrality Strategy of Korea promotes waste reduction at source and increases recycling and eco-friendly disposal of waste; the strategy calls for landfill standards to promote low-carbon landfill management and methane recovery for landfills of a certain size.[139] Finally, Korea's Methane Emissions Reduction Roadmap commits the country to a 49% reduction of emissions from the waste sector through policy revision, new infrastructure to reduce food waste, increased gas capture at landfills, and expansion of biogas facilities.[140]

Legislative and Regulatory Approaches

- **Pollution standards**
  - Enforcement decree on the Waste Control Act requires that landfills be equipped with facilities for gas flaring or power generation and fuel making.[141]

- **Source separation and/or diversion requirements**
  - Article 13 of the Act on Promotion of Saving and Recycling Resources calls for the separate collection of recyclable resources and required guidelines for implementation of the program from the MOE.[142] Household waste is separated into general, recyclable, food, and bulky waste.
  - The Act on the Promotion of the Production and Use of Biogas Using Organic Waste Resources sets a biogas production target for large-scale public and private organic waste generators.[143]

- **Bans**
  - A ban on direct landfilling of food waste began in 2005.[144]
  - Article 8 of the Waste Control Act bans dumping and burning of waste in areas other than permitted and approved landfills and incinerators.[145] Violators may be subject to fines, mandatory education on waste disposal, and delayed waste collection.

Market-Based Approaches

- **Taxes, charges, and fees**
  - A volume-based waste fee, introduced in 1995, required citizens to purchase specific bags to dispose waste; recyclables were disposed at no cost. The system originally applied to municipal waste, but was expanded to wastes from commercial, institutional, and industrial sectors.

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138 Republic of Korea. (2015). Promotion of Installation of Waste Disposal Facilities and Assistance to Adjacent Areas Act. https://elaw.klri.re.kr/kor_service/lawView.do?hseq=55765&lang=KOR

139 Republic of Korea. (2020). *2050 carbon neutral strategy of the Republic of Korea.* FAOLEX Database. https://faolex.fao.org/docs/pdf/kor223761.pdf

140 Republic of Korea. (2023). *Republic of Korea's 2030 methane emissions reduction roadmap.* Climate & Clean Air Coalition. https://www.ccacoalition.org/policy-database/republic-koreas-2030-methane-emissions-reduction-roadmap

141 Republic of Korea. (2016). *Republic of Korea Enforcement Decree of the Wastes Control Act.* FAOLEX Database. https://faolex.fao.org/docs/pdf/kor117279.pdf

142 Republic of Korea. (2002; amended 2015). *Republic of Korea Act on Promotion of Saving and Recycling Resources.* FAOLEX Database. https://faolex.fao.org/docs/pdf/kor51892.pdf

143 Lee, S., & Kim, D. (2024). *Methane Leaks from Buried Food Waste.* Solutions for Our Climate. https://forourclimate.org/research/517

144 Yoon, 2020.

145 Republic of Korea. (2007; amended 2017). *Wastes Control Act.* Korea Law Translation Center. https://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=43284&type=part&key=39#:~:text=To%20the%20extent%20possible%2C%20wastes,of%20wastes%20shall%20be%20restrained.&text=Wastes%20shall%20be%20recycled%20rather,the%20improvement%20of%20resource%20productivity

146 Republic of Korea Ministry of Environment and Korea Environment Institute. (2016). Two decades in effect: Volume-based waste fee system in South Korea. *Korea Environmental Policy Bulletin, XIV(3).* Green Policy Forum. https://www.greenpolicyplatform.org/national-documents/two-decades-effect-volume-based-waste-fee-system-south-korea

Improper disposal of waste is fined. Between 1995 and 2013, the system generated USD 19.5 billion in positive economic benefits from reduced generation and increased recycling.[146]

- A weight-based food waste fee, established in 2014, requires municipal and select commercial and institutional (schools, restaurants, and supermarkets) generators to pay for the collection and disposal of food wastes based on the amount disposed. Generators can 1) purchase a designated standard bag for food waste, 2) apply a chip or sticker to a food waste container, or 3) use radio frequency identification-enabled collection bins.[147]
- The Framework Act on Resource Circulation established the waste disposal charge in 2018, further charging individuals and businesses that send recyclable resources to landfills or incinerators. The fee raises the cost of disposing of the resource, so it is equal to that of recycling it. The funds raised through the charge are invested into waste management and recycling.[148]

Subsidies and incentives

- Korea's MOE provides subsidies to local governments for new recycling and waste disposal facilities, covering up to 50% of costs for the former and 70% for the latter.[149]
- Korea's MOE provides low interest loans to small- and medium-scale recycling companies to develop facilities and for research and development. In 2016 over USD 94 million was allocated for loans with a 1.51% variable interest rate and maximum ten-year repayment period.[150]
- The Act on Public-Private Partnerships in Infrastructure is the legal framework for these partnerships in the country and promotes private sector investment in infrastructure projects including waste disposal, wastewater treatment, and recycling.[151]

Emissions markets

- The Korean ETS sets an emissions cap on covered sectors and allocates emissions allowances to entities included in the scheme; allowances correlate with targets in Korea's NDC. In 2022, 76 waste sector entities were required to participate in the ETS. Landfill gas recovery projects are also the third most popular external offset credits issued by the ETS.[152]

Purchasing and procurement

- The Act on Promotion of Purchase of Green or Environment-Friendly Products tasks the MOE with developing and implementing plans and guidelines (which public institutions must abide by) to further the purchase of environment-friendly products including recycled paper and cardboard.[153]

147 Republic of Korea Ministry of Environment. (2015). [Annual report]. https://eng.me.go.kr/eng/file/readDownloadFile.do?fileId=115224&fileSeq=1&openYn=Y

148 Republic of Korea Ministry of Environment and Korea Environment Institute. (2016). Introduction of the Framework Act on Resource Circulation toward Establishing a Resource-Circulating Society in Korea. *Korea Environmental Policy Bulletin, XIV(2)*. Green Policy Forum. https://www.greenpolicyplatform.org/national-documents/introduction-framework-act-resource-circulation-toward-establishing-resource

149 Yoon-Jn, 2020.

150 Cho, I.-H., & Kang, M. (2017). *Comprehensive Study of Waste Management Policies & Practices in Korea and Recommendations for LDCs and MICs.* Sustainable Development Goals Policy Brief Series No. 3. Korea Environment Corporation and United Nations Development Programme. https://www.undp.org/sites/g/files/zskgke326/files/migration/seoul_policy_center/USPC-Policy-Brief-3.pdf

151 Republic of Korea Ministry of Economy and Finance. (1998). *Act on Public-Private Partnerships in Infrastructure.* Korean Law Information Center. https://www.law.go.kr/eng/engLsSc.do?menuId=1&query=Public+private&x=0&y=0#liBgcolor15

152 Greenhouse Gas Inventory and Research Center of Korea. (2023). *2022 Korean Emissions Trading System Report.* https://www.gir.go.kr/eng/board/read.do?pagerOffset=0&maxPageItems=10&maxIndexPages=10&searchKey=&searchValue=&menuId=31&boardId=8&boardMasterId=21&boardCategoryId=

153 Republic of Korea. (2004; amended 2010). *Republic of Korea Act on Encouragement of Purchase of Environment-Friendly Products.* FAOLEX Database. https://faolex.fao.org/docs/pdf/kor100466.pdf

Voluntary Agreements

- **Agreements between national and/or subnational governments**
  - Korea is a signatory to the Paris Agreement, the GMP, and COP29's declaration on Reducing Methane from Organic Waste.

- **Public-private partnerships or agreements**
  - Korea is a member of the Global Methane Initiative, an international public-private partnership focused on reducing barriers to the recovery and use of methane as an energy source.

Information and Education Approaches

- **Technical assistance**
  - The Korea Environment Corporation, established via the K-eco Act, provides technical support to local governments including capacity-building and training, feasibility and pre-feasibility assessments, assistance negotiating contracts and public-private partnerships, and construction of waste treatment facilities including anaerobic digestion, composting, landfills and gas capture systems, and incineration.[154]

- **Education and behavior change**
  - The Environmental Education Promotion Act of 2008 requires the Ministries of Environment and Education to establish an Environmental Education Master Plan and promote environmental education in schools.[155]

154 Korea Environment Corporation. (2023). *Installation of environmental energy facility.* https://www.keco.or.kr/en/lay1/S295T412C424/contents.do

155 Republic of Korea. (2008; amended 2015). *Republic of Korea Environmental Education Promotion Act.* FAOLEX Database. https://faolex.fao.org/docs/pdf/kor167973.pdf

United States of America

National Policies, Strategies, and Plans

The U.S. government has the authority to regulate air pollution from landfills under the Clean Air Act. Under this law, the Environmental Protection Agency (EPA) is responsible for establishing New Source Performance Standards for new, modified, and reconstructed municipal solid waste landfills as well as establishing emissions guidelines for existing facilities. The current New Source Performance Standards and emission guidelines for landfills were finalized on August 29, 2016. The EPA was required to review and, if necessary, revise the regulations for landfills by August 15, 2024, though this had not occurred at the time this guide was written. The U.S. also requires uniform reporting of emissions for landfills through the GHGRP, implemented by the EPA.

The U.S. has a Methane Emissions Reduction Action Plan, which was last updated in December 2023. The plan's section on landfills and food waste discussed various grants available for enabling emissions reductions from landfills, including the Solid Waste Infrastructure for Recycling funding, Climate Pollution Reduction Grants, Recycling Education and Outreach grants, and the Compost and Food Waste Reduction Program. The plan also highlighted efforts to detect methane emissions through aerial cameras operated by a NASA partnership. Notably, the 2023 plan reiterated the national goal of reducing food loss and waste by 50% by 2030.

At a Glance

Population[156]

335M

Annual Waste Generation[157]

265M tons

57% organic

Methane Emissions from Solid Waste[158]

CH_4 4.4 million tons

Change in Methane Emissions: 2005 to 2022

18% decrease

GMP Signatory

Yes

GMP Waste Sector Commitment[159]

70% methane emissions capture goal for all landfills

156 World Bank Group. (2023). *Population, total: United States.* https://data.worldbank.org/indicator/SP.POP.TOTL?locations=US

157 U.S. EPA. (2020). *Advancing Sustainable Materials Management: 2018 fact sheet.* https://www.epa.gov/sites/default/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf

158 U.S. EPA. (2024). Inventory of U.S. *Greenhouse Gas Emissions and Sinks, 1990-2022.* https://www.epa.gov/system/files/documents/2024-04/us-ghg-inventory-2024-main-text_04-18-2024.pdf

159 U.S. White House Office of Domestic Climate Policy. (2022). *Delivering on the U.S. Methane Emissions Reduction Action Plan.* https://www.ccacoalition.org/sites/default/files/resources/files/United%20States%20Methane%20Action%20Plan_0_0.pdf

To target reductions in landfilled organics, the U.S. has a National Strategy for Reducing Food Loss and Waste and Recycling Organics. This strategy was released in June 2024 and outlines four objectives: (1) prevent food loss, (2) prevent food waste, (3) increase the recycling rate for all organic waste, and (4) support policies that incentivize and encourage the prevention of food loss and waste and organics recycling. The strategy outlines ways the Department of Agriculture and the EPA can support local, tribal, state, and international policymakers in efforts to build circular economies.

The U.S. has also made commitments to lower landfill methane emissions on the international stage. Jointly with the EU, the U.S. launched the GMP at COP26. In line with Article 4 of the Paris Agreement, the U.S. has also committed to reducing economy-wide greenhouse gas emissions to 50% below 2005 levels by 2030.

Legislative and Regulatory Approaches

- **Pollution standards**
  - Current regulations under the Clean Air Act require landfills constructed, reconstructed, or modified after July 17, 2014, with a design capacity greater than or equal to 2.5 million megagrams and 2.5 million cubic meters, and estimated non-methane organic compound emissions of at least 34 Mg per year to install gas collection and control systems.[160]
  - Certain states, such as Maryland, California, Washington, and Oregon, have more stringent regulations than those at the federal level.

- **Source separation and/or diversion requirements**
  - The U.S. does not have a federal standard for source separation of municipal waste. Some state and local governments do institute source separation policies, but the details vary by location.

- **Bans**
  - Under the Resource Conservation and Recovery Act, the EPA has the authority to issue regulations regarding the generation, transport, treatment, and disposal of hazardous waste. Subtitle D of this act concerns non-hazardous waste. Subtitle D bans the open dumping of waste and sets minimum requirements for landfills. This includes setting design requirements, location restrictions, financial requirements, and cleanup and closure requirements.
  - The U.S. does not have any federal bans prohibiting disposal of certain type of non-hazardous municipal waste. Some states and local governments have varying prohibitions on certain categories of waste such as yard debris, food waste, or recyclable materials.

Market-Based Approaches

- **Subsidies and incentives**
  - There are various federal subsidies to incentivize, in particular, the installation of gas capture systems at landfills. The subsidies include the Renewable Fuel Standard, which created a compliance market for landfill gas along with other transportation fuel feedstocks with a carbon intensity less than that of gasoline, and the Renewable Electricity Production Tax Credit, which was enacted in 2022 under the Inflation Reduction Act.

- **Purchasing and procurement**
  - The EPA's Comprehensive Procurement Guideline program includes recycled content recommendations for paper and paper products, as well as compost and fertilizer made from recovered organic materials.[161]

160 U.S. EPA. (2016, August 29). *Standards of performance for municipal solid waste landfills.* Federal Register, 81(167). https://www.govinfo.gov/content/pkg/FR-2016-08-29/pdf/2016-17687.pdf

161 U.S. EPA. (2024). *Comprehensive procurement guideline program*. https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program

Voluntary Agreements

- **Agreements between national and/or subnational governments**
  - The U.S. is a signatory to the Paris Agreement, the GMP, and COP29's declaration on Reducing Methane from Organic Waste.
  - Public-private partnerships or agreements
  - LMOP is a voluntary partnership program working with industry and waste management decision-makers to reduce landfill methane and promote recovery and beneficial use of biogas from municipal solid waste. In addition to providing technical assistance and informational materials on the benefits of biogas, LMOP maintains a U.S. landfill gas energy project database comprised of voluntarily reported data from partners.[162]

Information and Education Approaches

- **Technical assistance**
  - Various grants and technical assistance programs exist for solid waste landfills in the United States. SWM grants provide such assistance to landfills located in rural areas. Water & Waste Disposal Technical Assistance & Training Grants are also available to rural communities. The Climate Action Reserve U.S. Landfill Protocol Project provides emissions reduction guidance to landfills.

- **Required or voluntary information disclosure.**
  - GHGRP Subpart HH requires MSW landfills that generate more than 25,000 metric tons of CO_2e to report their emissions and other data annually, which are then published and made available online.[163] In May 2024, the EPA finalized updated GHGRP reporting requirements to include the percentage of recovered methane sent to a destruction device annually.

- **Education and behavior change**
  - The National Environmental Education Advisory Council provides consultation to the EPA regarding needs for environmental education across the country. Many state governments also maintain or provide funding for educational campaigns targeted toward waste management, recycling, and organics diversion.

162 U.S. EPA. (2024). *Voluntary data collection from LMOP partners.* https://www.epa.gov/lmop/voluntary-data-collection-lmop-partners

163 U.S. EPA. (2024). *GHGRP wastes*. https://www.epa.gov/ghgreporting/ghgrp-waste