Mexican Waste Sector Methane Analysis

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About

About the Clean Air Task Force

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

About the Waste Methane Assessment Platform

The Waste Methane Assessment Platform (WasteMAP), a joint initiative by RMI and CATF, is an open online platform that brings together waste methane emissions data with decision support tools for stakeholders in the waste sector. The platform is supported by country engagement that involves collaboration with national and subnational governments, waste management officials, and other key decision makers to provide capacity building and technical assistance—providing a pathway to reduce solid waste methane emissions. Please visit **https://wastemap.earth/** to learn more.

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Abbreviations and Acronyms

AD	Anaerobic digestion
BUR	Biennial Update Report
DBGIR*	Basic Diagnosis for Integrated Waste Management
FONADIN*	National Infrastructure Fund
GHG	Greenhouse gas
GIZ+	German Agency for International Cooperation
GWP	Global warming potential
INECC*	National Institute of Ecology and Climate Change
INEGI*	National Institute of Statistics and Geography
INEGyCEI*	National Emissions Inventory of Greenhouse Gases and Compounds
LGCC*	General Law on Climate Change
LGPGIR*	General Law for the Prevention and Integrated Management of Waste
MSW	Municipal Solid Waste
MtCO2e	Million metric tons of carbon dioxide equivalent
NDC	Nationally Determined Contribution
NMX	Mexican Standards
NOM*	Official Mexican Standards
PGIR*	National Prevention and Integrated Waste Management Program
PMPGIRSU*	Municipal Prevention and Integrated Waste Management Programs
PRORESOL*	Sectorial program for municipal solid waste
SEMADET*	Secretariat of Environment and Territorial Development of Jalisco
SEMARNAT*	Secretariat of Environment and Natural Resources

* Acronym in Spanish

+ Acronym in German

SECTION 1

Introduction

Mexico, like other countries in the Latin American & Caribbean region, faces the enormous task of achieving adequate management of municipal solid waste (MSW) generated in its territory. In this region, Mexico is the second largest MSW generator after Brazil. In 2022, Mexico generated a total of 47 million metric tons of waste.[1]

General Law for the Prevention and Integrated Management of Waste (LGPGIR) is the key legal framework for the management of different types of waste in the country, including MSW. This law defines MSW, the responsibilities of subnational governments to manage it, and the shared responsibilities of government bodies and waste generators. In 2019, the federal government launched the National Zero Waste Vision based on circular economy concepts. Additionally, Mexico City, Quintana Roo, and Baja California states have waste management and circular economy laws.[2,3,4]

1 Waste generation is calculated based on total waste collected in 2023 and the national collection coverage of 84%. INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023. https://www.inegi.org.mx/programas/cngmd/2023/#tabulados. SEMARNAT. (2020). Diagnóstico Básico para la Gestión Integral de los Residuos (DBGIR). Ciudad de México.

2 Congreso del Estado de Quintana Roo. (2023). Ley para la prevención, gestión integral y economía circular de los residuos del Estado de Quintana Roo (L. 199-XVII-20231222-L17). Congreso del Estado de Quintana Roo. http://documentos.congresoqroo.gob.mx/leyes/L199-XVII-20231222-L1720231222200.pdf

3 Congreso del Estado de Baja California. (2021). Ley de residuos del Estado de Baja California. Congreso del Estado de Baja California. https://www.congresobc.gob.mx/Documentos/ProcesoParlamentario/Leyes/TOMO_VII/20210326_LEYRESIDUOS.PDF

4 Secretaría del Medio Ambiente de la Ciudad de México. (2023). Ley de economía circular de la Ciudad de México. Secretaría del Medio Ambiente de la Ciudad de México. https://www.sedema.cdmx.gob.mx/storage/app/uploads/public/640/775/796/640775796545e564034573.pdf

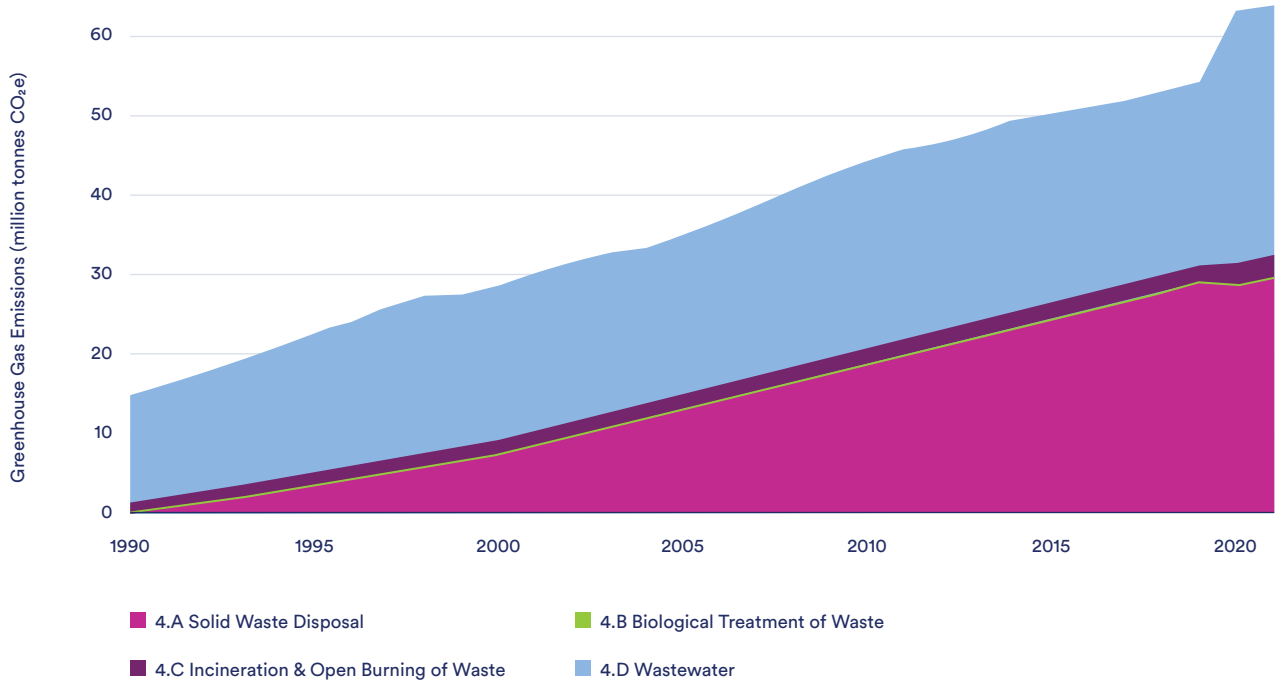
Despite the presence of these laws, the implementation of a circular economy has been slow in Mexico, with MSW being mostly disposed in landfills and dumpsites. Such disposal practices result in emissions of methane, a potent climate pollutant that has a warming potential more than 80 times greater than carbon dioxide in the short term. Emissions from MSW have significantly increased in Mexico in recent decades (Figure 1).

In 2019, methane emissions from solid waste accounted for 29% of total methane emissions in the country.[5]

This report provides an overview of waste management in Mexico and focuses on methane emissions from the sector. Section 2 presents an overview of methane emissions from the Mexican solid waste sector; Section 3 dives into key stakeholders involved in improving waste management and mitigating methane and outlines their responsibilities; Section 4 presents the existing institutional framework for waste management and methane mitigation in the country; Section 5 discusses the current state of waste management and trends; and Section 6 presents challenges and key opportunities to mitigate methane pollution from the waste sector in Mexico.

Figure 1: Historic Emissions from Mexico's Waste Sector (1990-2021)

Source: INECC. (2021). INEGYCEI 1990-2019. INECC. (2023). INEGYCEI 2020-2021.



[5] INECC. (2021). Inventario Nacional de Emisiones de Gases y Compuestos de Efecto Invernadero (INEGYCEI) 1990-2019. https://datos.gob.mx/busca/dataset/inventario-nacional-de-emisiones-de-gases-y-compuestos-de-efecto-invernadero-inegycei/resource/a78be745-05c6-4dd4-bf65-057498b13c20

SECTION 2

Methane Emissions from the Mexican Solid Waste Sector

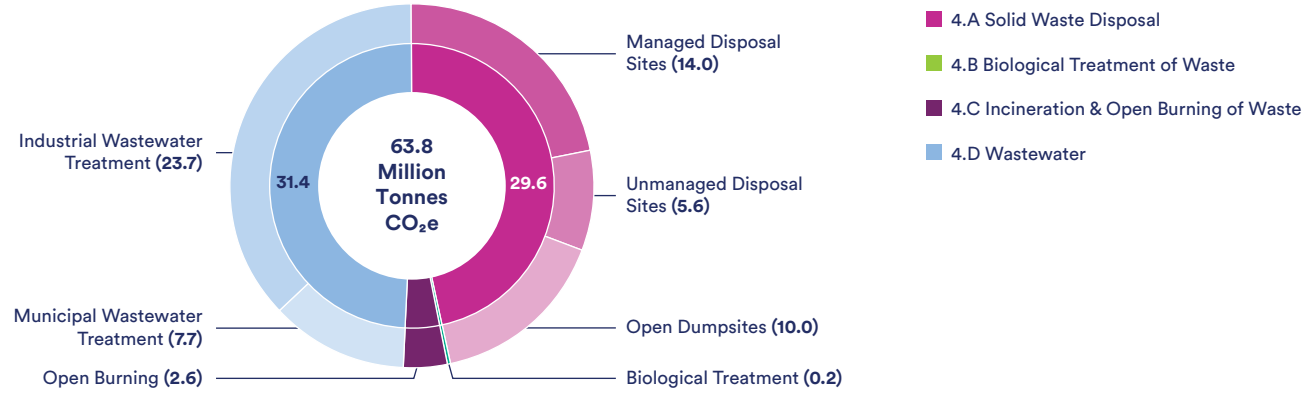
Mexico's National Institute of Ecology and Climate Change (INECC) published the most recent National Emissions Inventory of Greenhouse Gases and Compounds (INEGyCEI) for 2020-2021. The inventory reports waste sector (including solid waste and wastewater) emissions of 63.8 million metric tons carbon dioxide equivalent ($MtCO_2e$) in 2021, which represents an 18 percent increase from 2019 and an increase of over 300% from 1990.[6,7] Forty six percent of 2021 emissions were from the solid waste sector, shown in Figure 2 below. Solid waste sector emissions are primarily from managed disposal sites (47%), followed by open dumpsites and unmanaged disposal sites (34% and 19%, respectively).

[6] INECC. (2023). *INEGYCEI 2020-2021.* https://www.gob.mx/inecc/documentos/investigaciones-2018-2013-en-materia-de-mitigacion-del-cambio-climatico

[7] INECC. (2021). *INEGYCEI 1990-2019*.

Figure 2: Mexico Waste Sector GHG Emissions 2021. Methane emissions are converted to metric tons of CO_2e using a 100-year global warming potential.

Source: INECC. (2023). INEGyCEI 2020-2021.



The INEGyCEI uses a 100-year global warming potential (GWP) of 28 to calculate the carbon dioxide equivalent of methane; however, if a 20-year GWP of 79.7 is used instead, the waste sector emissions increase 2.6 times (by 104 million metric tons CO_2e).[8] Although a 100-year GWP is generally used in inventories for comparison purposes, the 20-year GWP is also valuable as it accounts for the significant short-term warming impacts of methane. Figure 3 shows impact of GWP value on historic emissions from Mexico's waste sector.

Figure 3: Historic Waste Sector Emissions Calculated Using a GWP of a) 100-year and b) 20-year

Source: INECC. (2021). INEGYCEI 1990-2019. INECC. (2023). INEGYCEI 2020-2021.

[8] Intergovernmental Panel on Climate Change. (2021). Climate change 2021: The physical science basis. In V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M.Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, & B. Zhou (Eds.), Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 1-2391). Cambridge University Press. https://doi.org/10.1017/9781009157896

Action on Waste Methane

Mexico's Nationally Determined Contribution (NDC) was most recently updated in 2022. In this update, the country committed to a 35% reduction of total GHG emissions by 2030, an increase from the 22% reduction established in the 2020 NDC. Further, conditional on scaling up of international financing and innovation and technology transfer, Mexico may increase its 2030 emission reduction goal to 40%.[9] These goals represent reductions of 347 $MtCO_2e$ and 397 $MtCO_2e$ for 35% and 40%, respectively.

In addition, the 2022 NDC indicates that a 30% reduction of global methane emissions, along with other global actions, will be necessary to keep a 1.5 °C target within reach.[10] However, the 2022 NDC does not establish specific methane nor waste sector emission reduction targets for Mexico, rather it considers improvements in municipal waste management and activities pertaining to final disposal, recycling, composting and biodigestion, as well as capture and utilization of landfill gas.

Existing mitigation efforts reported in Mexico's Third Biennial Update Report (BUR) included solid waste sector emissions reductions of 3.76 $MtCO_2e$ from 2018 to 2020 through the implementation of eight landfill gas capture and utilization projects (Table 1).[11]

Table 1: Avoided emissions from landfill gas capture and utilization (2018-2020)

Source: SEMARNAT & INECC. (2022). México: Tercer Informe Bienal de Actualización ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático

Project	State	Emissions ($MtCO_2e$)			
		2018	2019	2020	Accumulated
Aguascalientes	Aguascalientes	0.30	0.29	0.26	0.85
Mérida	Yucatán	0.08	0.08	0.08	0.23
Santiago	Querétaro	0.12	0.12	0.12	0.37
Mompaní	Querétaro	0.08	0.08	0.08	0.23
El Verde	Guanajuato	0.17	0.17	0.17	0.52
Norte Culiacán	Sinaloa	0.03	0.03	0.00	0.06
Ciudad Jardín	Estado de México	0.01	0.01	0.003	0.01
Benlesa	Nuevo León	0.48	0.48	0.40	1.35

9 UNDP. (2022) Climate Promise. México. https://climatepromise.undp.org/es/what-we-do/where-we-work/mexico

10 SEMARNAT & INECC. (2022). Contribución Determinada a Nivel Nacional. https://unfccc.int/sites/default/files/NDC/2022-11/Mexico_NDC_UNFCCC_update2022_FINAL.pdf

11 SEMARNAT & INECC. (2022). *México: Tercer Informe Bienal de Actualización ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático.* https://www.gob.mx/cms/uploads/attachment/file/747507/158_2022_Mexico_3er_BUR.pdf

SECTION 3

Stakeholders Involved in Waste Methane

Waste and waste sector methane management requires the coordinated and integrated efforts of different stakeholders. The LGPGIR recognizes this shared responsibility and requires the active participation of government (i.e., Federal, State, and Municipal), producers, importers, exporters, marketers, consumers, and waste services providers. The legal framework laid out by LGPGIR not only identifies relevant stakeholders in its definition of shared responsibility for waste management, but also outlines their responsibilities (see Figure 4). However, in practice this participation is generally low to nonexistent. In addition to those stakeholders outlined in LGPGIR, there are others involved in waste management and waste methane mitigation; Table 2 below provides a list of relevant stakeholders.

Table 2: Key Stakeholders in Mexico's Municipal Solid Waste Management and Waste Methane

Stakeholder	Role
Secretariat of Environment and Natural Resources (SEMARNAT)	Responsible for developing, implementing, and evaluating national policy, including the development of the National Prevention and Integrated Management of Waste Program (PGIR) and the Basic Diagnosis for Integrated Waste Management (DBGIR). In addition, SEMARNAT is responsible for setting standards for environmental performance of MSW management and landfill characteristics for organic waste utilization, as well as integrating national data systems on waste management.* Furthermore, SEMARNAT is responsible for the development of a National Circular Economy Strategy and its implementation plan.
Municipal Governments	Responsible for the management of household MSW including collection, transportation, treatment, and disposal. Municipalities are also responsible for developing Municipal Prevention and Integrated Management of Waste Programs (PMPGIRSU).

Stakeholder	Role
State Governments	Responsible for developing, implementing, and evaluating state policy in accordance with the PGIR and promoting programs and infrastructure development for MSW management. In addition, states are responsible for establishing the obligations, criteria, and guidelines for the management of special handling waste, which includes bulk generated MSW.
Federal Congress	Responsible for publishing and updating the General Law for the Prevention and Integrated Management of Waste. In addition, it sets national budgets for climate change mitigation and adaptation.
Office of the Federal Prosecutor for Environmental Protection	Evaluates compliance with regulations designed to restore, preserve and protect natural resources, such as NOM-083-SEMARNAT-2003 and others pertaining to waste management.
National Institute of Geography and Statistics (INEGI)	Develops data and statistics on generation, composition, and management of household MSW.
INECC	Responsible for developing national emission inventories and establishing Mexico's NDC. In addition, INECC also plays an important role in conducting applied research on municipal solid waste.
Secretariat of Energy	Responsible for elaborating sectoral programs; publishing and verifying implementation of relevant standards (e.g., safety); and issuing permits for the production, storage, transport, distribution, commercialization, and efficient use of bioenergy, including biogas from landfills.
National Infrastructure and Public Service Bank (BANOBRAS)	Fosters access to credit for states, municipalities and the private sector for infrastructure projects. BANOBRAS is also responsible for the operation of the national infrastructure fund (FONADIN).
FONADIN	Supports local governments and state agencies to develop infrastructure projects in the environmental sector, among others, through credits, guaranties, and capital. FONADIN also operates the sectoral program for municipal solid waste (PRORESOL), which provides non-reimbursable funds for studies and projects on integrated solid waste management.
Informal Sector/Recyclers	Individuals, alliances and/or organizations that conduct solid waste management activities (e.g., collection, transportation, source separation and recycling) that generally work without official recognition from national and municipal governments. They generate an income by revaluing waste and, thus, reduce the percentage of waste reaching final disposal. For additional information on the informal sector, see box 1.
Private Sector	Some private companies offer waste collection, transportation, treatment, and disposal services. Approximately, five percent of the registered disposal sites in Mexico are operated by the private sector. In 2023, 7.6% of municipalities had private collection services.** Furthermore, special waste streams, under the jurisdiction of states, are typically managed by the private sector.

** Other responsibilities conferred by LGPGIR to SEMARNAT and States include those focused on hazardous waste management, special waste management, and mining waste.*

*** Calculated based on INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023.*

Sources:

Gobierno de México. (2023). Ley General para la Prevencion Integral de Residuos. https://www.diputados.gob.mx/LeyesBiblio/pdf/LGPGIR.pdf

Gobierno de México. (n.d.). "Qué es el FONADIN?."https://www.fonadin.gob.mx/fni2/acerca-del-fonadin/

Secretaría de Hacienda y Crédito Público & BANOBRAS. (n.d.). Fondo Nacional de Infraestructura Programa de Residuos Sólidos Municipales. https://www.fonadin.gob.mx/fni2/wp-content/uploads/sites/3/2019/10/Presentación_PRORESOL.pdf

Calculated based on INECC. (2022). *Atlas Nacional de Residuos Sólidos Urbanos*. https://www.gob.mx/cms/uploads/attachment/file/693803/125_2022_Atlas_Nacional_Residuos_Solidos.pdf

Secretaría de Hacienda y Crédito Público & BANOBRAS. (n.d.). Fondo Nacional de Infraestructura Programa de Residuos Sólidos Municipales. https://www.fonadin.gob.mx/fni2/wp-content/uploads/sites/3/2019/10/Presentación_PRORESOL.pdf

SECTION 4

Legal Framework for Waste Management and Methane Mitigation

Mexico has a regulatory framework that sets a strong foundation for effective solid waste and waste methane management. This section overviews significant laws, regulations, standards, and policies related to waste management, organic waste treatment, final disposal, and methane pollution.

National Level Framework for Waste Management

The Constitution

The Political Constitution of the United Mexican States is the basis for Mexico's legal system and establishes the limits and relationships between the legislative, executive, and judicial branches. The constitution includes the following articles, which are relevant to environmental measures and to MSW management.

- Article 4: provides broad protection by establishing a *"right to a healthy environment for development and well-being."*
- Article 25: establishes responsibilities of the State including, but not limited to, leading national development in an integrated and sustainable manner and supporting the private and public sectors under social equity, productivity and sustainability criteria.
- Article 73 (XXIX-G): congress has faculties to issue laws that establish alignment between national, state, and municipal governments on environmental protection and ecological balance.
- Article 115 (III): confers responsibility on municipalities as they pertain to public services including waste cleaning, collection, transfer, treatment, and final disposal services. Further, municipalities may coordinate and form associations to improve these services.

Laws

General laws in Mexico are those that originate from the Constitution and once promulgated and published must be applied by all relevant authorities. The main laws that regulate solid waste in Mexico are:

1. General Law of Ecological Balance and Environmental Protection. This law was first published in 1988 and most recently revised in 2024 and addresses all environmental issues (e.g., air, soil, water, waste).[12] Provisions relevant to MSW include:
   - Criteria to prevent and control soil and water pollution from solid waste:
     - Need to minimize MSW and reuse or recycle waste to prevent soil pollution (Article 134 (III));
     - Include soil pollution considerations in municipal solid waste management (Article 135 (II))
   - Definition of the responsibilities of the three government levels: federal, state, and municipal:
     - Requirement for municipalities to authorize solid waste management operations (Article 137);
     - SEMARNAT shall engage in coordination and advisory agreements with state and municipal authorities to improve waste management and data (Article 138); and
   - Established the requirement for SEMARNAT, states and municipalities, to develop a pollutant release and transfer registry (Article 109 BIS);
2. General Law for the Prevention and Integrated Management of Waste. This law was published in 2003 and most recently revised in 2023 and addresses all types of waste except radioactive waste. It guarantees everyone's right to a healthy environment and promotes sustainable development through waste prevention; increased recovery and recycling; and integrated management of hazardous, municipal, and special handling waste. This law assigns responsibilities for hazardous waste, special handling waste, and municipal solid waste to federal, state, and municipal governments, respectively.[13] It also defines large generators—commercial enterprises, food processing facilities, restaurants, and markets that exceed 10 tons of waste per year—as special handling waste.

Box 1: Informal Sector in Mexico

The recycling supply chain in Mexico also includes informal workers who play an important role by, usually, being the first link of the materials recovery chain. According to SEMARNAT around 500,000 people work in the informal sector in Mexico, generating an economic income of more than 21 million USD a year. However, there is no official data on the quantity of waste recovered for recycling by informal workers.

Scarce public participation has been a constant throughout the history of waste management in Mexico, despite an increase in recycling through some waste prevention and separation strategies. This highlights the importance of the informal sector role in recycling and the need for educational and outreach campaigns for pro-environmental behavior change.

Sources:

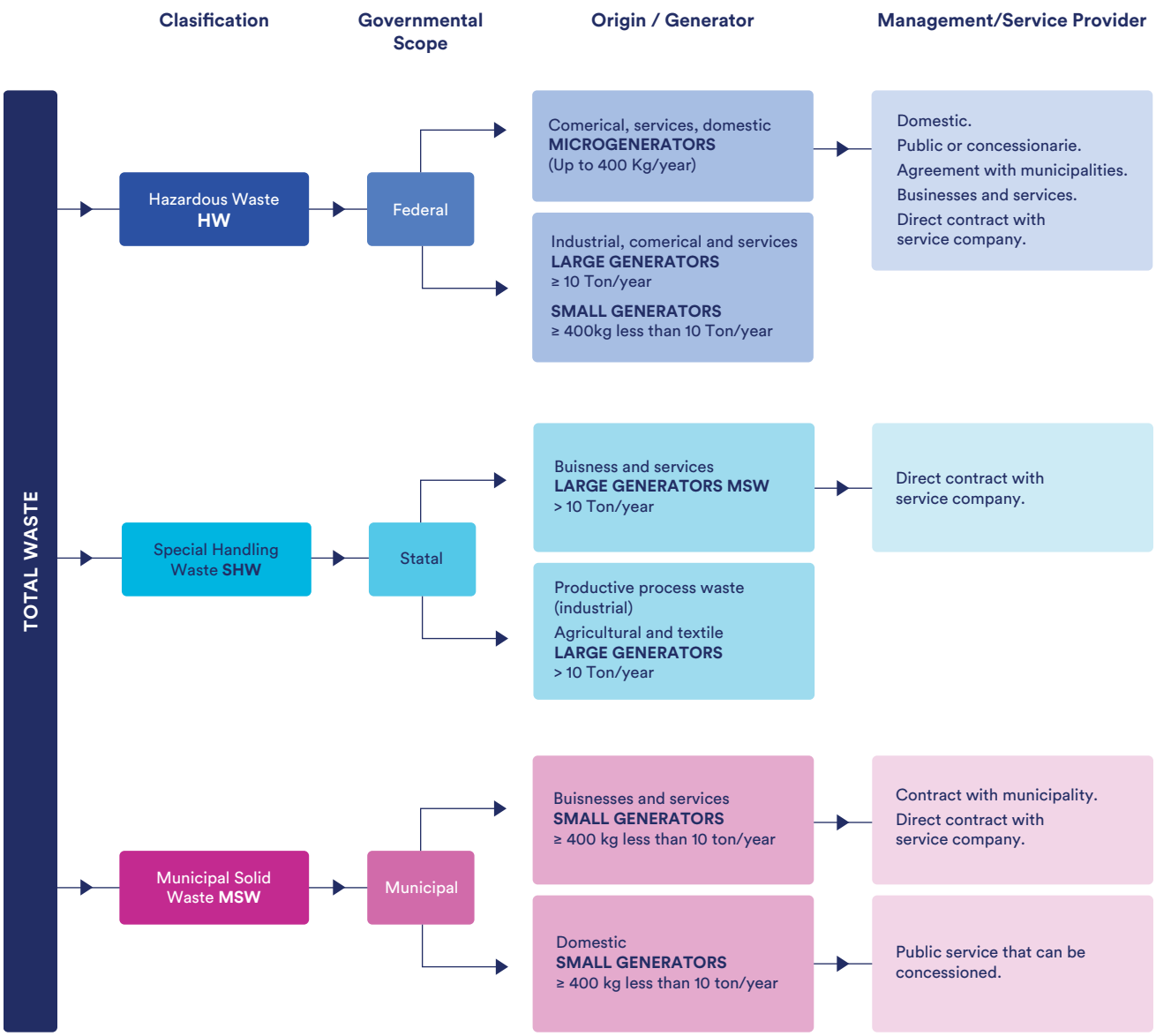
Armijo, C., Ojeda-Benitez, S., & Quintanilla-Montoya, A. (2006). Waste management system in Mexico: History, state of the art and trends. Journal of Solid Waste Technology and Management.SEMARNAT. (2020). DBGIR. Ciudad de México. Torres-Pereda, P., Parra-Tapia, E., Rodríguez, M. A., Félix-Arellano, E., & Riojas-Rodríguez, H. (2020). Impact of an intervention for reducing waste through educational strategy: A Mexican case study, what works, and why? *Waste Management, 114*, 183–195. https://doi.org/10.1016/j.wasman.2020.06.027

[12] Gobierno de México. (2023). Ley General para la Prevencion Integral de Residuos. https://www.diputados.gob.mx/LeyesBiblio/pdf/LGPGIR.pdf

[13] Secretaría de Economía. (2016). Standards. Gobierno de México. https://www.gob.mx/se/acciones-y-programas/standards

Figure 4: Responsibilities of Mexican national, state, and municipal governments, related to waste management

Source: Adapted from GIZ. (2019). Perspectivas, retos y propuestas para mejora y armonización legal del aprovechamiento energético de residuos urbanos en México. https://www.bivica.org/files/5392_aprovechamiento-energetico_Mexico.pdf



Regulations

In Mexico, regulations are issued by the Executive branch, and they are the instrument that enables the application of a general law. Of the two general laws described above, the most relevant regulation for waste management is that based on the LGPGIR: Regulation of the General Law for the Prevention and Integrated Management of Waste (RLGPGIR). The RLGPGIR, updated in 2014, focuses primarily on the content and particularities of waste management plans (required for hazardous and special waste, including bulk waste generators); metallurgy industry waste; hazardous waste, and remediation.[14] However, the regulation does include some articles on solid waste, which are related to definitions, management plans, shared responsibility, coordination between governments, and promotion of solid waste reduction and utilization.

Standards

In Mexico, there are three types of standards 1) Official Mexican Standards (NOM), which are mandatory technical regulations issued by federal government agencies that establish the rules, specifications, attributes, guidelines, characteristics or requirements applicable to a product, process, service or production method or operation, as well as the rules regarding terminology, symbology, packaging and marking or labeling and their compliance or application; 2) Mexican Standards (NMX), which are voluntary and prepared by a national standardization body; and 3) Reference Standards (NRF) produced by public administration entities when Mexican or international standards do not cover requirements or are obsolete.[15]

NOMs provide the necessary elements so that the implementation of the obligations established in higher legal systems (e.g., Regulations) can be monitored. Relevant NOMs for the waste sector include:

1. *NOM-004-SEMARNAT-2002, Environmental protection—Sludge and biosolids—Specifications and maximum permissible limits of contaminants for their use and final disposal.*[16] This NOM establishes the requirements that biosolids (sludge) must meet for their final disposal at authorized sites and allows their disposal in landfills.
2. *NOM-083-SEMARNAT-2003, Environmental protection specifications for the selection of the site, design, construction, operation, monitoring, closure, and complementary works of final disposal sites for municipal solid waste and special handling waste.*[17] Article 7 of this NOM requires that systems for extraction, collection, transport, and control of the landfill gas generated in the final disposal site must be installed. If the landfill gas cannot be used, it should be flared. Article 7 requires the development of a landfill gas monitoring program to detect the migration of gas, and must specify the composition, explosiveness, and gas flow parameters. A new version of this NOM (NOM-083-SEMARNAT-2021) is currently under review by SEMARNAT.
3. *NOM-161-SEMARNAT-2011, which establishes the criteria to classify special handling waste and determines which are subject to a management plan; the list of the same, the procedure for the inclusion or exclusion to said list; as well as the elements and procedures for the formulation of management plans.*[18] The list of special handling waste subject to the management plan includes "organic waste from department stores or shopping centers, including grocery stores, supermarkets, supply centers, public and street markets, and that are generated in an amount greater than 10 metric tons per year per waste or its equivalent". The producer of the organic waste stream is responsible for its adequate handling and disposal.

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[14] Gobierno de México. (2014). Reglamento de la ley General para la Prevención y Gestión Integral de los Residuos. https://www.gob.mx/cms/uploads/attachment/file/131723/17._REGLAMENTO_DE_LA_LEY_GENERAL_PARA_LA_P REVENCI_N_Y_GESTI_N_INTEGRAL_DE_LOS_RESIDUOS.pdf

[15] Secretaría de Economía. (2016). Standards. Gobierno de México. https://www.gob.mx/se/acciones-y-programas/standards

[16] Secretaría de Gobernacíon. (2003). NOM-004-SEMARNAT-2002, Protección ambiental.- Lodos y biosólidos.-Especificaciones y límites máximos permisibles de contaminantes para su aprovechamiento y disposición final. https://dof.gob.mx/nota_detalle.php?codigo=691939&fecha=15/08/2003#gsc.tab=0

[17] Secretaría de Gobernacíon. (2021). NOM-083-SEMARNAT-2003, Especificaciones de protección ambiental para la selección del sitio, diseño, construcción, operación, monitoreo, clausura y obras complementarias de un sitio de disposición final de residuos sólidos urbanos y de manejo especial. https://www.dof.gob.mx/nota_detalle.php?codigo=5617899&fecha=10/05/2021#gsc.tab=0

[18] Secretaría de Gobernacíon. (2013). NOM-161-SEMARNAT-2011, Que establece los criterios para clasificar a los Residuos de Manejo Especial y determinar cuáles están sujetos a Plan de Manejo; el listado de los mismos, el procedimiento para la inclusión o exclusión a dicho listado; así como los elementos y procedimientos para la formulación de los planes de manejo. https://www.dof.gob.mx/nota_detalle.php?codigo=5286505&fecha=01/02/2013#gsc.tab=0

NMX technical standards are non-binding unless they are cited in a NOM. Usually these standards describe methodologies, procedures or techniques to carry out tests, measurements, and analytical processes in a laboratory, such as those for waste sampling and characterization, and measurement of physical or chemical parameters (e.g., composition, humidity, pH, volumetric weight, carbon content, and sulfur). Relevant NMX include: NMX-AA-015-1985, NMX-AA-0161984, NMX-AA-018.1984, NMX-AA-019-1985, NMX-AA-021-195, NMX-AA-022-1985, NMX-AA-024-1984, NMX-AA-025-1984, NMX-AA-033-1985, NMX-AA-052-19855, NMX-AA-061-1985, NMX-AA-067-1985, among others.[19]

Policies and Programs

The National Program for the Prevention and Integrated Management of Waste 2022-2024, prepared by SEMARNAT, prioritizes waste segregation at source, separate collection of segregated waste, and treatment of organic waste. It calls for the creation of appropriate infrastructure to segregate and treat organic waste (e.g., composting and biodigestion).

The National Vision towards Sustainable Zero Waste Management, published in 2019, includes circular economy elements. Item 6 in its roadmap calls for avoiding food waste and taking advantage of the energy potential of organic waste, including promoting the creation of synergies with food markets and supply chains.

In addition, the National Program for General Ecological Land Use Planning establishes guiding principles and strategies to regulate land use and promote sustainable development. These strategies include diversification of the energy matrix by incentivizing bioenergy and, thus, mitigation of GHG emissions, as well as actions that promote coordination with national and municipal government entities for the creation of adequate solid waste disposal systems and increased coverage of waste management services.[20]

State and Local Legislation on Waste Management

Per LGPGIR, states and municipalities are responsible for developing policy and legal instruments for integrated waste management. As such, nearly all states in Mexico have a waste law, such as the Law of Prevention and Integrated Management of Waste for the State of Baja California; Law for the Prevention, Integrated Waste Management and Circular Economy of Waste of the State of Quintana Roo; and Law Number 593 on the Use and Integrated Management of Waste of the State of Guerrero. These laws typically promote improved collection, source segregation, and treatment of organic waste.

Likewise, municipalities develop regulations and policies at the local level, such as PMPGIRSU, to meet national requirements for waste management. In 2022, 140 municipalities had programs on waste management and 53 of these had PMPGIRSU.[21] In addition, some municipalities (e.g., Municipality of Mérida) have issued local regulations for waste management, which are more enforceable than PMPGIRSU, and that include, among others, stipulations on fines and waste collection fees.[22] Similar to the National Program for General Ecological Land Use Planning, states and municipalities develop Local Programs for Ecological Land Use Planning some of which (e.g., Pachuca de Soto and the Costalegre region) consider and/or set criteria for solid waste management including final disposal site compliance with regulations.[23,24]

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19 SEMARNAT. (2017). Normatividad aplicable al tema de residuos. Gobierno de México. https://www.gob.mx/semarnat/acciones-y-programas/normatividad-aplicable-al-tema-de-residuos

20 SEMARNAT. (2012). Acuerdo por el que se expide el Programa de Ordenamiento Ecológico General del Territorio. https://www.semarnat.gob.mx/archivosanteriores/temas/ordenamientoecologico/Documents/documentos_bitacora_oegt/dof_2012_09_07_poegt.pdf

21 INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023.

22 H. Ayuntamiento de Mérida. (2020). REGLAMENTO PARA LA GESTIÓN INTEGRAL DE RESIDUOS SÓLIDOS DEL MUNICIPIO DE MÉRIDA. https://isla.merida.gob.mx/serviciosinternet/normatividad/files/Reglamentos/GESTION_INT._RES._SOL.-20211105-110303.pdf

23 Municipio de Pachuca de Soto, Hidalgo. (2022). *Decreto Municipal 27 que contiene el Programa de Ordenamiento Ecológico Local.* https://dsiappsdev.semarnat.gob.mx/datos/portal/poet/2023/d_pachuca_221230.pdf

24 Secretaría de Medio Ambiente y Desarrollo Territorial. (2021). Programa de ordenamiento ecológico y territorial regional Costalegre que comprende los municipios de Cabo Corrientes, Cihuatlán, Tomatlán y La Huerta https://dsiappsdev.semarnat.gob.mx/datos/portal/poet/2022/d_costalegre_210911.pdf

National Level Framework for Climate and Methane Mitigation from the Solid Waste Sector

Multilateral Environmental Agreements

Mexico is a signatory to the Kyoto Protocol and the Paris Agreement, with both treaties addressing climate change. Through its 2022 NDC, Mexico committed to reducing total GHG emissions by 35% and to act on improving municipal waste management (see discussion in Section 2 above).

Specific to methane, Mexico signed the Global Methane Pledge announced at the 26th United Nations Framework Convention on Climate Change Conference in 2021. More recently, in 2023, Mexico, alongside the United States and Canada, committed to reducing methane emissions from the solid waste and wastewater sector by at least 15% by 2030 from 2020 levels and to develop a Food Loss and Waste Reduction Action Plan.[25]

Laws

The main regulatory instrument that establishes guidelines to control climate pollutants in Mexico is the General Law on Climate Change (LGCC).[26] Published in 2012 and last reformed in 2023, the LGCC turns Mexico's climate targets into strategies and provides a framework for implementation. The LGCC not only establishes roles and responsibilities for the federal, state, and municipal governments as it relates to design and implementation of national and international climate change policy, but also establishes the following relevant to solid waste:

- Article 7(XIV)(d) confers responsibility on the federal government for developing methodologies, criteria, etc. necessary to develop national inventories on waste.
- Article 9(II)(e) confers responsibility to municipalities to develop and implement climate change policies and actions related to MSW management.
- Article 33(XI) establishes public policy mitigation objectives including harnessing of energy from waste.
- Article 34(IV) and (VI)(b) call on federal, state, and municipal entities to design mitigation policies and actions, including infrastructure for waste minimization and valorization. It also calls for education and other programs and economic incentives to encourage behavioral changes needed for improved integrated waste management.
- The Third Transitory Article calls on municipalities to "design and build infrastructure for solid waste management that does not emit methane into the atmosphere in urban centers of more than fifty thousand inhabitants, and when feasible, [municipalities] will implement technologies to generate electricity from methane emissions."
- Finally, the Second Transitory Article commits Mexico to a total greenhouse gas (GHG) emission reduction target of 22% by 2030 compared to the 2000 baseline, which includes a 28% GHG mitigation target for the waste sector.[27]

Additional laws related to the use of biomass and organic waste as an energy source, include:

- Law for the Use of Renewable Energies and the Financing of Energy Transition (published 2008; amended 2013) which supports bioenergy, including biogas generated from biomass and organic waste, as renewable energy.
- Law for the Promotion and Development of Bioenergy (published 2008) which promotes and develops bioenergy, including biogas, to contribute to energy diversity and sustainable development.
- Electric Power Industry Law (published 2014; amended 2022) promotes the sustainable development of the electricity industry and guarantees its continuous, efficient, and safe operation for the benefit of all users. It also includes under its clean energy definition the energy produced from burning methane at waste disposal sites, livestock farms, and wastewater treatment plants, among others.

Regulations

Mexico's Regulation of the General Law on Climate Change establishes the National Emissions Registry, which mandates entities in the waste sector to report direct and indirect emissions when annual emissions from a site are equal to or larger than 25,000 metric tons CO_2e.[28]

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25 The White House. (2023). FACT SHEET: Key Deliverables for the 2023 North American Leaders' Summit. https://www.whitehouse.gov/briefing-room/statements-releases/2023/01/10/fact-sheet-key-deliverables-for-the-2023-north-american-leaders-summit/

26 Gobierno de México. (2024). Ley General de Cambio Climático. https://www.diputados.gob.mx/LeyesBiblio/pdf/LGCC.pdf

27 Note that the 22% reduction of total GHG emissions was included in 2018, but Mexico's most recent NDC sets an unconditional mitigation target of 35%.

28 Gobierno de México. (2014). Reglamento de la Ley General de Cambio Climático en Materia Del Registro Nacional de Emisiones. https://www.diputados.gob.mx/LeyesBiblio/regley/Reg_LGCC_MRNE_281014.pdf

Activities subject to reporting are: waste prevention; separation; reuse; recycling; co-processing; biological, chemical, physical or thermal treatment; collection; storage; transportation, and final disposal of waste.

Policies and Programs

Other policy instruments related to GHG mitigation in Mexico that are relevant to the waste sector are listed below. However, despite the existence of these national regulations and policies, they have not had significant impacts given the current political landscape.

- *National Strategy for Climate Change: Vision 10-20-40.* Strategic axis M3 of the Strategy, focuses on transitioning to sustainable cities, and includes action items to improve integrated waste management such as encouraging the participation of the private sector; promoting new technologies and infrastructure for biogas use through co-investment schemes and economic instruments; creating regional and inter-municipal bodies for landfill development; correcting and promoting tariff systems for collection and disposal services; encouraging reinvestment in technological and logistical improvements and best practices; and, promoting surveillance, inspection and enforcement of fines as a central part of compliance.[29] As of 2023, the Senate established that this strategy must be reviewed, at most, every ten years for mitigation actions and six years for adaption actions and should be aligned with Mexico's NDC.[30]
- *Special Program on Climate Change 2021-2024.*[31] The updated Program establishes general activities and guidelines in the MSW sector, including the modernization of waste management infrastructure; aligning the objectives of waste policy to the principles of circular economy and NDC compliance; promoting waste minimization and integrated management of MSW; implementing environmental training at schools on energy, waste and water issues, related to climate change. The program also sets the following specific actions 1) mitigation of methane and carbon dioxide through the waste-to-energy projects, and 2) promotion of food banks to reduce organic fraction.
- *Pollutant Emission and Transfer Registry.* Environmental policy instrument that annually reports information of pollutant generation for substances listed in NOM-165-SEMARNAT-2013. It is reported at a site or facility level through the Annual Operation License and, consistent with RENE, requires reporting of GHG when annual emissions are equal to or larger than 25,000 metric tons CO_2e. NOM-165-SEMARNAT-2013 specifically indicates that methane should be reported as part of RETC when the following thresholds are met 1) 2,500 kg per year in manufacture, processes or other uses or 2) 100,000 kg/year for emissions/transfer.

State and Local Programs on Waste Methane Mitigation

States and municipalities also publish corresponding subnational programs on climate change. In 2018, an evaluation of subnational progress on policies related to climate change was published. Few actions were identified related to solid waste management. Of the 18 municipalities analyzed, only Monterrey was mitigating emissions by using landfill gas as fuel for power generation; the facility has an installed capacity of up to 12.72 MW.[32] The evaluation highlighted that the lack of availability and reliability of information on waste generation hinders effective and efficient decision-making for the sector.

Since then, additional policy instruments have been developed at the subnational level. Some, such as the Climate Action Plan of the Metropolitan Area of Guadalajara, propose actions including the diversion of waste from final disposal sites and establish specific goals for the use of biogas.[33] Others, like the Roadmap on Energy Uptake from Organic Waste with Biogas Technology for the State of Quintana Roo, develop roadmaps to meet these objectives. However, little progress has been made in achieving these objectives at present.[34]

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29 SEMARNAT. (2013). *Estrategia Nacional de Cambio Climático. Visión 10-20-40.* México: Gobierno de la República. https://www.gob.mx/cms/uploads/attachment/file/41978/Estrategia-Nacional-Cambio-Climatico-2013.pdf

30 Senado de la República. (2023). Comisión aprueba revisar Estrategia Nacional de Cambio Climático conforme al Acuerdo de París. https://comunicacionsocial.senado.gob.mx/informacion/comunicados/6907-comision-apruebarevisar-estrategia-nacional-de-cambio-climatico-conforme-al-acuerdo-de-paris

31 Secretaría de Medio Ambiente y Recursos Naturales. (2021). Programa Especial de Cambio Climático 2021-2024. https://www.gob.mx/semarnat/documentos/programa-especial-de-cambio-climatico-2021-2024

32 INECC. (2018). Evaluación estratégica del avance subnacional de la política nacional de cambio climático. https://www.gob.mx/inecc/documentos/evaluacion-estrategica-del-avance-subnacional-de-la-politica-nacional-decambio-climatico

33 IMEPLAN. (2020). Plan de Acción Climática del Área Metropolitana de Guadalajara. Guadalajara.

34 GIZ. (2022). Hoja de Ruta para el Aprovechamiento Energético de Residuos Orgánicos con Tecnología de Biogás en el estado de Quintana Roo.

SECTION 5

Solid Waste Management Systems in Mexico

In Mexico, there are three main sources of information on solid waste management: the Basic Diagnosis for Integrated Waste Management (DBGIR), the National Census of Municipal Governments and Territorial Demarcations of Mexico City and the National MSW Atlas. Though these sources are updated periodically, and often pull information forward from previous publications, the data provided can be significantly different, making analysis and comparison between the sources (i.e., to analyze data trends year over year) complicated. For example, MSW sent to treatment facilities reported in the most recent DBGIR—which uses information from the 2017 National Census—equals 8,944 metric tons per day. However, the National 20 MSW Atlas published in 2022 reports this value as 1,889 metric tons per day—the Atlas uses 2020 DBGIR and 2019 National Census data. In 2023, a new National Census was published, the most updated information on MSW collection in Mexico, which reports this value as 5,661 metric tons per day. Annex I: Waste Information Systems includes a comparison of the three main sources of waste data. To craft an accurate picture of solid waste management in Mexico today from generation to final disposal, we have used these three sources and have identified additional information from others, including the InterAmerican Development Bank. Mexico does not have one common system to which waste management information is reported.

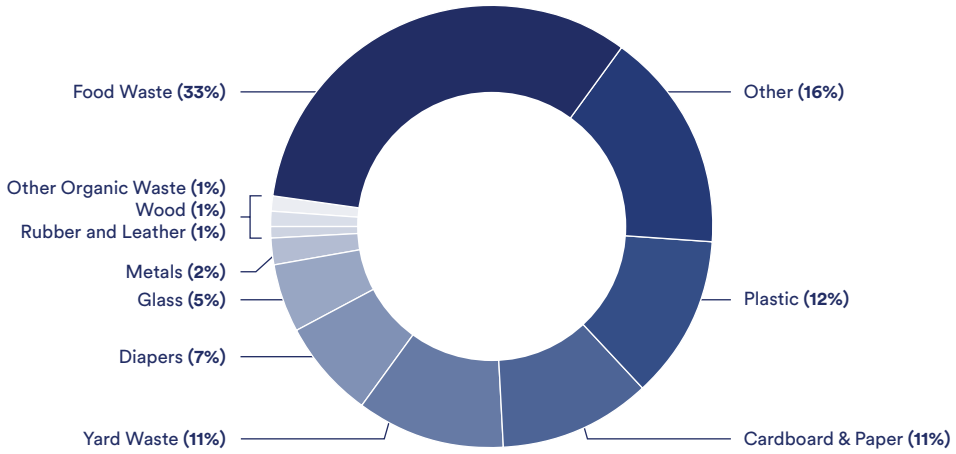
Generation & Composition

In 2022, Mexico generated 129,000 metric tons of waste per day totaling approximately 47 million metric tons of waste a year.[35] This is equivalent to an average national per capita generation of 0.99 kg of waste per day; however, generation per capita is not evenly distributed amongst the country with the Center[36] having the smallest generation and the Northwest[37] the largest (0.77 kg/day and 1.08 kg/day in 2017, respectively).[38,39] Various factors, such as population growth (particularly in urban areas), industrial and technological development, and changes in consumption habits, have led to an increase in MSW generation.

Of waste generated, 46% corresponds to organic waste, 32% could be recovered through material recycling or energy recovery; while the rest is classified as other waste and is likely not recoverable.[40] As with waste generation, this composition represents a national average, and organic waste can range from 29% to 50% depending on the region.[41] A more detailed national waste composition by type of waste is depicted in Figure 5.

Figure 5: Mexico's waste composition

Source: Adapted from SEMARNAT. (2020). Diagnóstico Básico para la Gestión Integral de los Residuos. Ciudad de México.



35 Waste generation is calculated based on total waste collected in 2023 and the national collection coverage of 84%. INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023. SEMARNAT. (2020). DBGIR. Ciudad de México.

36 State of Mexico, Hidalgo, Morelos, Puebla, Tlaxcala and Mexico City.

37 Baja California, Baja California Sur, Sinaloa and Sonora

38 Waste generation per capita is calculated based on a 2022 population of 130.1 million. CONAPO. (2022). La situación demográfica de México, Año 4, núm. 4. https://www.gob.mx/cms/uploads/attachment/file/895798/SDM_Parte1_2022.pdf

39 SEMARNAT. (2020). DBGIR. Ciudad de México. https://www.gob.mx/cms/uploads/attachment/file/554385/DBGIR-15-mayo-2020.pdf

40 SEMARNAT. (2020). DBGIR. Ciudad de México.

41 Calculated by SIPRA with information from INECC. (2022). Atlas Nacional de Residuos Sólidos Urbanos. Ciudad de México.

Collection

According to the DBGIR, 84% of waste generated in 2017 was collected, while the rest was burned or disposed of in streets, vacant lots, and rivers.[42] Waste collection has grown from 2017 to 2022 by 8% (100,751 metric tons per day in 2017 to 108,146 metric tons per day in 2022). According to the 2023 National Census, nearly 94% of 2,475 municipalities[43] have waste collection services. This collection is carried out on a weekly basis by service providers, of which approximately 90% are from the public sector, eight percent from the private sector, and two percent from the civil society sector.[44]

In Mexico, there are three main collection methods: door-to-door, community bins, and large-scale community collection (67%, 25%, and 8% of waste collected, respectively);[45] in 2022, only 14% of waste was collected in a segregated manner. Segregated collection is generally done through differentiated collection days, routes, and/or specialized vehicles. By further encouraging door-to-door collection and improving route design, segregated collection could be encouraged. Waste collection is conducted using over 17,000 vehicles of which 54% are 12 years or older.[46] In addition, 73% of vehicles run on diesel. The age of the MSW vehicle fleet and fuel used contribute to costly and inefficient collection and transportation and to increased GHG emissions. In fact, in Mexican municipalities, collection and transportation of waste represents about 78% of integrated waste management system costs.[47]

Waste Transfer

After MSW is collected, it is transported to different destinations, including recycling centers[48] and final disposal sites. To streamline this operation, transfer stations are employed in some parts of the country.

Collection vehicles unload their waste at transfer stations and vehicles with greater capacities (up to 30 tons) transport it for treatment or final disposal. However, transfer stations are not well utilized in Mexico, and over 90% of collected waste goes to final disposal without passing through a transfer station.[49] The lack of transfer stations in large urban areas make collection more expensive and inefficient, as smaller trucks make frequent – and often long – trips to disposal sites.

In 2022, there were 132 transfer stations in Mexico of which 43 conducted segregation activities.[50] Generally, transfer stations are improperly operated in Mexico; most of these facilities are not designed for materials recovery, however, waste often remains there for more than 24 hours due to waste picking activities and thus generates environmental problems as MSW accumulates.

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42 SEMARNAT. (2020). Diagnóstico Básico para la Gestión Integral de los Residuos. Ciudad de México.

43 For analysis purposes, in these sections “municipalities” also includes Mexico City’s sixteen alcaldías.

44 INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023.

45 Door-to-door collection occurs at household level with established schedules, routes, and collection frequencies. Community bins are typically placed at street corners for citizens to dispose their waste. Large scale community collection involves large containers, usually for bulk generators.

46 INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023.

47 SEMARNAT. (2020). Diagnóstico Básico para la Gestión Integral de los Residuos. Ciudad de México.

48 Recycling centers are facilities where recyclable or usable MSW or special handling waste that has been previously separated at the source or during the waste stream may be collected, treated, and temporarily stored. SEMARNAT. (2020). Diagnóstico Básico para la Gestión Integral de los Residuos. Ciudad de México.

49 INECC. (2022). Atlas Nacional de Residuos Sólidos Urbanos. Ciudad de México. https://www.gob.mx/cms/uploads/attachment/file/693803/125_2022_Atlas_Nacional_Residuos_Solidos.pdf

50 INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023.

Recycling Centers

Among the waste materials that have a market for recycling in Mexico, the most important are paper, cardboard, glass, certain metals, and plastic, primarily polyethylene terephthalate. Mexico has two types of collection centers for recyclables– one where individual waste generators drop off their recyclables and the other where larger amounts of recyclable materials are disposed from collection services. In some cases, there is a weight-based payment scheme at these facilities. In 2022, Mexico had 874 recycling centers and received 32 metric tons of recyclables a day, a significant decrease in volume from 56 metric tons per day in 2020.[51,52] The most common materials received by recycling centers include paper and cardboard, plastics, and glass.

Treatment

Waste treatment plants, dedicated to the valorization of waste, are limited in Mexico with only 48 facilities with the capacity to separate, grind, compact, compost, or digest waste in 2022. These facilities recovered approx. 2,400 metric tons per day, more than a third of which was organic.[53] Of the 48 treatment facilities in Mexico, 16 performed composting activities.

The 2021 National Census states that 19 of the 50 treatment plants are compost plants, 7 of which were in Mexico City and recovered 223 metric tons of organic waste per day.[54] According to the Secretariat of the Environment of Mexico City, in 2021, the city had 8 compost facilities which received approximately 1,260 metric tons of organic waste per day and produced roughly 250 metric tons of compost each day.[55] Although the volume of treated waste is similar, the number of facilities and the organic waste recovered for each is different between sources. Further inconsistencies with the 2023 census, which doesn't report organic waste recovery for Mexico City, highlight the need for coordination between governments and institutions for improved data.

According to data from the Commission for Environmental Cooperation, about 7% of the organic MSW generated in the country is composted or treated via anaerobic digestion.[56] Based on this, there is a tremendous opportunity in Mexico to increase organic waste valorization and reduce methane emissions from the sector.

There are few anaerobic digester facilities for MSW in Mexico; both the National MSW Atlas and the 2021 National Census report one facility; however, one is located in Mexico City while the other is in the State of Mexico. In addition, the 2020 DBGIR reports five AD facilities, and other independent sources report two additional digesters. Further understanding of operating AD facilities is needed to estimate realized benefits and growth potential for this technology. Known facilities described below:

- Mexico City: processing 3 ton per day of *nopal* (cactus) waste;[57]
- Atlacomulco, State of Mexico: processing 30 metric tons per day from special waste generators such as restaurants, markets, and others;[58]
- Mérida, Yucatan: a wet process system with a 250 metric ton per day capacity;[59] and,
- Linares, Nuevo León: a private plant utilizing extra-dry (garage) technology, with a 60 metric ton per day capacity and installed capacity of 633 kW.[60]

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51 INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023.

52 INEGI. (2022). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2021.

53 INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023.

54 INEGI. (2022). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2021.

55 Secretaría del Medio Amiente de la Ciudad de México. (2022). Inventario de Residuos Sólidos de la Ciudad de México 2021. https://www.sedema.cdmx.gob.mx/storage/app/media/DGCPCA/residuos/InventariodeResiduosSolidos2021.pdf

56 Commission for Environmental Cooperation. (2017). Caracterización y gestión de los residuos orgánicos en América del Norte, informe sintético. http://www.cec.org/files/documents/publications/11770-characterizationand- management-organic-waste-in-north-america-white-paper-es.pdf

57 SEMARNAT. (2020). Diagnóstico Básico para la Gestión Integral de los Residuos. Ciudad de México.

58 SEMARNAT. (2020). Diagnóstico Básico para la Gestión Integral de los Residuos. Ciudad de México.

59 Programa EnRes Aprovechamiento Energético de Residuos Urbanos. (2018). Proyectos de Aprovechamiento Energético a partir de Residuos. México: GIZ. https://www.giz.de/en/downloads/giz2019-ES-EnRes-Proyectos-de- Aprovechamiento.pdf

60 Tamez, R. (2023). Producción de CDR mediante biosecado y generación de biogás a partir de los residuos sólidos urbanos. Presentation at ECOMONDO, Guadalajara, Mexico.

Final Disposal of MSW

In 2022 Mexico had 2,250 final disposal sites, which received around 35 million metric tons of waste (e.g., after recyclable and other wastes are sent for treatment, co-processing, etc.).[61,62] Although, historically, various efforts from different levels of government and institutions have led to the construction of infrastructure for the proper disposal of MSW in Mexico, there are less than 100 sanitary landfills with capacity to use landfill gas.[63] Additional disposal sites that were designed and built as sanitary landfills, after a period of operation, have become controlled disposal sites[64] or, more frequently, open dumps.[65]

Furthermore, the number of controlled landfills in the country is small as most disposal sites are unable to meet infrastructure and operational needs. For example, in 2022, only 36% of final disposal sites had waterproof covers, 15% had leachate treatment systems, and less than 3% had landfill gas capture systems.[66] As such, most disposal sites in Mexico can be classified as open dumps, causing significant impacts to human health, environmental pollution, and climate change.

Methane emissions at landfills can be mitigated, among other best practices, by capture and flaring or energy recovery of landfill gas. In Mexico, final disposal sites implementing these best practices are minimal with only 54 sites conducting flaring and 7 utilizing gas for energy.[67] It is worth noting that energy recovery projects may be underreported or have ended as the INEGI 2023 data and the most recent BUR do not coincide. This further highlights the need for an integrated data system.

Financial sustainability of waste management

Waste management costs are mostly covered through general municipal funds and limited options exist for funding new infrastructure. Financial support for municipal waste management and infrastructure can often be provided by states and the national government through initiatives such as PRORESOL, mentioned in Section 3. However, the waste sector in Mexico is generally underfinanced resulting in impacts on the service provided and the neglect of assets.

According to the World Bank, solid waste management represents about 10% to 20% of municipal budgets in middle-income and low-income countries respectively or can be much higher in certain cases.[68,69] For example, in Tijuana, MSW management represents about 13% of expenditure of the municipality.[70]

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61 INEGI. (2022). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2021.

62 Calculated based on total waste collected and source separated waste sent to treatment, donations, transfer stations, etc. INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023.

63 SEMARNAT & INECC. (2022). *México: Tercer Informe Bienal de Actualización ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático.*

64 Inadequate final disposal sites that partially meet the specifications of a sanitary landfill per NOM-083-SEMARNAT- 2003.

65 Inadequate final disposal sites that do not meet the requirements established in NOM-083-SEMARNAT-2003.

66 INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023.

67 INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023.

68 Kaza, S., Yao, L. C., Bhada-Tata, P., & Van Woerden, F. (2018). What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Washington, DC: World Bank. doi:10.1596/978-1-4648-1329-0

69 Even though, Mexico is considered as an upper middle-income country, in terms of waste management it has similarities to middle income countries.

70 Dirección de Servicios Públicos Municipales de Tijuana. (2019). *Diagnóstico del actual sistema de residuos sólidos urbanos (RSU) en Tijuana* [Unpublished Manuscript]. Tijuana, México.

In 2020, waste collection and final disposal cost the Mexican government, on average, $26 and $7 USD[71] per metric ton of waste, respectively.[72] Costs greatly differ within municipalities as reported costs range from $3 to $160 USD per metric ton collected. As such, municipal level understanding of costs is necessary to adequately budget for MSW management activities, but less than 10% of municipalities have reported this data through state, municipal, and intermunicipal plans.[73]

Municipalities may establish tariff systems to charge for waste management. For example, Torreón, Puebla, and Mérida have tariff systems that charge residents for the costs of cleaning, collection, transfer, treatment, and final disposal of waste.[74] In addition, some municipalities also charge fines for noncompliance, littering, burning waste, transporting waste without adequate cover, illegal dumping, and not having adequate temporary waste storage. In general, the fees are insufficient to adequately fund MSW management activities as they do not consider the actual costs of waste management nor subsidies provided to lower-income areas and older populations (see Table 3).

Challenges and Opportunities to Mitigate Waste Methane

Throughout the waste management chain, infrastructure in Mexico requires substantial improvement. While collection rates appear to be high, there is little source segregated collection that would enable proper treatment of organic waste. This is, in part, due to several factors listed below:

- lack of national and subnational regulations, policies, and programs requiring segregated collection. In most cases, segregated collection if included, is voluntary;
- limited public education related to waste management and outreach to stakeholders; and
- insufficient state-of-the-art infrastructure and final disposal capacity for the different waste streams.

Table 3: Waste fees compared to estimated costs of waste management in Mexico

Municipality	Fee (USD/month)	Fee (USD/ton)	Collection and final disposal cost (USD/ton)	Deficit (USD/ton)
Torreón	3.03	31.51	62.2	-30.69
Puebla	3.28	34.14		-28.06
Mérida (middle income residential)	2.45	25.55		-36.65

Source: GIZ. (2017). Análisis de instrumentos de política pública para estimular la valorización energética de residuos urbanos en México propuestas para mejorarlos o ampliarlos

[71] May 27, 2024 conversion $1 USD = $16.66 MXN

[72] Final disposal costs are underestimated as they do not consider rent for the site nor depreciation of assets.

[73] SEMARNAT. (2020). DBGIR. Ciudad de México.

[74] GIZ. (2017). Análisis de instrumentos de política pública para estimular la valorización energética de residuos urbanos en México y propuestas para mejorarlos o ampliarlos

Likewise, as described previously, most final disposal sites in Mexico do not meet requirements to qualify as controlled or sanitary landfills increasing health and environmental risks. Furthermore, there is a substantial infrastructure need for landfill gas capture and use (or flaring). Challenges faced for proper landfill operation and infrastructure include:

- insufficient funding;
- poor operating practices potentially due to a lack of training for onsite staff;
- lack of enforcement of standards and regulations; and,
- capacity constraints due to additional waste from non-municipal sources being sent to municipal final disposal sites.

As disposal sites reach the end of their lifetimes throughout the country, it is imperative that waste is adequately segregated and treated in order to reduce volumes sent to landfill. However, there are currently insufficient organic waste treatment facilities, as well as guidance for their operation and commercialization of products.

Many of the challenges faced by the waste management system are dependent on data availability and quality, legal requirements and regulatory frameworks, financing, and technical capacity. The recommendations in the sections below will help strengthen the entire system. The information presented in this section is based on a review of public and academic literature, meetings with different national entities, and a waste clinic hosted by CATF in Mexico City in November 2023 with representatives of 12 municipalities, national government, and other stakeholders. For more information on the waste clinic and the challenges identified by the participants, please see Box 2.

Box 2: Identifying Challenges in Mexicos's Waste Management Sector with Municipal Stakeholders

What Is a Waste Clinic?

A Waste Clinic is an expert (**the doctors**) and peer assisted group session that focuses on discussing and identifying solutions to municipal solid waste challenges faced by local governments (**the patients**) by drawing on perspectives and knowledge of peers and experts. The waste clinic focused on three topics: (1) waste sector data, (2) source separation, collection, and organics treatment, and (3) final waste disposal (additional information on the Waste Clinic process can be found here).

In November 2023, CATF convened 12 municipalities and national government representatives in Mexico City to discuss waste management and methane mitigation. Challenges identified by the municipalities include:

Waste Sector Data

1. Process/Reporting
    a. Difficulty using and sharing information as a unified data system does not exist.
    b. Lack of expertise and standardization for data collection and reporting.
    c. Lack of coordination between areas to use landfill data for GHG emission estimates.
2. Data and Quality
    a. No or outdated waste characterizations.
    b. Incomplete sectoral data as little or no information is available on informal sector and dumpsites.
    c. Some municipalities do not have scales for deposited waste at landfills.
    d. Lack of disaggregated data (e.g., municipal and special handling waste, organic and inorganic) does not allow for adequate project design and implementation.

e. Generally, data is reported by a third party.
f. Lack of transparency and data traceability.

Source Separation, Collection, and Organic Treatment

1. Source Separation and Collection
    a. Capacity constraints for collection given growing population, tourism and/or migration.
    b. Little or no infrastructure for segregated waste collection.
    c. Lack of waste separation campaigns and clear guidance.
    d. Contaminated waste streams.
    e. Separation is primarily conducted by the informal sector.
2. Organic Waste Treatment
    a. Lack of communication on waste projects and their benefits
    b. Inexistent or small compost market.
    c. Some contracts require all municipal waste be sent to landfill disincentivizing organic waste treatment projects.
    d. Anaerobic digestion projects cancelled or on-hold due to political, regulatory, and financial barriers.

Final Disposal

1. Capacity, Lifetime and Location
    a. Limited land available for final disposal sites.
    b. Landfills nearing the end of their lifetime.
    c. Capacity constraints for disposal given mixed waste streams and growing generation.
    d. Land tenure.
    e. Some final disposal sites are located in ecologically relevant areas.
2. Operation
    a. Uncontrolled access to final disposal sites.
    b. Hazardous waste at final disposal sites.
    c. Environmental impacts due to leachate.
    d. Fires due to poor operation of the final disposal sites.
    e. Potential human rights concerns due to poor operation and informal sector conditions.

Other

1. Limited political will for waste projects.
2. Municipal funds are prioritized for other tasks (e.g., water and sanitation, electricity availability) over waste management activities.
3. Lack of tariff collection limits available fund for implementation of appropriate waste management.

Emissions Visibility – Detection, Quantification, and Repair

Methane emissions from solid waste are estimated by countries via bottom-up inventories; therefore, it is fundamental to have granular and high-quality municipal and site-level data. Every two years, INEGI conducts a census that surveys waste management at the municipal level, which is used to inform national reports. Unfortunately, national reports are often published using outdated census data because of a lack of planning and coordination between government agencies, leading to inconsistent reporting between official documents. For example, the Urban Solid Waste National Atlas, published in early 2022, uses 2019 census data rather than 2021 census data as the latter was published later in the year.

Furthermore, the quality of the data is also subject to uncertainty, as most municipalities use outdated information; lack site-specific waste characterizations; do not have scales to record amounts of waste (i.e., per INEGI 2021, only 169 have scales); rely on third party operators for data; and do not have reporting and data management systems.

Remote sensing observations and ground-based measurements can help estimate methane emissions from final disposal sites and can be used as tools for leak detection and repair. However, getting access to remote sensing can currently be expensive, and local measurement efforts require human resource availability, technical expertise, and/or partnerships with research institutions. As technologies evolve and additional open-access data from sources, such as MethaneSAT, SRON and Carbon Mapper, become available, municipal, state, and national governments will be able to use these tools to evaluate facility-level emission estimates, inform waste management practices, and validate national emission inventories.[75]

To improve data, streamline sources and provide one comprehensive view of the sector and its emissions, the following are recommended:

- Municipalities should require that necessary equipment for the weighing of waste at transfer stations, treatment facilities and disposal sites be installed. Municipalities should periodically conduct monitoring and verification activities on waste volumes disposed.
- Improvements to facilitate the regular reporting of detailed waste sector data and emissions are necessary. SEMARNAT and INEGI should facilitate the development and use of a data platform for municipalities and disposal site operators to share periodic detailed data on waste. This data should be used by INEGI, SEMARNAT and INECC to develop consistent waste census and inventories, respectively. The data reported should be consistent throughout government levels and include details on waste generation, characterization of waste streams, organic waste final disposal, and treatment.
- INEGI, INECC, and SEMARNAT should coordinate in the elaboration of official documents to ensure the most up-to-date data is used and there is consistency throughout national level reporting.
- INECC should collaborate with the National Council for Humanities, Science and Technology, civil society, and academia to incorporate remote sensing observations and ground-based measurements into official inventory processes.

Finance

The waste sector in Mexico is underfunded resulting in numerous challenges in properly managing MSW. Local administrations are unable to obtain the resources needed for management as they: 1) lack reliable data to determine scope and budget of improvement projects, and 2) face a long and complex process for obtaining federal and international funds or credits which can exceed the duration of municipal administrations. Municipal staff are often unaware of external funding bodies or are unable to provide the technical documentation that would support their applications. In addition, federal funds for waste infrastructure have been reduced thus, limiting the ability of municipalities to access them.

[75] The IPCC has developed guidance on using atmospheric inversion results in inventory validation in their 2019 Refinement to the 2006 IPCC Guideline for National GHG Inventories (chapter 6.10.2). Intergovernmental Panel on Climate Change. (2019). Chapter 6: Quality assurance/quality control and verification. In 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas. https://www.ipccnggip.iges.or.jp/public/2019rf/pdf/1_Volume1/19R_V1_Ch06_QA_QC.pdf

Municipalities are responsible for the operational and infrastructure costs of managing MSW. However, most struggle in determining budgets and allocating resources as they lack a comprehensive understanding of expenses (e.g., when available, costs are generally underestimated as they do not consider asset depreciation, disposal site rent, etc.) and must balance a limited budget with other municipality needs.[76] One tool for raising revenues to pay waste management costs is to implement or raise fees (e.g., pay as you throw or flat rate fees) on waste generators. In Mexico, there are few examples of tariffs, and those that exist are insufficient to fully fund municipal waste management.

Finally, financing for organic waste treatment or landfill gas to energy projects is particularly limited as funding for other MSW management activities are prioritized due to their visibility or health and safety considerations. Although economic incentives may be obtained on a project basis through government and international incentives, these are generally focused on capital rather than operating costs. To support long-term sustainability of these projects both a competitive market for products (e.g., compost, biomethane, and electricity) and municipal funds are necessary. However, an enabling regulatory and political environment for by-product commercialization is currently lacking.

To facilitate access to federal and international funds for capital expenses for infrastructure, the following are recommended:

- Municipalities should incorporate cost analyses to better understand expenses, and the development of technical studies to scope improvements in their PMPGIRSU. These analyses should be updated on a routine basis to assist with applications for federal and international financing.
- Federal authorities, including SEMARNAT and the Secretariat of Treasury and Public Credit, should encourage municipalities to establish a fee system in which recuperated funds are reinvested in waste management. In addition, federal authorities must provide a mandatory methodology for fee determination that requires up-to-date and comprehensive municipal-level cost estimates including segregated collection, organic waste treatment and landfill gas capture.[77]
- SEMARNAT should identify and publicize on a regular basis international funding available (e.g., InterAmerican Development Bank, Climate and Clean Air Coalition, and Global Methane Initiative) and coordinate with state and municipal governments to access funding and monitor projects.
- FONADIN, BANOBRAS, and other relevant entities should improve outreach on available federal funds and provide guidance to municipalities throughout the application process.
- Lastly, we recommend that all financing processes and determination of costs are done in a transparent way to ensure tenders and concessions granting is competitive.

Enabling Policy and Regulatory Framework

Mexico's regulatory and policy framework for the solid waste sector is insufficient for adequate management of MSW and mitigation of waste methane emissions. Specifically, the existing framework does not require organic waste diversion or treatment; adequately incentivize landfill gas capture and use; nor does it include an environmental justice perspective in which the work of the informal sector is recognized and protected. In addition, some regulatory instruments are outdated, and other instruments have become obsolete as new administrations change relevant waste policies and programs. This lack of continuity, especially at the municipal level with government transitions every three years, contributes to making long-term projects, like those needed for methane mitigation in the sector, very difficult to implement.

Although the existing framework could provide a strong foundation for MSW management; in practice, there is a lack of compliance and enforcement throughout the management chain. This is particularly true at the municipal level, where staff lack the expertise, tools, and resources to properly develop and implement their PMPGIRSU. Furthermore, a lack of surveillance and enforcement at disposal sites has contributed to the deterioration of landfills and an increase in health and environmental risks, as well as GHG emissions.

[76] SEMARNAT. (2020). DBGIR. Ciudad de México.

[77] This recommendation is aligned with PGIR 2022-2024 specific action 4.3.1 that calls on tariff guidance for municipalities.

Mexico was the second country in the world to establish a regulatory framework for climate change in 2012 and is one of the few countries that has a specific target for waste methane mitigation;[78] however, the framework for waste methane is incomplete and lacks enforcement. For example, there are no follow-on regulations to the LGCC which would result in systemic change in all municipalities, but rather waste sector goals are set through the NDC which are met via projects in specific sites. Furthermore, there is a lack of coordination between regulatory instruments which hinders synergies between LGCC compliance and waste management best practices.

The following key recommendations would help strengthen Mexico's legal framework:

- Congress should strengthen LGPGIR and its follow-on regulations to require waste diversion and/or ban organic waste being sent to landfill and require the development of complementary regulations on organic waste treatment.
- SEMARNAT should update technical regulations and standards to incorporate the most up-to-date technologies and practices for waste management and establish a roadmap towards achieving sectoral GHG targets to be considered in the development of PMPGIRSU and state programs. SEMARNAT should also issue and/or update guidance for municipalities on best practices for the sector.
- Policy instruments developed at all levels must exceed administration periods and have a longterm vision. A waste governance body, established at the national level, could help to ensure policy implementation and longevity of programs.
- Federal agencies should create policies and market incentives, which result in a competitive price for products. Additionally, SEMARNAT and the Secretariat of Energy should publish regulations and policies to facilitate energy use from landfill gas and anaerobic digesters.

Stakeholder Awareness and Capacity Strengthening

Government transitions at all levels, but especially at the municipal level where elections occur every three years, result in staff turnover and loss of expertise. Municipalities with limited resources are not able to provide trainings and resources for staff. In some cases, knowledge may be spread throughout different areas of the government (e.g., public services and sustainability) that do not coordinate with each other. Although INECC provides a course on waste sector emission inventory development for municipal and state officials, accessibility and ongoing availability of tools can be improved.[79]

In addition, there is a lack of public awareness and education on the waste sector and its impacts on climate change. Public awareness of the importance of source separation and waste diversion initiatives is lacking. This contributes to minimal waste prevention and separation, ultimately hindering the implementation of policies and projects aimed to increase waste recovery and reduce emissions.

Furthermore, communities living in near proximity to transfer stations and final disposal sites, as well as the waste sector workers (informal and formal) are key stakeholders which are more likely to experience the impacts from improper waste management.

Priority recommendations that the Government of Mexico can take to improve capacity and understanding to develop and implement waste sector methane solutions include:

- Municipalities should identify staff needs and capacity strengthening requirements to include in PMPGIRSU and ensure MSW management is supported throughout the administration.
- Municipalities and state governments should consult local communities and waste sector workers in the planning and development of waste management projects.
- SEMARNAT and INECC should provide specific trainings to municipal government staff, waste sector workers, and local communities on best practices for MSW management and methane mitigation to support local action.
- SEMARNAT should conduct communication campaigns on the importance of waste prevention, source separation, and other steps waste generators can take to minimize their impact on the sector; particular focus should be provided at schools of all levels.

[78] IDLO. (n.d.). A LEGAL WORKING BRIEF ON THE NEW GENERAL LAW ON CLIMATE CHANGE IN MEXICO Leading National Action to Transition to a Green Economy. https://www.files.ethz.ch/isn/144159/MexicoClimateChangeLWB.pdf

[79] INECC. (2023). Inscríbete al curso en línea ´Sector Residuos para la Elaboración de Inventarios de Gases de Efecto Invernadero (GEI)´ https://www.gob.mx/inecc/articulos/inscribete-al-curso-en-linea-sector-residuos-para-laelaboracion- de-inventarios-de-gases-de-efecto-invernadero-gei-332694?idiom=es

SECTION 6

Conclusions

Given Mexico's size, population, number of municipalities, and increasing waste generation, waste management in the country is and will continue to be a complex task for all involved. Despite having laws, rules, and programs for waste management, financial programs for waste infrastructure, and sectoral targets for GHG mitigation, existing efforts to manage organic waste and mitigate methane emissions from the sector are insufficient. Waste management in the country has prioritized collection and cleaning services and neglected adequate treatment and infrastructure for methane mitigation at final disposal sites.

Mexico's waste sector, which emits approximately 29% of national methane emissions,[80] needs changes for the adequate management of waste and the mitigation of emissions. By improving integrated solid waste management governance and addressing challenges in data quality and availability; source separation; waste treatment; and overall financing needs, the country will be in a better position to meet its climate targets for the sector and its national GHG emissions targets.

[80] INECC. (2021). INEGYCEI. 1990-2019.

ANNEX 1

Waste Information Systems

Table A 1: Comparison of MSW Data From Different Official Sources

Item	DBGIR, SEMARNAT (2020)	National MSW Atlas, INECC (2022)[a]	National Census 2021, INEGI (2022)	National Census 2023, INEGI (2024)
Year reported		2021	2020	2022
MSW generation (Metric ton/day)	120,128	124,122	N/A	N/A
MSW generation per capita (kg/person/day)	0.94	0.85	N/A	N/A
Collected MSW (Metric ton/day)	100,751	285,346	106,523	108,147
Source separated MSW (Metric ton/day)	5.281	N/A	14.385	14,679
MSW received at transfer stations (Metric ton/day)	N/A	9,600	10.275[b]	11,752[b]
MSW sent to treatment facilities (Metric ton/day)	8.944	1,889	5,433	5,661
MSW received at recycling centers (Metric ton/day)	38	13	56	32
MSW sent to final Disposal (Metric ton/day)	86,353	102,546	N/A	N/A
Number of collection Vehicles	16,615	16,679	16,927	17,593
Number of transfer stations	127	102[c]	104	132
Number of treatment facilities	47	39	50	48
Number of recycling centers	173[d]	501[e]	447[f]	874
Number of Total Final Disposal Sites	2,203	2,215	2,338	2,250

Item	DBGIR, SEMARNAT (2020)	National MSW Atlas, INECC (2022)[a]	National Census 2021, INEGI (2022)	National Census 2023, INEGI (2024)
Notes	Data reported in the DBGIR 2020 is based on the 2017 Census by INEGI.	Data reported in the 2022 Solid Waste National Atlas is based on the 2021 Census by INEGI, the 2020 DBGIR, as well as state and municipal waste management plans. The 2022 Solid Waste National Atlas reports all information by state and has been aggregated to a national level for this table.		

N/A = Not Available.

[a] National data for the National MSW Atlas was calculated by SIPRA from individual state information.

[b] Source separated waste sent to transfer station.

[c] Information about the amount of MSW received is provided for 65 transfer stations.

[d] 1050 recycling centers reported in 2017 Census of which 423 centers in Mexico City and 464 centers in San Luis Potosí were containers.

[e] Information on type of waste received is provided for 75 recycling centers.

[f] Accounts for 400 batteries collection containers in Mexico City.

Sources:

SEMARNAT. (2020). Diagnóstico Básico para la Gestión Integral de los Residuos. Ciudad de México.

INECC. (2022). Atlas Nacional de Residuos Sólidos Urbanos. Ciudad de México.
https://www.gob.mx/cms/uploads/attachment file/693803/125_2022_Atlas_Nacional_Residuos_Solidos.pdf

INEGI. (2024). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2023.
https://www.inegi.org mx/programas/cngmd/2023/#tabulados.I

INEGI. (2022). Censo Nacional de Gobiernos Municipales y Demarcaciones Territoriales de la Ciudad de México 2021.
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