Briefing series

Sectoral implementation of nationally determined contributions (NDCs)

October 2017

CIRCULAR ECONOMY AND SOLID WASTE MANAGEMENT

This publication forms part of a series of NDC sectoral overviews, which provide information about current sectoral contributions to global greenhouse gas (GHG) emissions and prospects for implementing NDCs in these sectors.

Each briefing paper presents concrete options for integrating sectoral measures in future NDCs, as well as more general cross-sectoral recommendations for moving forward with emissions-reductions measures.

Written primarily from the perspective of climate change experts, with input and suggestions from sector colleagues, the briefing series' intended target audience is twofold: first sectoral experts, who are facing the challenge of implementing the NDCs and related climate policies in their respective sectors; and second climate change experts, highlighting the relevance of the sector for NDC implementation.

This briefing paper presents the current situation and prospects for implementation of NDCs with a focus on solid waste management and circular economy. It outlines sources of GHG emissions, mitigation options as well as related policy and implementation measures.

Solid waste management and climate change

Implications of the Paris Agreement targets for the waste sector

The Paris Agreement has triggered a new wave of climate change mitigation policies through the elaboration of Nationally Determined Contributions (NDCs). Many NDCs include mitigation measures in the waste sector. Decision makers in ministries, regional authorities and municipalities now face the **challenge of incorporating the high-level NDC targets into their sectoral waste management policies and local waste management plans.** This NDC brief highlights the potentials of a circular economy approach to implement NDC targets related to the waste sector and other sectors (see Figure 1).

Greenhouse gas (GHG) emissions from the **waste sector largely depend on waste generation and waste composition**. Globally, households produce around 2 billion tons of municipal solid waste (MSW) each year. Adding industrial, construction and demolition waste to this, the annual solid waste production totals some 7-10 billion tons (UNEP/ISWA, 2015). Whilst per capita generation of MSW averages between 50-400 kg/year in low and middle-income countries (UNEP/ISWA, 2015), citizens in high-income countries produce 300-790 kg/year (Eurostat, 2017).

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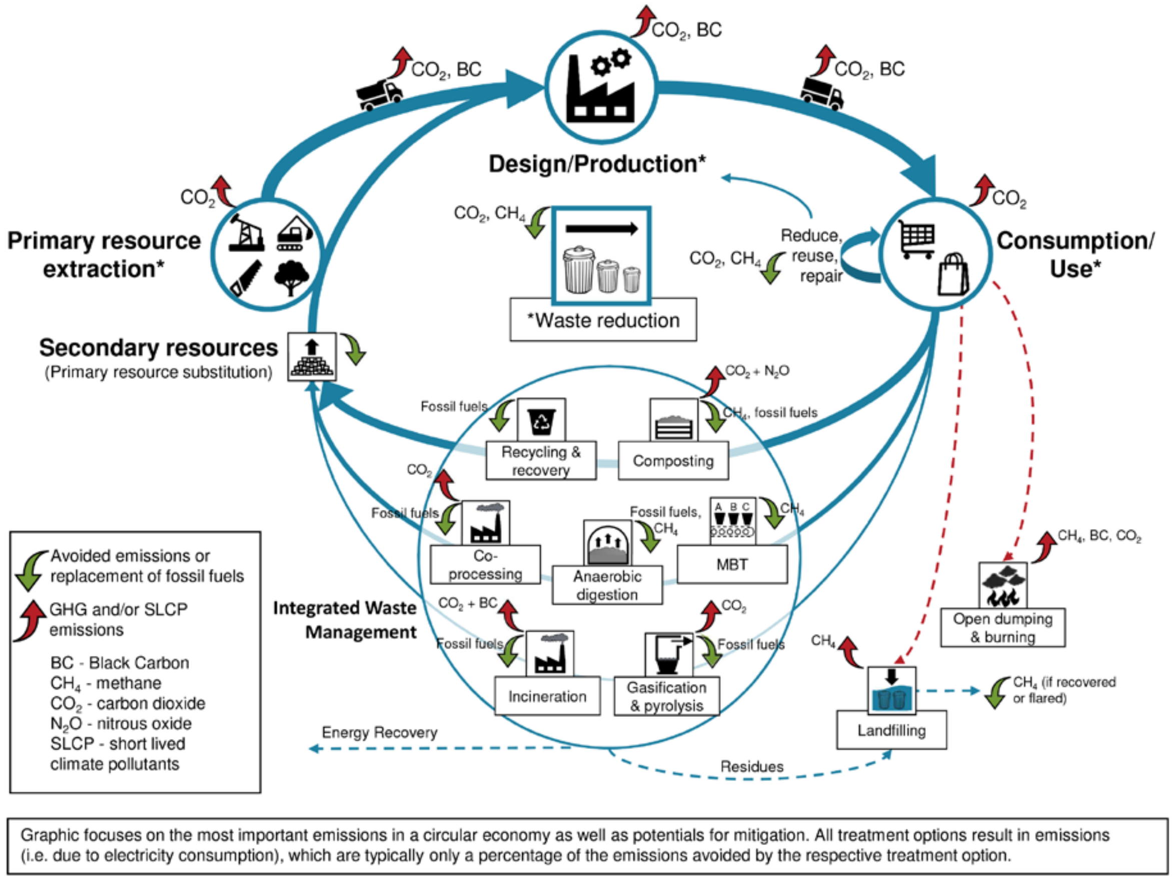

FIGURE 1: Relationship between circular economy and climate change. Source: Own elaboration / GIZ.

Some high-income countries have achieved a relative decoupling of waste generation from gross domestic product (GDP). However, waste generation in low and middle-income countries will continue to rapidly increase over the coming decades, driven by economic and population growth, urbanisation and changing consumption and production patterns. At the same time, 2 billion people worldwide still lack access to waste collection services and 3 billion people do not have access to controlled waste disposal facilities (UNEP/ISWA, 2015). Organic waste makes up around 50-70% of MSW in low-income countries, while it represents around 20-40% in high-income countries. Landfilled organic waste is a major source of methane (CH_4) emissions. These emissions are projected to potentially increase fourfold by 2050 compared to 2010 due to further population growth and economic development in low- and middle-income countries (UNEP, 2010).

The **GHG emissions reported for the waste sector** according to the 2006 IPCC guidelines consist of four sub-categories: solid waste disposal, incineration and open burning, wastewater treatment and biological treatment of solid waste (IPCC, 2006a). GHG emissions resulting from the waste sector are **mostly non-CO_2 emissions** such as CH_4 or N_2O, which require a conversion into CO_2 equivalents (CO_2e) by applying Global Warming Potentials (GWPs) in order to provide aggregated GHG emissions (see Table 1). However, GHG inventories following the 2006 IPCC guidelines do not include all substances relevant for climate change such as black carbon emissions (IPCC, 2013), which some studies have modelled to be a substantial additional source (Wiedinmyer et al., 2014).

GHG emissions **from solid waste disposal** mainly consist of methane generated from anaerobic decomposition of organic material over time in solid waste disposal sites. As such, GHG emissions particularly depend on the proportion of organic matter in the waste. They occur over a long period of time, i.e. 50 years and more. Furthermore, **methane and black carbon** (commonly called soot) **are categorised as short-lived climate pollutants** with high short-term GWP. Polar regions are especially sensitive to the effects of black carbon as its deposition on snow and ice has an additional warming effect (World Bank, 2013).

Given the complexity of emission effects in the waste sector, any quantification of emissions needs careful assessment to avoid an under- or overestimation. According

TABLE 1: GHG and substances resulting from solid waste management. Source: Own elaboration based on IPCC (2007), Bond et al. (2013) and IPCC (2013). [1] = reported for waste sector. [2] = reported for other sectors. [0] = not reported. [0], [1], [2] as per IPCC 2006 guidelines.

GHG OR SUBSTANCE AND MOST IMPORTANT EMISSION SOURCES IN THE WASTE SECTOR AND REPORTING REQUIREMENTS	LIFE TIME	GWP	
		20 YEARS	100 YEARS
Carbon dioxide CO_2: Energy consumption during collection, transport and treatment of waste [2]; Waste incineration (fossil carbon) [1]	Variable (long)	1	1
Methane CH_4: Decomposition of organic waste in landfills under anaerobic conditions [1]	12 years	72	25
Nitrous oxide N_2O: Composting, biological treatment; Waste incineration [1]	114 years	289	298
Fluorinated compounds (HFCs, PFCs, SF_6): Production, use and disposal of various products such as electric/electronic devices (e.g. fridges) [2]	various	various	various
Data for main refrigerant HFC-134a used as sample here:	*14 years*	*3830*	*1430*
Black carbon (BC): Uncontrolled and open burning of wastes (e.g. "backyard burning") [0]; Treatment and transport (fossil fuel combustion) [0]	7-10 days	3200	910

to IPCC, the **waste sector accounts for around 3% of global anthropogenic GHG emissions** (IPCC, 2014). Global GHG emissions from waste reached roughly 1.5 $GtCO_2e$ in 2010, of which approx. 0.6 $GtCO_2e$ arose from solid waste disposal, 0.75 $GtCO_2e$ from wastewater handling and the rest from incineration and other waste treatment (IPCC, 2014).

Sustainable waste management is not only relevant for mitigation but also for **adaptation**. As uncollected waste often ends up in drainage systems and hence increases flooding in urban areas in developing countries, improved collection, treatment and disposal systems can reduce negative effects of extreme weather events. In turn, waste management services and infrastructure also need to be resilient to climate change and allow secure and continued operation during extreme weather events such as heavy rain or flooding. Furthermore, improved waste management contributes to the achievement of the **UN Sustainable Development Goals**, namely 3.9 (health), 6.3 (water quality), 11.6 (environmental impact of cities), 12.4 (chemicals and waste), 12.5 (recycling and reuse), 12.a (sustainable consumption and production) and 14.1 (marine litter prevention).

Approaches and opportunities for mitigation in the waste sector

Compared to other sectors, the relevance of sustainable waste management for climate change mitigation might seem relatively small. However, mitigation activities in the waste sector can have significant impacts on GHG emissions generated and reported in other sectors such as the energy and industry sector. This only becomes visible when applying a **life-cycle assessment (LCA) approach** (see Figure 1 and 3). For example, the use of biogas from anaerobic waste digestion requires waste management measures, however, the resulting reduction of fossil fuel emissions in energy production are accounted for in the energy sector and not in the waste sector.

International and national efforts towards climate-friendly waste management should follow the **waste management hierarchy**. It prioritises waste prevention, reuse, recycling (including composting) and energy recovery from waste before landfilling and open dumping or burning.

Mitigation options for solid waste management can address the following:

» Waste prevention and reuse;

» Recycling of materials (e.g. paper, plastics, glass, metal); composting of separated organic waste from markets, hotels, restaurants, households and sewage sludges; mechanical-biological treatment of mixed municipal solid waste or residual waste; recycling of building and demolition waste;

» Anaerobic digestion (wet fermentation for separated organic waste and possibly sludges; dry fermentation also suitable for mixed municipal solid waste); alternative fuels and resources (e.g. refuse-derived fuel for cement industry, power plants & other industries); incineration of mixed waste with energy generation;

» Landfill gas capture (with electricity generation or only flaring); methane oxidation layer and other options to reduce landfill gas generation and release.

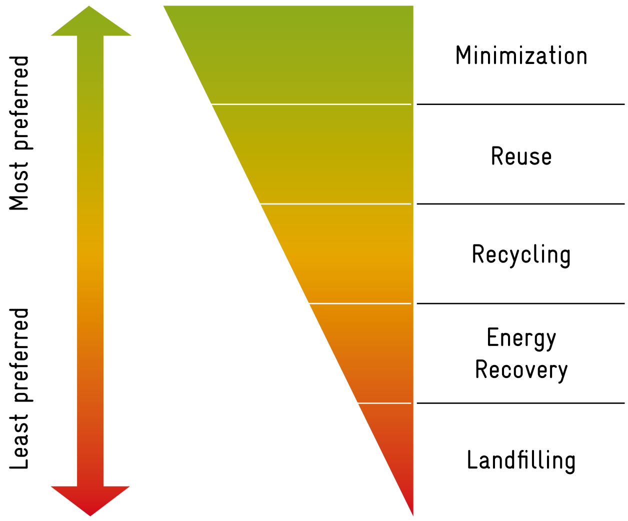

FIGURE 2: Waste management hierarchy.
Source: Own elaboration / GIZ

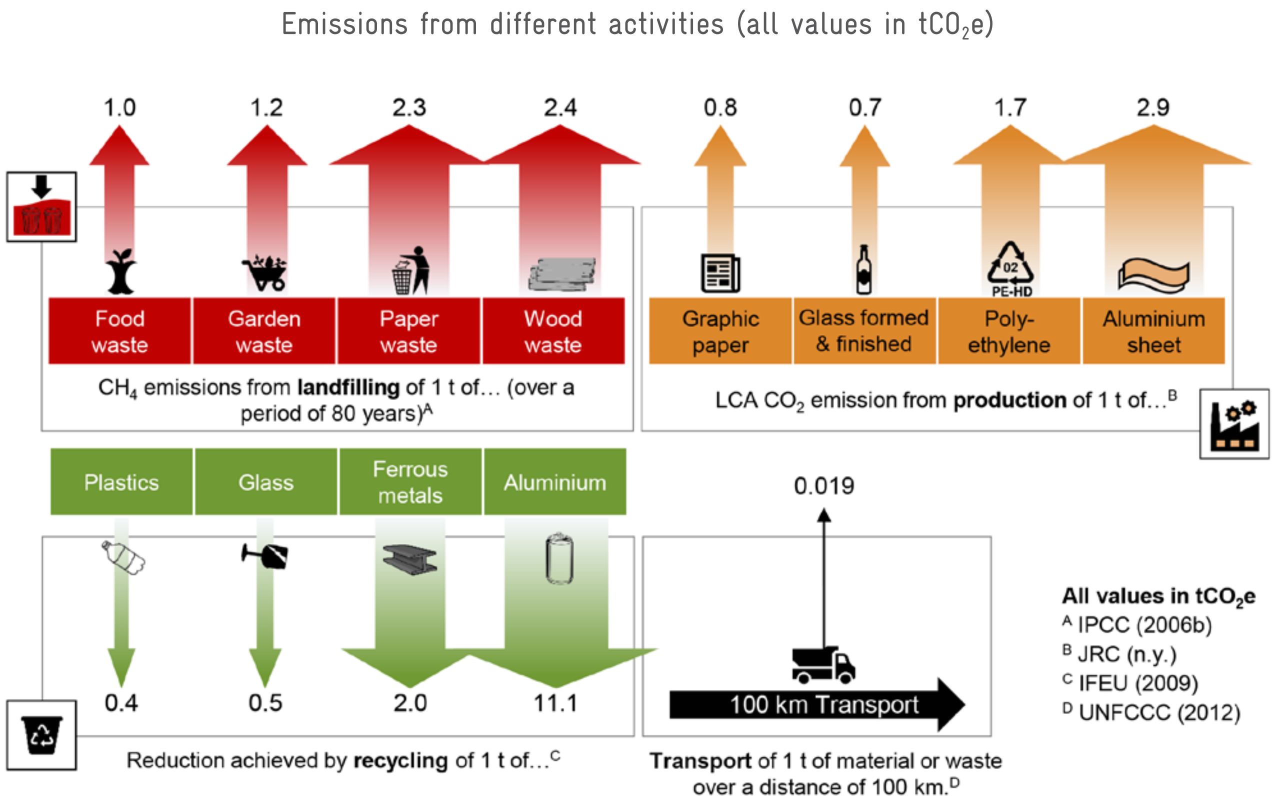

FIGURE 3: Indicative GHG emissions and mitigation potentials from different waste management and circular economy activities. Compilation of different sources. Numbers vary according to local contexts. Source: Own elaboration / GIZ

Material recovery in a sorting plant.

The Global Waste Management Outlook (UNEP/ISWA, 2015) estimates that around **10-15% of global GHG emissions could be reduced through improved waste management** following a life-cycle assessment approach. It considers enhanced recycling (substituting primary raw materials, avoiding energy-related and process-related emissions) and energy recovery from waste (substituting fossil fuels) as well as optimised waste transport (more efficient routes, vehicles, etc.). Moreover, a circular economy would encompass waste avoidance, eco-design, selective dismantling of products to enable re-use of materials and components, enhanced repair and refurbishment systems and extension of product lifetimes, among other approaches.

If the effects of **waste prevention** to avoid emissions from the use of primary resources and waste recovery for other sectors are included, the contribution of waste management related measures to total GHG mitigation could increase to 15-20% (UNEP/ISWA, 2015). For example, unconsumed food ("global food waste") amounts to one third of total food production, generating 3.3 $GtCO_2e$ per year (see FAO/UNEP 2013).

The implementation of NDCs in the waste sector requires **investment in infrastructure and a careful choice between different technological options** that require support by appropriate policy instruments. Decision makers should consider local aspects such as different waste streams and characteristics, city size, financial capacities and logistical circumstances, as well as associated co-benefits. Technology selection needs to go hand in hand with development of national, local and sector policies as well as capacity building.

Waste sector in NDCs

Figure 4 provides an overview of the waste sector in the NDCs. Its contribution to mitigation is explicitly referred to in 67% of the NDCs, but is hardly mentioned for adaptation.

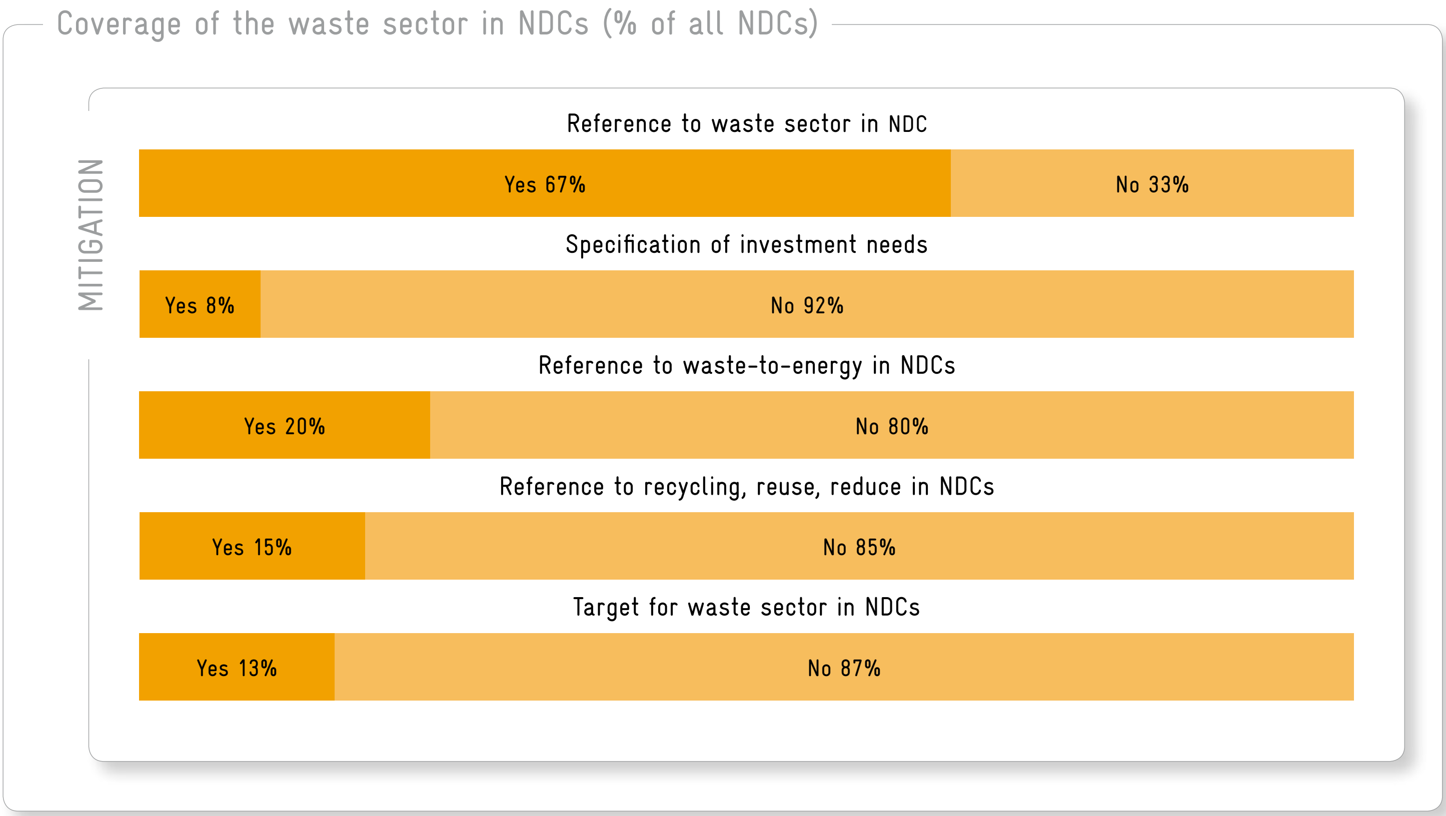

FIGURE 4: Coverage of the waste sector in NDCs (% of all NDCs). Source: Own elaboration based on World Bank (2016). The analysis is based on the review of the INDCs, but is also deemed appropriate for NDCs.

Key steps for moving towards sector-driven implementation and ambition raising

Many of the key steps for moving ahead with NDC implementation and ambition raising are relevant for all sectors. They are summarised in this box. Further details on the individual steps can be found in the overview briefing paper of this briefing series.

Establishment of institutional bodies for oversight of implementation and monitoring of progress: Alignment of institutions based on optimisation of existing mandates, to include broader levels of governance in strategy making including finance and planning ministries, and devolvement of responsibilities to line ministries and agencies with most sector influence. Approaches developed should be resilient to government staff turnover.

Development and dissemination of knowledge on climate requirements and benefits: Enhancing understanding on the implications of the Paris Agreement for the sector, and the social and economic benefits of climate change mitigation and adaptation measures.

Plans for achievement of sector targets, and review of potential for increasing ambition in specific sub-sectors: Stock-take and integration of subnational, national and non-state action, translation to subsector targets, determination of long-term full decarbonisation targets for the sector, and collation of this information into a target-based roadmap. Potential for ambition raising can be analysed based on regional best practice policies and consideration of targets for sub-sectors not covered in climate strategy.

Planning and implementation of instruments to leverage investments: Evaluation of investment requirements and the role of private and public finance for leveraging those investments. Analysis of persisting barriers and development of concepts for projects/programmes that can address those barriers through unilateral action or international support (e.g. NAMAs).

Revision of NDC: Update content of NDC for greater transparency, clarity and in line with aligned national strategy and identified ambition raising potential.

Introduction of policy packages and programmes to kick-start action: Introduction of new policies and strengthening of existing policies, in accordance with sector planning process, and development and submission of proposals for internationally supported programmes (e.g. NAMAs).

Raising ambition to support mitigation and implementation

Transition of the waste sector from a significant emission source to a mobiliser of indirect emission reductions in other sectors started in several industrialised countries long before the adoption of the Paris Agreement and the elaboration of NDCs. Initially, mitigation measures not only targeted GHG emission reductions, but were also driven by their **strong environmental and sustainable development benefits**. Frequently, they are financed by mechanisms based on the polluter pays principle. In countries such as Germany and Switzerland, the solid waste sector has reduced emissions by more than half, mainly through (combined) **strategies and policy amendments** such as extended producer responsibility, segregated waste collection, enhanced recycling and energy recovery as well as avoidance of (organic waste) landfilling. Strong fiscal instruments such as waste collection fees and landfill taxes or bans as well as awareness raising among civil society, consumers and businesses have supported these changes. Further legislative measures that support GHG mitigation are the setting of long-term targets for waste avoidance and recycling, mandatory landfill gas capture and energy feed-in tariffs for waste to energy or landfill gas utilization projects.

The responsibility for MSW management services usually lies with the **municipalities**. In low-income countries, municipalities often spend up to 20-40% of their budget on waste collection and disposal. Introducing waste-related mitigation policies to reach NDC targets can incentivise improvements in current practices, while offering high flexibility in terms of available strategies and necessary support to the municipalities. A **dialogue between central government and the municipalities** involving all concerned governmental levels and agencies as well as private sector and civil society stakeholders, including the informal waste sector, is a necessary condition for success. Policy development should be based on a participatory, iterative process that combines bottom-up and top-down elements and includes the development of **waste data reporting systems** to create a solid basis for decision-making. Action can be taken by the public or private sector or in public-private partnerships. Increasing the role of the private sector in waste management is considered as a relevant factor to realize a climate-friendly circular economy. Climate financing offered for the implementation of the conditional targets defined by the NDCs or revenue from the sale of emission credits under the market mechanisms of Art. 6 of the Paris Agreement would allow increased ambition in the measures undertaken. This could also provide additional financial and technical support to municipalities aiming to mobilise the private sector to implement and operate mitigation technologies.

The possible mitigation impacts of waste management measures should be more strongly considered in **cross-sectoral mitigation strategies** and in other sector strategies (e.g. energy and industry sectors). Sub-national authorities should also be supported in implementing mitigation actions in waste management. **Extending waste collection and moving from uncontrolled dumpsites to engineered sanitary landfills will lead to rising methane emissions if no additional measures such as mechanical-biological waste treatment prior to disposal, landfill gas capture** or other preventive strategies such as diverting organic material from disposal are applied. It is therefore crucial to steer available funds into climate-friendly practices, strategies and concepts, instead of merely proceeding with installation of conventional sanitary landfills that neglect GHG mitigation and resource conservation targets.

While the Paris Agreement does not explicitly mention **Nationally Appropriate Mitigation Actions (NAMAs)**, they are still a key instrument for achieving the targets specified in the NDCs. More than 50 NAMAs in more than 25 different countries address the waste sector. Although NAMA development could open new ways to tap into international financial support, further international financing for the effective implementation of waste-related NAMAs is required.

The NAMA funding landscape is slowly starting to gain momentum with emerging funding opportunities such as the NAMA Facility or the Green Climate Fund. NAMAs are an ambitious concept that require certain enabling conditions such as legal framework, institutional capacities, access to suited technology and know-how. However, waste management actions for GHG mitigation could significantly accelerate the transition towards a progressive, resource-efficient circular economy with advanced technologies, and in this sense enable “leapfrogging” towards modern resource management.

Separate collection of organic waste and its treatment contributes to climate change mitigation

FURTHER READING

Further details on the topics discussed in this briefing paper may be found in the following sources, amongst others:

Tools and methodological support documents
- GIZ/IWA (2017): → ECAM 2.0 – Energy Performance and Carbon Emissions – Assessment and Monitoring Tool (relevant for sludges and wastewater).
- IFEU (2009): → Tool for Calculating Greenhouse Gases (GHG) in Solid Waste Management (SWM), KfW Development Bank.
- UNFCCC (2016): → CDM Methodology booklet.

Long term implications of 2°C and 1.5°C for the waste sector
- UNEP 2016, → Emissions Gap Report 2016 (indication of timeline for full decarbonisation from energy and non-energy sectors).
- → Climate Action Tracker, 10 most important steps to limit warming to 1.5 °C, 2016.
- → AR5 Scenario Database, Long-term scenarios reviewed in the Fifth Assessment Report (AR5) of Working Group III of the Intergovernmental Panel on Climate Change (IPCC).

Support for GHG inventories
- GIZ (2015): → Good practice study on GHG-inventories for the waste sector in non-annex 1 countries.

Specific waste technologies
- GIZ (2017): → Waste-to-Energy Options in Municipal Solid Waste Management: A Guide for Decision Makers in Developing and Emerging Countries, Eschborn, Germany.

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GIZ Climate Policy Support Programme aims at developing and mainstreaming innovative approaches to tackle the challenges of climate change in the context of German Development Cooperation. On behalf of the Federal Ministry for Economic Cooperation and Development (BMZ), it supports developing countries in their efforts to mitigate climate change and to adapt efficiently to its impacts. Through conceptual and practical activities, the Climate Policy Support Programme actively contributes to the implementation of the Paris Agreement and the UN Sustainable Development Goal. It has developed the broader NDC Briefing Series. The fact sheet presented here is developed by the GIZ Sector Project 'Concepts for Sustainable Solid Waste Management and Circular Economy'. It elaborates guidance papers, trainings and policy advice on resource efficient and climate friendly waste management in cities of developing and emerging countries with focus on municipal waste management and circular economy.

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