WASTE & CLIMATE CHANGE

Atlas on Waste Management and Climate Change Mitigation

FOCUS ON INTEGRATING WASTE INITIATIVES INTO NDCs

ISWA International Solid Waste Association

AFD AGENCE FRANÇAISE DE DÉVELOPPEMENT

Partenariat français pour les déchets PFD

FSWP French solid waste partnership

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This publication is produced in partnership with the French Development Agency (AFD) and with the support of the International Solid Waste Association (ISWA) working group on Waste Management and Climate Change.

AFD — The French Development Agency Group

The French Development Agency Group (AFD) implements France's international partnership policy defined in the law approved on August 4th 2021 dealing with solidarity development and global inequalities worldwide. It contributes to the dual agenda of combating poverty and inequality and preserving common goods, such as climate, biodiversity, and global health. Jointly with Proparco and Expertise France, AFD contributes to France's commitment to the Sustainable Development Goals (SDGs).

The inadequate management of solid waste is a factor of inequality and has a lasting impact on health amongst populations worldwide. It also leads to social, environmental and climate urgency. The AFD Group has been active to support financially and technically the improvement of the waste management sector for 25 years through 75 projects amounting to nearly 1 billion euros.

AFD offers a differentiated response adapted to the different contexts on the three continents (Africa, Asia, and Latin America). It takes into consideration the maturity of local actors, ensuring an integrated approach in the sector, in line with public policies. It aims to improve access and quality of the service delivered, from collection to treatment, by reducing health, environmental and climate risks.

ISWA — International Solid Waste Association

The International Solid Waste Association (ISWA) is a global network of waste professionals, researchers, and experts dedicated to promoting sustainable and professional waste management and advancing the global transition towards a circular economy. For over a decade, ISWA has actively ensured the representation of the Waste and Resources sector within the UNFCCC Climate COPs, notably hosting a dedicated Waste and Resources pavilion since COP28 in 2023. This pavilion has provided an essential platform to position the waste management industry as a pivotal contributor to global climate change mitigation discussions and providing a home for waste related issues.

This "Atlas on waste management and climate change mitigation", prepared by FSWP, supported by AFD, and in collaboration with the ISWA's Working Group on Climate Change and Waste Management along with other ISWA experts, marks an important milestone in ongoing efforts to integrate sustainable waste management strategies into Nationally Determined Contributions (NDCs). The French Solid Waste Partnership, ISWA's National Member for France jointly with Astee, has significantly supported the ongoing efforts of ISWA's Working Group on Climate Change and Waste Management, and generously contributed time and resources to the Waste and Resources pavilion and campaigns. ISWA deeply values the efforts of all its National Members, whose overall participation within ISWA has been instrumental in shaping the global dialogue and implementing actionable strategies within their local contexts. Through such collaboration, ISWA effectively incorporates diverse regional insights, fostering global understanding while addressing local realities and challenges. ISWA would further like to thank the members of the Working Group as well as the ISWA Scientific and Technical Committee for their contributions that have made this publication possible.

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Executive summary

This publication focuses on countries within the scope of intervention of the French Development Agency (AFD), which has provided the source material presented in Annex 3, supporting this report. It highlights the **critical role that solid waste management can play in achieving global climate objectives,** particularly through its **inclusion in countries' Nationally Determined Contributions** (NDCs). While the waste sector is directly responsible for only 3 to 5% of global greenhouse gas (GHG) emissions on a 100-year period calculation basis, its indirect mitigation potential is significantly higher—up to 20% when accounting for avoided emissions through prevention, recycling, and energy recovery. This **potential remains largely underutilized in national climate strategies.**

Current trends point to a **sharp increase in waste-related emissions unless urgent action is taken.** By 2050, global waste generation is expected to **rise by over 70% since 2016,** driven by population growth and economic development. Waste production is closely correlated with GDP per capita, with the sharpest increases expected in low- and middle-income countries. Without significant investment in waste systems, these regions risk a dramatic surge in methane emissions, mainly from unmanaged organic waste and poor landfilling practices.

Despite these stakes, the waste sector remains insufficiently represented in climate policies, though a positive trend is visible, with many more countries including waste in their NDCs between 2020 and 2025. In the revised NDCs in 2025, more than half of the countries reference solid waste in their NDCs. However, most do not specify actions, targets, or indicators. Waste prevention, though the most impactful strategy, is mentioned in only 34% of the NDCs reviewed.

To unlock the full climate mitigation potential of the waste sector, this Atlas identifies four major levers for action:

1. **Waste prevention:** Changing production and consumption patterns to reduce waste volumes at source is the most effective way to limit GHG emissions during production, transport and waste management. This includes promoting eco-design, repair, reuse, and food waste reduction, and shifting towards a true circular economy. Jobs and the global economy will be deeply transformed by this transition.

2. **Ending open burning, poor landfilling and poor organic waste management:** Ending open burning will improve air quality and reduce black carbon emissions, and their associated high global warming effect. Diverting organic waste from disposal and applying pre-treatment to residuals will reduce methane emissions. Properly designed engineered landfills associated with sound operational practices will drastically reduce methane leakage. All these actions are based on the collection of all waste everywhere and for everyone, as well as infrastructures and organizations that enable sorting and reuse to prevent engineered landfill sites from becoming saturated too quickly.

3. **Energy recovery:** When waste cannot be avoided or recycled, waste to energy facilities enable reducing the use of landfill sites while preventing fossil energy consumption by other sectors. Energy from waste can also come from organic waste treatment (anaerobic digestion) or by capturing landfill gas. Urban energy networks, urban transport, and local industries may benefit from these energies in place of fossil fuels. However, these contributions are often invisible in national GHG inventories, which hinders access to carbon markets.

4. **Recycling and material recovery:** Substituting virgin raw materials with recycled content may avoid emissions in the industrial sector, in particular during extraction and production of materials, while reducing the pressures on natural resources. It is essential to support local reuse loops and the engagement of the informal sector in emerging economies.

National strategies vary: some countries focus on building foundational waste systems, while others prioritize reducing waste volumes and maximizing material recovery. What is universal, however, is the urgent need to **phase out uncontrolled practices, comply with Environmentally Sound Management (ESM) of waste practices and to align waste strategies with climate objectives.**

For this transformation to succeed, waste management must be made visible in climate reporting frameworks and carbon finance mechanisms. The Atlas **calls for evolving NDCs and carbon markets** (especially under Article 6 of the Paris Agreement) **to acknowledge and reward avoided emissions from the waste sector to the benefit of other sectors.** Doing so will enable sound waste management to emerge as a cornerstone of climate action—delivering emissions reductions, health benefits, job creation, and progress on multiple Sustainable Development Goals.

Credit: Saj Shafique.

Key Terms

Avoided emissions: GHG emissions that are reduced outside the scope of an organization's activities. They result from the use of one of the organization's products or services to replace a more "carbon-intensive" solution providing an equivalent service. In practical terms, avoided emissions are the result of a comparative analysis of emissions between two scenarios: the new solution implemented is compared with a reference scenario representing the previous situation. They must not be subtracted from the organization's GHG emissions. Avoided emissions must always be accounted for separately[1].

Anaerobic digestion: Microbial decomposition of organic material in enclosed tanks in the absence of oxygen. The process produces two potential outputs: biogas, which can be used for heating, cooking, electricity, or vehicle fuel and digestate, which can serve as an organic fertilizer or soil improver[2].

Biogas: gas produced by the anaerobic digestion process which contains mostly methane and carbon dioxide.

Biomethane: gas obtained from the refining of biogas or landfill gas (see definition below) to contain the appropriate level of methane gas to qualify for use in the natural gas distribution grids.

Business as usual (BaU): way to qualify actions that maintain existing practices and trends.

Carbon markets: Financial mechanisms that assign a monetary value to reduced or avoided greenhouse gas (GHG) emissions, allowing entities to buy and sell emission reduction credits. These markets support climate action by channeling funds into mitigation projects. Carbon markets include compliance markets (e.g., Emissions Trading Systems or carbon taxes), cooperative international mechanisms under Article 6 of the Paris Agreement, and voluntary carbon markets based on independent standards[3].

Circular economy hierarchy of actions: As per ISO 59004, the circular economy relies on the following hierarchy of actions: refuse, rethink, source, reduce, repair, re-use, refurbish, remanufacture, repurpose, cascade, recycle, recover energy, and re-mine[4].

CO_2 equivalent: "Carbon dioxide equivalent (CO_2eq) is a unit of measurement used to compare the emissions of various greenhouse gases on the basis of their global warming potential (GWP), by converting the quantities of the various gases emitted into an equivalent quantity of carbon dioxide" (Astee, 2024, p. 10).

Composting: The decomposition of organic waste by micro-organisms in the presence of oxygen to produce compost. Clean compost can be used as a soil amendment.

Environmentally Sound Management (ESM) of waste: Taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes (Basel Convention, Article 2(8))[5].

Incineration: Incineration is a thermal treatment process in which wastes are converted into gases and incombustible solid residues by a combustion process. Incineration may be ESM-compliant or not. In this report, only ESM-compliant incineration is considered.

Landfill Gas: Gas generated in landfills from the degradation of the materials buried. It contains methane, carbon dioxide, and some toxic and corrosive gases.

Municipal Solid Waste (MSW): Includes all residential and commercial waste but excludes industrial waste[6].

[1] Adapted from Astee (2024). *Guide méthodologique.*

[2] RMI (2024). *"A Playbook for Municipal Solid Waste Methane Mitigation, Recommendations Based on Global Waste Management Archetypes,"* accessible at: https://rmi.org/wp-content/uploads/dlm_uploads/2024/03/wastemap_global_strategy_playbook.pdf

[3] PFD (2024). Waste Management to Address the Climate Crisis.

[4] ISO 59004 standard on circular economy, 2025. Available at: https://www.pfd-fswp.fr/presentation-economie-circulaire-par-iso-anglais?lang=en

[5] Secretariat of the Basel Convention. (2020). *Basel Convention on the control of transboundary movements of hazardous wastes and their disposal. Protocol on liability and compensation for damage resulting for transboundary movements of hazardous wastes and their disposal. Texts and Annexes.* UNEP. https://www.basel.int/TheConvention/Overview/TextoftheConvention/tabid/1275/Default.aspx

[6] UNEP (2024), *Global Waste Management Outlook 2024: Beyond an Age of Wast,* p5.

Key Terms

Nationally Determined Contributions (NDCs) are climate action plans that each country party to the Paris Agreement commits to develop, implement, and regularly update. They outline national targets for reducing greenhouse gas emissions and planned adaptation measures, reflecting each country's level of ambition. NDCs are revised periodically to reflect increased ambition over time.

Open burning: Burning municipal solid waste in open environments, such as barrels and fire pits. This process can release hazardous components from nonhazardous substances and, thus, poses health risks. Open burning may also include burning of non-municipal solid waste[7].

Open dumping: the uncontrolled disposal of solid waste at a site lacking basic environmental or operational safeguards. Waste is deposited indiscriminately, often uncovered, uncompacted, and exposed to weather, with no systems for leachate treatment or landfill gas capture. These sites frequently pose severe health and environmental risks due to pollution, uncontrolled fires, and the spread of disease vectors[8].

Prevention: Any measure taken before a substance, material or product becomes waste, with the aim to reduce waste generation.

Recycling: Processing of waste materials for the original purpose or for other purposes, excluding energy recovery[9]. The processing of the waste, as well as the incorporation of recycled raw materials in new products should comply with strict environmental standards to prevent pollution, particularly regarding plastics.

Refuse-Derived Fuel (RDF): a combustible material produced from non-hazardous municipal solid waste (MSW) through mechanical pre-treatment processes such as shredding, sorting, and removal of inerts and metals. RDF typically consists of the high-calorific fractions of waste—such as plastics, paper, and textiles— leaving a residual waste that needs to be treated or landfilled. RDF is used as a fuel substitute in cement plants, dedicated RDF energy plants or in co-incineration in WtE[10].

Safe final disposal: disposal of waste through incineration or engineered landfills, compliant with ESM guidelines, as defined by the Basel Convention.

Specially Engineered Landfills: landfills that are designed and operated to comply with ESM guidelines of the Basel Convention.

Waste Sector: As defined by the IPCC in its greenhouse gas inventory guidelines, the waste sector encompasses emissions resulting from solid waste disposal, biological treatment of solid waste, incineration, and wastewater handling[11]. In the context of this publication, the term refers specifically to the IPCC-defined sector, which includes wastewater but excludes Waste-to-Energy (WtE) also referred to as incineration with energy recovery. WtE is accounted for under the energy sector. This definition ensures consistency with national GHG reporting practices under the UNFCCC.

Waste-to-Energy (WtE): Waste-to-Energy (WtE) (or Energy-from-Waste (EfW)) is the thermal treatment of residual waste. The technology enables the recovery of the energy and materials that cannot be recycled[12]. WtE facilities must comply with Environmentally Sound Management (ESM) guidance and with national atmospheric emissions thresholds.

[7] *RMI (2024). Global Strategy Playbook: Building High-Impact National Waste & Climate Strategies.* Available at: https://rmi.org/wp-content/uploads/dlm_uploads/2024/03/wastemap_global_strategy_playbook.pdf

[8] ISWA (2016). *A Roadmap for Closing Waste Dumpsites: The World's Most Polluted Places.* International Solid Waste Association. Available at: https://www.iswa.org/closing-the-worlds-biggest-dumpsites-task-force/?v=11aedd0e4327

[9] UNEP (2024). *Global Waste Management Outlook 2024: Beyond an Age of Wast,* p5,6.

[10] ISWA (2023). *Whitebook on Energy from Waste Technologies.* International Solid Waste Association. Available at: https://www.iswa.org/wp-content/uploads/2023/07/ISWA-Whitebook-on-Energy-from-Waste-Technologies.pdf

[11] IPCC (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 5: Waste.* Intergovernmental Panel on Climate Change. Available at: https://www.ipcc.ch/site/assets/uploads/2018/03/5_Waste-1.pdf

[12] ISWA (2023). *Whitebook on Energy from Waste Technologies.* International Solid Waste Association.

Introduction

Credit: Antoine Giret.

The Atlas on Waste Management and Climate Change Mitigation highlights the potential of waste management to reduce greenhouse gas (GHG) emissions through a geographical representation of data on waste and GHG emissions. It is based on work carried out by AFD in the 103 countries in which it operates. This document details how waste management has been included to date in the Nationally Determined Contributions (NDCs) of these 103 countries and opens up opportunities to further include it in future NDCs or Biennial Transparency Reports (BTR) submitted in the context of transparent reporting on the Paris Agreement.

The Atlas aims to support decision-makers in areas such as development financing focused on climate and waste management, the development of national policies and the implementation of projects related to waste management and climate action. The main objective of the Atlas is to raise awareness of the impact of waste management on climate change and to increase its integration into the NDCs of all countries.

In this perspective, the **widespread adoption of Environmentally Sound Management (ESM) of waste,** as defined under the Basel Convention, is a fundamental pillar. ESM refers to all practical measures ensuring that waste is managed in a manner that protects both human health and the environment, resulting in the **prevention of open dumping and open burning.**

It must be noted that the climate reporting standards for countries to the United Nations Framework Convention on Climate Change (UNFCCC) are designed to avoid double-accounting. The National Inventories account for emissions by "sectors", with the following activities being counted under the "Waste sector": solid waste disposal, biological treatment of solid waste, incineration without any energy recovery (see also **MAP 7**) and wastewater handling.

However, the scope of the Waste Atlas intends to be broader than the sectorial divisions according to UNFCCC, aiming to feature contributions of waste management like recycling or energy-recovery, which are accounted in the UNFCCC sections under the industry or energy sectors. If the avoided emissions in these sectors are taken into account through methods such as Life-Cycle Assessment (LCA), the impact of waste management and its circular economy is estimated to represent up to 20% of the global GHG emission reduction potential[13]. A broader scope allows decision-makers to address the full potential that waste management and circular economy have in stock when defining NDCs across all sectors.

[13] UNEP (2024), *Global Waste Management Outlook 2024: Beyond an Age of Wast.*

Introduction

The implementation of the NDCs requires a mix of local, national or transnational financing from public and/or private sources including loans, grants to bonds or carbon off-set mechanisms or carbon credit programs. Carbon markets could in the future play a major role with carbon credits trading systems, given that the use of such market mechanisms is operational since COP29 through Article 6 of the Paris Agreement. There are different types of carbon markets. Voluntary carbon markets – national and international – refer to the issuance, buying and selling of carbon credits, on a voluntary basis between private and/or public actors. Buyers so far mainly focus on the conditional elements of NDCs of the host countries, as unconditional targets should be pursued using domestic funding. In addition, compliance markets such as the EU-ETS, could be created in other places through national, regional and/or international regulations to drive mitigation actions.

The document is divided into 3 parts:

Part 1: An overview of the contribution of waste management to GHG emissions and the trends affecting them.

Part 2: A summary by region of the integration of waste management into current NDCs.

Part 3: A look at four emission reduction levers that could be further integrated into the NDCs.

Credit: Collab Media.

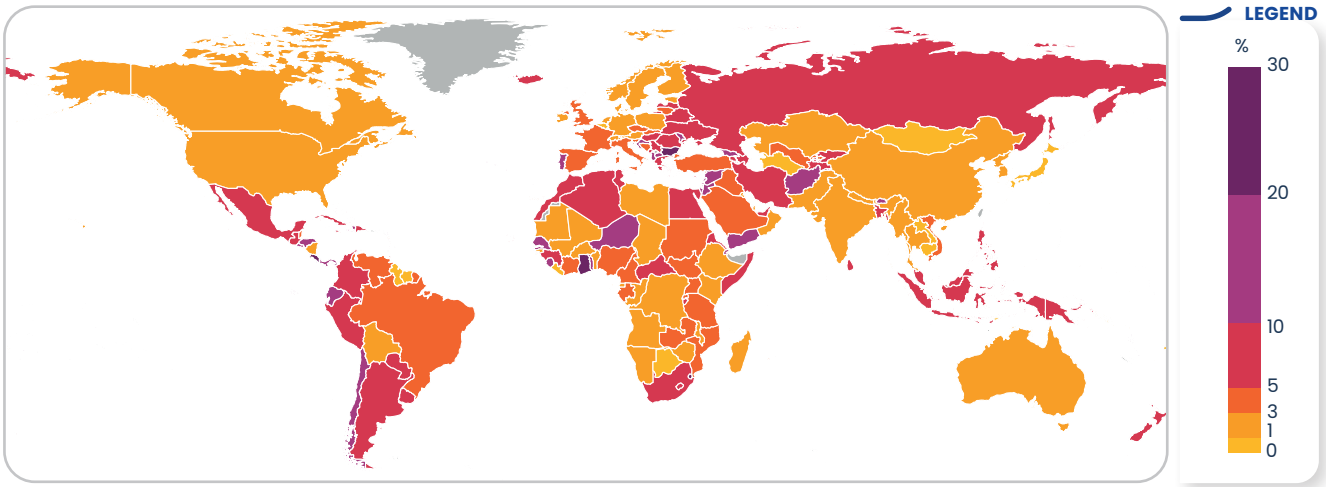
1. Contribution of Waste Management to Global Greenhouse Gas Emissions

Waste management is a local issue with global climate consequences. Its contribution to global GHG emissions is often underestimated. This first section provides a global overview of emissions associated to waste management, clarifies the definition of the "waste sector" used in official climate inventories, and explores future trends in waste generation and their impact on emissions. Note that this first section provides a global overview on the contribution of the waste related activities to the global GHG emissions and occasionally provides focused insights on the 103 countries reviewed in Section 2.

1.1. SHARE OF WASTE SECTOR IN GHG EMISSIONS: A GLOBAL VIEW

At the global level, the waste sector (which includes wastewater management) is estimated to contribute approximately **3 to 5% of total greenhouse gas (GHG) emissions**[14], as reported by UNEP based on IPCC estimates, with notable variations between countries, as reflected on **MAP 1**. In some cases, it can be as high as 20%, or even 30% in several island states. Of the 22 countries where waste-related emissions exceed 15% of the national total, more than half (12) are small island states. Other countries with a high proportion of emissions from the sector are Costa Rica (28%), Ghana (23%), Bulgaria (21%), Eswatini (20%), Bhutan (20%), Georgia (18%), Jordan (17%), El Salvador (16%), Niger (15%) and Syria (15%)[15].

MAP 1 **Share of greenhouse gas emissions from the waste sector in total emissions, 2021**



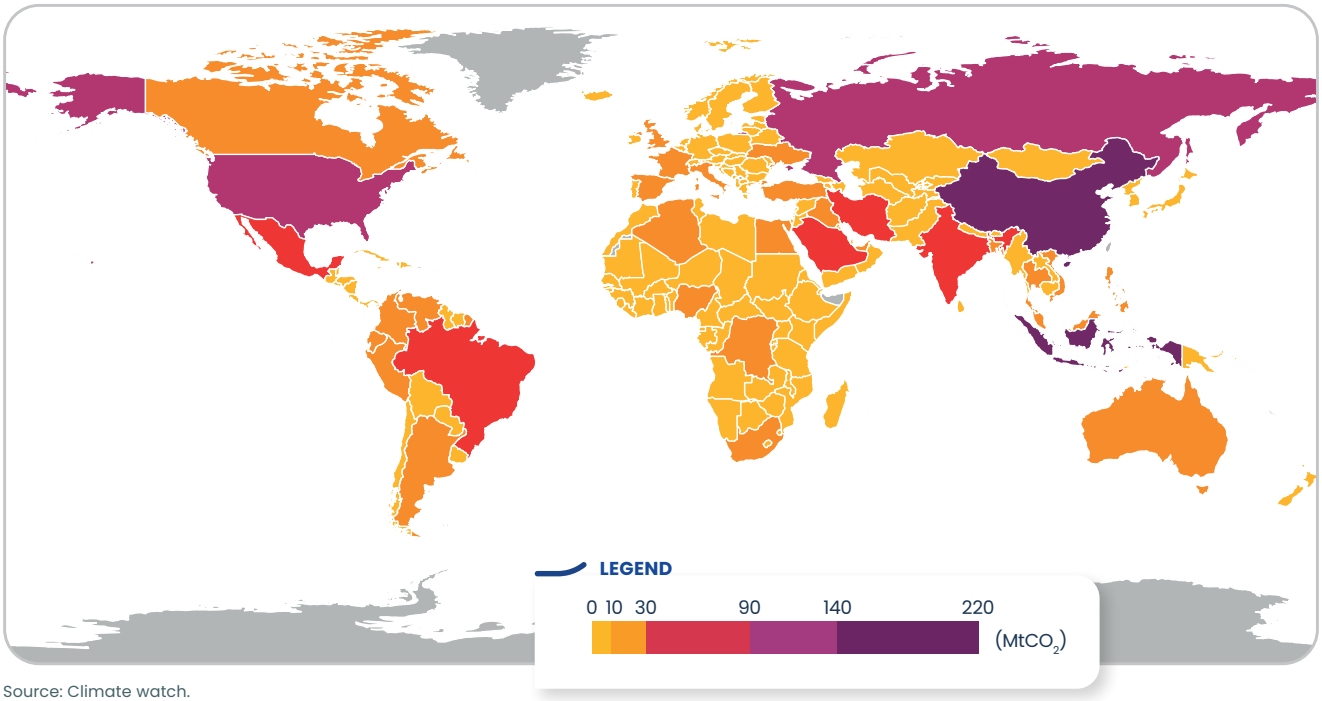
Source: Climate watch.

[14] UNEP (2024), *Global Waste Management Outlook 2024: Beyond an Age of Wast*, p109.
[15] Climate watch, Historical emissions, https://www.climatewatchdata.org/data-explorer/historical-emissions, accessed on 03 April 2025.

It is important to note that not all countries contribute equally to global GHG emissions. For instance, as shown on **MAP 2**, total emissions from the waste sector are highly concentrated in a few major emitting countries, notably **China** (~216 $MtCO_2e$), **Indonesia** (~138 $MtCO_2e$), **the United States** (~ 130$MtCO_2e$), Russia (~116 $MtCO_2e$), **India** (~ 72 $MtCO_2e$) and **Brazil** (~ 72,24 $MtCO_2e$). **The European Union,** considered as a whole, emits ~ 98$MtCO_2e$, but with significant variation among Member States. In contrast, many countries in Africa, South-East Asia, the Pacific and the Caribbean record very low volumes of emissions on a global scale, even though the waste sector can represent a substantial share of their national emissions inventories.

Emissions shown in **MAP 1** and **2** include all waste-related sources as defined by the IPCC (refer to **Section 1.2**). However, emissions related to waste transport, the production of materials that become waste, the recycling using secondary raw-materials or the energy recovered from waste are not included in the waste sector's accounting, as they are attributed to other sectors such as energy or industry in GHG inventories.

MAP 2 **Total greenhouse gas emissions from the waste sector by country (in $MtCO_2e$), 2021**



Source: Climate watch.

BOX 1

Greenhouse Gas emitted by waste management and their impacts

Waste management mainly contributes to emissions of three greenhouse gases (GHGs) reported under the Paris Agreement, each with a different warming effect:

- **Methane (CH_4)** is the main GHG emitted by the waste sector. It is produced during the **decomposition of organic waste** in the absence of oxygen, particularly in dump sites, non-ESM compliant landfills or specially engineered landfill[16] sites. Landfill gas can to some extent be captured in landfill gas collection systems and be energetically valorized if the methane concentration permits this. Methane has a **warming power 84 times greater than CO_2 over a 20-year period and 28 times greater over a 100-year period,** making its reduction a short-term climate priority[17]. Reducing methane emissions is therefore a priority to rapidly curb global warming. **MAP 3** presents the share of methane in each country's waste-related GHG emissions.
- **Nitrous oxide (N_2O)** is emitted in composting processes, and through the direct discharge of untreated wastewater into the environment. The biological mechanisms behind these emissions are complex, they are usually not measured but only estimated. **Its warming potential is extremely high, 273 times greater than CO_2 over a 100-year period, and it remains in the atmosphere for over a century,** making it a significant long-term climate forcer[18].
- **Fossil CO_2**[19] is mainly linked to **the manufacture and transport of goods** before they become waste (fossil energy consumption) and **to incineration of non-biogenic waste.**

In addition to these greenhouse gases, **black carbon,** produced by incomplete combustion, particularly through the open burning of waste, **is also a significant driver of short-term climate warming.** Although it is not included in official GHG accounting under the Paris Agreement, its climate impact is considerable: black carbon has a warming impact **up to 1,500 times stronger than CO_2** per unit of mass, in addition to its harmful effects on human health[20].

In the waste sector, greenhouse gas emissions are largely dominated by methane, as shown on **MAP 3**. Globally, waste (including wastewater) is the **third largest anthropogenic source of methane** (after fossil fuels industry and agriculture), accounting for **nearly 20% of estimated global methane emissions**[21]. This gas is mainly released during the decomposition of organic matter (food and green waste, paper/cardboard waste, wood waste etc.). In low- and middle-income countries, **organic waste often accounts for more than 50%** of total municipal waste volumes, as shown on **MAP 4**. In high-income countries, this proportion is relatively smaller, around 32%. The higher share of organic waste in low- and middle-income countries is mainly due to the lower presence of non-organic materials like plastics and packaging. In high-income countries, although organic waste volumes can be similar or higher, they represent a smaller proportion of the total waste stream.

[16] The Basel Convention defines environmentally sound management (ESM) of waste and provides guideline for specially engineered landfills that are ESM compliant. Basel Convention, Technical guidelines on the environmentally sound disposal of hazardous wastes and other wastes in specially engineered landfill (D5)). Available at: https://synergies.pops.int/Portals/4/download.aspx?d=UNEP-CHW.15-6-Add.5-Rev.1.English.pdf

[17] French Ministry of Energy Transition (2022). Global overview of GHG emissions. *Key figures on climate. France, Europe and Worldwide.* DATALAB. https://www.statistiques.developpement-durable.gouv.fr/edition-numerique/chiffres-cles-du-climat/fr/ p13, last accessed on April 2025.

[18] French Ministry of Energy Transition (2022). Global overview of GHG emissions. *Key figures on climate. France, Europe and Worldwide.* DATALAB, p13.

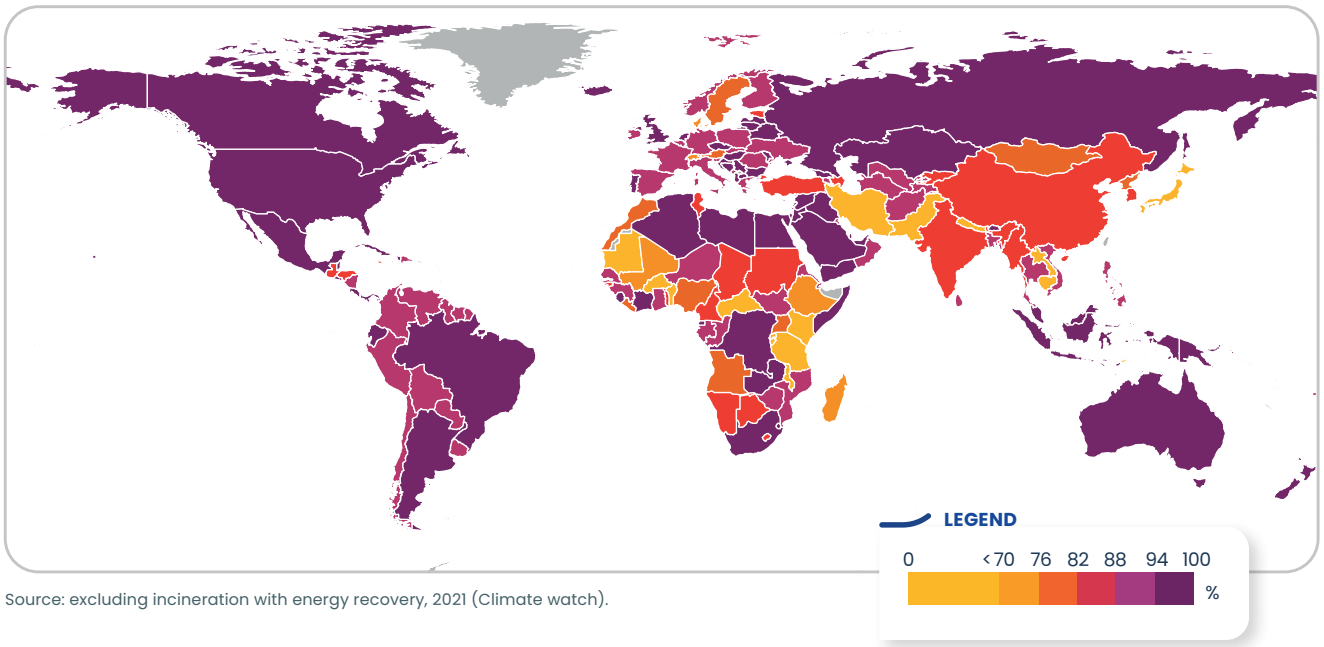
[19] Under the Paris Agreement, only fossil CO_2 emissions are included in the waste sector's greenhouse gas inventory. Fossil CO_2 originates from carbon stored over geological timescales (long carbon cycle). In contrast, biogenic CO_2, resulting from the decomposition or combustion of organic materials such as food waste, paper, or wood, is part of the short carbon cycle and is therefore not included in national greenhouse gas accounting.

[20] *Climate and Clean Air Coalition. "Black Carbon."* https://www.ccacoalition.org/short-lived-climate-pollutants/black-carbon. Last accessed on March 2025.

[21] Climate and Clean Air Coalition & United Nations Environment Programme, *Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions* (Nairobi: UNEP, 2021). Available at: https://www.ccacoalition.org/sites/default/files/resources//2021_Global-Methane_Assessment_full_0.pdf.

MAP 3

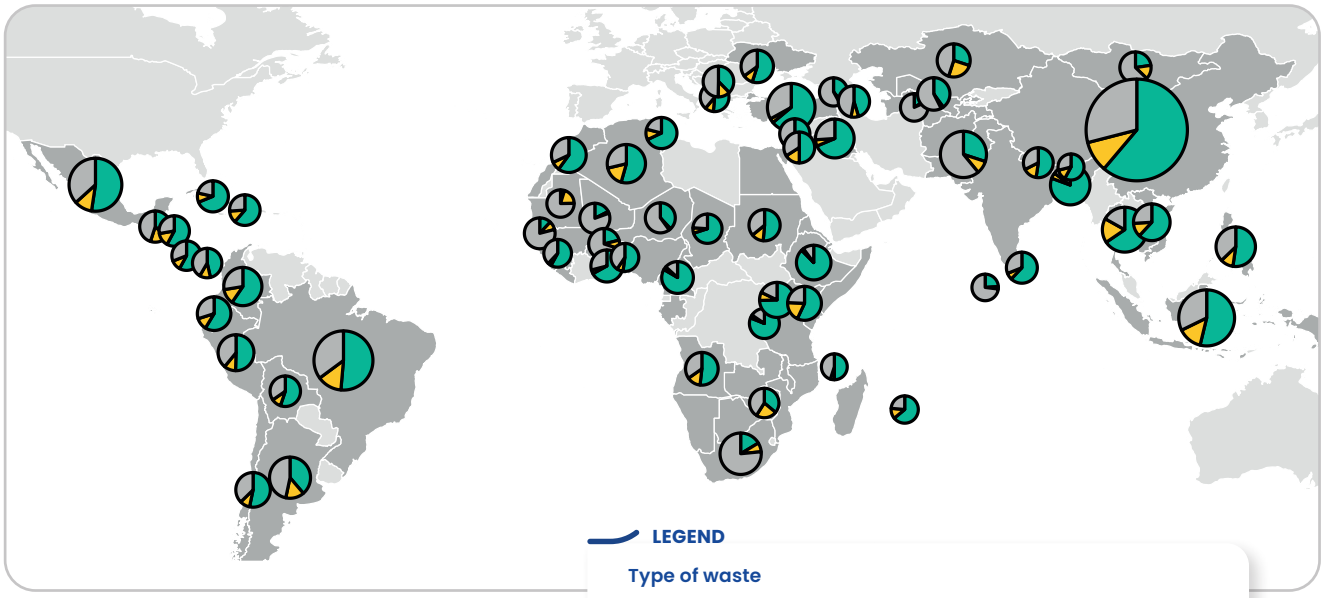
Contribution of methane emissions to total emissions from the "waste sector" in %



Source: excluding incineration with energy recovery, 2021 (Climate watch).

MAP 4

Volume of household waste and composition by country (%), 1995-2017

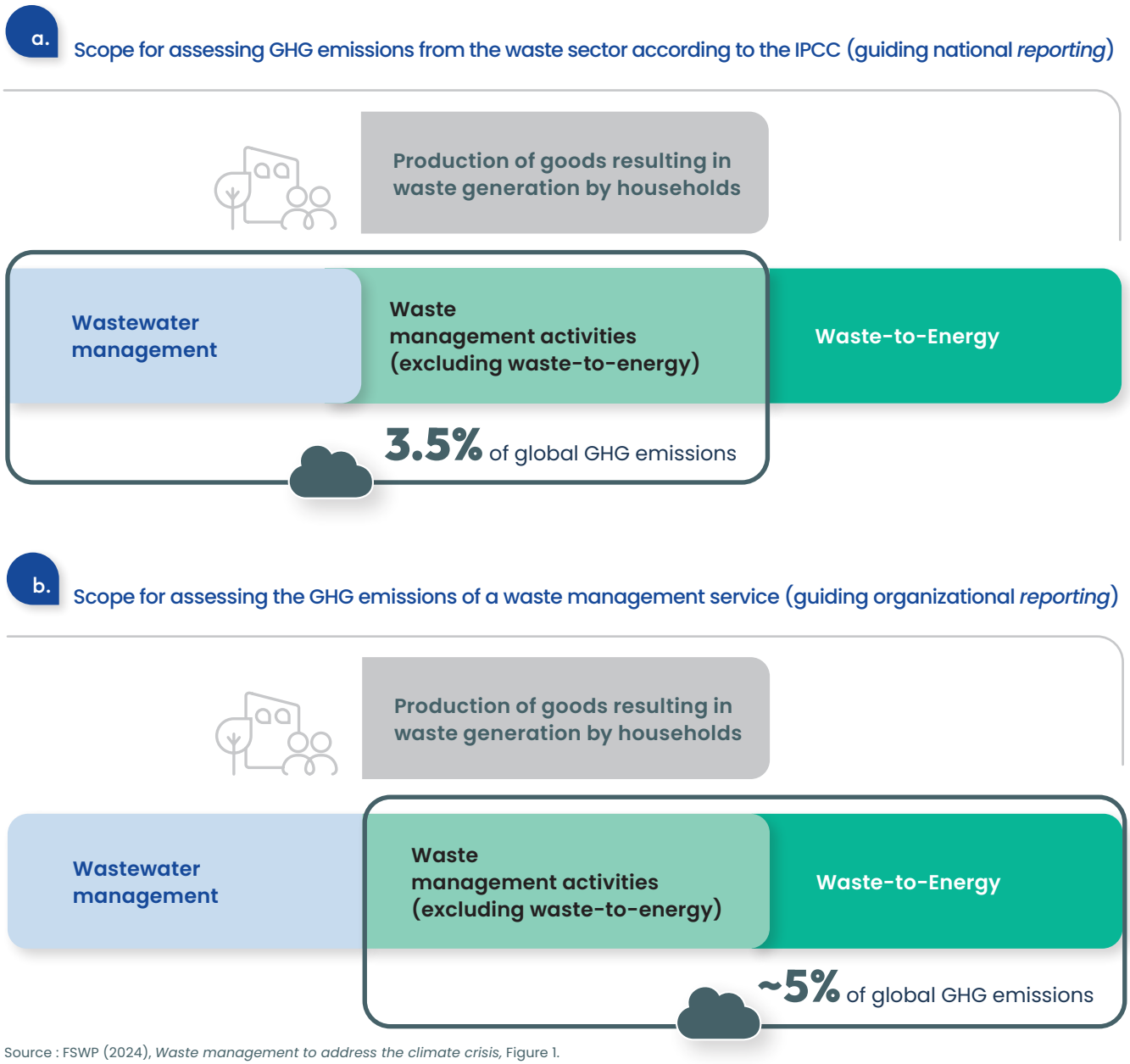


Source: What a Waste 2.0, excel data dated between 1995 and 2017 according to country.
The pie chart size is proportional to the total amount of household waste.

1.2. THE DEFINITION OF THE "WASTE SECTOR" INCLUDES WASTEWATER AND EXCLUDES WASTE-TO-ENERGY

This section aims to clarify the definitions of terms used when referring to GHG emissions from waste management. There is a difference between what the climate world calls "waste sector emissions", defined under national inventory reporting according to UNFCCC, and the emissions reported by local solid waste management services. National reporting is sector-based to avoid double accounting, whereas local services reporting aims to drive GHG reduction by the services themselves. In the case of national reporting as per the IPCC, **solid waste and wastewater management are both included in the "waste sector"**, as shown in **FIGURE 1**, while **waste-to-energy[22] activities are excluded from the "waste sector"** and reported under the "energy sector". In contrast, **waste-to-energy emissions are included in local assessments by waste management services**, in order to drive their mitigation strategies.

FIGURE 1 **The scope of GHG emissions assessment for reporting on the waste sector according to the IPCC (a) and for reporting on waste management services (b)**



Source : FSWP (2024), *Waste management to address the climate crisis,* Figure 1.

[22] Waste to energy is incineration with energy recovery. IPCC guideline Vol 5, providing guidance for national reporting, includes incineration without energy recovery, as well as wastewater management. https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html last access 11/06/25.

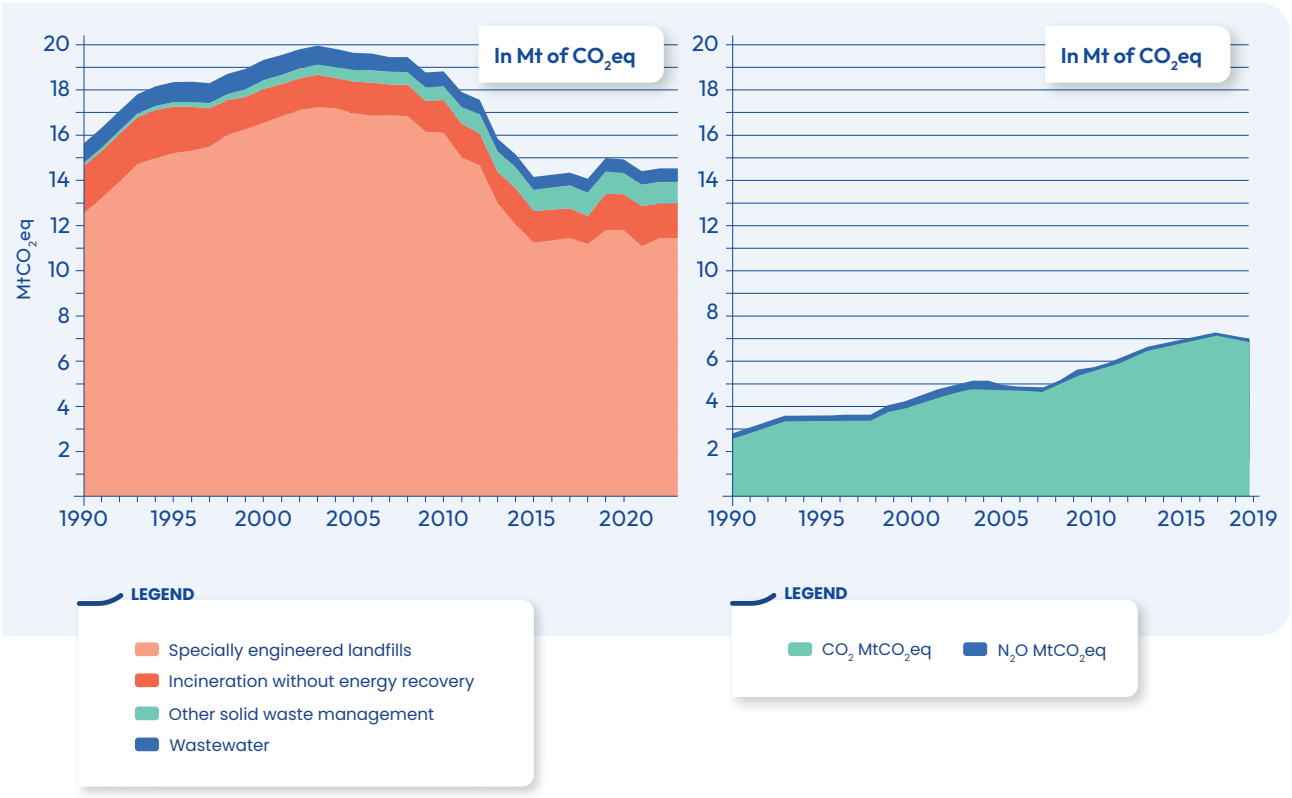
It is important to keep in mind this sectoral definition when analyzing trends of GHG emissions over time, particularly in developed countries such as EU countries which have invested in industrial equipment to recover the energy produced by waste incinerators with strict control of the flue gases. **FIGURE 2** illustrates the reduction in GHG emissions from the waste sector in France since 2009, and the parallel increase in emissions from waste-to-energy plants.

FIGURE 2

Impact on GHG emissions of the transition from landfill-based waste management to incineration with energy recovery in mainland France and overseas territories (centralized treatment)

a. GHG emissions from the "waste sector"

b. GHG emissions from waste incineration with energy recovery and advanced flue gas treatment (excluded from the "waste sector" and included in the "energy sector")



Note: National inventory excluding land use, land-use change, and forestry (LULUCF)Scope: France, Kyoto perimeter (metropolitan + overseas territories belonging to the EU).

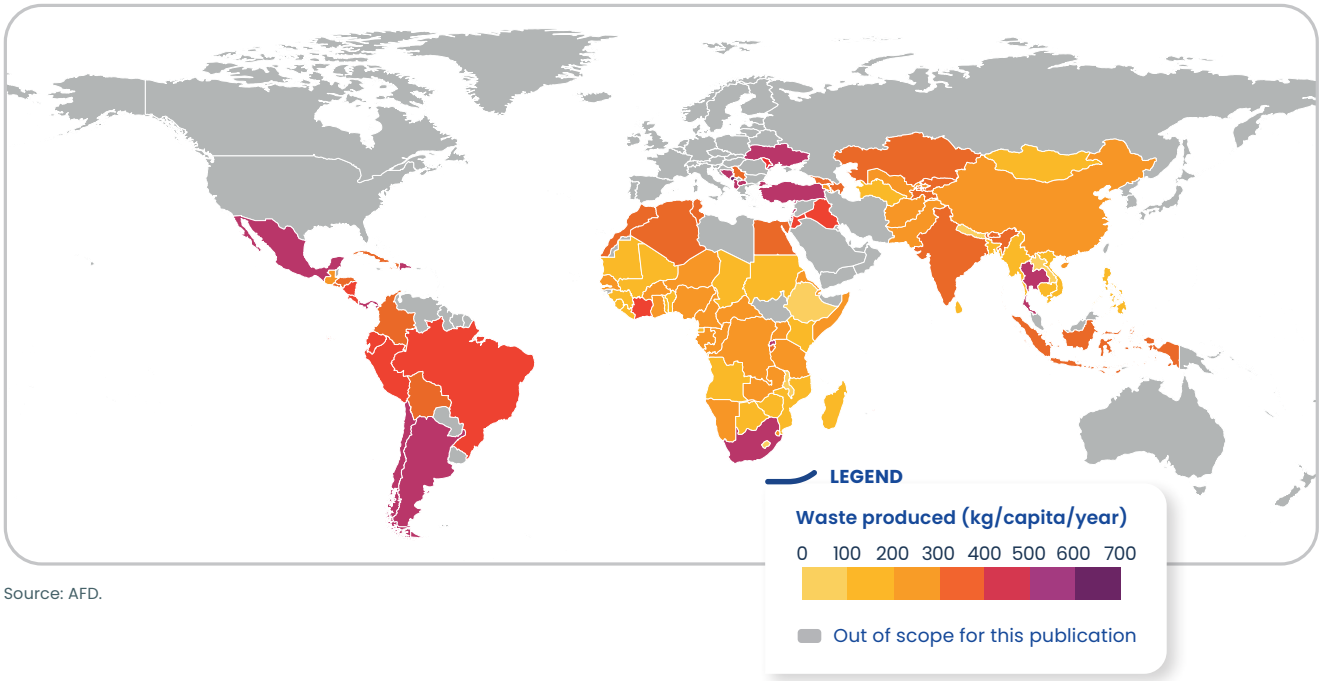
Source: CITEPA, Secten report, 2018 and 2022 editions. Astee (2024), Methodological guide, p. 43 and 44.

1.3. GLOBAL TREND UNTIL 2050 IMPACTING WASTE SECTOR GHG EMISSIONS

In 2016, **global waste production** was estimated at 2.01 billion tonnes and **could reach 3.4 billion tonnes by 2050** under the Business-as-Usual (BaU) scenario, which assumes no significant improvements in management systems[23]. If we focus on the 103 countries of intervention of AFD, the East Asia and Pacific region were the world's largest producer of waste, accounting for 23% of the global total, while the Middle East and North Africa region accounted for just 6%. However, this disparity is expected to shift, as the regions of the **global South are now recording the strongest growth in waste generation**[24].

Also based on 2016 data, among the 103 countries studied, 23 generated less than 140 kg of waste per capita per year, while 50 countries exceeded 190 kg/capita/yr. By 2050, a significant increase is anticipated under the BaU trend scenario (see **MAP 5**): only 9 countries would remain below the 140 kg threshold, while 78 countries would exceed 190 kg/capita/yr[25].

MAP 5 **Forecast generation of waste per person per year in 2050**



Source: AFD.

A direct correlation can be established between population growth, Gross Domestic Product (GDP) growth and its associated change in consumption patterns, **and the increase in waste production per person.** As population rises and lifestyles change, GDP per capita increases, the volumes of waste produced rise. This topic will be explored in more detail in **Section 3.1** on reducing waste at source.

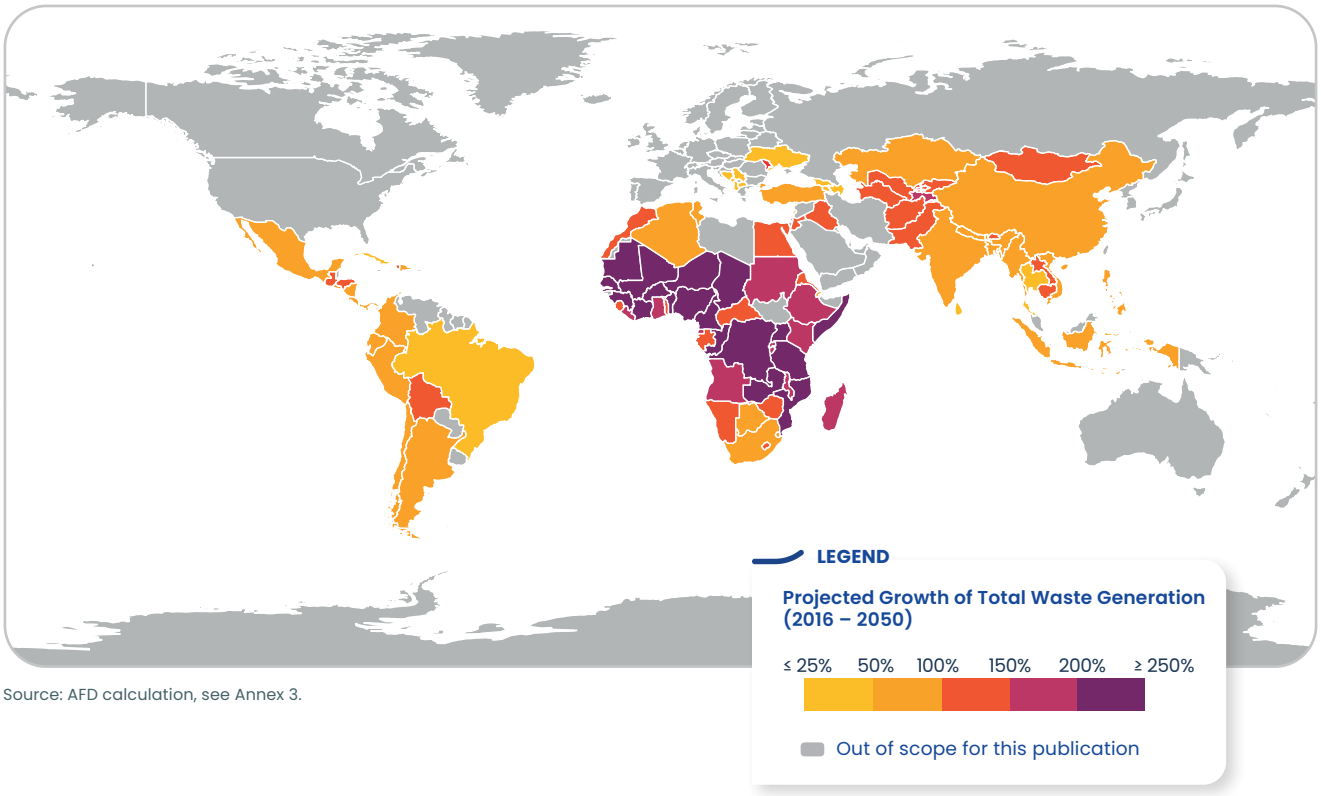
Projections under the BaU scenario indicate that this pattern will be especially pronounced in low- and middle-income countries (see **MAP 6**):

- In low-income countries, waste production is expected to triple by 2050.
- **In middle-income countries, it is expected to double over the same period.**
- High-income countries, on the other hand, will experience a more moderate increase, as their waste production stabilizes with already high levels of consumption[26].

[23] World Bank, *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050,* 2018. Available at https://datatopics.worldbank.org/what-a-waste/
[24] World Bank, *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050,* 2018, p.17.
[25] Of the 103 countries surveyed, according to AFD data, see annex 3.
[26] World Bank, *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050,* 2018.

MAP 6

Projected growth in waste generation between 2016 and 2050



Source: AFD calculation, see Annex 3.

Regionally, **Sub-Saharan Africa is expected to experience the highest rates of increase,** with many countries projected to see **growth exceeding 250%.** This reflects a combination of rapid demographic expansion, urbanization and economic development, often in contexts where waste management infrastructure remains limited. In absolute volume, however, Asia—particularly South and Southeast Asia—will continue to contribute most significantly to global waste generation.

Chapter transition

To effectively address waste-related GHG emissions, **these trends call for** the implementation of appropriate national strategies:

- **To prevent the increase of waste-related GHG emissions in countries experiencing the most significant growth in waste generation** while their waste management systems remain underdeveloped.
- **To reduce waste-related GHG emissions in countries with high waste generation per capita.**
- **To reduce and prevent waste-related GHG emissions** through the levers presented in **Section 3**.

Building on this global diagnosis, the next section explores how these challenges and opportunities are currently reflected in the Nationally Determined Contributions (NDCs) submitted under the Paris Agreement.

2. Including Waste Management in Nationally Determined Contributions (NDCs)

Under the Paris Agreement, each signatory country is required to submit a Nationally Determined Contribution (NDC), which sets out its commitments to reduce greenhouse gas (GHG) emissions and adapt to climate change. These NDCs, which are updated every five years, must demonstrate increasing ambitions in order to align national trajectories with the global objective of limiting global warming to 1.5°C or 2°C[27]. This section provides an overview of the integration of solid waste management in the NDCs.

2.1. GLOBAL OVERVIEW

After an initial submission of Intended Nationally Declared Contributions (INDCs) in 2015, the Paris Agreement (Article 4) requires each country to prepare, communicate and maintain successive Nationally Determined Contributions (NDCs) that it intends to achieve. Starting in 2020, NDCs are submitted every five years, regardless of their respective implementation time frames. Successive NDCs should be more progressive compared to the previous NDCs and reflect their highest possible ambition.

Therefore, countries currently prepare and report their successive NDCs, in the run-up to COP30 in Belem. While some countries have submitted their NDCs, others have yet to do so, and these may be revised until COP30. NDCs declared in 2020 rarely included actions in the waste sector, and do not mention wider waste management activities as a mitigation measure. In 2020, relatively few countries (48 out of 103 surveyed) mentioned waste management. Since then, through the biennial transparency reports and the ongoing NDCs 3.0 revision process, many countries have included it in a more structured way in their climate strategies, as illustrated in **MAP 7**. On the other hand, sanitation and wastewater treatment, which are also part of the waste sector, as explained in **Part 1.2**, continue to receive limited attention, despite their significant role in nitrous oxide and methane emissions.

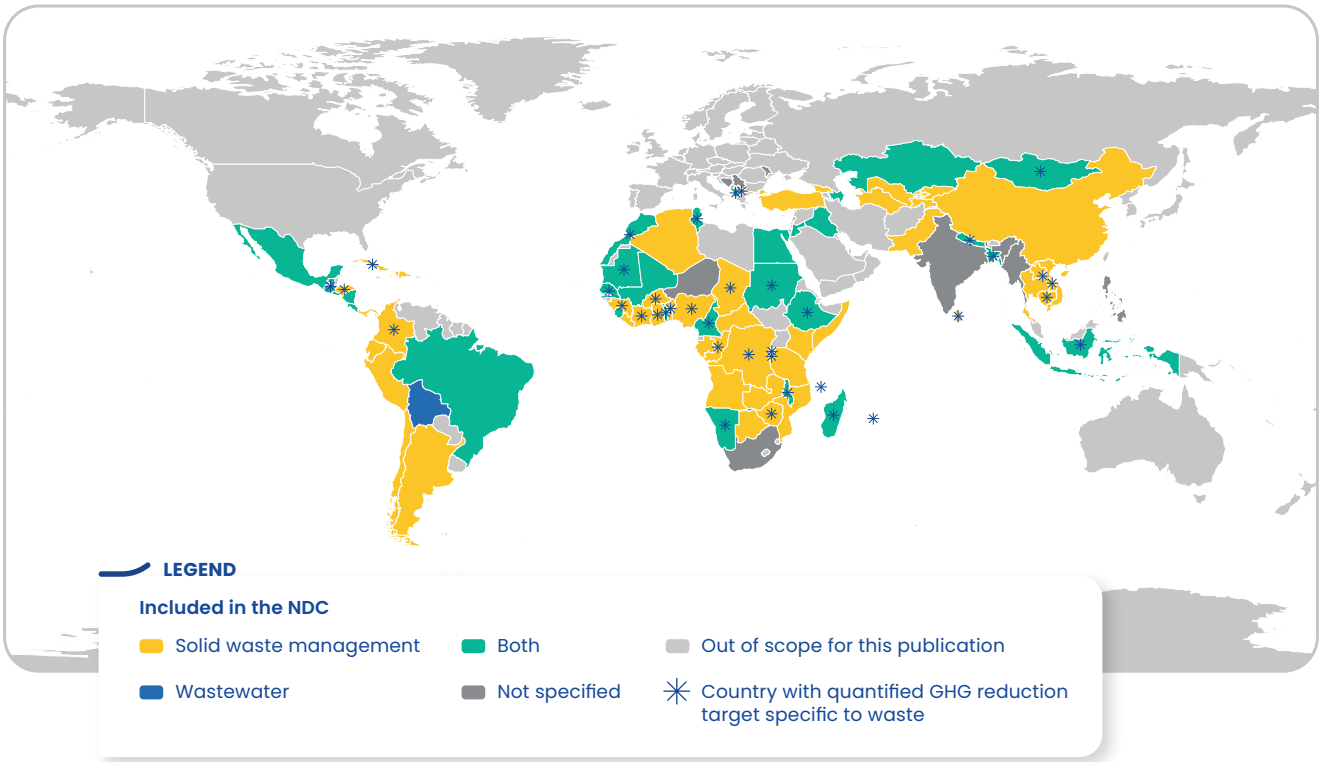
Although most countries now reference solid waste management in their NDCs, actual commitments are still lacking. Mentions often remain general, unquantified and difficult to track, as illustrated in **MAP 8**.

> Since 2020, many countries have included waste in a more structured way in their climate strategies.

[27] United Nations, *All about NDC*. Available at https://www.un.org/fr/climatechange/all-about-ndcs, consulted on 3 April 2025.

MAP 7

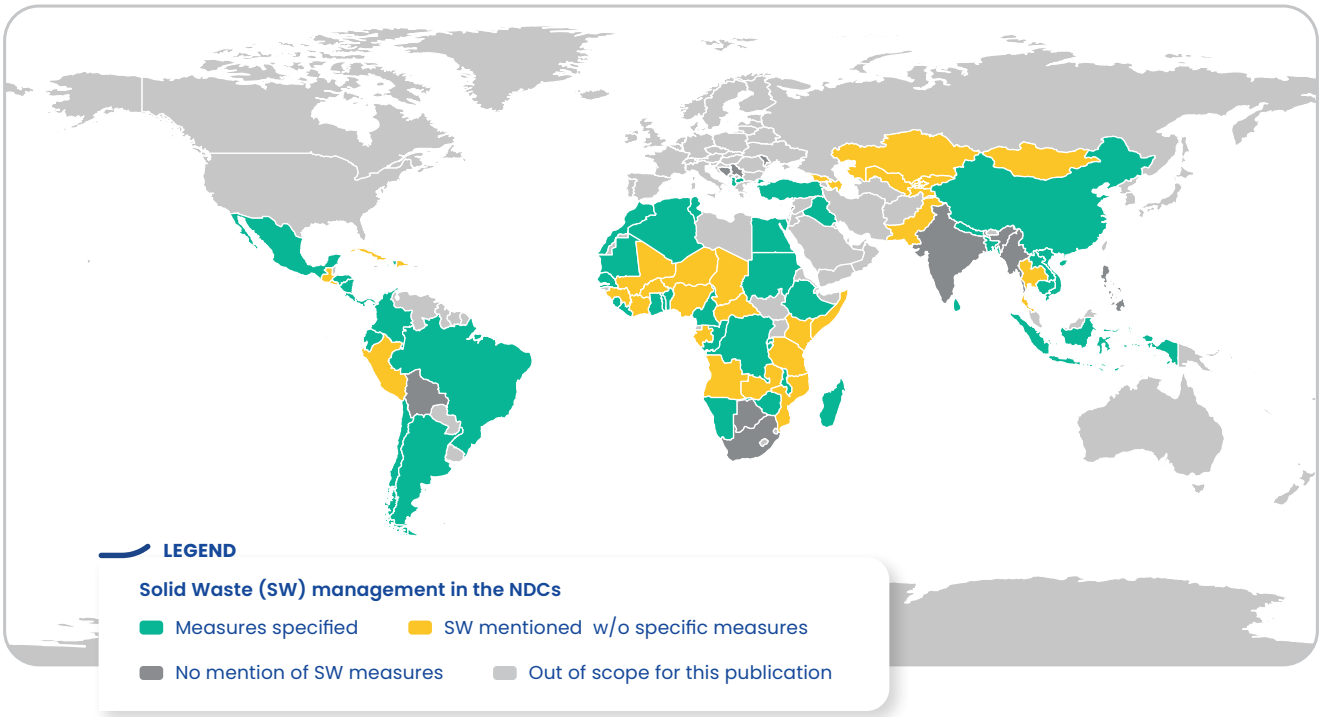
Integration of the waste sector in the most recent NDCs: solid waste only, wastewater only, or both



Source: Compilation of the most recent NDCs available as of April 2025 on the UNFCCC website (https://unfccc.int/NDCREG); see Annex 1.

MAP 8

Specific solid waste initiatives in the NDCs



Source: Compilation of the most recent NDCs available as of April 2025 on the UNFCCC website (https://unfccc.int/NDCREG); see Annex 1.

The following sections of this chapter present a summary, by regions of the world, of the way in which NDCs account for waste management. **TABLE 1** provides details by country of the components included in the NDCs. The analysis of the NDCs by country is presented in **ANNEX 2**.

TABLE 1: List of countries mentioning waste management in their NDCs with details of the components identified in the action plans (full list of countries in Annex 1)

Region Code AFD	AFD Sub-Regions	Countries	Pop. (M inhab) 2016	Date of NDCs consulted	Waste prevention	Improving collection	Improving treatment	Improving landfills (no precision)	Landfill and organic waste management			Energy production			
									Diverting organic waste from landfills	Establish engineered landfills with biogas capture	Bio waste recovery	Anaerobic digestion	Refuse-derived fuel	Methane recovery from engineered landfills	Waste-to-Energy
AFR	Afrique Australe	Angola	29	2021	✗	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗
AFR	Afrique Australe	Mozambique	28	2022	▼	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗
AFR	Afrique Australe	Zambia	16,5	2025	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗
AFR	Afrique Australe	Malawi	18	2021	✗	✓	✓	✓	✗	✓	✗	✗	✗	✓	✗
AFR	Afrique Australe	Namibia	2,4	2016	✗	✗	✓	✓	✓	✓	✓	✗	✗	✓	✗
AFR	Afrique Australe	Zimbabwe	16	2017	✗	✗	✓	✓	✓	✓	✓	✗	✗	✓	✗
AFR	Afrique Centrale	Central African Rep.	4,6	2022	👥	✓	✓	✗	✓	✗	✓	✓	✗	✗	✗
AFR	Afrique Centrale	Gabon	1,9	2022	✗	✓	✓	✓	✓	✗	✗	✓	✗	✗	✗
AFR	Afrique Centrale	Cameroon	23	2021	👥▼	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗
AFR	Afrique Centrale	Congo Brazzaville	5	2017	✗	✗	✓	✗	✓	✗	✓	✗	✗	✗	✓
AFR	Afrique Centrale	Rep. Demo. Congo	78	2021	✗	✓	✓	✓	✓	✗	✓	✗	✗	✓	✗
AFR	Afrique de l'Est	Kenya	48	2020	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗
AFR	Afrique de l'Est	Somalia	14	2021	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗
AFR	Afrique de l'Est	Tanzania	55,5	2021	✗	✓	✓	✓	✗	✓	✗	✗	✗	✓	✗
AFR	Afrique de l'Est	Burundi	10,5	2021	👥	✓	✓	✗	✗	✗	✓	✓	✗	✗	✓
AFR	Afrique de l'Est	Ethiopia	102	2020	👥	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗
AFR	Afrique de l'Est	Rwanda	12	2020	✗	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗
AFR	Afrique de l'Est	Sudan	39,5	2022	✗	✓	✓	✓	✓	✗	✓	✓	✗	✗	✗
AFR	Afrique de l'Est	Uganda	41,5	2022	👥	✓	✓	✗	✓	✗	✓	✓	✗	✗	✗
AFR	Afrique du Nord	Algeria	40	2016	✗	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗
AFR	Afrique du Nord	Egypt	95	2023	👥	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓
AFR	Afrique du Nord	Morocco	35,2	2021	👥▼	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗
AFR	Afrique du Nord	Tunisia	11,4	2021	👥	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
AFR	Golfe de Guinée	Guinea Conakry	12,39	2021	✗	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗
AFR	Golfe de Guinée	Ivory Coast	23	2022	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗
AFR	Golfe de Guinée	Nigeria	186	2021	✗	✓	✓	✗	✗	✗	✗	✗	✗	✓	✗
AFR	Golfe de Guinée	Benin	10,8	2021	▼	✓	✓	✓	✗	✓	✗	✗	✗	✓	✗
AFR	Golfe de Guinée	Ghana	28,2	2021	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗
AFR	Golfe de Guinée	Liberia	4,6	2018	👥▼	✓	✓	✓	✗	✓	✓	✗	✗	✓	✗
AFR	Golfe de Guinée	Sierra Leone	7,39	2016	✗	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗
AFR	Golfe de Guinée	Togo	7,6	2017	▼	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗
AFR	Grand Sahel	Burkina Faso	18	2021	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗
AFR	Grand Sahel	Chad	14,5	2021	✗	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗
AFR	Grand Sahel	Mauritania	4	2017	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✓
AFR	Grand Sahel	Senegal	15	2020	✗	✓	✓	✓	✓	✗	✓	✓	✗	✗	✗
AML	Andes	Colombia	49	2020	✗	✗	✓	✓	✓	✓	✓	✗	✗	✓	✗
AML	Andes	Ecuador	16,4	2025	👥	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗

✓ Specified ▼ Mentioned ✗ Not included 👥 Awareness ‹ Ambition to reduce

Region Code AFD	AFD Sub-Regions	Countries	Pop. (M inhab) 2016	Date of NDCs consulted	Waste prevention	Improving collection	Improving treatment	Improving landfills (no precision)	Landfill and organic waste management			Energy production			
									Diverting organic waste from landfills	Establish engineered landfills with biogas capture	Bio waste recovery	Anaerobic digestion	Refuse-derived fuel	Methane recovery from engineered landfills	Waste-to-Energy
AML	Brésil, cône sud	Argentina	44	2021	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✗
AML	Brésil, cône sud	Brazil	207	2024	✓	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗
AML	Brésil, cône sud	Chile	18	2020	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗
AML	DRMCC	Cuba	11,5	2025	✗	✗	✓	✗	✓	✗	✓	✓	✗	✗	✗
AML	DRMCC	El Salvador	6,3	2017	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗
AML	DRMCC	Guatemala	16,5	2016	✓	✓	✓	✓	✗	✓	✓	✗	✗	✓	✗
AML	DRMCC	Costa Rica	4,8	2020	✓	✓	✓	✗	✓	✗	✓	✗	✗	✗	✗
AML	DRMCC	Honduras	9,1	2016	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗
AML	DRMCC	Mexico	127	2022	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗
AML	DRMCC	Nicaragua	6	2020	✗	✗	✓	✓	✓	✓	✗	✗	✗	✓	✗
AML	DRMCC	Panama	4	2020	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗
OCE	Océan Atlantique	Dominican Rep.	10	2020	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✗
OCE	Océan Atlantique	Haiti	11	2022	✗	✓	✓	✗	✓	✗	✗	✗	✓	✗	✗
OCE	Océan Indien	Comoros	0,796	2016	✗	✓	✓	✗	✓	✗	✗	✓	✗	✗	✗
OCE	Océan Indien	Madagascar	24,8	2024	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗
OCE	Océan Indien	Mauritius	1,2	2016	✗	✗	✓	✗	✓	✗	✓	✓	✗	✗	✓
ORE	Asie Centrale	Kazakhstan	18	2023	✓	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗
ORE	Asie Centrale	Kyrgyzstan	6	2020	✗	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗
ORE	Asie Centrale	Tajikistan	8,7	2017	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗
ORE	Asie Centrale	Uzbekistan	31,4	2021	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗
ORE	Asie du sud	Pakistan	193	2021	✓	✓	✓	✓	✓	✗	✓	✓	✗	✗	✗
ORE	Asie du sud	Bangladesh	163	2021	✓	✓	✓	✓	✓	✗	✓	✓	✗	✓	✓
ORE	Asie du sud	Nepal	28	2020	✓	✓	✓	✓	✗	✗	✓	✓	✗	✓	✗
ORE	Asie du sud	Sri lanka	20	2021	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓
ORE	Asie du Sud-Est	Thailand	68	2020	✗	✗	✗	✓	✓	✗	✓	✗	✗	✗	✓
ORE	Asie du Sud-Est	Cambodia	15	2020	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	✗
ORE	Asie du Sud-Est	Indonesia	261	2022	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗
ORE	Asie du Sud-Est	Laos	6,75	2016	✗	✓	✓	✗	✓	✗	✗	✗	✗	✗	✗
ORE	Asie du Sud-Est	Vietnam	94,5	2022	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
ORE	Balkans et EU de l'Est	Albania	2,9	2016	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓
ORE	Balkans et EU de l'Est	Northern Macedonia	2	2021	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗
ORE	Chine / Mongolie	Mongolia	3	2020	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗
ORE	Moyen Orient	Iraq	37	2021	✗	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗
ORE	Moyen Orient	Jordan	9,4	2016	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗
ORE	Turquie ...Caucase	Azerbadjan	9	2023	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗
ORE	Turquie ...Caucase	Georgia	3,9	2017	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗
ORE	Turquie ...Caucase	Turkey	79	2023	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✗

2.2. AFRICA (AFR COUNTRY CODE IN AFD DOC)

Solid waste management occupies an important place in African NDCs: 35 countries (out of 46) refer to it, 20 of them with specific measures. Nearly half of the continent's countries (22 out of 46) go further by including quantified GHG emission reduction targets for the waste sector. This trend is particularly marked in the Gulf of Guinea, where the figure rises to 6 out of 7 countries (Except for Nigeria), and in North Africa to 4 out of 4 countries.

Improving waste collection was mentioned by 59% of African NDCs, reflecting a shared need to set up basic services for the Environmentally Sound Management of waste. Improving waste treatment, mentioned by 70% of countries, shows that waste management practices are evolving towards more responsible solutions. **The reduction of waste at source** (preventing the increase of waste volumes per capita), on the other hand, **remains little addressed,** with only 8 countries concerned.

Waste recovery still receives relatively little attention. When it is mentioned, it **mainly concerns methane capture at landfills, while energy recovery remains very marginal.** Only 26% of countries adopt a comprehensive approach combining capture and recovery, and almost half (46%) make no mention of it at all. Some sub-regions stand out, however, such as East Africa, where 75% of countries (6 out of 8) emphasize the recovery of bio-methane.

Landfill improvement is addressed in around 70% of African NDCs, reflecting a **widespread effort to modernize waste disposal systems.** About one-third of these also include landfill gas capture, highlighting a growing focus on methane mitigation. Nearly **half of the countries also mention diverting organic waste from landfills,** to limit methane emissions at the source. These measures are particularly emphasized in regions such as the Gulf of Guinea, Central Africa, and East Africa.

North Africa stands out for its more structured approach to waste management in NDCs. Almost all the countries in the sub-region include both sanitation and specific measures for solid waste management. The stated objectives for improving collection are particularly high, reaching 95% in Egypt and 100% in Algeria. The strategies proposed include advanced recovery systems such as anaerobic digestion, the production of refuse-derived fuel and the capture of landfill gas.

Incineration with energy recovery is mostly absent from African NDCs. The Republic of the Congo is an exception, mentioning this option, but it does not appear to be part of a broader regional strategy. This absence likely reflects both the high implementation costs and the current priorities, which are more focused on basic waste collection and treatment.

In addition to individual NDCs, African countries with support from the UNEP Regional office in Nairobi, adopted a resolution at the African Ministers' Conference on Environment (AMCEN) in Sept 2022 at Dakar, Senegal, which committed to a 60 per cent reduction of open waste burning by 2030 and to fully phase out open waste burning by 2040[28]. This led to the initiation of the Multi Stakeholder Partnership to end open burning of waste in Africa, co-Chaired by AMCEN and United Cities and Local governments of Africa, to implement the resolution.

> There was some mention of waste generation reduction for Africa, but this represented an exeption rather than a general trend.

Note that there was some mention of waste generation reduction for Africa, but this represented an exception rather than a general trend. This is probably caused by the low waste generation per capita but may reveal a lack of strategy to curb the growth in waste volumes projected towards 2050 (refer to **MAP 6** in **Section 1.3**).

[28] UNEP : African Environment Ministers vow to end plastic pollution, eliminate open dumping and burning of waste, address antimicrobial resistance, 2022. Available at https://www.unep.org/news-and-stories/press-release/african-environment-ministers-vow-end-plastic-pollution-eliminate#:~:text=The%20conference%20took%20place%20from,adverse%20impacts%20of%20antimicrobial%20resistance. Last accessed 11 June 2025.

2.3. LATIN AMERICA AND THE CARIBBEAN (AML COUNTRY CODE IN AFD DOC)

In Latin America and the Caribbean, the integration of the waste sector into the NDCs remains uneven, although certain themes are well represented. Only 30% of countries (4 out of 13) have quantified GHG emission reduction targets for this sector. Solid waste management is nevertheless addressed in 92% of the NDCs, with 8 countries proposing specific measures.

> Reducing waste at source is included in almost half of the countries.

Reducing waste at source is included in almost half of the countries (6 out of 13), often as part of a broader circular economy approach. It is generally referred to through concepts such as integrated waste management or the proximity principle, but without any concrete details of the actions envisaged.

Improving collection is mentioned in 62% of NDCs. This reflects less a need to extend services - which are often already well developed in the region - than a desire to optimize practices. Countries are mainly aiming to modernize existing waste handling systems, for example by using fewer polluting vehicles or improving logistical efficiency.

Landfill improvement is mentioned in 80% of NDCs from the region. Additionally, in 60% of cases, this includes landfill gas capture and two-thirds of the countries address organic waste diversion.

No country, however, mentions Waste-to-Energy.

2.4. SMALL ISLAND DEVELOPING STATES (OCE COUNTRY CODE IN AFD DOC)

In many Small Island Developing States, **the waste sector accounts for a significant proportion of greenhouse gas emissions,** mainly due to the absence of other sectors and their related emissions, and inadequate treatment with a high proportion of organic waste. It accounts for almost 30% of national emissions in Mauritius (2021), 14% in Haiti and 6.5% in the Dominican Republic, compared with less than 2% reported in the Comoros and Madagascar[29].

These findings are reflected in the actual content of the NDCs: all the countries studied include solid waste management in their NDCs, and three of them include quantified emission reduction targets. In four cases, these commitments are accompanied by specific measures, reflecting the relatively advanced consideration given to waste issues in national climate strategies.

> All the countries studied include solid waste management in their NDCs.

Improving collection is cited by the majority of countries (4 out of 5), although none of them specify quantified targets. On the other hand, **waste generation prevention (at source) is totally absent** from the region's NDCs, which highlights a blind spot in the priorities within the waste management strategies. This finding is confirmed by the country fact sheets: in both Madagascar and Haiti, collection rates remain low (18% and 11% respectively), and waste is often burnt or left in the open, as stated in their NDCs.

Only the Dominican Republic mentions landfill improvement. Landfill gas capture is included in only one country. By contrast, 4 out of 5 countries (All except Madagascar) include measures to divert organic waste from landfilling, reflecting the **integration of methane mitigation strategies in landfill management.** Dominican Rep., Comoros and Mauritius countries are integrating biowaste recovery and Comoros and Mauritius are integrating anaerobic digestion. Mauritius, in particular, has a strategy that combines sorting, composting, anaerobic digestion, incineration with energy recovery and the deployment of small pilot biogas units.

Overall, waste management ambitions are high with strong integration in their NDCs, even if they often remain dependent on international funding. Madagascar estimates the cost of its waste strategy at nearly 24 billion USD, of which only 3 to 4% can be covered by the country itself. Similarly, the Comoros is making its efforts contingent on external aid of €22 million.

[29] Climate watch, Historical emissions, https://www.climatewatchdata.org/data-explorer/historical-emissions, accessed on 03 April 2025.

2.5. EASTERN EUROPE AND ASIA (ORE COUNTRY CODE IN AFD DOC)

The ORE region is made up of very heterogeneous sub-regions (Asia, the Caucasus, the Balkans, the Middle East), with no marked regional coherence in the way waste management is integrated into NDCs. While most countries refer to it, approaches vary widely.

Solid waste management is mentioned by a majority of countries (almost 75% on average), but only 10 out of 36 countries associate specific measures with it, and few of them set quantified targets.

South-East Asia stands out slightly, with several countries such as Indonesia, Vietnam and Thailand having national waste management plans aligned with clear climate objectives. Their NDCs include measures such **as landfill improvement, landfill gas capture and organic waste diversion,** often supported by specific laws and funding mechanisms. Cambodia and Laos are also following this approach, though Cambodia's measures remain general and non-quantified, while Laos's initiatives are limited to conditional pilot projects in specific urban areas. Overall, 5 out of 6 countries in the sub-region refer to landfill improvement, 3 mention landfill gas capture, and 5 address organic waste diversion. The Philippines and Myanmar mention national strategies, but with few operational details or quantified targets.

In South Asia, Bangladesh and Sri Lanka present the most detailed strategies, including incineration, composting, and Waste-to-Energy plants, with defined emission reduction targets. Nepal also plans wide-scale waste treatment and energy recovery by 2030. 4 out of 5 countries in the sub-region refer to landfill improvement, but only one (Sri Lanka) mentions landfill gas capture explicitly, and 3 refer to organic waste diversion. **The 3R approach (reduce, reuse, recycle) is often mentioned,** sometimes combined with tax incentives or green mobility programs (e.g. biogas buses in Pakistan), while Bhutan promotes zero waste principles. India, although a major emitter of GHG from waste sector, has embarked on a national plan on improving waste management, with nationwide reclamation of more than 3 000 existing dumpsites, which helped the country reclaim 15 000 hectares of urban land and avoid more than 0.3 million tons of methane emissions[30]. Apart from this, major thrust is focused upon conversion of organics to bio-methane with massive national incentivization and policy deployment[31].

In Central Asia, countries such as Kazakhstan, Turkmenistan and Kyrgyzstan are considering anaerobic digestion of organics and recycling as part of conditional scenarios, backed up by laws or strategic plans. However, these efforts often remain at a preliminary stage **or dependent on international support.** Azerbaijan stands out for having a comprehensive national strategy integrating the circular economy and attracting private investment. Azerbaijan national strategy promotes landfill rehabilitation, recycling, and energy recovery through biogas and incineration (One WtE in operation in Baku since 2021).

Turkey has the most advanced strategy in the Caucasus region, with the "Zero Waste by 2053" project, which aims to put an end to landfill without pre-treatment, to capture landfill gas across the board, and to ramp up energy production from waste (4 TWh produced per year from 2021 in one WtE in Istanbul). The Turkish regulatory framework is based on a national waste management plan, an environmental law and a "Zero Waste by 2053" strategy, based on waste generation reduction, sorting, energy recovery and the circular economy.

> Turkey has the most advanced strategy in the Caucasus region, with the "Zero Waste by 2053" project.

Countries such as Jordan and Iraq are showing a desire to improve their waste management systems, with biogas, composting and sludge recovery projects. But these ambitions are often limited by a lack of infrastructure, governance or funding. In the Balkans, Albania is carrying out incineration and landfill gas capture projects, but without a fully operational sorting system. North Macedonia has set out a detailed strategy combining sorting, recycling, biogas, and alternative fuels within a broader circular economy framework, while the other countries are still at the declarative stage.

[30] Legacy waste management and dumpsite remediation to support swachh bharat mission 2.0, 2022 available at https://sbmurban.org/storage/app/media/pdf/sbm_knowledge_center/sbm-20-toolkit-legacy-waste-management-and-dumpsite.pdf

[31] ICN bureau, 2023. Available at : https://www.indianchemicalnews.com/policy/india-aims-to-establish-15000-tpd-bio-cbg-plants-by-2026-19765

China's NDC does not include a dedicated section on waste management, but related measures are scattered across other sectors, **particularly agriculture and energy** with a strong focus on agricultural biowaste through rural biogas projects and organic fertilization to reduce emissions. Urban waste is mentioned briefly via Waste-to-Energy initiatives, while broader efforts include biomass energy development, industrial circular economy policies, and source reduction strategies such as shared economy promotion and low-carbon lifestyle awareness. Apart from its NDC **China puts great importance to solid waste management and has implemented a zero-waste city pilot program** in 11 cities and 5 special areas. During the 14th Five-Year Plan period (2021-2025), China has been promoting the establishment of zero-waste cities in 113 cities and 8 special areas through waste management system improvements and public awareness campaigns[32]. This plan for Municipal Solid Waste Segregation and Treatment Facilities aimed for the Waste-to-Energy capacity of 800,000 t/d by 2025, covering around 65% of total MSW treatment capacity. Actually, by the end of 2024, 1,135 Waste-to-Energy projects (public data from the monitoring platform established by the Ministry of Ecology and Environment) are operational, with total capacity reaching 1.1 million t/d[33].

Chapter transition

While the ambition is to inspire more countries to include specific waste management actions in their NDCs, it is important to note that buyers on the international carbon markets prefer to purchase carbon credits for GHG emissions reduced through projects in relation to conditional measures in NDCs.

To inspire further integration of waste management measures in the NDCs, the following chapter presents four levers for reducing GHG emissions from waste management, which can serve as actionable components in future NDC updates.

Note for the reader

This section is complemented by the following annexes and documents:

- **Annex 1:** Detailed table of waste commitments in NDCs by country
- **Annex 2:** Summary of how waste is integrated into NDCs by country, organized by AFD region (One short paragraph of text per country)
- **Country profiles** including a description of the waste management situation as of 2020 (available in French only)

[32] Exploration and practice of "zero-waste city" in China, 2024.
Available at: https://www.sciencedirect.com/science/article/pii/S2773167724000074?ref=pdf_download&fr=RR-9&rr=93324e1c38773396

[33] CAUES, to be released in Jully 2025, Overview of China's MSW Incineration Industry : Development and Best Practices.

3. Levers for Reducing Waste-Related Emissions

This section aims to inspire the integration of concrete actions into NDCs in order to reduce GHG emissions associated with waste management. These actions are about implementing Environmentally Sound Management (ESM) of waste, as defined in Article 2 of the Basel Convention[34], which refers to all practical measures taken to ensure that waste is managed in a manner that protects human health and the environment from its harmful effects. This approach applies to all stages of the waste life cycle: collection, transport, treatment, disposal, and post-treatment monitoring.

In this section four main categories of actions are identified as levers[35] and presented in the following order, relating the importance of their contribution to reducing global GHG emissions, rather than the traditional waste management hierarchy:

1. Prevention

2. ESM compliant landfilling and organic waste management

3. ESM compliant energy recovery

4. ESM compliant material recycling

Any action proposed to be included in the national plans needs to be adapted to the local context, accounting for: existing infrastructure, financial resources for the initial investment and running costs, human resources and their level of technical expertise, and regulatory frameworks supported with appropriate market instruments for promoting circular economy models.

This local context is key to determining the success of the proposed actions. **FIGURE 3** describes typical waste management activities under four archetypes[36]. It illustrates that not all technical solutions are suitable for all situations. This figure aims to drive the ambition to progress from controlling waste flows to investing in capacity development and facilities that enable waste to be used as a resource. Controlling waste flows has two major components: 1/ acting upstream to control the generation of waste and 2/ ensuring its safe collection and safe final disposal. The “controlling waste flows” step is the initial building block of any strategy and is covered in greater detail in the publication "Waste management to tackle the climate crisis" (2024, FSWP). **The diversion of organic waste from landfilling** is an activity that may be undertaken under all four waste management archetypes to prevent methane emissions, although certain complexities must be addressed as noted in **Section 3.4**.

[34] Basel Convention, *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal & Basel Protocol on Liability and Compensation* (revised 2023). Available at: https://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-IMPL-CONVTEXT-2023.English.pdf

[35] Carbon capture and storage, though a promising innovative technology, is not included here given our focus on emerging and developing economies.

[36] Refer to “A Playbook for Municipal Solid Waste Methane Mitigation, Recommendations Based on Global Waste Management Archetypes,” RMI 2024, for additional tables and graphics that highlight key strategies and levers recommended for each archetype.

FIGURE 3

Waste management archetype and developments to reduce emissions

Build the Basics (BtB)

- No or limited actions taken to reduce waste generation
- Low to medium waste collection rates
- Limited or no source-separated organics or recycling
- Limited or no waste treatment
- Waste is disposed of at dumpsites
- Illegal dumping and open burning of waste are common

Build the Basics Plus (BtB+)

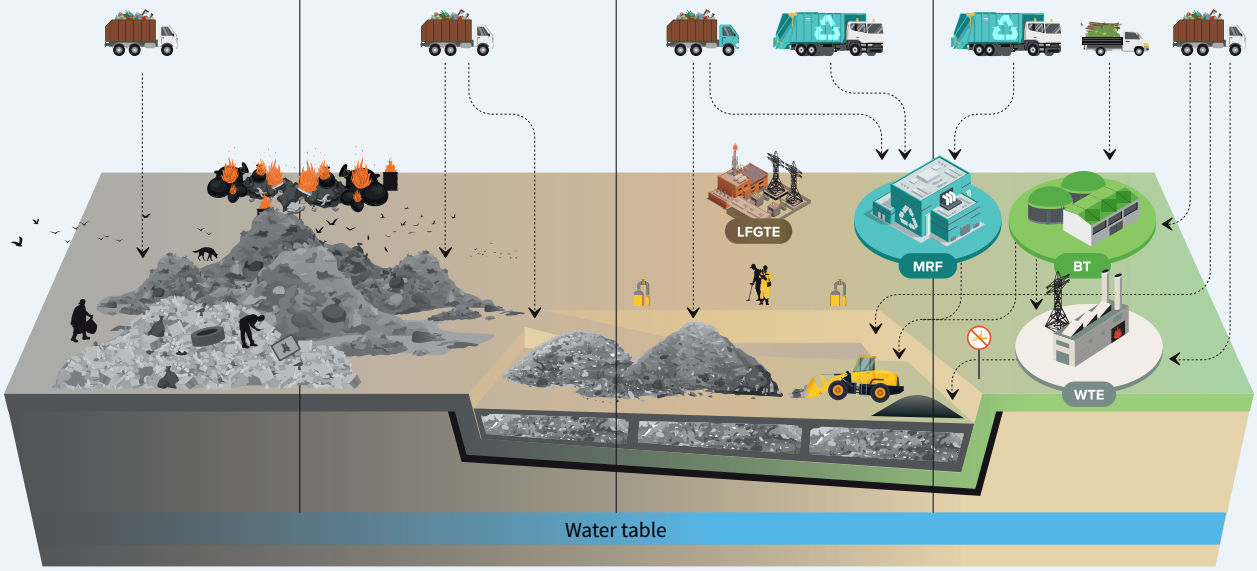
- Some actions taken to reduce waste generation
- Higher waste collection rate than BtB
- Limited or no source-separated organics or recycling
- Limited waste treatment
- Transitioning from dumpsites to sanitary landfills
- Illegal dumping and open burning of waste may occur

Move up the Hierarchy (MuH)

- More actions taken to reduce waste generation than BtB and BtB+
- Universal or near-universal waste collection
- Higher source-separated organics and recycling rates than BtB and BtB+; source-separated organics is still relatively limited compared to CtC
- Waste treatment and material recovery facilities are common
- Waste is disposed of in sanitary landfills
- Methane emissions monitoring and capture may occur

Close the Circle (CtC)

- Extensive actions taken to reduce waste generation
- Universal or near-universal waste collection
- In most CtC countries, source-separated organics and recycling rates are higher than in BtB and BtB+ countries and source-separated organics is mandated by law
- Most CtC countries have banned biodegradable waste from landfills
- Biological treatment and incineration of waste are common
- Least reliant on landfills



Waste collection, treatment, and disposal activities occur at different sites. Note that the primary outputs from the materials recovery facility and the biological treatment plant (e.g., plastics and biogas) are not depicted. The graphic has been simplified for illustrative purposes.

LEGEND

WTE : Waste To Energy
BT : Biological Treatment
MRF : Materials Recovery Facility
LFGtE : Landfill Gas to Energy Process Works

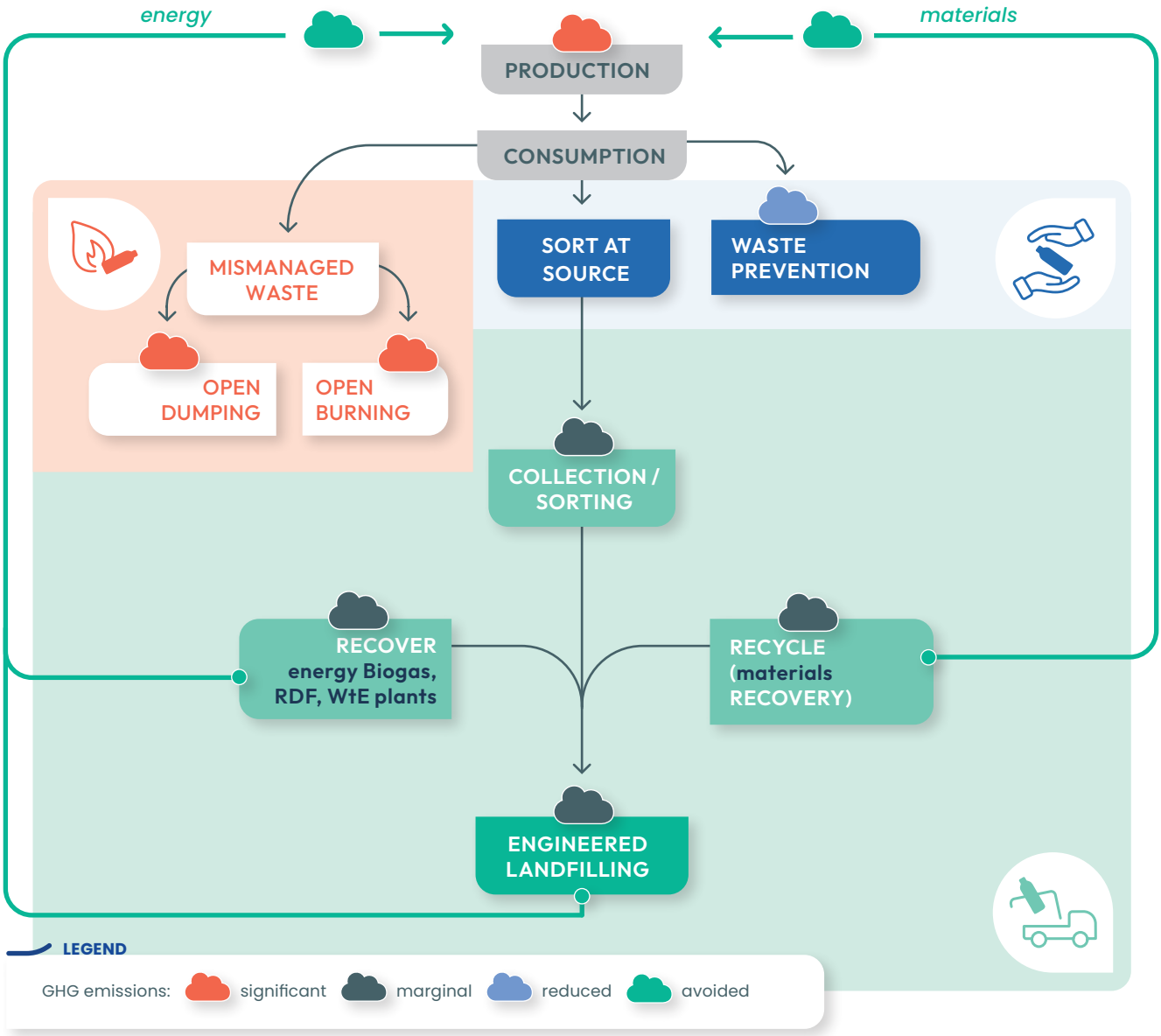
Source: Adapted from "A Playbook for Municipal Solid Waste Methane Mitigation, Recommendations Based on Global Waste Management Archetypes," RMI 2024.

Once the waste system is up and running with collection and safe disposal under control, while legislating and encouraging behavior change to reduce waste generation, then the hierarchy of management solutions applies as follows:

1. **Recycling and composting** (recovery of organic matter, formal and informal sorting of materials)
2. **Energy recovery** (landfill gas recovery, anaerobic digestion, Waste-to-Energy)
3. **Final disposal through ESM-compliant engineered landfill** (last resort with landfill gas capture and methane emission mitigation)

It is crucial **to reduce the generation of waste and maximize recycling schemes** to avoid over-saturating too rapidly safe final disposal facilities.

FIGURE 4 **GHG emissions associated with waste management solutions**



Source: Adapted from Figure 7 of FSWP, 2024, Waste Management to Adress the Climate Crisis.

The following sub-sections detail the possible actions to reduce the GHG emissions presented in **FIGURE 4**, organized in ascending order of mitigation impact.

3.1. PREVENTION LEVER

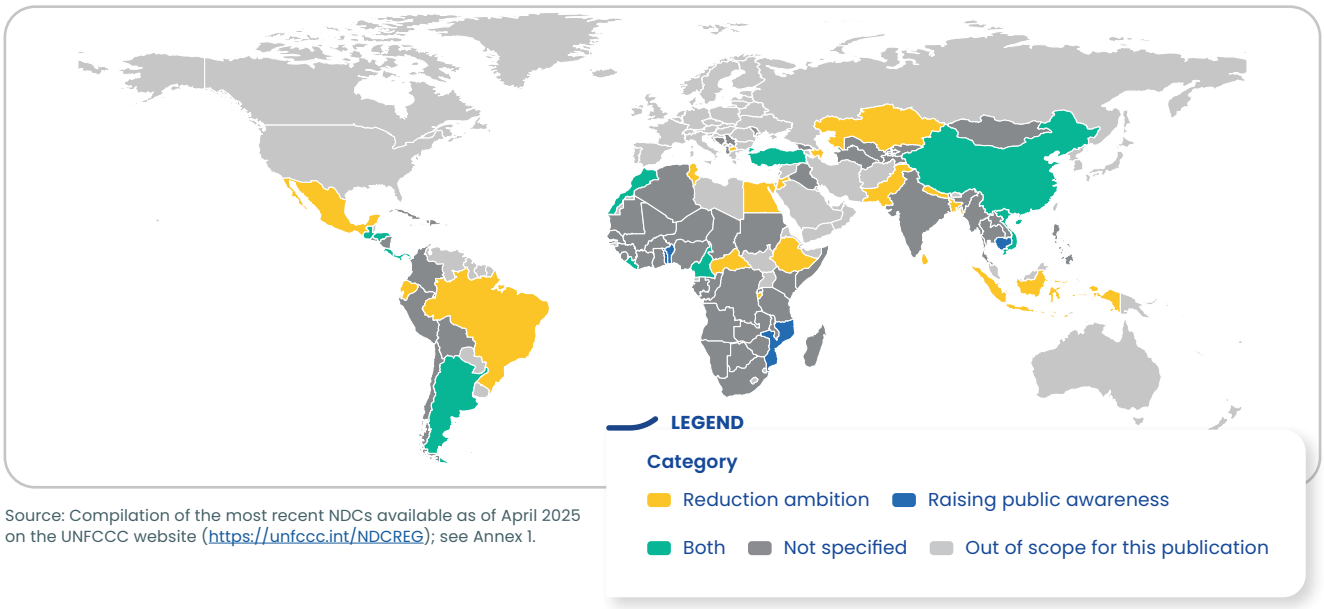
The first lever for action is prevention, not only because it is the number one action in the waste treatment hierarchy, but also because the potential for reducing GHG **emissions linked to waste management increases from ~5% (See FIGURE 1) to ~20% when the impact of the production of food or consumer goods is considered,** as illustrated in **FIGURE 5**. Through a more **resource-conscious** consumption approach and eco-design, it is possible to reduce the upstream production of goods, thereby limiting waste generation and the associated GHG emissions, both during manufacturing and at the end-of-life management stage. This lever, though particularly significant in developed economies, is **also relevant in emerging economies** to curb the BaU trend of waste generation associated with higher living standards.

MAP 9 shows the countries that mention waste generation reduction as a mitigation action. Overall, only 34% of countries include waste reduction as an objective in their NDC[37].

FIGURE 5 **Share of the waste sector in global GHG emissions, taking into account the entire life cycle of products**

Source: FSWP, 2024, *Waste management to address the climate crisis,* Figure 2c.

MAP 9 **Countries incorporating waste reduction into their NDCs**



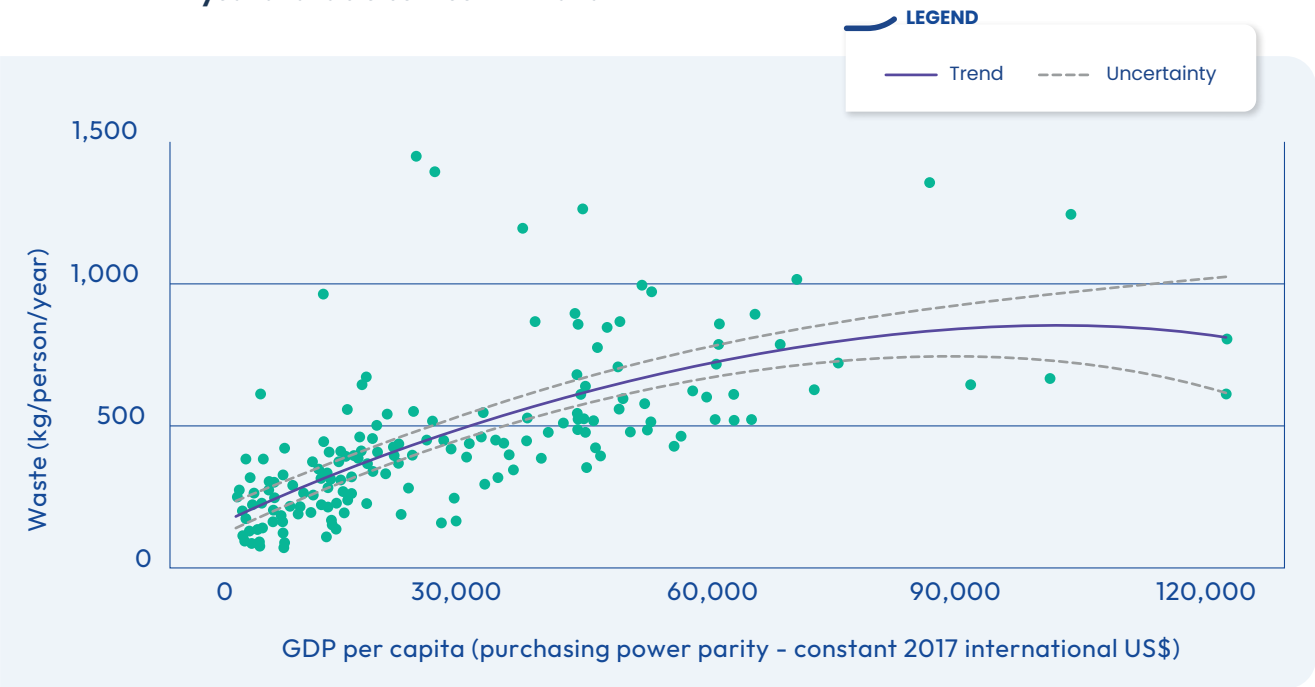
Source: Compilation of the most recent NDCs available as of April 2025 on the UNFCCC website (https://unfccc.int/NDCREG); see Annex 1.

[37] Global Waste Management Outlook 2024, UNEP.

It is essential to initiate the development of new economic models aimed at **extending product lifespans and reducing waste generation at the source.** This includes promoting **the functional economy** (selling the use rather than the ownership of goods), but also reuse, repair, and second-hand markets, alongside targeted regulations on single-use packaging.

The goal of these measures is to decouple waste generation from economic growth. Indeed, under current production and consumption patterns, **GDP per capita remains strongly correlated with the volume and the composition of waste generated per person** (FIGURE 6).

FIGURE 6 **Relationship between GDP and waste production for the most recent year available between 2010 and 2020**



Source: UNEP, 2024, *Global Waste Management Outlook 2024*, Figure 1.

There is an urgent need to rethink, both locally and globally, the production-consumption couple according to the hierarchy of actions of the circular economy. The below-detailed 10Rs framework[38] has helped shape international approaches to circular economy and is explicitly referenced in ISO 59004 (2024), the foundational standard on circular economy[39]. **The first R's** aim to generate less waste upstream.

[38] The 10 Rs are: Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, Recover. Framework drawn up by Julian Kirschherr. Framework also presented in the 2024 ISWA Manual: Assessing Circularity in Cities, available at : https://www.iswa.org/wp-content/uploads/2024/09/ISWA-CALC-Handbook-Assessing-Circularity-in-Cities.pdf?v=796834e7a283

[39] Presentation of the ISO 59004 standard on circular economy. Available at: https://www.pfd-fswp.fr/presentation-economie-circulaire-par-iso-anglais?lang=en

10R

refuse
avoid producing and buying unnecessary products.

rethink
questioning the potential environmental impact of a product throughout its life cycle before producing or consuming.

reduce
minimizing resource use and developing more efficient consumption patterns. This includes reducing food waste.

reuse
reusing products for a second purpose - moving away from an industry based on resource extraction, and from an economy based on planned obsolescence.

repair
working against the culture of throwing away, both for consumers, and for producers, especially by designing the products that can easily be repaired.

refurbish
restoring and modernizing an old object to make it as new as possible again, by changing some parts and pieces – *for example, replacing a laptop's hard drive or screen to extend its use.*

remanufacture
completely rebuilding an object *for refurbishing; for example, remanufacturing a printer in an industrial process to meet quality standards equivalent to a new one.*

repurpose
redefine a new destination for the object - creatively finding new uses for items that might otherwise be discarded, thus turning potential waste into a resource.

recycle
See **Section 3.4**

recover
See **Section 3.3**

The last 2 Rs, **"Recycle"** and **"Recover"** energy, are detailed in the following sections.

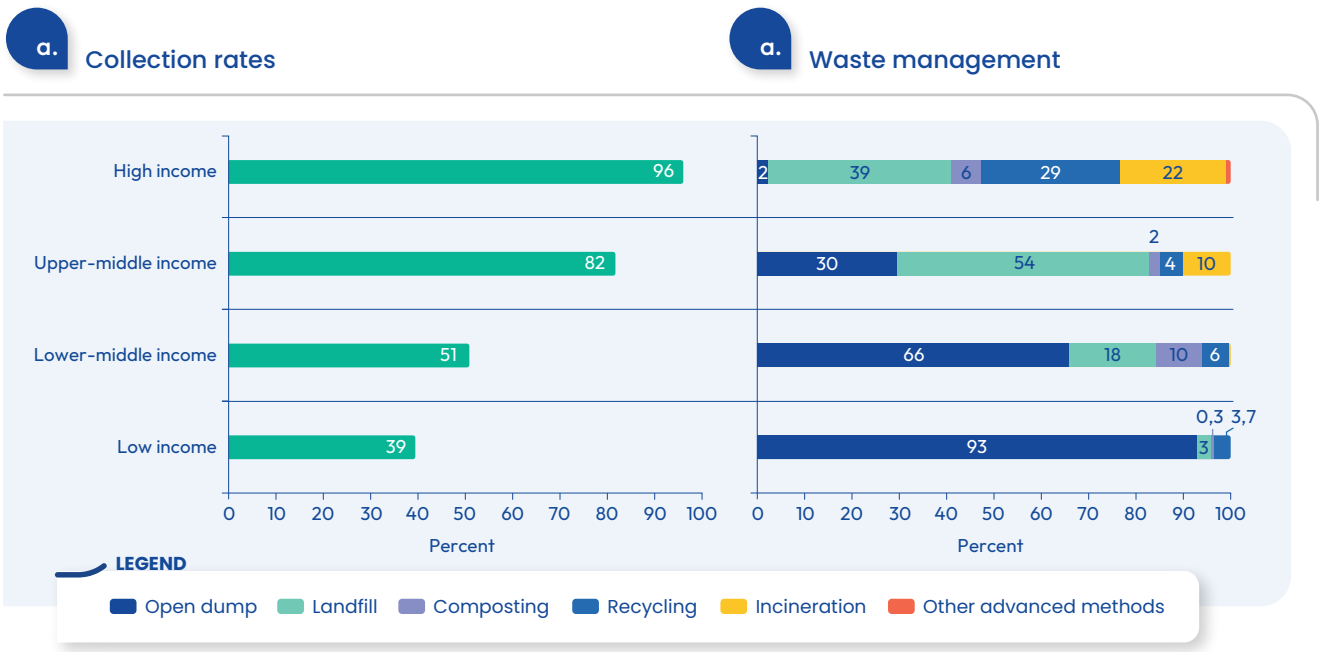
In this prevention lever, special care should be given to **prevent food loss and waste to avoid both the embedded emissions from unnecessary production and the methane emissions generated during disposal.** Approximately 14% of food is lost before reaching retail, and 17% is wasted at the consumer level, (FAO, 2019; UNEP, 2021), contributing up to 10% of global GHG emissions[40].

[40] The Global FoodBanking Network (2024). *FRAME Methodology: Food Recovery to Avoid Methane Emissions.* Available at: https://www.foodbanking.org/wp-content/uploads/2024/08/FRAME-Methodology_Food-Recovery-to-Avoid-Methane-Emissions_GFN.pdf

3.2. TRANSITIONING FROM OPEN DUMPING & BURNING TO ESM-COMPLIANT LANDFILLING AND ORGANIC WASTE MANAGEMENT

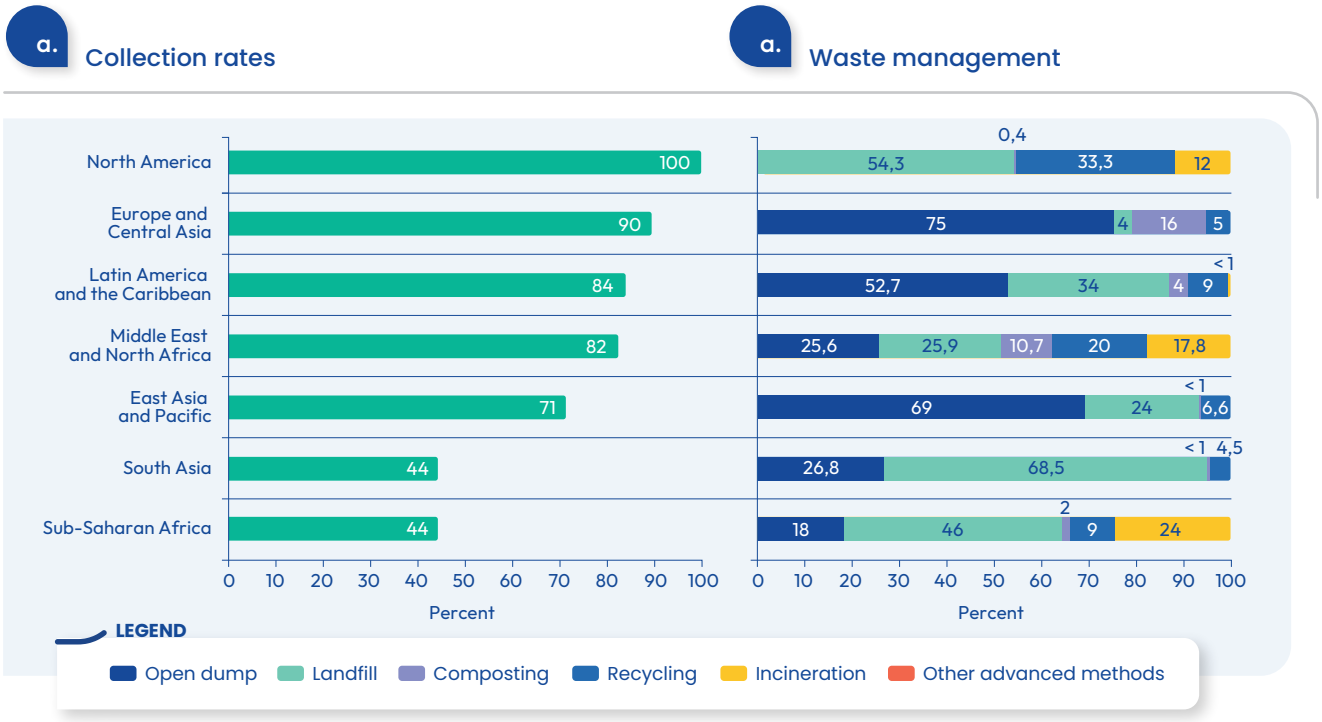
ESM of waste at its most basic level involves the collection of all waste and its safe final disposal to control health and environmental impacts. Many existing systems are deficient, with a lack of collection services as shown in **FIGURE 7**, and open dumping sites representing a high proportion of the existing waste management solution, if not the highest in some regions, as shown in **FIGURE 8**.

FIGURE 7 **Collection rates and waste management by income level**



Source: World Bank, What a Waste 2.0, p33.

FIGURE 8 **Collection rates and waste management by region**



Source: World Bank, What a Waste 2.0, p33.

This section focuses on the implementation of ESM-compliant landfilling and organic waste management, as it is a key lever for reducing greenhouse gas emissions.

Current practices such as open burning, open dumping and non-ESM compliant incineration[41] or landfilling[42] are still widely present in contexts where technical, financial or institutional capacities are limited. They need to be gradually replaced, as they are a source of black carbon (refer to BOX 1 in **Section 1.1**), in the case of open burning or non-ESM compliant incineration, and of methane resulting of the anaerobic decomposition of stockpiled organic waste.

As these practices are replaced, the most low-tech and affordable solution is to establish waste collection and ESM-compliant landfilling. However, to go beyond health protection and pollution prevention, and also address the climate crisis, it is critical to reduce the methane emissions from landfills. Two strategies should be considered:

1. **controlling the waste that enters the landfill to reduce the organic content and its degradability;**
2. **improving the operating practices on landfills to reduce methane leakage to the atmosphere during the landfill life and its aftercare.**

Controlling the waste that enters the landfill to reduce the organic content, and its degradability requires implementing the following measures:

- **Source separation of non-contaminated organic waste** (including food waste) towards composting, anaerobic digestion, or animal feed production such as black soldier flies (BSF) treatment, as detailed in **Sections 3.3** and **3.4** respectively.
- **Pretreatment of the mixed residual waste** which contains soiled packaging, and contaminated organic waste aims to change the composition of the landfilled waste to inert materials and stabilized organic waste, less prone to generate methane rapidly.

By reducing the overall organic content through separate collection and treatment of biodegradable waste like food, green waste or paper/cardboard, and by pre-treating the residual waste before landfilling so that waste is stabilized, the generation of methane within landfills and dump sites can be reduced significantly over the lifetime of the waste. This was implemented in Germany, where the landfill regulation demands strict waste acceptance criteria for landfills[43] and a ban on landfilling untreated municipal waste, which came into force in 2005. The systemic change driven by this regulation resulted in a drop by 94% in the sector's GHG inventory methane emissions from landfills from 1990 until today[44,45].

> Controlling the type of waste sent to landfilling is the most efficient measure to reduce methane emissions, complemented by biogas capture.

The strategy of controlling the type of waste sent to landfilling is the most efficient measure to reduce methane emissions. It can be complemented by improved operational practices to optimally capture the biogas that is still generated by the landfill.

FIGURE 9 shows "landfilling" as a single category, but there are many landfills controlled by local authorities or companies that do not comply with the recommendations of the Basel Convention on ESM[46]. For those that do comply, and are therefore called specially engineered landfills, the practices implemented may be further improved to reduce methane emissions and reduce the leakage to the atmosphere down to ~20% of the total lifecyle emissions[47]. **FIGURE 9** shows the good practices (in green) and poor practices (in white) associated with the management of landfill sites. **FIGURE 10** illustrates the potential for reducing emissions as a function of the practices implemented.

[41] Basel Convention, Technical guidelines on the environmentally sound disposal of hazardous wastes and other wastes in specially engineered landfill (D5)). Available at: https://synergies.pops.int/Portals/4/download.aspx?d=UNEP-CHW.15-6-Add.5-Rev.1.English.pdf

[42] Basel Convention, Technical guidelines on the environmentally sound incineration of hazardous wastes and other wastes as covered by disposal operations D10 and R1. Available at: https://synergies.pops.int/Portals/4/download.aspx?d=UNEP-CHW.15-6-Add.4-Rev.1.English.pdf

[43] German Landfill Ordinance waste acceptance criteria for landfills: Total Organic Carbon (TOC) less than 3%; for waste from mechanical biological treatment TOC < 18%, when Respiration Activity (AT4) < 5 mg O_2/g, and Gas Formation Rate (GB21) < 20 ml/g.

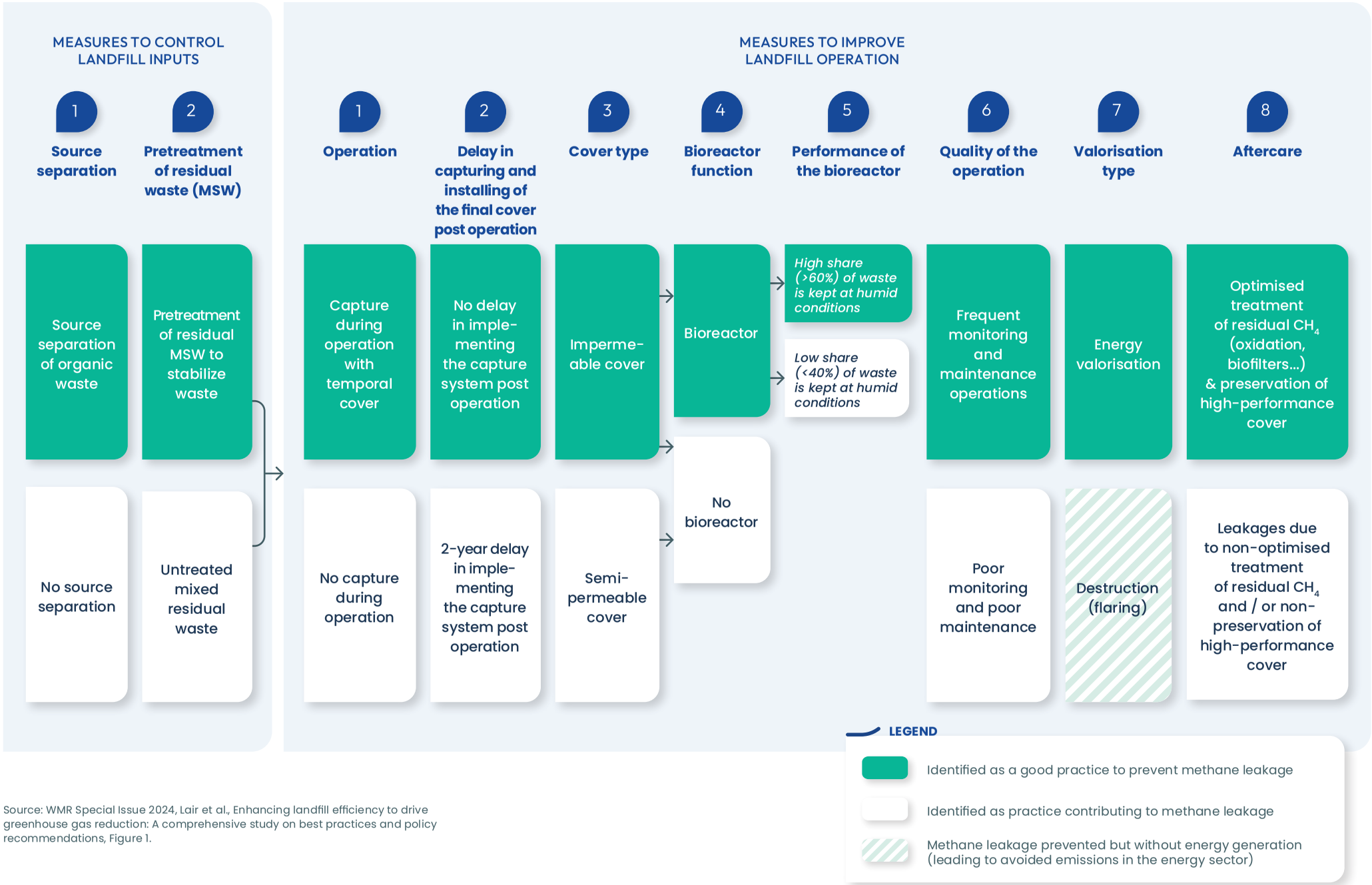
[44] German Environment Agency, 2024.

[45] The waste received in German landfills after 2005 has low to no methane formation properties due to pretreatment, while legacy waste is decomposing, so that the formation of methane in the landfill comes to a natural end over time.

[46] Technical guidelines on the environmentally sound disposal of hazardous wastes and other wastes in specially engineered landfill (D5). Available at: https://synergies.pops.int/Portals/4/download.aspx?d=UNEP-CHW.15-6-Add.5-Rev.1.English.pdf

[47] Waste decomposes over ~50 years in specially engineered landfills. Total lifecycle emissions refer here to the total methane emissions over the 50 years of decomposition of the buried waste.

FIGURE 9 Measures leading to reduce methane emissions from landfilling include waste content management and best practices in landfill operations



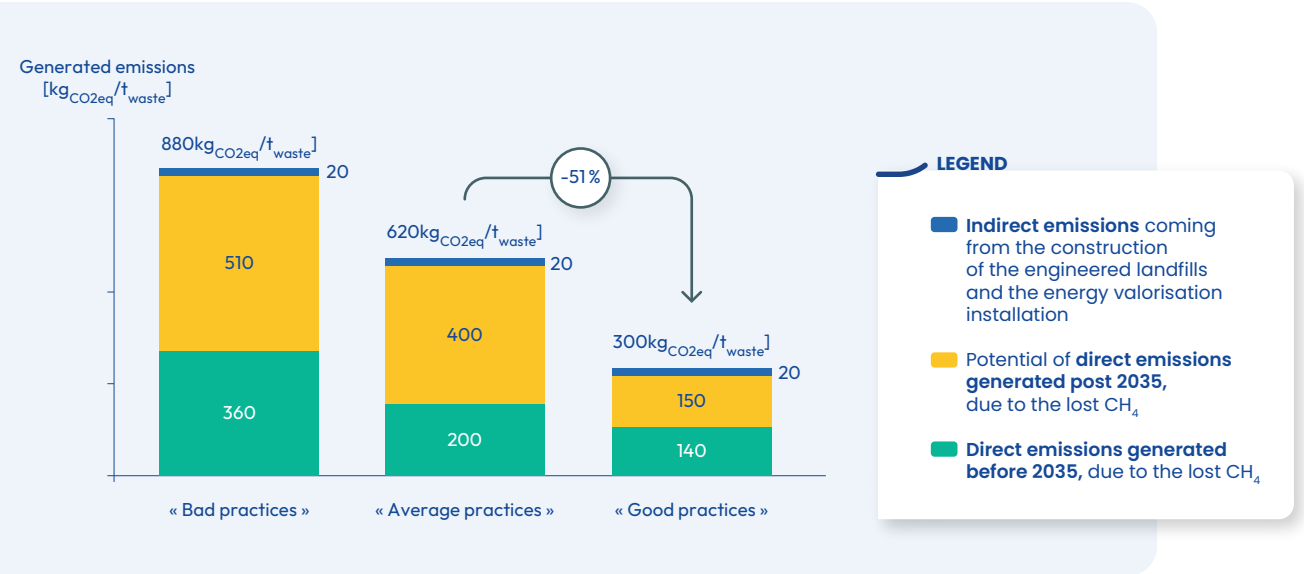
Source: WMR Special Issue 2024, Lair et al., Enhancing landfill efficiency to drive greenhouse gas reduction: A comprehensive study on best practices and policy recommendations, Figure 1.

The main best practices to be implemented are as follows:

1. **An anticipated capture system is installed as soon as technically feasible** during the operating phase.
2. **The final cover and capture system are installed without delay** when a landfill cell is closed.
3. **The cover used is impermeable,** enabling a theoretical capture rate up to 90% of methane emissions.
4. **The landfill is designed to recirculate the needed leachate** uniformly to maintain optimal humidity.
5. **The landfill is operated to keep 60% of waste at an optimal humidity level** to accelerate the aging of the landfill.
6. **Important maintenance and reporting operations** are carried out.
7. **Captured gas is recovered through cogeneration or injection instead of being flared.**
8. **Residual methane emissions are limited by the use of treatment processes** (natural oxidation, biofilters, etc.) throughout the waste decomposition process that lasts many years after the closures of landfills (aftercare).

For instance, in the case of Europe, further improving operational practices to include all of the good practices mentioned above could reduce total emissions from 620 to 300 $kgCO_2e$ per tonne of waste over the entire lifespan of the landfill, as illustrated on **FIGURE 10**. This represents a 51% reduction, beyond what was already prevented through existing "average" practices. This reduction is primarily achieved by mitigating long-term methane emissions occurring after 2035, and accounts for organics diversion.

FIGURE 10 **Comparative analysis illustrating emissions from landfills with "poor", "average" and "good" operating practices, based on european data**



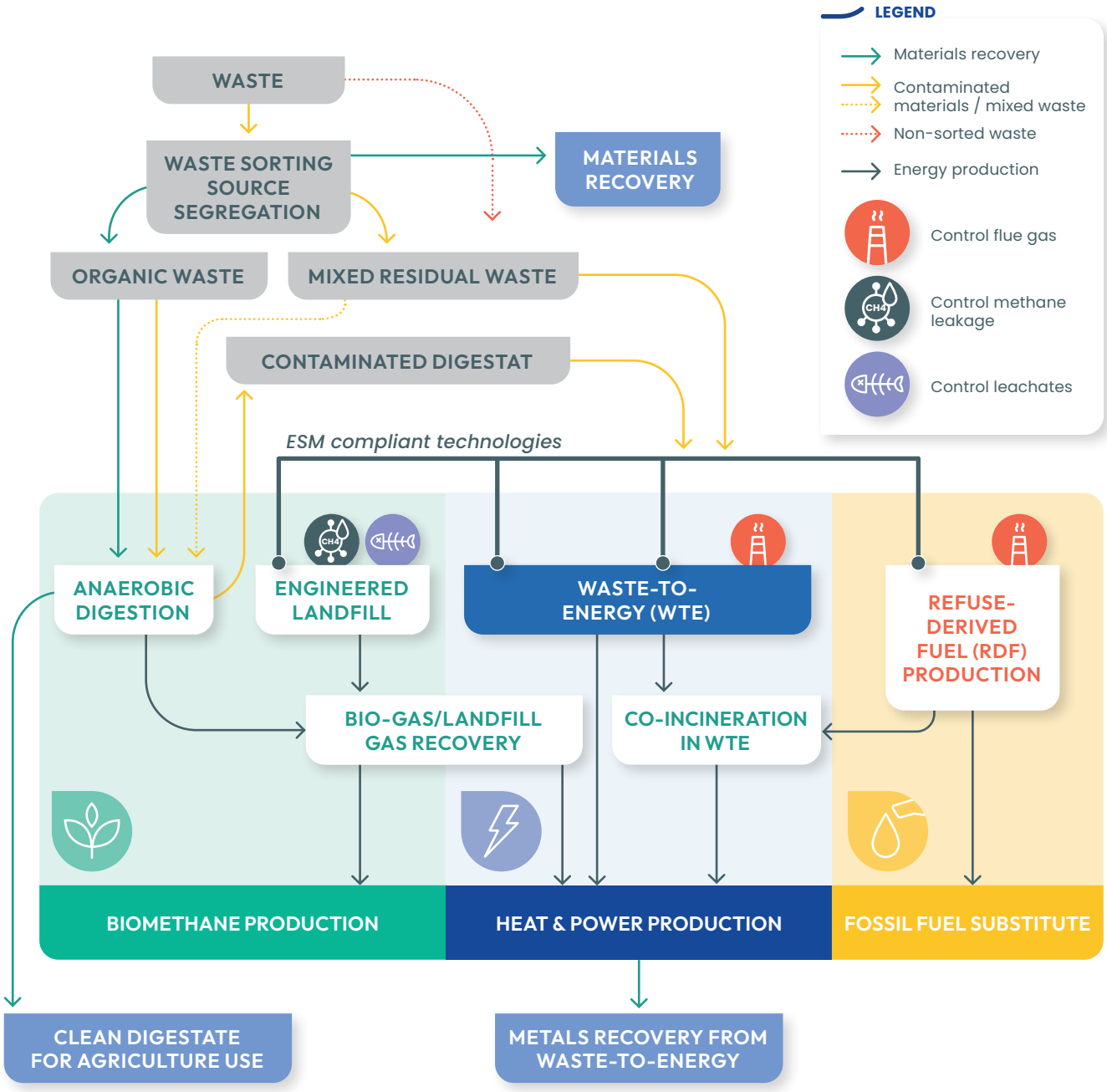
Source: WMR Special Issue 2024, Lair et al, Enhancing landfill efficiency to drive greenhouse gas reduction: A comprehensive study on best practices and policy recommendations, Figure 4.

3.3. ESM-COMPLIANT ENERGY RECOVERY: A WAY TO CONTRIBUTE TO GLOBAL EMISSIONS REDUCTION

Energy can be recovered from waste that cannot be avoided or recycled. The production of energy from waste treatment facilities presents an opportunity to **avoid emissions which would have been generated in the energy sector otherwise.** "Avoided emissions" are GHG reductions occurring outside of the organization reporting its emissions. This occurs when its products or services from the reporting organization replace more carbon-intensive alternatives used by a third party. They are calculated through a comparison against a reference scenario and must be reported separately from the organization's own emissions.

When the energy produced from waste replaces virgin fossil fuels, the sector contributes to global decarbonization, though this contribution is not recognized at national or international reporting level. This lack of recognition impedes the access to carbon markets for the energy components of waste management projects and also reduces the visibility of waste management in climate strategies.

FIGURE 11 **Opportunities for energy recovery**



Several types of energy production are possible, as follows and as illustrated in **FIGURE 11:**

- **Anaerobic digestion** of organic waste to produce biogas, which can be refined into bio-methane, in facilities designed to reduce methane leakage.
- **Landfill gas valorization** into bio-methane or heat & electricity.
- Recovery of thermal energy from ESM-compliant incineration within a facility equipped to comply with atmospheric emissions thresholds: **Waste to Energy plants.**
- Production of **Refuse-Derived Fuel** (RDF) to supply industrial boilers as a substitute for fossil fuels, while complying with atmospheric emissions thresholds[48]. This requires sorting high calorific and low hazard waste upstream of the process, and adequate treatment of the residual waste.
- Less main-stream technologies, such as ESM-compliant gasification or pyrolysis.

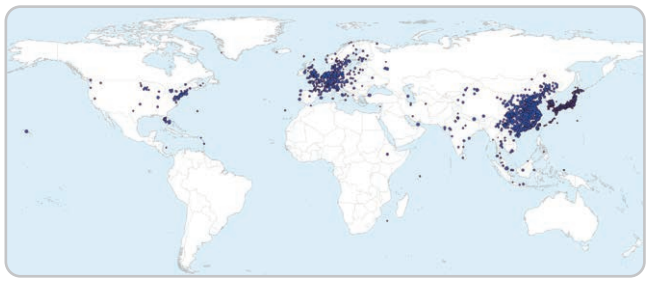
Energy recovery from waste is still limited though a growing trend. **In 2016, only 8% of the world's waste was landfilled with a landfill gas capture system[49].** However, many of these facilities flare the landfill gas, due to poor economic feasibility, especially in contexts where renewable gas, heat or electricity are not subsidized. Also in 2016, only 11% of the world's waste was incinerated[50] but the proportion of facilities including energy recovery was not documented. Anaerobic digestion of organic waste, though not well documented as a global trend, appears to be increasingly considered as a result of the local strategies to divert organics from landfills. In the same spirit, RDF production is trending as a strategy to prevent saturating the landfill capacity too quickly.

The production of biomethane for use as a substitute for natural gas is the most efficient in terms of energy yield, but particular attention must be paid to methane leaks. Even leakage rates as low as 0.2% can negate its avoided emissions (as defined above) and bring its overall impact on par with coal[51].

Improving the capture and valorization of landfill gas in Europe could lead to a 30% reduction in emissions from the European waste sector by 2030 and provide ~5%-10% of the renewable biogas production targets[52].

Large-scale Waste-to-Energy plants are mainly installed in Europe and Asia and include air pollution control relying on proven technologies implemented in accordance with local regulations. There are relatively few Waste-to-Energy plants in the AFD intervention countries covered by this publication, due to their highly technical nature and the need to have a good grasp of waste collection and treatment before dimensioning these costly facilities. China and a few emerging countries like Turkey are the main exception (see **MAP 10**). By the end of 2024, 1,135 Waste-to-Energy plants (public data from the monitoring platform established by the Chinese Ministry of Ecology and Environment) are operational, with total capacity reaching 1.1 million t/day[53]. In Europe in 2022, around 500 Waste-to-Energy plants treated more than 100 million tons of residual waste per year representing 26% of the Municipal Solid Waste production. These European Waste-to-Energy plants supplied electricity to 20 million people and heated 17 million people via heating networks[54] - equivalent to 13.8 billion m³ of natural gas in energy. Waste-to-energy plants produce CO_2 emissions that are partly fossils and partly biogenic. In France, the proportion of fossil CO_2 emissions is evaluated to average at 42%[55]. Nevertheless, WtE facilities produce energy with avoided emissions exceeding the actual emissions (see **FIGURE 12**) by substituting energy that would otherwise be produced from fossil fuels. Carbon capture and usage is a growing field of investigation, with the potential to produce carbon negative energy, but remains very costly.

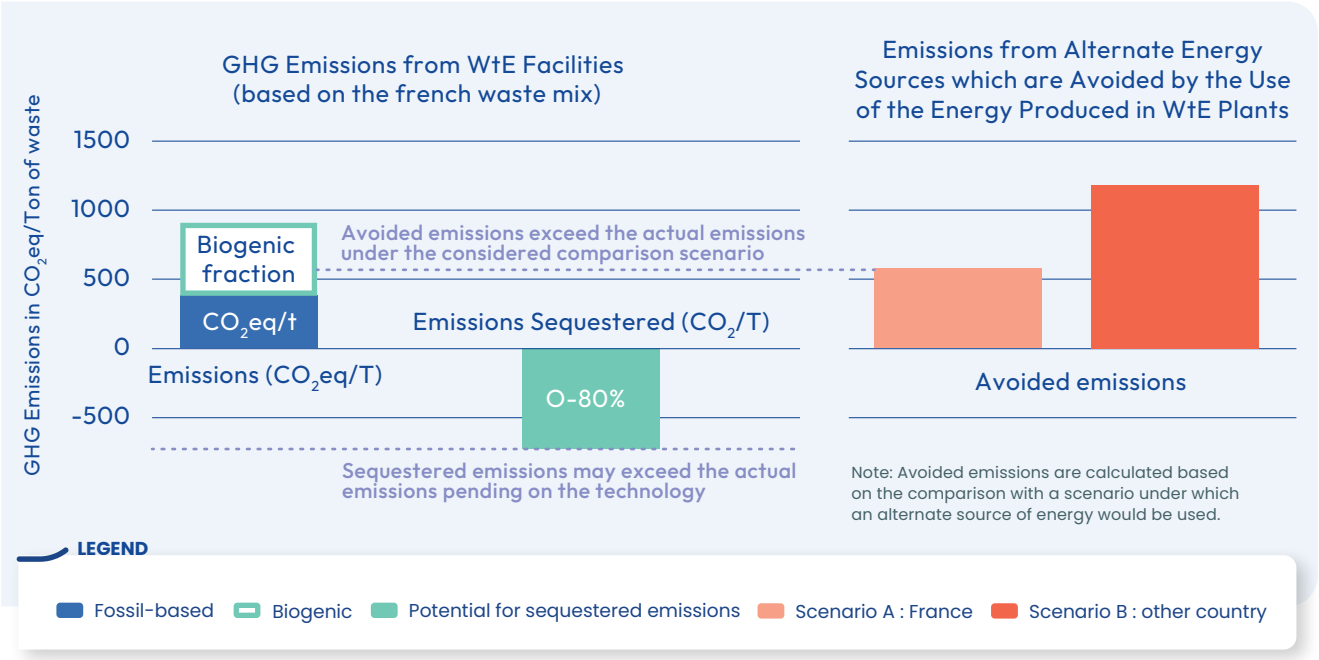
MAP 10 **WtE facilities distribution worldwide**



Source: Ecoprog - 2022.

[48] For example, in France, these thresholds are defined under ICPE classification 2971.
[49] World Bank, What a Waste 2.0. Figure 2.12. The proportion of waste incinerated with or without energy recovery is not specified.
[50] World Bank, What a Waste 2.0.
[51] RMI, Reality Check: The True Climate Risk of Natural Gas. Available at: https://rmi.org/reality-check-natural-gas-true-climate-risk, accessed April 30, 2025.
[52] Lair et al. WMR 2024 Enhancing landfill efficiency to drive greenhouse gas reduction: A comprehensive study on best practices and policy recommendations.
[53] CAUES, to be released in Jully 2025, Overview of China's MSW Incineration Industry : Development and Best Practices.
[54] CEWEP Waste to Energy Roadmap 2022.
[55] ADEME, *Détermination des contenus biogène et fossile des ordures ménagères résiduelles et d'un CSR, à partir d'une analyse 14C du CO_2 des gaz de post-combustion,* https://librairie.ademe.fr/energies-renouvelables-reseaux-et-stockage/4007-determination-des-contenus-biogene-et-fossile-des-ordures-menageres-residuelles-et-d-un-csr-a-partir-d-une-analyse-14c-du-co2-des-gaz-de-post-combustion.html, accessed April 4 2025.

FIGURE 12 **Overview of the potential contribution of WtE facilities to GHG mitigation**



Source data: for France, data estimated in a study by engineering firms grouped within SN2E, supported by Fnade and ADEME in 2020. For "other country", data is based on the following assumptions: an energy mix with an emissions factor double from the French energy mix, and a similar waste mix characteristics.

The production of Refuse-Derived Fuel (RDF) can only accept the fraction of residual waste with a high calorific value, excluding those containing harmful substances (such as PVC plastics, which contain chlorine). Therefore, the need for a final disposal system remains, with two options: ESM compliant engineered landfill with leachate treatment and biogas capture, or ESM compliant incineration with flue gas treatment and with, or without, energy recovery.

In all cases, and in alignment with the waste treatment hierarchy, **these energy recovery solutions must not supplant actions to reduce waste at source or to recycle,** as a contribution to a circular economy that preserves the planet's resources as a whole.

> Energy from waste presents an opportunity to avoid emissions which would have been generated in the energy sector otherwise.

3.4. ESM- COMPLIANT RECYCLING AND MATERIAL RECOVERY

Recycling and materials recovery is an important way of reducing global greenhouse gas emissions, while limiting the extraction of natural resources and dependence on imported raw materials. Recycled and recovered materials present an opportunity to **avoid emissions which would have been generated in the industry sector otherwise.** Avoided emissions are GHG reductions occurring outside of the organization reporting its emissions. This occurs when its products or services from the reporting organization replace more carbon-intensive alternatives used by a third party. They are calculated through a comparison against a reference scenario and must be reported separately from the organization's own emissions.

When recycled and recovered materials replace virgin raw materials, the sector contributes to global decarbonization, though this contribution is not recognized at national or international reporting level. This lack of recognition impedes access to carbon markets for the recycling and recovery components of waste management projects and also reduces the visibility of waste management in climate strategies.

Recycling may have a significant potential to reduce greenhouse gas (GHG) emissions worldwide, potentially saving the equivalent of 10.4 to 11.2 gigatons of carbon dioxide equivalent (CO_2eq) between 2020 and 2050. This is roughly equivalent to a year's worth of carbon dioxide emissions from Japan[56]. This estimate is based on specific assumptions on the environmental impact of extracting, transporting and processing raw materials, which often travel far to be used by industries. However, recycling and materials recovery facilities cannot always be local either, depending on the technologies involved and the need for centralized facilities to achieve economic viability.

> In 2016, only 13.5% of municipal waste was recycled.

However, **implementing effective recycling systems requires technical infrastructure and a structured organization, from collection to treatment.** In low-income countries, the most basic management systems (collection, transport, sanitary disposal) already cost a minimum of 35 dollars per tonne, while the integration of sorting, recycling or advanced treatment facilities can increase management costs to 50-100 dollars per tonne or more[57]. **The choice of technologies and operational models therefore depends heavily on the local context, investment capacity and long-term management resources.** In many countries, the informal sector plays an essential role in reuse and collection for recycling. Recycling itself is often not locally implemented, as illustrated through the plastics for recycling trade[58]. Promoting local re-use loops and regional planning that support the development of nearby industrial facilities, whether they process recyclable materials (such as sorting or pre-treatment centers) or incorporate secondary raw materials, helps reduce transport-related emissions while also lowering dependence on imported products and raw materials.

Given that organic waste represents a significant share of the waste stream in many regions, the biological recovery of organic waste is a significant lever. **Diverting organic waste from landfilling is a relevant strategy to reduce methane emissions.** In addition, organic waste may be transformed into soil amendments or protein products that have an agricultural value and can replace GHG emitting activities such as fertilizer production or animal feed production. Innovative methods of organic waste recycling, such as black soldier fly (BSF) farming, make it possible to transform this waste into high-value products like insect-based animal feed and organic fertilizer. These systems are particularly well suited to low-income contexts due to their technical simplicity and ease of local implementation, and they can generate economic opportunities at the community level. In Uganda and Kenya, small-scale BSF models have been successfully established: they promote employment, reduce reliance on imported products, and help avoid emissions linked to both waste decomposition and the production of conventional protein sources.

[56] Menegat, R., Ledo, A., Tirado, R., & Smith, P. (2022). Integrated assessment of organic waste management in Sub-Saharan Africa: Environmental, economic, and social analysis. *Science of The Total Environment,* 812, 152407. Accessible on https://doi.org/10.1016/j.scitotenv.2021.152407

[57] World Bank, What a Waste 2.0 p.101.

[58] BRS Report https://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-PWPWG-PUB-ImportExport-PlasticWaste-February2025.English.pdf Last accessed 2025.

Some of these systems are even integrated into carbon credit schemes recognizing the reduced emissions on landfills[59]. However, even if the treatment itself is quite low-tech and accessible, it requires an overall sophisticated system to ensure that methane and nitrous oxide emissions are controlled in the transformation process, and in the case of valorization in agriculture or as animal feed, a market needs to be developed. Without such a systemic approach the environmental and economic benefits of organic waste recycling risk being diminished.

Worldwide recycling rates remain low. In 2016, **only 13.5% of municipal waste was recycled,** with marked differences between types of materials and income levels: around 35% in high-income countries, compared with less than 4% in low-income countries. In addition to recycling, composting accounted for a further 5.5% of municipal waste treatment worldwide[60]. Care should be given to ensure that composting practices do not result in significant nitrous oxyde or methane emissions.

BOX 2

The Case of France

The example of France illustrates both the environmental benefits of material recycling and the differences in performance between sectors. One tonne of recycled glass incorporated into new production avoids more than 2,000 kWh of fossil energy or nearly 2 tonnes of CO_2, compared to producing new glass. Mechanical recycling of one tonne of plastic avoids nearly 9,400 kWh of fossil energy or up to 2.7 tonnes of CO_2, compared to virgin polymer production[61].

If these materials are not recycled, they become waste to be treated, which not only generates additional costs for local authorities, but also emissions during disposal (incineration, specially engineered landfill). **But not all materials can be recycled with the same efficiency.** The diagrams below illustrate the major differences in performance between the glass and plastic recycling processes in France. **Glass has a more closed and efficient recycling cycle,** with little loss between collection, cullet preparation and incorporation into the manufacture of new products (see **FIGURE 13**). In 2021, the glass incorporation rate reached 63%, and the rate had risen by 4 percent since 2012.

In contrast, **the plastic cycle is more complex and fragmented,** with losses at every stage. End-of-life plastic products are mostly incinerated (2.8 Mt/year) and only partially collected by the waste management system for recycling (1.3 Mt/year), of which only a sub-fraction (0.5 Mt/year) is actually regenerated into recycled raw materials (RRM). Finally, the rate of incorporation of RRM is only 14%. This rate remains stable despite a sharp increase in collection as illustrated on **FIGURE 14** (+142% since 2012).

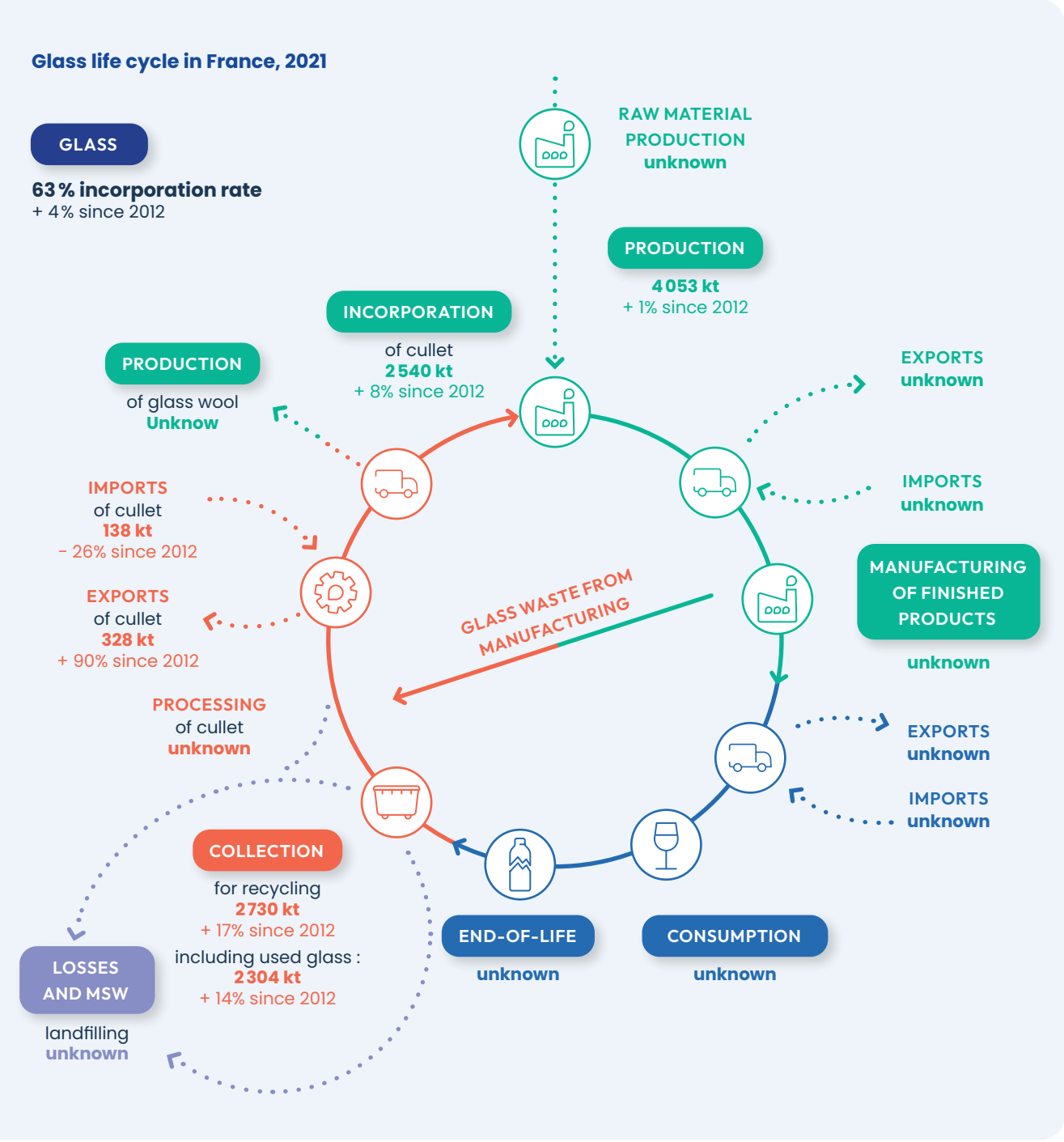
Glass can be recycled efficiently thanks to its high density, its homogeneous composition and a well-structured process. Plastics, on the other hand, present an entirely different complexity: the diversity of its resins, the requirements for sorting by polymer, the need for decontamination processes, and the difficulties in guaranteeing a consistent quality for the regenerated material all hamper the efficiency of the cycle.

[59] Climate and Clean Air Coalition (2025). Transforming Organic Waste with Black Soldier Flies: A Guide for Decision-Makers, Entrepreneurs, and Implementers to Unlock the Organic Waste Potential of Black Soldier Fly Systems. Paris.

[60] World Bank, What a Waste 2.0, p.34-35.

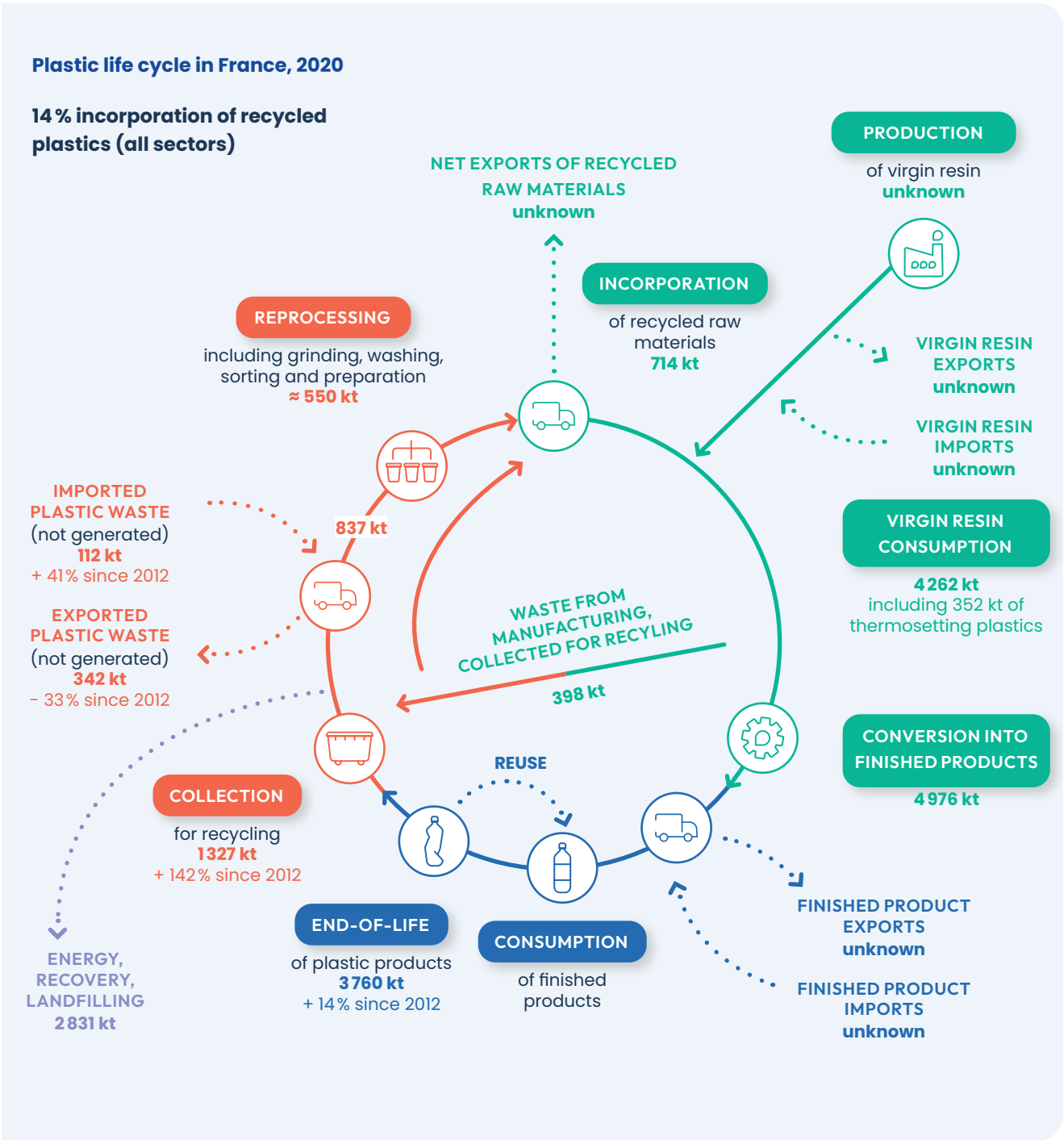
[61] ADEME, *Bilan national du recyclage 2012-2021*, March 2024, https://librairie.ademe.fr/dechets-economie-circulaire/6959-bilan-national-du-recyclage-bnr-2012-2021.html, consulted on 3 April 2025.

FIGURE 13 **Glass recycling in France as an example of functional circularity**



Source : ADEME : Bilan National du recyclage 2012-2021, 2021, Figure 42.

FIGURE 14 The plastics recycling challenge: an example of poor circularity



Source: ADEME: Bilan National du Recyclage 2012-2021, 2021, Figure 48.

Conclusion

Although **waste management** is often perceived as a local public service issue, it **plays a crucial role in addressing the global climate crisis.** While the waste sector directly accounts for only 3 to 5% of global greenhouse gas (GHG) emissions, its mitigation potential **could reach up to 20%, when circular economy strategies and avoided emissions are considered.** It is therefore an important, yet largely underutilized, lever for climate action. With the current frameworks, the climate benefits of the actions taken by the waste managers to avoid emissions in the energy and the industry sectors are not visible. However, the waste generation prevention, energy recovery and recycling actions taken have to be integrated in the NDC strategies to fully leverage the potential of the waste sector. This work calls for the carbon finance system to evolve to acknowledge these contributions so that waste management projects that most contribute to reducing global GHG emissions can benefit of this financial incentive.

This publication demonstrates that **integrating solid waste management into Nationally Determined Contributions (NDCs) is necessary.** This requires coordinated national strategies, adapted to local contexts, and supported by strong political will and reliable data. While policies must reflect local realities, including existing infrastructure, institutional capacity, and available resources, there are universal priorities that should guide action everywhere.

The key message from this work is the importance of aligning waste management systems with climate objectives by acting on three fronts presented in the order of their climate mitigation potential:

- **Preventing waste generation at the source,** by rethinking consumption and production patterns. This involves promoting eco-design, reuse, repair, and circular economic models. Prevention reduces emissions generated by the extraction of raw materials, the production of goods and waste management. GHG emissions are reduced in the waste sector, energy sector and in the industry sector.
- **Establishing ESM-compliant landfilling and organic waste management,** by putting an end to the most polluting practices such as open dumping, poor landfilling practices or open burning. This requires the implementation of universal waste collection services, the rehabilitation or replacement of non-compliant landfills, and the deployment of ESM-compliant landfills which limit the entrance of biodegradable waste and implement improved operational practices to optimally capture the landfill gas generated.
- **Recovering materials and energy wherever possible,** through recycling, the recovery of organic matter (compost, digestate), biogas production, or energy recovery from ESM-compliant incineration. As landfilled organic waste is a major source of methane emissions, diverting it towards energy production and soil amendment or animal feed production is particularly virtous, if systems are properly designed.

Conclusion

The implementation of these measures must be accompanied by enabling public policies, holistic territorial planning and improved access to finance, especially in developing countries, where investment needs are highest. Conditional components of NDCs can provide entry points to carbon markets and other climate finance mechanisms.

As countries prepare the next round of NDCs updates, fully integrating waste management and circular economy solutions into national climate strategies represents a significant opportunity. Doing so would not only reduce emissions, but also improve public health, create jobs, and contribute to achieving several Sustainable Development Goals (SDGs).

Credit: Fiona Yi.

Annexes

ANNEXES 1 AND 3 are available online at:

https://pfd-fswp.fr/atlas-waste-climate-mitigation?lang=en

ANNEX 2 Analysis of the inclusion of waste management in NDCs by country

INTRODUCTION

This document is Annex 2 of the French Waste Partnership's Atlas on Waste Management and Climate Change Mitigation, which aims to illustrate the waste sector's potential to reduce greenhouse gas (GHG) emissions. This annex provides a country-by-country summary of how waste management is currently taken into account in the Nationally Determined Contributions (NDCs) of the 104 countries in which AFD operates. The countries are listed by world sub-region.

The information presented is taken from the NDCs made public on the official repository of the UNFCCC (United Nations Framework Convention on Climate Change), accessible at the following address: https://unfccc.int/NDCREG. The content of each national data sheet is based on the version of the NDC available online on the consultation date mentioned in the corresponding summary.

AFRICA ZONE

Southern Africa

South Africa, NDC consulted: 2021

South Africa's updated NDC (2021) does not mention any specific measures on waste management, energy recovery, bio-waste or sanitation. The waste sector is included in the GHG emissions inventory, but without a detailed strategy.

Angola, NDC consulted: 2021

The unconditional contributions provide for the composting of 500 tonnes of waste per day, enabling a reduction of 2,068 $ktCO_2e$ at an estimated cost of USD 7 million. The conditional contributions aim to double this capacity to 1,000 tonnes per day, thus reducing 4,136 $ktCO_2e$ with a financing requirement of USD 8.1 million. The country faces challenges related to the lack of infrastructure and advanced technologies, as well as insufficient awareness. However, opportunities exist through the development of carbon markets, the adoption of energy recovery technologies and the strengthening of the circular economy. Implementing these measures will require international support to achieve the targets set.

Botswana, NDC consulted: 2024

Botswana's NDC focuses on climate change mitigation and adaptation, prioritising the energy, agriculture and industry sectors. Waste management is not treated as a major focus, and there is no specific mention of waste-to-energy. However, Botswana is planning to develop 20 biogas plants by 2030, with a potential reduction of 118.8 Gg CO_2eq, subject to international funding. Botswana plans to expand domestic biogas installations to 500 units by 2030, with an estimated reduction of 5.4 Gg CO_2eq, subject to international financing.

Malawi, NDC consulted: 2021

The waste sector accounted for around 1.67 million tonnes of CO_2e in 2017, or 18% of Malawi's total emissions. Of these emissions, 1.07 million tonnes of CO_2e came from unmanaged landfills, or 13% of the country's total emissions. Emissions from domestic wastewater treatment amounted to 0.47 million tonnes of CO_2e. In its commitment to reduce greenhouse gas emissions, Malawi is planning measures for the waste sector with an estimated reduction potential of 0.9 million tonnes of CO_2e in 2040. These measures include landfill biogas recovery and waste-to-energy, representing 5% of the country's total emission reduction potential. However, these actions require external funding, as they are mostly classified as conditional contributions.

Mozambique, NDC consulted: 2022

Mozambique's NDC mentions waste management, with a focus on promoting sustainable waste management through the NAMA Waste programme, the implementation of a technological action plan and projects for the management and treatment of urban solid waste. It also plans to set up recycling industries and encourage investors to assess GHG emissions in their projects.

Namibia, NDC consulted: 2024

Namibia's NDC includes measures to improve waste management and reduce methane emissions. The waste sector represents 1% of the country's mitigation potential. The main actions focus on recycling, composting and recovering landfill gas to generate electricity, with a target of reducing open burning by 25% by 2030. Wastewater management will be improved by installing reticulation systems in several towns. The total cost of the measures is USD 499 million, mostly conditional on international support. Adaptation includes the reuse of wastewater and the creation of green corridors in urban areas. Implementation of these actions depends on international funding, local capacity building and technology transfer for waste and energy recovery.

Zambia, NDC consulted: 2021

Zambia's NDC refers to waste management, in particular through the following categories: landfilling of solid waste, biological treatment of solid waste, incineration and open burning, and treatment and discharge of wastewater. Zambia has developed Nationally Appropriate Mitigation Actions (NAMAs) that include integrated waste management. The country is projecting an increase in waste collection and landfill rates of up to 80% by 2050, and projections for emissions from the waste sector are based on a per capita increase linked to GDP and population growth.

Zimbabwe, NDC consulted: 2021

The waste sector contributes around 5.4% of national methane emissions, mainly from the decomposition of municipal solid waste. To reduce these emissions, Zimbabwe plans to capture and recover 42% of the methane generated for energy production via waste-to-energy projects by 2035. At the same time, 20% of organic matter will be composted by the same deadline to limit greenhouse gas emissions from biodegradable waste. These measures should make it possible to avoid around 1,288 Gg CO_2eq of emissions by 2035.

Central Africa

Cameroon NDC consulted : 2021

Cameroon plans to set up inter-communal waste management centres in all ten regions, as well as controlled landfill sites, with a target of 70% methane capture by 2035. Energy recovery involves the production of biogas from municipal solid waste, the collection of methane from landfill sites and industrial wastewater, and the thermal gasification of waste for cogeneration. Methanisation is being encouraged on rural farms and large holdings to replace non-renewable firewood. Composting is being developed to recover organic agricultural and forestry waste. Sanitation is being strengthened with projects for anaerobic biological treatment of wastewater and integrated management of water resources. Methane emissions can be reduced by improving agricultural practices, particularly in rice growing. The circular economy is being promoted through initiatives to recycle plastics and structure a waste market. A budget of USD 1,001.99 million has been allocated to the waste sector to mitigate climate change. the waste sector accounts for a potential reduction of 2,701.78 Gg CO_2e by 2030, representing 6.4% of the total planned mitigation and 2.3% of current national emissions.

Congo Brazzaville, NDC consulted 2022 :

The waste sector is taken into account as a greenhouse gas emitter, with emissions projected to 2030. In the business-as-usual (BAU) scenario, emissions from the sector would reach 467.67 $ktCO_2e$ in 2030. However, in the mitigation scenarios, these emissions become negative from 2025, reaching -496.10 $ktCO_2e$ (unconditional) and -2613.47 $ktCO_2e$ (conditional), suggesting the implementation of recovery or improved treatment measures. In particular, the plan provides for the installation of an incineration plant (200 t/day) and a municipal solid waste composting plant (1000 t/day).

Gabon, NDC consulted: 2022

In 2016, **Gabon committed to halving GHG emissions from waste and wastewater treatment by 2025.** Given the expected growth in the population, this commitment should make it possible to reduce GHG emissions by more than 2,000 $GgCO_2$ between 2015 and 2025, or 16% compared with the trend scenario (50% in 2025). However, in the 2022 NDC, Gabon considers the waste sector to be a marginal emitter of greenhouse gases, mainly due to open burning and wastewater management. It is not included in the country's quantified mitigation commitments. However, with population growth at 2.7% per year, waste-related emissions are set to increase. Gabon therefore plans to study and develop improvement measures, including sorting, recycling, composting and the recovery of municipal solid waste into biogas. No quantified reductions have been set, but a management strategy is envisaged to limit the sector's future environmental impact.

Central African Republic, NDC consulted: 2022

The Central African Republic's NDC focuses on improving the management of solid and liquid waste and excreta in order to improve the living environment and protect people's health. It plans to build the institutional capacity of municipalities to improve waste collection, management and recycling, with the aim of training 30% of municipalities by 2025. Energy recovery is encouraged through the promotion of bio-digesters and the recovery of industrial waste to increase energy efficiency and limit the use of fossil fuels. Optimising energy efficiency through bio-methanisation and improved furnaces is also one of the measures supported. However, the implementation of these initiatives faces financial and technical constraints. The National Water Policy 2020-2030 integrates these issues into a broader perspective of universal access to water and sanitation.

Democratic Republic of Congo, NDC consulted: 2021

The DRC plans to strengthen the institutional and legal framework for waste management and to set up a rational waste management programme. It is promoting the use of landfill gas and energy recovery from waste in order to reduce methane emissions from landfill sites. Aerobic composting is also encouraged. The production of energy and organic fertilisers from solid waste, wastewater and faecal sludge is also envisaged. Methane emissions from waste account for around 11% of national emissions, and are mainly due to the disposal of solid waste, the discharge of domestic wastewater and open-air combustion. The DRC aims to reduce emissions from the waste sector by 20% by 2030.

East Africa

Burundi, NDC consulted: 2021

Burundi is planning a number of initiatives to manage waste and reduce methane emissions. An 8.38 MW thermal power plant using municipal waste will be built in Bujumbura to recover energy from waste and reduce emissions from landfill sites. Solid waste management will be improved in the country's main cities (Bujumbura, Gitega, Ngozi and Rumonge) by setting up transit sites and final landfill sites. As for wastewater treatment, eight urban areas of Bujumbura are to be connected to the wastewater treatment network by 2025. In terms of reducing methane emissions, the correction factor is estimated at 46%, with a degradation time of six months. The country is also banking on the production of biogas through the installation of digesters in public infrastructures, with a target of 30 establishments covered by 2027.

Ethiopia, NDC consulted: 2021

The waste sector accounts for 3% of emissions in the reference scenario for 2030. Emissions come mainly from municipal solid waste, the decomposition of organic matter in landfills, wastewater and incineration. Targeted policy interventions include reducing per capita waste production, separating and composting organic matter, and improving wastewater treatment. These actions can reduce emissions by up to 2.9 $MtCO_2eq$ in 2030 (74.7% conditional reduction compared to BAU). The unconditional option would allow a reduction of 17.1%.

Kenya, NDC consulted: 2020

The waste sector is mentioned globally as contributing to 1% of national GHG emissions in 2015, and is included among the sectors covered by the mitigation objective, but without any technical details or figures on the measures or actions planned. The only close reference is a general mention of "sustainable waste management systems" among the priority mitigation activities, with no further details.

Uganda, NDC consulted: 2022

Uganda is incorporating waste management into its climate strategy, with the aim of reducing emissions from the sector by 34.8% by 2030. To achieve this, the country is implementing integrated urban planning in five major cities and fifteen municipalities to improve the collection, recycling and treatment of solid waste and wastewater. Energy recovery is a key focus, with the installation of bio-latrines in schools to produce biogas and the exploitation of sugar cane waste for energy production. Treatment of agro-industrial wastewater is also being stepped up, with anaerobic digesters capturing methane and converting it into biogas, reducing emissions by 14,358 tCO_2e/year. Uganda also plans to improve the coverage of sanitation services and make wastewater treatment plants energy-neutral by using renewable energy. These initiatives are part of a strategy to limit pollution, optimise waste management and recover energy from waste treatment.

Rwanda, NDC consulted: 2020

The waste sector accounted for 12% of Rwanda's GHG emissions in 2015, or 0.64 $MtCO_2e$. Following a BAU the sector should reach 1.6 $MtCO_2e$ but the NDC indicates a reduction plan of 0.7 $MtCO_2e$. Waste management in Rwanda is mainly based on a "collect and dump" model, particularly in urban areas such as Kigali. The volume of waste treated has risen sharply, and the involvement of the private sector has led to an improvement in the collection service coverage rate (90% in Kigali in 2015 compared with 44% in 2012). The country plans to exploit landfill gas to produce energy, thereby reducing methane emissions. Wastewater treatment is still largely based on septic tanks and rudimentary drainage systems, with no centralised treatment systems, although projects are planned in Kigali (including a central station in Nyarugenge and a system in Kibagabaga/Kinyinya). Rwanda also intends to promote aerobic biological composting to recycle organic waste. These measures are integrated into its emission reduction strategy, with the potential for emission reductions conditional on international support. Methane is taken into account in the sources of emissions (notably landfill and wastewater), but the specific reductions linked to the energy recovery of methane, such as that from Lake Kivu, are not yet accounted for due to the lack of a recognised methodology.

Somalia, NDC consulted: 2021

The country plans to develop two sanitary landfills as part of its waste sector, with a projected reduction of 0.28 $MtCO_2eq$ in greenhouse gas emissions, at an estimated cost of $50 million.

Sudan, NDC consulted: 2021

Sudan's updated NDC document addresses waste management and related methane emissions in a limited way. It recognises that municipal solid waste management is one of the country's major environmental problems, with increasing quantities of waste and negative impacts on public health and the economy. In 2017, 11.8 million tonnes of municipal solid waste (MSW) were generated, of which only 13% was disposed of at appropriate management sites. A large proportion (44%) was sent to unmanaged landfill sites, while 15% was burnt in the open air, contributing to air pollution and health impacts. Recycling is practised, but informally and without strict regulation.
GHG emission reduction targets for the waste sector are set at a reduction of 1,278,822 tonnes of CO_2e by 2030, a 20% reduction compared to the baseline scenario. Among the measures planned, Sudan aims to compost 60% of bio-waste and recycle 15% of total waste. The creation of controlled landfill sites in all major urban areas is also planned. Wastewater treatment is another major challenge, with around 50,600 m^3/day mainly from industrial activities , often dumped in shallow landfills or close to urban areas.
In terms of waste-to-energy, Sudan is planning to install systems to produce biogas from the sludge generated by wastewater treatment, thereby helping to generate electricity. However, these initiatives remain limited and require international financial support for their effective implementation.

Tanzania, NDC consulted: 2021

Tanzania's NDC document does not specifically mention waste management, waste-to-energy, bio-waste or sanitation in any detail. However, it does include waste management in its mitigation contributions, with an emphasis on reducing greenhouse gas emissions. The measures proposed concern the promotion of environmentally-friendly waste management practices, including the reduction, recycling and reuse of waste, as well as the adoption of waste-to-energy technologies. There is also talk of improving the management of landfill sites and developing programmes to recover landfill gas for electricity generation. Methane emissions are considered in the greenhouse gas inventory, particularly in relation to the agriculture and waste sectors.

North Africa

Algeria, NDC consulted: 2016

In terms of methane reduction, Algeria intends to give priority to the management of solid household waste. By 2030, the country aims to achieve complete coverage of its territory by waste collection systems, leading to a considerable reduction in CO2-equivalent emissions.

The actions proposed in the NDC are :

- Waste recovery ;
- Composting organic waste and green waste ;
- Recovery and energy conversion of methane gas from landfill sites and wastewater treatment plants.

Egypt, NDC consulted: 2023

Egypt aims to modernise waste management by improving collection and treatment infrastructure, with a target of achieving 95% efficient collection by 2025 and limiting landfill to 20% of waste collected. Energy recovery is a key focus, with the ambition of treating 20% of waste through the production of biofuels, incineration and pyrolysis to reach a capacity of 300 MW. The country is also promoting the use of waste as an alternative fuel in the cement sector. Wastewater treatment is being stepped up with the extension of sludge recycling and recovery infrastructures. A regulatory framework supports these efforts, notably law 202/2020 and decrees promoting the integration of alternative fuels. Funding of USD 5.6 billion is based on public and private investment and international mechanisms.

Morocco, NDC consulted: 2023

Morocco's updated NDC sets out to improve waste management in order to reduce its environmental impact and help mitigate GHG emissions. By 2030, the country aims to recycle 20% of household and similar waste, recover 20% of its organic matter, achieve 10% energy recovery, recycle 25% of industrial waste and 70% of end-of-life vehicles. To achieve this, a number of measures are being implemented, including the construction of landfill and recovery centres, the integration of ragpickers into the formal economy, the development of public-private partnerships and the promotion of sorting at source. Two specific measures in the waste sector are conditional on international funding. This strategy is part of the 2030 National Climate Plan, the National Sustainable Development Strategy and the National Sanitation Programme, which also aims to achieve 100% wastewater treatment by 2030. The aim is to limit the landfill of waste, promote the circular economy and reduce GHG emissions linked to this sector.

Tunisia, NDC consulted: 2021

In terms of solid waste, the country aims to reduce the daily quantity of household waste, increase the rate of recycling and organic and energy recovery, in particular through the production of refuse derived fuels (RDF) used in the cement industry. The sanitation sector will see an improvement in the rate of wastewater treatment, the rehabilitation of wastewater treatment plants, the recovery of sludge for agricultural and industrial use, and the development of cogeneration and photovoltaics. Methane gas is targeted by systematically degassing landfills and producing electricity from their biogas. Taken together, these actions would reduce emissions from the waste sector by 23% by 2030, with an estimated financing requirement of USD 1.18 billion.

Gulf of Guinea

Benin, NDC consulted: 2021

In 2018, the waste sector accounted for 5.38% of the country's total greenhouse gas (GHG) emissions, and this share was projected to fall to 4.64% in 2030 in the absence of mitigation measures. The mitigation strategy in this sector is based on improving solid and liquid waste management, as well as waste-to-energy conversion. A key measure is the implementation of an integrated urban solid waste management programme, including selective sorting and the recovery of methane from landfill sites for energy production. This measure is estimated to result in a reduction of 1.2 Mt E-CO_2 over the period 2021-2030. There is no specific mention of bio-waste in the NDC, but energy recovery through methane capture in connection with solid waste management is highlighted.

Côte d'Ivoire, NDC consulted: 2022

Côte d'Ivoire aims to improve waste collection and urban hygiene, while ensuring sustainable management and recovery. The waste sector is helping to reduce greenhouse gas emissions, with a reduction target of 30.41% by 2030, rising to 98.95% with international financial support. Waste management is an integral part of the transition to a low-carbon economy, in particular by promoting green jobs and improving health conditions. Although energy recovery from waste is mentioned, the technical details of the technologies used are not specified. The implementation of mitigation measures, including this sector, requires funding of around US$10 billion and relies on an investment and monitoring-evaluation plan to ensure their effectiveness.

Ghana, NDC consulted: 2021

Ghana plans to use alternative urban solid waste management to reduce emissions by 21,313 kt CO_2e, with a medium impact on gender equality and a high impact on reducing short-lived climate pollutants, particularly methane. No specific programme on bio-waste or its energy recovery is mentioned directly, although solid waste management may include sorting and treatment measures. The reduction of fugitive methane emissions in the oil and gas sector is also included, with a target of 20%. Other measures, such as the promotion of clean cooking and the development of sustainable transport, contribute indirectly to limiting the production of fossil waste and polluting emissions.

Guinea, NDC consulted: 2021

The Republic of Guinea's NDC document mentions the waste sector and its greenhouse gas emissions. Emissions from the waste sector in 2018 were 298 ktCO_2eq, with projected growth of 3% per year until 2030. Currently, solid waste is not treated in the country, including in major cities, which has negative health, environmental and economic impacts. A major project is currently being studied to collect Conakry's waste and convert it into electricity by burning methane. This project plans to treat a total of 1,740 ktonnes of waste by 2025 and 4,148 ktonnes by 2030, representing a potential reduction of 110 ktCO_2eq/year by 2030 and a total of more than 900 ktCO_2eq.

Liberia, NDC consulted: 2021

Liberia's long-term strategy is to achieve carbon neutrality by 2050. The strategic mitigation options considered as part of the INDC are the energy sector (electricity, transport) and the waste sector (solid waste disposal). In 2000, the waste sector accounted for around 0.60% of Liberia's total national CO_2 equivalent emissions.

An important sub-category is CH_4 emissions from solid waste disposal sites (SWDS), which contributed 91.7%. The CH_4 mitigation targets are waste incineration with energy recovery, composting of organic waste, controlled wastewater treatment, recycling and waste minimisation.
The waste sector targets a 7.6% reduction in GHG emissions by 2030 compared to the business-as-usual scenario. Key measures include installing landfill gas recovery systems at Whein Town (by 2022) and Cheesemanburg (by 2025), and developing small-scale market waste composting (500 tons/year). The plan also aims to improve waste collection, sorting, reuse, recycling, composting, and/or biodigestion. Feasibility studies for biogas-based energy recovery are planned once gas capture systems are operational. On adaptation, Liberia aims to enhance landfill management (drainage, landslide prevention, regular covering, fire safety systems, etc.) and implement separate collection of organic waste to reduce health and environmental risks related to extreme weather events. These measures also address methane emissions from untreated organic waste. There is a clear link with the health sector, through joint actions on waste sorting, public awareness, and community-based management. Composting and biodigestion are identified as complementary high-potential solutions.

Nigeria, NDC consulted: 2021

Nigeria's NDC document explicitly mentions the inclusion of the waste sector in its updated climate commitment, which was not the case in the 2015 version. The waste sector accounts for around 9% of the country's total GHG emissions in 2018. The updated NDC includes waste management actions, particularly in relation to reducing methane emissions and improving waste recovery. A review of the circular economy and waste management is also mentioned.

Sierra Leone, NDC consulted: 2021

Sierra Leone's NDC mentions waste management as a priority sector for mitigating GHG emissions. It states that increasing urbanisation and population growth are generating a significant amount of waste, estimated at around 219,000 tonnes per year for Freetown alone (0.5 kg/inhabitant/day for a population of around 1.2 million). This context contributes to the increase in CH_4 emissions from landfill sites, as well as CO_2 and precursor gases (NO_x, CO). Sanitation is deficient, with many discharges of untreated wastewater directly into watercourses, which limits N_2O emissions from industrial wastewater treatment for the time being. Unconditional contributions include improving access to environmentally-friendly waste management infrastructure. As for conditional contributions, the country is considering incineration facilities to reduce CH_4 emissions from landfills, investments in reuse and recycling technologies, and bio-waste treatment systems with digestate recovery. The sector is also integrated into wider GHG reduction plans through the promotion of the circular economy.

Togo, NDC consulted: 2021

The waste sector in Togo presents major challenges linked to the collection of household waste and the disposal of wastewater, with individual waste production varying between 0.4 and 2 kg per inhabitant per day. Emissions from this sector have risen from 335.7 Gg CO_2-eq in 2010 to 573.3 Gg CO_2-eq in 2030, an increase of 70.8%. The national policy aims to improve urban sanitation, in particular by eliminating illegal dumps, disposing of urban waste and building biomedical waste incinerators. The aim is to recover 12% of urban solid waste through composting and to use 80% of the biogas produced by the Lomé landfill site to generate electricity. There is also a plan to recover 3.5 Gg (around 2.9 million m^3) of methane and to sort and recycle 145,000 tonnes of waste, including 50,000 tonnes through composting. Sanitation is a priority, with investment in the construction of family latrines and the reinforcement of the rainwater drainage network. Wastewater management includes converting 5% of domestic effluent into biogas using appropriate septic tanks. All the measures in the sector require a total investment of USD 262.5 million, with a potential reduction of 412.20 Gg CO_2-eq in cumulative emissions over the period 2020-2030.

Great Sahel

Burkina Faso, NDC consulted: 2021

The waste sector in Burkina Faso accounted for 2.7% of national GHG emissions in 2015, with a projected increase to 2,901.61 Gg CO_2eq in 2030 and 4,959.79 Gg CO_2eq in 2050 in the absence of reduction measures. In particular, it contributes to methane emissions from landfill sites and wastewater treatment. The NDC forecasts a reduction in GHG emissions in this sector of 262 Gg CO_2eq in 2025, 614.8 Gg CO_2eq in 2030 and 1,246.9 Gg CO_2eq in 2050, exclusively under the conditional scenario. The actions envisaged include improving solid and liquid waste management and recovering energy from waste, although these measures are not detailed in the document. The planned funding for mitigating emissions from the sector amounts to USD 166.2 million, but is entirely dependent on external funding. No reduction action is planned under the unconditional scenario.

Gambia, NDC consulted: 2021

Only a third of this waste is collected in Banjul, the capital, and there are no services serving rural areas. The majority of waste ends up in illegal dumps close to homes. Toxic combustion fumes represent a major health risk. Improvements to the waste collection system are hampered by a lack of vehicles. The government is planning to implement an integrated solid and liquid waste management initiative, but the cost of implementation (estimated at $68 million) may be an obstacle. Reductions in greenhouse gas emissions at GDS will be achieved through methane capture, waste recycling and composting.

Mali, NDC consulted: 2021

Waste management in Mali is based on collection and evacuation to two final landfill sites in Bamako and Sikasso, but suffers from a lack of infrastructure, encouraging uncontrolled dumping. The sector's GHG emissions, mainly methane, totalled 436.12 kT CO_2 eq in 2019. No specific methane reduction or energy recovery measures are mentioned. There are projects to improve collectors, treat wastewater and process plastic waste, but no specific actions on waste prevention or bio-waste recovery.

Mauritania, NDC consulted : 2021

The updated NDC of Mauritania addresses the issue of waste concisely. It identifies a moderate mitigation potential in the sector, with a total of 1,573.99 Gg CO_2-eq (3.91% of total emissions), of which only 0.56% is unconditional. The main planned project is the establishment of a solid waste incineration plant with energy recovery (12 MW), currently under study through a public-private partnership. The document also notes the low efficiency of the urban solid waste management system, limited waste collection, and low levels of waste recovery. Regarding sanitation, the NDC includes plans for ecological sanitation projects, including the recovery and reuse of fecal sludge at 10 sites, particularly in cities most exposed to flooding.

Niger, NDC consulted: 2021

Niger's NDC document does not contain any specific measures concerning waste management, waste-to-energy, bio-waste or sanitation. However, it does mention that greenhouse gas emissions from the waste sector amount to 945.758 GgCO_2eq, representing 2.29% of the country's total emissions. The main gases taken into account are CO_2, methane (CH_4) and nitrous oxide (N_2O). Wastewater treatment is mentioned in the management of water resources, but there is no explicit link with energy recovery or the reduction of methane emissions.

Senegal, NDC consulted: 2020

Senegal's NDC puts forward a strategy for the management and recovery of waste in order to reduce greenhouse gas emissions. The government has undertaken reforms (National Solid Waste Management Programme), including reorganisation of the sector, introduction of a regulatory framework, development of modern infrastructure and awareness-raising programmes. The aim is to reduce emissions from the waste sector by 10.99% to 11% unconditionally, and up to 65.28% with international support. Planned measures include improving the sewerage network to achieve 85% coverage by 2030, closing or rehabilitating illegal dumps, building waste management centres and implementing appropriate regulations. Energy recovery is based on the development of biogas with more than 48,000 biodigesters and the promotion of biochar to reduce dependence on fossil fuels. These initiatives aim to reduce the environmental footprint of waste, improve public health and promote the country's energy transition. However, their success depends largely on financial and technological support from the international community.
Waste sectors: Unconditional costs: USD 648m
Contingent costs USD 1,185m
Total: USD 1,834m/

Chad, NDC consulted: 2021

Chad produces around 88 kg of waste per capita per year, a rate that will remain stable until 2030. Currently, 86% of waste is sent to unmanaged open landfill sites, with the remainder burnt in the open air. Under these conditions, GHG emissions from the waste sector will rise from 326 kt CO_2eq in 2018 to around 546 kt CO_2eq in 2030, with average annual growth of 5%. Wastewater will generate 814 kt CO_2eq in 2030, compared with 552 kt CO_2eq in 2018. The installation of waste treatment plants in major cities could reduce these emissions by around 10%. The government plans to improve collection and treatment, in particular by recovering methane from controlled landfill sites and studying the composting of bio-waste. Urban sanitation is also mentioned as an issue, because of the impact of wastewater on water resources and public health.

LATIN AMERICA ZONE

Andes

Bolivia, NDC consulted: 2022

Bolivia is incorporating waste management into its climate strategy by focusing on improving solid waste treatment, developing recycling and composting, and reducing methane emissions from landfills. Waste-to-energy is not explicitly mentioned as a priority, although modernisation of the sector could include biogas projects. Wastewater management is also addressed, with the aim of achieving total sanitation coverage by 2030. The implementation of these commitments depends on international funding, the modernisation of infrastructure and the involvement of local authorities.

Colombia, NDC consulted: 2020

Colombia's NDC document contains detailed information on waste management and methane emissions, and includes Integrated Solid Waste Management (GIRS) as a strategic priority. Measures include the gradual introduction of mechanical-biological treatment (MBT) to reduce the organic fraction sent to landfill, the promotion of recycling (with a target of 15% by 2030), the capture and combustion of biogas from landfill sites (with a biogas treatment rate of 2% by 2030), and the energy recovery of biogas (in particular at the Doña Juana site, with an expected recovery of 0.6% of the biogas produced by 2030). The potential reduction in GHG emissions is estimated at 1.3 MtCO_2eq by 2030.

Ecuador, NDC consulted: 2025

Ecuador's Second NDC focuses on comprehensive waste management to reduce GHG emissions, particularly methane from the decomposition of organic waste, which accounts for 54.9% of municipal solid waste. The waste sector contributes 5.43% of the country's total emissions, or 4,790.54 kt CO_2-eq in 2022. The strategies adopted include capturing methane in landfills, separating waste at source, recovering organic waste through composting and biomethanisation, and promoting the circular economy to reduce, reuse and recycle. The country also plans to improve the treatment and reuse of wastewater to limit pollution and reduce emissions. These actions will be implemented as part of the National Plan for the Integrated Management of Non-hazardous Solid Waste (PNGIRS) and will benefit from international financial support. Cross-cutting approaches, such as gender equality and intergenerational inclusion, are integrated into waste management policies to ensure sustainable and resilient development.

Peru, NDC consulted: 2021

Peru's NDC document makes no specific or detailed mention of actions concerning waste management. The waste sector is listed among those taken into account for greenhouse gas emissions (particularly methane), but there are no targeted sectoral measures.

Brazil, Southern Cone

Argentina, NDC consulted: 2021

Argentina presents its waste generation in its NDC, but has no specific ambition to reduce waste-related emissions. In 2019, Argentina generated around 49,300 tonnes of waste per day, with a high proportion of compostable material (over 40%), which favours the use of biological methods to reduce the volumes destined for final disposal. The proportion of plastics in waste has increased considerably since 1972, reaching between 15% and 20%, while paper and cardboard account for between 13% and 20%. The country aims to reduce waste production, promote the circular economy, improve source separation and strengthen the recycling industry. Energy recovery is encouraged, notably through the exploitation of industrial residues and the use of alternative fuels in industry. The management of bio-waste is based on composting and the improvement of infrastructures to reintegrate it into economic and environmental cycles. Although the reduction of methane emissions is not explicitly addressed, the reduction of landfill waste and the strengthening of waste management infrastructures should indirectly contribute to limiting these emissions.

Brazil, NDC consulted: 2024

Brazil aims to reduce methane emissions from the waste sector by capturing and recovering biogas from solid waste and wastewater, in particular through anaerobic digestion and advanced aerobic treatment. Waste management is aligned with national sanitation and solid waste management policies, with the aim of achieving integrated and sustainable management. The gradual elimination of open dumps is planned in favour of modern treatment infrastructures and wastewater treatment plants. The circular economy is encouraged by recycling, reusing and recovering energy from waste through combustion and the production of biofuels. These measures are part of a wider strategy of ecological transition and carbon neutrality by 2050.

Chile, NDC consulted: 2021

The document provides for the development of a National Organic Waste Strategy (2020) geared towards greater recovery of municipal bio-waste, with the aim of reintegrating nutrients and organic matter into the production cycle, thereby helping to both mitigate and adapt to climate change. Chile is also planning a roadmap towards a circular economy (2020-2040), incorporating waste management as a central lever. The emphasis is on the circularity of organic materials. As part of its carbon neutrality scenario, Chile expects 100% of urban household waste to be disposed of by 2035 in landfills using combustion or biogas systems, with biogas capture or recovery. New sewage sludge treatment plants are planned in Concepción and Valparaíso, with methane management and sludge recovery as forest biostabilisers. In agriculture, it is planned that the pig population will gradually be redirected towards biodigesters.

DRMCC

Costa Rica, NDC consulted: 2020

The Costa Rica NDC document includes concrete and ambitious actions regarding waste management. The country aims for an integrated waste management system based on waste reduction, reuse, recovery, treatment, and final disposal with minimal GHG emissions. It commits to achieving 50% coverage of sanitation and wastewater treatment in high-density areas by 2030. It plans to implement the National Composting Plan in at least 10 municipalities by 2025, as well as to launch the Solid Waste Integrated Management Action Plan 2021-2026, aligned with efforts to reduce emissions and promote a circular economy and bioeconomy. The country also emphasizes the recovery of biowaste through composting. Regarding methane, although this gas is not explicitly mentioned in the waste section, the biowaste treatment and recovery measures, along with improved wastewater management, indirectly contribute to reducing its emissions.

Cuba, NDC consulted: 2025

Cuba's NDC 3.0 document contains little specific information on waste management. It indicates that GHG emissions from the waste sector will account for around 14% of the country's total emissions in 2022, mainly due to the increase in solid waste going to uncategorised landfill sites. Cuba has identified the waste sector as a priority for reducing emissions, alongside energy and agriculture. One notable measure concerns the reduction of methane emissions through the anaerobic treatment of vinasse in 11 sugar cane distilleries, with the aim of reducing the potential for methane emissions by 50% by 2035.

Guatemala, NDC consulted: 2022

In its NDC 2021 (Update), Guatemala includes the waste sector among the areas for climate change mitigation. It mentions integrated solid waste management, including reduction at source, awareness-raising, waste separation, recycling, composting and improving existing landfills, but does not provide any further details. Capture of methane gas from landfills, with no mention of specific infrastructure such as methanisation or RDF units. With regard to wastewater treatment, wastewater is recognised as a source of methane emissions, and a quantified measure aims to reduce emissions linked to its treatment by 0.15 $MtCO_2e$ by 2030. The waste sector, including wastewater treatment, is estimated to contribute between 0.3 and 0.4 $MtCO_2e$/year of emission reductions by 2030.

Honduras, NDC consulted: 2021

The NDC document mentions "Gestión Integral de Residuos (GIR)" as a specific mitigation objective, aimed at promoting waste management at all levels (national to local) in conjunction with a circular economy, reducing health and environmental risks, and educating the population. Mention is also made of the "relleno sanitario de Tegucigalpa" (sanitary landfill) as a mitigation measure to reduce GHG emissions. Methane is included in the GHGs monitored, notably via emissions from the treatment of solid waste and wastewater, but without any in-depth details on the strategies for reducing these emissions. The document states that the overall reduction in GHG emissions of 16% compared with the BaU scenario is broken down by sector, with 1% attributed to the waste sector.

Mexico, NDC consulted: 2022

Mexico recognises that methane emissions from the waste sector are a significant source of greenhouse gases (GHGs), and is putting forward measures to improve the comprehensive management of municipal solid waste and the treatment of municipal and industrial wastewater. The country plans to optimise the processes of reuse, recycling, composting and biodigestion. It is also committed to capturing and using biogas from landfill sites and wastewater treatment plants. A transition to a circular economy is envisaged, including actions to improve the management of food waste and electronic waste, with a strong potential for reducing emissions through life-cycle analysis of materials.

Nicaragua, NDC consulted: 2020

The La Chureca project - to close and rehabilitate the country's largest landfill site - has led to the construction of a recycling plant, as well as houses and a school for the more than 250 families living on the site, and a reduction in emissions of gases produced by decomposing waste. These gases should be used to generate electricity by the Mayor of Managua.

Panama, NDC consulted: 2024

Panama's Second Nationally Determined Contribution (NDC2) directly addresses waste management issues under the circular economy pillar. The country outlines commitments to improve the integrated management of solid waste, promote energy recovery, incorporate biowaste, and reduce methane emissions. The NDC2 includes the implementation of the Basura Cero (Zero Waste) Policy, the development of infrastructure for composting, biowaste valorization, and the use of biogas as a renewable energy source. Emphasis is placed on reducing methane emissions from organic waste, and efforts are planned to integrate the waste sector into the Measurement, Reporting, and Verification (MRV) system. The plan also includes specific commitments for urban areas, such as the creation of waste management plans in targeted communities (e.g., Chilibre), contributing to watershed resilience. Methodologies are mentioned for estimating greenhouse gas emissions from waste, particularly CH_4 emissions.

Salvador, NDC consulted: 2022

El Salvador's NDC document explicitly mentions waste management and sanitation issues. The waste sector accounted for 9.2% of the country's GHG emissions in 2014. The NDC includes a specific section on "Saneamiento y Residuos Sólidos" as a priority adaptation sector. The objectives are to reduce health risks, improve sanitation services and ensure comprehensive solid waste management, in particular by modernising infrastructure and promoting recycling.

OCE ZONE

Atlantic Ocean

Haiti, NDC consulted: 2022

Haiti's NDC includes a number of measures relating to waste management and the reduction of methane emissions. The country plans to recycle plastics with a central capacity of 1,000 tonnes per year, produce fuels from municipal solid waste at a rate of 200 tonnes per day, and compost municipal solid waste with a central capacity of 1,000 tonnes per day. In terms of sanitation, Haiti plans to meticulously manage and treat wastewater by installing treatment plants. Methane emissions linked to waste and fugitive emissions are mentioned, but without any specific measures to capture or recover methane for energy purposes.

Dominican Republic, NDC consulted: 2020

The Dominican Republic's NDC deals succinctly with waste management. It identifies five mitigation options in the waste sector, but without sufficient data for a quantitative assessment. These options are: to develop a national strategy for organic waste in order to increase its recovery and reduce methane emissions; to capture and use methane from landfills for energy purposes; to recycle new waste to produce energy or compost; to introduce the circular economy into waste management with indicators for MRV (*Measurement, Reporting and Verification*); to use municipal, industrial and biological waste as fuel in cement works. Law 225-20 on the integrated management and co-treatment of solid waste is also mentioned as an enabling framework.

Indian Ocean

Comoros, NDC consulted: 2021

The treatment of waste, most of which is organic (food), has been identified as a sector that emits greenhouse gases, mainly methane. Two mitigation measures are planned for 2030: improving waste collection and developing biogas and compost, for an estimated reduction of 15 $ktCO_2eq$, at a total cost of €22.4 million. These measures are conditional on international funding. Improving waste management, in particular by composting bio-waste, is also a priority in the short and medium term.

Madagascar, NDC consulted: 2024

Madagascar is aiming for a 51.4% reduction in GHG emissions in the waste sector by 2030, dropping from 2,083 Gg CO_2 eq. to 1,072 Gg CO_2 eq. eq. To achieve this target, the country plans to strengthen regulatory frameworks, integrate the waste value chain and promote waste standardisation. Initiatives will be put in place to improve the management of liquid effluents and promote the energy recovery of waste. The transfer of innovative technologies and the introduction of a reliable system for monitoring waste flows are also planned. Developing the circular economy, improving urban sanitation and protecting water resources are among the expected co-benefits. However, major challenges remain, in particular the need for substantial funding, estimated at USD 23.9 billion between now and 2030, of which only 3 to 4% will be covered by Madagascar. The success of the plan will also depend on institutional strengthening and the mobilisation of appropriate technologies.

Mauritius, NDC consulted: 2021

The NDC mentions waste management as a sector for reducing GHG emissions, with a reduction target of 313 $ktCO_2eq$ by 2030. The plan calls for 70% of waste to be diverted from landfill through composting, sorting, anaerobic digestion (biogas) and waste-to-energy incineration. The use of anaerobic digestion is explicitly mentioned. Bio-waste is included in the composting and methanisation solutions, although not specifically mentioned. Agriculture will also benefit from small-scale biogas pilot units.

ORE ZONE

Central Asia

Kazakhstan, NDC consulted: 2021

Kazakhstan's NDC includes waste management and energy recovery in its climate commitments. The country aims to reduce GHG emissions from waste, particularly methane from landfill sites, by improving sorting, recycling and advanced treatment infrastructures. Waste-to-energy has been identified as a solution for replacing fossil fuels and reducing the country's carbon footprint. The government is planning incentives and a regulatory framework to encourage investment in the sector, with the aim of reducing landfill deposits and developing energy conversion facilities. Carbon taxation and green finance mechanisms will be mobilised to support these initiatives and accelerate the transition to a low-carbon economy.

Kyrgyzstan, NDC consulted: 2020

Kyrgyzstan's NDC provides for the introduction of separate waste collection and recycling systems, but does not quantify the emission reductions (not estimated). It also envisages the installation of biogas plants on landfills and sewage treatment plants from 2025, the methane reduction potential of which is accounted for in the energy sector. These measures are all part of the WAM scenario (with international support). Methane emissions from waste are mentioned indirectly via biogas, without specific details. Emissions from the waste sector rose by 26.92% between 1990 and 2017.

Uzbekistan, NDC consulted: 2021

Uzbekistan's NDC document does not explicitly mention detailed measures for waste management. However, it does include a reference to the waste sector, which accounted for 1.4% of the country's greenhouse gas emissions in 2017. The main emissions in this sector come from solid waste disposal and wastewater treatment. The document also mentions plans to improve household waste management as part of the country's environmental strategies.

Tajikistan, NDC consulted: 2021

Tajikistan's NDC mentions waste management as part of the improvement of industrial and municipal waste treatment infrastructures. It provides for the development of innovative technologies for recycling and the integration of waste into the circular economy. The introduction of waste monitoring systems is envisaged to improve waste management and optimise treatment processes. No specific information is provided on the recovery of energy from waste and bio-waste. The document takes account of methane emissions as part of the greenhouse gas inventory, but does not detail any specific measures for reducing methane emissions from waste.

Turkmenistan, NDC consulted: 2023

Turkmenistan has included waste management in its NDC as a priority sector for reducing greenhouse gas emissions, particularly methane from landfill sites. The country plans to optimise waste treatment by reducing the volumes landfilled and developing recycling. Energy recovery from waste involves producing biogas and setting up facilities to convert solid waste into energy. These initiatives are part of the national strategy for renewable energy and the fight against climate change. The regulatory framework has been strengthened by a law on waste and the inclusion of this sector in national climate policies. Public-private partnerships are being encouraged to finance the necessary infrastructure. By 2030, the country aims to reduce methane emissions by improving sorting, recycling and energy recovery, while increasing the share of renewable energy thanks to bioenergy from waste. The involvement of the private sector and NGOs is also encouraged to promote innovative solutions and raise awareness.
No figures on waste management.

South Asia

Afghanistan, NDC consulted: 2016

The sector is developed in the NDC in terms of technological needs and capacity building

Bangladesh, NDC consulted: 2021

Bangladesh includes waste management in its NDC with targeted actions to reduce methane emissions from landfills and wastewater. In 2012, waste sector emissions were 24.11 $MtCO_2e$, representing 14.26% of total emissions, and are projected to reach 30.89 $MtCO_2e$ in 2030 without intervention. Unconditional actions call for a reduction of 0.6 $MtCO_2e$ by 2030 through improving municipal waste management, applying the 3Rs principle, installing a waste-to-energy unit in Dhaka, setting up incineration in one city and creating an integrated waste management centre. The conditional actions target a further reduction of 1.84 $MtCO_2e$ with the extension of incineration to three other cities, the construction of wastewater treatment facilities and the development of regional waste recovery centres. The estimated investment for these actions is USD 608 million for unconditional measures and USD 1.958 billion for conditional measures. The strategy is based on recovering energy from waste, reducing anaerobic landfill and integrating the circular economy, while requiring international financial and technological support for its full implementation.

Bhutan, NDC consulted: 2017

The NDC advocates minimising GHG emissions by applying the zero waste concept and sustainable waste management practices using the three Rs (Reduce, Reuse, Recycle), converting waste into resources and improving the current waste management system and infrastructure.

India, NDC consulted: 2022

Waste management is not explicitly mentioned in this version.

Nepal, NDC consulted: 2021

Nepal's NDC includes commitments to waste management and the reduction of methane emissions. By 2025, 380 million litres per day of wastewater will be treated before discharge, and 60,000 cubic metres of faecal sludge will be managed, thus reducing approximately 258 Gg CO_2eq compared with the baseline scenario. By 2030, the country plans to create a favourable environment for the treatment of industrial and municipal waste, including faecal sludge, and to implement sorting, recycling and energy recovery programmes in at least 100 municipalities. Nepal will also ban the incineration of hospital waste in 1,400 health establishments by adopting alternative technologies. It emphasises the principles of the 3Rs (reduce, reuse, recycle) and the co-production of energy and organic fertilisers from solid waste, wastewater and faecal sludge.

Pakistan, NDC consulted: 2021

Pakistan, through its NDC 2021, is implementing several initiatives to improve waste management and limit methane emissions. The **Clean Green Pakistan Index** programme **(CGPI - 2019)** aims to strengthen municipal services, particularly solid waste management, sanitation and hygiene. A ban on single-use plastics has been introduced to reduce waste, while the use of **cow manure to produce methane** is being encouraged, notably with the Karachi Bus Rapid Transit (BRT) project, which supplies biogas to a public transport network. The waste sector accounted for **21.72 Mt CO_2eq in 2018,** including **19.2 Mt CO_2eq of methane,** mainly from **landfills, wastewater treatment and waste incineration.** Pakistan promotes better solid waste management through reduction, reuse and recycling, as well as energy production from bio-waste. A programme to reduce the burning of agricultural waste has also been introduced to limit pollution and methane emissions. Improving WASH infrastructure is a priority, with a national strategy aimed at strengthening sanitation and water management services in a context of climate resilience.

Sri Lanka, NDC consulted: 2021

Sri Lanka generates around 9,000 tonnes of municipal solid waste per day, 40% of which is generated in the Western Province. Collection remains inadequate, with a rate of 55% in this province and 25% elsewhere. The country aims to reduce waste production by 10%, improve sorting and collection to 75% coverage in the Western Province and 60% elsewhere, and increase recycling to 7% and 5% respectively. Bio-waste recovery is based on increasing composting to 30%, optimising wastewater treatment plants and developing biogas. The production of energy from waste is being encouraged by the installation of two waste-to-energy facilities and the development of new thermal treatment technologies. To reduce methane emissions, the transition to sanitary landfills and the rehabilitation of old landfills with gas recovery are planned. These measures should enable a reduction in GHG emissions of 11% by 2030, or 2.5 million tonnes of CO_2, 8.5% of which can be achieved without external aid and 2.5% conditional on international support. The major challenges involve financing infrastructure, tightening regulations on sorting and raising public awareness of more sustainable waste management.

Southeast Asia

Burma, NDC consulted: 2021

In the NDC, to mitigate GHG emissions, Myanmar proposes to produce energy and reduce pollution from non-recyclable waste and to put in place a national waste management strategy and action plans. In 2015, these were under development and were due to be completed in 2017.

Cambodia, NDC consulted: 2020

Cambodia's updated NDC document mentions actions to reduce GHG emissions in the waste sector, but does not provide details. The plan includes initiatives such as increasing sanitary landfill sites with landfill gas extraction, promoting composting of the organic fraction of municipal waste and producing refuse derived fuels (RDF). The aim is to capture and reduce methane emissions associated with municipal solid waste.

Indonesia, NDC consulted: 2022

Indonesia is committed to improving waste management and energy recovery to reduce greenhouse gas emissions. The objective is to reduce emissions from the waste sector by 40 $MtCO_2$-eq in an unconditional scenario and up to 43.5 $MtCO_2$-eq in a conditional scenario. The country is implementing waste reduction and recycling policies with Presidential Decree No. 97/2017, setting a national solid waste management strategy, and Decree No. 35/2018, aimed at accelerating waste-to-energy infrastructure. The focus is on optimising the treatment of solid and liquid industrial waste, in particular through composting, the reuse of sewage sludge and the capture of methane from industrial effluents. The development of biogas and biomethanisation technologies is a priority for exploiting methane emissions from landfill sites and waste-water treatment plants. By 2030, Indonesia is aiming for a significant reduction in methane emissions and an increase in the production of energy from waste, supported by a strengthening of infrastructure and institutional capacity.

Laos, NDC consulted: 2020

Laos' NDC 2020 document explicitly mentions the waste sector only as part of conditional mitigation measures. There are plans to implement a sustainable municipal solid waste management project (500 tonnes/day) in Vientiane, with an estimated reduction of 40 $ktCO_2e$/year between 2020 and 2030. Although the sector contributed less than 1% of GHG emissions in the base year, methane emissions associated with open waste incineration as well as the disposal of organic waste at sites without biogas capture systems are expected to continue to rise steadily with economic development. The project is in line with the Strategy and Action Plan for Sustainable Solid Waste Management in Vientiane (2020-2030), including bio-waste separation and recycling. There is no mention of energy recovery or specific treatment of bio-waste beyond separation. The aim is also to adopt a circular economy approach.

Philippines, NDC consulted: 2021

The Philippines has included waste management in its NDC, with a GHG emissions reduction target of 75% by 2030, of which 2.71% is unconditional and 72.29% conditional. The country is focusing on a circularity and sustainable consumption approach, using market mechanisms and technology transfer to improve waste management. Implementation relies on international funding and bilateral and multilateral partnerships.

Thailand, NDC consulted: 2022

Thailand's NDC mentions waste management as part of its plan to reduce GHG emissions, and in particular talks about its (2012-2031) Waste Management Roadmap without detailing its content. It includes the recovery of energy from waste through the promotion of waste-to-energy technologies (much emphasised) and the improvement of waste management systems at local level. The NDC states that negative public perception is a major obstacle to the acceptance and deployment of **waste-to-energy** facilities. The 3R approach (reduce, reuse, recycle) is also discussed.

Vietnam, NDC consulted: 2022

Vietnam's NDC includes measures for waste management and the reduction of methane emissions. The country plans to reduce the production of solid waste and encourage recycling using advanced technologies. It promotes the production of compost and refuse derived fuels (RDF), as well as the recovery and use of methane from landfills and anaerobic treatment for energy production. Efforts are being made to optimise the treatment of domestic and industrial wastewater by incorporating biotechnologies to limit methane emissions.

BALKANS AND EASTERN EU

Albania, NDC consulted:

The revised NDC says that emissions from the waste sector come mainly from landfills, particularly methane (CH_4), which accounted for around 80% of the sector's emissions in 2016. The country forecasts a modest reduction in these emissions of -0.7% by 2030 compared with the trend scenario. Incinerators have been built in Elbasan, Tirana and Fier (operational in 2023), but there is as yet no separate collection system, despite the legal obligation to do so. Mitigation actions include: reducing landfill of bio-waste to 35% of 2010 levels, methane capture from 2025 (10% of 1.34 million m^3 in 2030), increasing composting (+85% between 2009 and 2020, +3%/year thereafter), increasing incineration of household waste, reducing open burning, and limited improvements in wastewater treatment (urban and industrial).

Bosnia and Herzegovina, NDC consulted: 2021

There are no specific measures or actions related to waste management outlined in the Nationally Determined Contribution of Bosnia and Herzegovina.

Northern Macedonia, NDC consulted: 2020

Northern Macedonia is aiming for a 51% reduction in GHG emissions by 2030, with a specific target of 21% for the waste sector. To achieve this, it plans to improve solid waste management by increasing sorting and recycling and developing regional treatment centres. Energy recovery from waste is encouraged through the production of alternative fuels (SRF), biogas and the installation of thermal treatment units. The circular economy approach targets several waste streams, including construction, electronic and plastic waste, with an ambition to reduce emissions by 951 Gg CO_2-eq/year, create 2,740 jobs and generate €47.17 million in benefits. The country plans to strengthen infrastructure, attract private investment and integrate waste management into the energy transition to maximise environmental and economic gains.

Moldova, NDC consulted:

The waste sector is mentioned as accounting for 10% of national GHG emissions in 2016, but no details are provided on any measures, strategies or projects targeting this sector.

CHINA / MONGOLIA

China, NDC consulted: 2021

Waste management in China's NDC is dealt with transversally, without a dedicated section. The municipal solid waste sector is briefly mentioned, via an incineration-to-energy project in Tianjin.
On the other hand, the management of agricultural bio-waste is clearly detailed: recovery of manure, straw and methanization via rural biogas projects, notably in Sichuan, with quantified GHG reductions. These actions are helping to reduce agricultural methane emissions. China is also seeking to reduce methane emissions from agriculture by optimizing fertilizer use and promoting organic fertilization. The country supports the development of biomass as a renewable energy source, including the production of electricity from bio-waste.
The document also describes industrial circular economy policies, including battery recycling and materials recovery in industrial parks.

Finally, the NDC seems to show ambitions to reduce waste at source through the promotion of the shared economy (mobility, rental) and low-carbon lifestyle awareness campaigns.

Mongolia, NDC consulted: 2020

Mongolia's NDC document briefly mentions, in the mitigation measures section, an action aimed at reducing the volume of waste sent to landfill through improved treatment and recycling processes, as well as increasing the population's access to improved sanitation and hygiene facilities. These measures will reduce GHG emissions by an estimated 106.1 Gg CO_2-eq.

MIDDLE EAST

Iraq, NDC consulted: 2021

Iraq is incorporating waste management and energy recovery into its climate strategy. It plans to improve wastewater treatment for reuse in agriculture and industry, and to develop organic waste treatment plants to produce biogas and compost. Energy recovery is based on sorting, recycling and using solid waste to produce electricity and fuel, in particular by recovering methane from landfill sites. Iraq is seeking to establish a regulatory framework that encourages private investment and technological innovation to optimise waste management and reduce its environmental impact. However, it faces challenges including a lack of infrastructure, the need for international funding and the need to build local capacity. **The document does not provide precise figures on the quantities of waste produced, treated or recovered, but it sets out the broad guidelines and financial requirements,** estimated at 100 billion dollars for all its climate commitments between now and 2030. The implementation of these initiatives relies on international support and regional cooperation to achieve the climate objectives.

Jordan, NDC consulted: 2021

Jordan's updated NDC document states that the waste sector accounted for 6% of the country's total GHG emissions in 2012. Jordan adopted the Waste Management Framework Law No.º 16 of 2020, which introduces producer/polluter responsibility and aims for modern integrated management based on the 3R model (Reduce, Reuse, Recycle). The National Solid Waste Management Strategy (2015-2034) sets short-, medium- and long-term targets, including reducing the amount of bio-waste sent to landfill. Specific projects include the collection and use of biogas from landfills (Al-Dhulil, Al-Salt, Madaba) and sludge from wastewater treatment plants (Wadi Arab, Baqa'a, Ramtha, Salt). The aim is to generate electricity from the captured methane, thereby reducing emissions and the consumption of fossil fuels. Composting units for sorted bio-waste are also planned (total capacity of 200 t/day). These measures are part of the 32 actions to reduce emissions, with a target of -31% by 2030. Wastewater treatment is mentioned in terms of energy recovery from sludge, but there is no explicit overall plan for wastewater.

Lebanon NDC consulted: 2021

The waste sector is included in the overall objective of reducing greenhouse gas emissions, but no detailed plan or measure is presented on this subject.

Palestine, NDC consulted: 2021

The waste sector is the second largest contributor to greenhouse gas emissions (751.7 Gg CO_2eq, or 23% of total emissions). Most emissions come from the treatment of industrial and domestic wastewater (66%). Solid waste accounts for 31% of the sector's emissions. Population growth is the main factor behind this upward trend in gas emissions in the energy and waste management sector. This is because it leads to an increase in emissive activities and therefore in the associated emissions.

TURKEY AND THE CAUCASUS

Azerbaijan, NDC consulted: 2023

2017 version
The NDC talks about developing solid waste management systems in the country's largest cities, without giving any further details.
Azerbaijan is aiming to reduce its greenhouse gas emissions by 40% by 2050, and is including waste management in its climate commitments. While emissions from most sectors have fallen, those from the waste sector have increased by 72% since 1990, accounting for around 2.2% of total emissions in 2016. This increase is mainly due to the poor management of solid waste and wastewater, resulting in significant methane emissions. To remedy this, Azerbaijan has adopted a National Strategy for the Improvement of Solid Waste Management (2018-2022) aimed at improving collection and treatment, attracting private investment and promoting recycling. The State is also seeking to develop waste-to-energy conversion using biogas and incineration with energy recovery in order to reduce dependence on landfills and limit methane emissions. A transition to a circular economy model is being encouraged, combining waste reduction, recycling and energy production from waste, while raising public awareness and implementing incentive policies.

Georgia, NDC consulted: 2021

Georgia's updated NDC deals very briefly with the waste sector. It provides for the low-carbon development of the sector through the promotion of innovative climate-friendly technologies, the adoption of sorting practices and the application of circular economy principles.

Turkey, NDC consulted: 2023

Turkey generated 32.3 million tonnes of municipal waste in 2020 and has invested in modernising its management, promoting the transition from dumps to controlled landfills. In 2021, 59.6% of the municipal waste collected was landfilled, with partial recovery of the biogas. By 2020, 303 kt of methane had been captured and prevented from being released into the atmosphere. Electricity generation from biogas and landfill gas is on the increase thanks to incentives, with 84 installations in 55 provinces, generating 4,096,452 MWh per year. The national Zero Waste project, initiated in 2017 and supported by the UN, aims to promote the circular economy and waste reduction. Turkey plans to increase the recovery rate of municipal waste to 60% by 2035, gradually reduce landfilling of waste without pre-treatment to reach zero landfilling by 2053, and increase the production of fuel derived from waste. It also aims to transform wastewater treatment plants into biorefineries and increase the reuse of wastewater. Its regulatory framework includes specific laws and regulations, including the national waste management plan (2016-2023) and a circular economy strategy currently being drawn up. These measures are part of its climate strategy to achieve carbon neutrality by 2053 by reducing GHG emissions and optimising the use of natural resources.

As the next generation of NDCs takes shape ahead of COP30 and ambitions must rise, waste management remains an overlooked yet powerful lever for mitigation.

Produced by the French Solid Waste Partnership (FSWP) with contributions from the French Development Agency (AFD) and the International Solid Waste Association (ISWA), this Atlas demonstrates how improved waste policies and practices can substantially reduce global greenhouse gas emissions.

Drawing on data from 103 AFD countries and their Nationally Determined Contributions (NDCs), the publication assesses the current state of waste management globally and outlines four strategic levers for impactful action: waste prevention, reduce open burning and open dumping to more environmentally sound landfilling and organic waste management, energy recovery, and material recycling.

Aimed at policymakers and climate finance stakeholders, this Atlas serves as an essential resource, calling for greater recognition and integration of sustainable waste management as a cornerstone of effective climate solutions.

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