SOLID WASTE MANAGEMENT SECTOR IN PAKISTAN

A REFORM ROAD MAP FOR POLICY MAKERS

MARCH 2022

ASIAN DEVELOPMENT BANK

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ISBN 978-92-9269-396-1 (print), 978-92-9269-397-8 (electronic); 978-92-9269-398-5 (ebook)
Publication Stock No. TCS220086-2
DOI: http://dx.doi.org/10.22617/TCS220086-2

Notes:
This publication is based on a report prepared in October 2021 by ADB consultants Melanie Hobson (Monitoring, Reporting, and Verification Specialist) and Nasir Javed (Urban Sector Specialist) for the TA 9720–REG: Supporting the Implementation of Climate Change Operational Framework 2017–2030 – Establishing Mechanisms to Measure, Monitor and Report on Commitments Made under the Paris Agreement (Subproject 3).

In this publication, "$" refers to United States dollars.

Cover design by Ross Locsin Laccay

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Foreword

Climate change is a major development barrier that needs to be addressed by every nation in the world. One of the seven operational priorities of the Asian Development Bank's (ADB) Strategy 2030 is tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability. Its Climate Change Operational Framework 2017–2030 identified mainstreaming climate considerations into corporate strategies and policies, sector and thematic operational plans, country programming, and project design, implementation, monitoring, and evaluation of climate change considerations as the foremost institutional measure to deliver its commitments under Strategy 2030. Responding to the call to intensify climate efforts in the face of worrying trends, in October 2021 ADB elevated its ambition to deliver climate financing to developing member countries (DMCs) to $100 billion from 2019–2030.

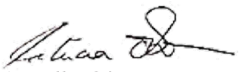
ADB commends the Government of Pakistan for recognizing the urgency of the climate crisis, raising their climate ambitions, and updating their Nationally Determined Contributions (NDCs). To work toward full implementation of its climate commitments, Pakistan aims to advance its climate change planning, policy, strategy, and legislation, and enhance its measurement, reporting and verification, and transparency of climate action.By accelerating the transition to more sustainable, low-carbon, and climate-resilient development, their enhanced target from the updated NDC of reducing projected emissions by 50% in 2030 can be within reach.

Through the NDC Advance technical assistance platform, ADB provided support to the Pakistan Ministry of Climate Change as they worked toward their updated NDCs. By supporting DMCs in planning and implementing their NDCs, mobilizing finance from a variety of sources, and monitoring and tracking climate actions and financial flows, NDC Advance helps keep ADB and its DMCs on track to achieve their climate commitments.

Pakistan's updated NDCs highlight critical sectors such as waste, which contributed around 22 metric tons of carbon dioxide equivalent in 2018. Greenhouse gas (GHG) emissions from the sector are expected to increase due to social and economic pressures. Thus, the necessity for a waste sector management road map aligned with the country's increased ambitions for reducing emissions.

This national guide is intended for policy makers as well as project developers and development professionals to facilitate policy dialogues and action planning by providing an analysis of the country's waste management systems, the steps to develop the road map including methods used in estimating GHG emissions, capacity and institutional development, and recommendations for financing the road map.

ADB looks forward to further collaboration with the Government of Pakistan in advancing sustainable, low-emissions development strategies and solutions, as we rise to the challenge of addressing the climate crisis.



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Acknowledgments

This knowledge product was developed by the Asian Development Bank (ADB) within its Sustainable Development and Climate Change Department (SDCC) in close coordination with the Government of Pakistan through the Ministry of Climate Change.

This road map was written by Nasir Javed and Melanie Hobson (Consultants, ADB). Technical guidance was provided by Esmyra Javier (Senior Climate Change Officer, ADB), Muhammad Irfan Tariq (Director General, Pakistan Ministry of Climate Change), and Syeda Hadika Jamshaid (Climate Change Specialist, Pakistan Ministry of Climate Change). It hugely benefited from peer review conducted by Stephen Peters (Senior Energy Specialist, ADB), Sing Cho (Senior Urban Development Specialist, ADB), Nathan Rive (Senior Climate Change Officer, ADB), and Mian Shafi (Senior Project Officer, ADB).

The publication of this report was made possible by the valuable coordination and administrative support of Janet Arlene Amponin, Zarah Zafra, Anna Liza Cinco, Ken Edward Concepcion, and Fernando Antolin Jr. The overall support from the Pakistan Resident Mission in the development of this publication is also recognized and appreciated.

Abbreviations

ADB	Asian Development Bank
BRT	bus rapid transit
BTU/lb	British thermal units per pound
EPR	extended producer responsibility
GHG	greenhouse gas
ISWM	integrated solid waste management
KPI	key performance indicator
MOCC	Ministry of Climate Change
MOU	memorandum of understanding
MSW	municipal solid waste
$MTCO_2e$	metric tons of carbon dioxide equivalent
NDC	Nationally Determined Contribution
NGO	nongovernment organization
RDF	refuse-derived fuel
SWM	solid waste management
WAC	waste analysis and characterization
WMC	waste management company
WTE	waste to energy
WEEE	waste electrical and electronic equipment

Executive Summary

Pakistan is a signatory to the Paris Agreement and, in its Nationally Determined Contribution (NDC), has committed to reducing 20% of its greenhouse gas (GHG) emissions by 2030, subject to the availability of funds. (This emission reduction target, and not the higher target of 50% in the October 2021 Updated NDC, is primarily referred to in this road map, which was developed as an input to the 2021 updating). Current estimates of GHG emissions from the waste sector are unreliable, and no mitigation measures are planned. Both of these concerns must be dealt with, and a plan put in place for that purpose.

This road map is intended to support Pakistan in developing an action plan for its solid waste management sector and to improve and expand waste collection and disposal services. The action plan covers municipal, industrial, electronic, and hospital waste. Carrying it out will boost the health of the population, reduce the pollution of land and water sources, make it easier to quantify GHG emissions, and improve visual aesthetics.

The waste hierarchy is a useful framework for prioritizing management options, with waste prevention being the most desirable, followed by reuse, recycling, recovery, and lastly disposal. Like other countries, Pakistan will probably need legislation, economic instruments, and new infrastructure to move up the waste hierarchy, and will have to identify sources of funding for these needs. But the environmental and health costs of not making the required fundamental changes far exceed the cost of developing and operating simple yet adequate waste management systems.

Key considerations in setting up a waste management system are outlined in this road map. These include ensuring basic levels of waste collection and disposal services—full collection coverage in urban areas, (at least) substantial coverage in rural areas, and sound environmental practices at disposal sites. Once waste is collected, data on the amounts of waste generated and its composition will have to be gathered. The data can feed into the waste management strategy and allow GHG inventory compilers to calculate historical emissions from the waste sector and to make projections.

Initial waste characterization estimates for Pakistan, provided in this road map, show that green kitchen waste often makes up the majority of household waste, with paper and plastic also having a sizable share. In addition, other types of waste—from electronics, hospitals, industry, agriculture, vehicle tires, and other sources—are significant. Waste management options for these sources are considered here. The options include landfilling or resource recovery and recycling, as well as the extended producer responsibility strategy and financing alternatives. As regards to landfilling, developing regional landfill sites, rather than smaller units for each city, would be advisable for this large country with more than 220 million people, spread out over 880,000 square kilometers.

The steps in developing a waste management action plan are then presented in this road map. These include understanding the waste collection and disposal situation in Pakistan and setting up an institutional framework for an effective waste management system for the country. Responsibilities for enforcing the system are suggested to be allocated to national and local government departments and municipalities. Adequate incentives need to be provided to spur the prompt delivery of appropriate waste management services. Linking finance with key performance indicators, for example, could serve the purpose.

Once a national waste management action plan has been developed, a steering committee could be formed to oversee progress, discuss ways of reducing waste generation, examine reuse options, and increase recycling rates in line with the waste hierarchy.

These actions would help reduce resource use and environmental impact. In addition, more accurate projections of GHG emissions from the waste sector would help the country to put the necessary mitigation measures in place.

1 Introduction

Pakistan generates 30 million metric tons[1] of municipal solid waste[2] (MSW) yearly, according to recent estimates. Moreover, a substantial increase in the coming years is foreseen due to rapid population growth, urbanization, and economic development. Overall, about 50% of this generated waste is collected. But the rate varies by locality, from 80% in larger cities to minimal in most rural areas (Mihai and Grozavu 2019). As for waste disposal, managed landfill sites are almost nonexistent. Urban waste is typically left uncollected or dumped on open ground. Pakistan urgently needs a waste road map for its policy makers, to make progress toward better health for its people, reduce the contamination of land and water sources, quantify greenhouse gas (GHG) emissions more effectively, and improve aesthetics.

GHG emission estimates for the waste sector are found in Pakistan's National Communication (MOCC, Pakistan, 2018), and in the Nationally Determined Contribution (NDC) submitted by the government to the United Nations Framework Convention on Climate Change (UNFCCC) (Government of Pakistan 2016).[3] Pakistan is a signatory to the Paris Agreement and has committed in its NDC to reducing 20% of anticipated GHG emissions in 2030,[4] subject to the availability of international funding to meet the abatement cost. However, the emission estimates for the waste sector are marred by uncertainties and no mitigation actions have been devised. Improving the accuracy of historical and projected GHG emission estimates is a critical need, and so is instituting mitigation actions to reduce emissions from this sector.

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1 Estimates from waste analysis and characterization studies over the past decade in around 15 cities in Pakistan (authors' compilation).

2 Municipal solid waste is mixed waste collected separately from households, including discarded paper and cardboard, glass, metals, plastics, wood, textiles, and packaging, as well as bio-waste, waste electrical and electronic equipment, waste batteries and accumulators, and bulky waste, such as mattresses and furniture. The term is also used for mixed waste and waste collected separately from other sources that is similar in nature and composition to waste from households.

3 The first Pakistan NDC submitted in 2016 was mainly referred to in this road map developed prior to the finalization and submission of the Updated NDC of Pakistan in October 2021. This road map was used as one of the reference materials during the review and updating of the NDC.

4 The Government of Pakistan in its Updated NDC submitted to the UNFCCC in October 2021 has raised the target to 50% reduction in GHG emissions by 2030 from 20%.

2 Objectives of the Road Map

This road map for Pakistan's solid waste management sector covers both the management of waste and assessment of GHG impact.

The road map has the following objectives:

- to reduce the negative impact of waste mismanagement on the environment, economy, and society;
- to minimize waste generation and maximize resource efficiency, across the product life cycle; and
- to promote synergy among local, provincial, and national efforts, plans, and programs in implementing waste management goals and objectives, including the NDC targets and United Nations Sustainable Development Goals (SDGs), among others.

3 Current Waste Management Situation In Pakistan

Municipal Waste

The country's current system of municipal waste management is far from satisfactory. The services are, by and large, provided by municipalities and limited to partial collection and open dumping or burning. A snapshot is provided below to serve as baseline for the development of the road map and a more sustainable system. No reliable national study has been made to determine the overall quantity of waste generated in the country, but estimates drawn from various sources are shown in Table 1.

Table 1: Waste Generation, Treatment, and Disposal Estimates, Pakistan

Settlement Area	Waste Quantity					
	Generated		Collected	Transported	Treated	Disposed of
	Daily (kg per capita per day)			Yearly (million metric tons per year)		(% of waste generated)
Large cities (11)	0.55	9.44	80	80	20	80–100[a]
Medium-sized and small cities[b]	0.42	4.44	50–70	50–70	10	90–100
Rural communities	0.33	13.72	20	20	20	80–100
Total		**27.58**				

kg = kilogram.

Note: Pakistan's large cities had a total population of 52 million in 2017; medium-sized and small cities, 32 million; and rural areas, 126 million. Large cities and most medium-sized and small cities dispose of waste in uncontrolled dumpsites, away from the cities. In rural areas, waste is scattered or burned in the outskirts of villages.

[a] Recovery rates have been reduced following the closure or partial operation of refuse-derived fuel (RDF) plants in Lahore, Multan, and Wah Cantonment, and the composting facility in Lahore.

[b] A few intermediate-sized cities like Bahawalpur and Sialkot are exceptions, with collection rates of more than 80%.

Sources: Batool, Chaudhry, and Majeed (2008); Government of Pakistan (2017); authors' compilation from waste analysis and characterization studies over the past decade, in around 15 cities in Pakistan; assessment of data collected in 2015–2020 from waste management/utility companies in Faisalabad, Gujranwala, Lahore, Multan, Peshawar, and Rawalpindi; and analysis of available data from the cities of Dera Ghazi Khan (2018), Hafizabad (2015), Okara (2015), and Sahiwal (2016–2017).

Waste analysis and characterization studies. Once waste is collected, data on the amounts of waste generated and its composition must be gathered. The data can then feed into the waste management strategy and provide GHG inventory compilers with the information they need to estimate historical and projected emissions from the waste sector. An estimate of the current composition of household waste is provided in Table 2.

Table 2: Estimated Waste Characterization Percentages

Waste Fraction	Abbottabad	Faisalabad	Sahiwal	Lahore	Rawalpindi	Mirpur	Sialkot	Muzaffarabad	Marden	Gujranwala	Peshawar	Islamabad	Kohat	Sahiwal	Mingora	Average
Kitchen green waste	66.74	72.67	34.21	56.32	54.70	62.33	38.14	68.24	62.96	62.50	53.74	59.95	55.82	56.90	49.21	56.96
Paper	11.86	1.59	8.90	3.20	2.40	4.46	12.95	4.95	3.91	15.30	7.32	7.26	8.2	5.219	13.1	7.37
Textile	1.78	3.87	2.21	9.21	6.05	3.05	3.54	2.71	3.71	3.87	2.35	1.81	2.75	3.71	3.53	3.61
Dry grass and wood	1.47	8.38	12.33	6.05	3.66	1.43	3.93	1.32	1.05	1.63	10.29	0.00	0.15	1.70	4.66	3.87
Plastic	9.46	4.16	9.67	10.64	10.51	12.52	10.22	10.22	7.36	7.70	9.34	7.49	12.00	9.54	14.69	9.71
Leather and rubber	1.07	0.08	0.54	1.00	1.20	0.84	3.20	1.09	0.61	0.77	0.63	0.00	0.723	0.88	0.33	0.86
Metal	0.08	0.38	0.58	0.06	0.03	0.31	3.20	0.26	0.20	0.23	0.72	0.68	0.025	0.375	0.46	0.51
Bottle and glass	0.75	0.21	1.96	0.69	0.64	1.03	7.13	1.31	0.87	1.16	2.32	2.79	9.73	0.75	0.74	2.14
Ceramic, stone, and soil, etc.	1.15	7.37	1.59	6.40	11.13	0.59	2.00	0.24	3.09	1.10	12.32	0.00	0.90	2.51	1.30	3.45
Domestic hazardous wastes	0.20	0.05	0.43	1.36	1.49	0.37	5.39	0.47	0.45	0.60	0.00	0.82	0.40	1.03	0.50	0.90
Sieve Remaining>6mm	0.05	0.00	5.39	2.00	0.00	1.61	2.00	0.78	0.00	3.23	0.00	0.00	0.76	3.06	2.86	1.45
Miscellaneous	5.39	1.24	22.25	3.07	8.28	13.47	6.00	8.41	15.79	1.91	0.97	19.20	8.54	14.33	8.62	9.16

mm = millimeter.

Source: Authors' compilation from waste analysis and characterization studies over the past decade in around 15 cities in Pakistan.

Industrial Waste

Industrial waste includes all wastes resulting from construction and demolition, manufacturing, agricultural operations, wholesale trade, mining, and other activities. A distinction should be made between scrap (materials that can be recycled at a profit) and solid wastes (those that are beyond economical reclamation) (Tchobanoglous and Kreith 2002).

Electronic Waste

According to an academic study, waste electrical and electronic equipment (WEEE), or e-waste, generated in Pakistan amounts to 1.68 kilograms per capita per year (Iqbal et al. 2015), or about 2% of the country's municipal waste total.[5] In addition, Pakistan receives a large amount of e-waste in various forms, less than 2% of which can be reused (Hashmi and Varma 2019). The unused material is recycled informally by workers, including women and children, without safety precautions. Although available information about the exposure of workers and impact on the environment is limited, the increasingly significant contribution of e-waste to health and environment concerns cannot be doubted. Formal recycling sites, similar to those in the People's Republic of China (PRC) and India, must be developed in Pakistan to protect laborers and the environment, and health awareness programs should be carried out.

Health-Care Waste

The country generates hospital waste at a rate of about 0.667 kilograms per hospital bed per day, on average (Ali, Wang, and Chaudhry 2016). About 10%–25% of this waste (Hashmi and Varma 2019) is infectious, and hence hazardous. Owing to poor sanitation practices, the hazardous waste is mixed with general waste, potentially worsening the problem of waste management. Proper management of health-care waste is therefore vital for public health and the environment. Hospital waste in Pakistan is regulated by the Hospital Waste Management Rules, 2005 (HWMR), issued by the Ministry of Environment in August 2005 (Ministry of Environment, Pakistan, 2005).

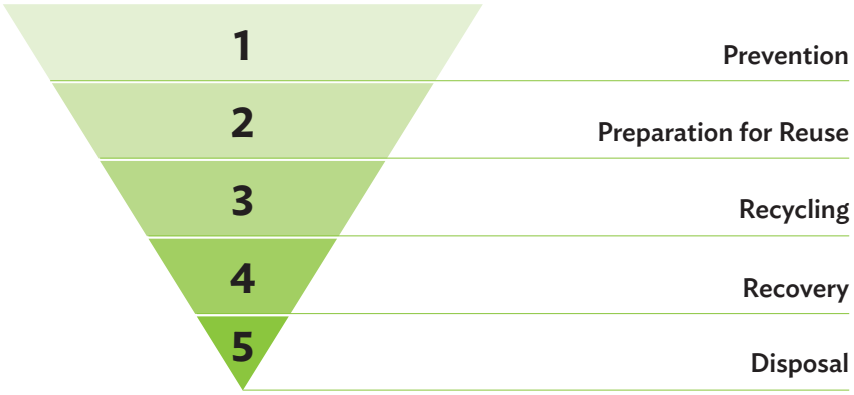
[5] Authors' estimation, considering per capita WEEE and MSW generation rates, and population size.

4 Waste Management Hierarchy

The waste management hierarchy provides an overarching vision for the Pakistan waste sector, to reduce the use of natural resource and impact on the environment. Waste prevention is of the highest priority, followed by reuse, recycling, recovery, and, as a last resort, waste disposal.

The aim is to move to a "circular economy," where the value of products and materials is maintained for as long as possible, and waste and resource use are minimized (European Commission, n.d.[a]). But more than improved waste management, the transition toward a circular economy calls for creativity and innovation in design, reverse logistics, and innovative business models. Three essential ambitions will facilitate this shift: (i) designing products, components, and materials for longer use; (ii) enhancing reverse logistics, remanufacturing, parts harvesting, and recycling processes; and (iii) putting the right enabling conditions in place.

Figure 1: The Waste Hierarchy



Source: European Commission (n.d.[b]).

Without intervention, market conditions in Pakistan are unlikely to support the prioritization of the waste hierarchy outlined in Figure 1 and Table 3. For example, disposing of waste in an open/controlled dumpsite is generally cheaper than recycling waste or recovering energy from it (EEA 2009). The operational components must also be given priority. Investing limited resources in state-of-the-art systems in a few large cities, or providing at least a basic level of service across the board, would achieve this purpose.

Table 3: Waste Hierarchy Definitions

Stage	Includes
Prevention	Using less material in design and manufacture; extending the life of products; using less hazardous materials
Reuse	Checking, cleaning, repairing, refurbishing whole items or spare parts
Recycling	Turning waste into a new product or substance. This includes composting.
Recovery	Including anaerobic digestion; incineration with energy recovery, gasification, and pyrolysis, producing materials and energy from waste; and backfilling
Disposal	Landfilling and incinerating waste without energy recovery

* "Backfilling" refers to any recovery operation where suitable nonhazardous waste is used for reclamation in excavated areas or for landscape engineering.

Source: European Commission (n.d. [b]).

Japan and the European Union (EU) have reached an advanced stage in the development and application of environmental policies in the waste sector, and have had to establish regulations to guide the development of market conditions in support of the new waste policies and make them implementable. These interventions were based on the perceived environmental benefits as well as on the benefits of safeguarding the planet's finite natural resources for future generations. The new sector environment was created through a combination of sophisticated legislation, economic instruments, and regulation. Taken together, these measures have made the disposal of untreated waste expensive or impossible in practice. Gradually, landfilling of untreated waste has been prohibited, while new landfill development has been made difficult (World Bank 2018). Therefore, to shift from untreated disposal to methods higher up in the hierarchy, Pakistan is likely to have to invest time, resources, and effort to put in place appropriate legislation and economic instruments and develop the necessary infrastructure. Large amounts of funding will be needed. For example, the financial cost of recycling and waste-to-energy incineration often exceeds $100 per metric ton, according to World Bank estimates (Kaza et al. 2018). On the other hand, landfilling in a properly engineered landfill site is also not cheap. But the cost of the environmental and health impact currently arising is many times higher than the cost of developing and operating simple, adequate waste management systems.

The lesson here is that for a sustainable waste and resource management system to be implemented at the national level in a country like Pakistan, a gradual or phased approach is required. Efficient management of waste requires applying a waste hierarchy; at the early stage of improving waste management, focus can be on waste collection with environmentally sound disposal practice.

This road map draws on the experience of other countries in developing and setting up waste management systems and outlines the building blocks of a well-functioning system, such as accurate and systematic data collection, a formal institutional framework, effective legislation, efficient operation, and good management.

5 Key Considerations in Developing the Road Map

Various overarching factors must be considered when setting up a waste management system. These factors, outlined below, draw heavily on the World Bank's municipal solid waste (MSW) management road map for policy makers but have been supplemented with useful information relevant to the scenario in Pakistan (World Bank 2018).

Gradual Approach

Enhancing any waste management system requires a gradual approach. Changes should be introduced incrementally, and the sector should be allowed to improve and grow naturally without outsize interventions. Most developed countries have taken decades to reach a stage of sustainable waste and resource management. However, it is highly recommended that Pakistan prioritizes the development of a realistic timeline for implementing its MSW management plan, considering the overall socioeconomic conditions and existing resource base.

Basic Level of Service Provision

The very first and basic objective of any waste management system is to provide professional collection and disposal services to the various constituencies, including at least full collection coverage in urban areas, substantial or full coverage in rural areas, and sound environmental practices at disposal sites. As a rule, investing in more sophisticated infrastructure and technologies should be considered only after the basic level of service provision is available to everyone. Currently, no more than 80% of the waste generated is collected from the points of generation, even in the 11 largest cities. Waste collection in medium-sized and small towns is close to 50%–70%, and in rural areas, it is almost nonexistent. These figures align with internationally reported data (Kaza et al. 2018). As for disposal, most of the generated urban waste is either left uncollected or dumped on open ground.

Comprehensive Approach

A comprehensive approach demands the inclusion of all categories of waste in the waste management road map. Besides common municipal or urban waste, solid waste includes waste from industries, health-care facilities, construction and demolition activities, slaughterhouses, and wastewater treatment facilities.

Optimized Waste Collection

Currently, container placement and collection routes are designed on the basis of guesstimates of nonengineering operational staff of the municipalities, resulting in loss of fuel and an increase in indirect GHG emissions. Waste management companies (WMCs) in Lahore and Rawalpindi have established collection optimization practices to some extent, using an advanced vehicle trip counting system (VTCS), which is quite helpful in resource deployment and optimization. However, a strategy should be developed to encourage other municipalities and WMCs to plan and optimize waste collection and transportation.

Managed Closure of Existing Open Dumps

In the near absence of engineered landfill sites, most of Pakistan's cities have resorted to open dumping, at a designated point or at city-controlled dump sites[6] like those in Islamabad, Karachi, Lahore, Peshawar, and other cities. A short-term plan is needed for the managed closure of these sites, including compacting dumped waste in layers and covering the compacted layers with soil, fencing off the sites, and arranging for the capture and treatment of landfill gas and leachate. Provincial-level projects would have to be carried out by the local government departments.

Landfilling

Landfilling of waste is a well-established and acceptable environment-friendly option, if done properly (at a minimum, with a bottom liner and provisions for leachate collection and treatment, arrangements for the capture and use of landfill gas, and proper daily landfilling operations) and especially when financial circumstances do not favor costlier alternatives. But Pakistan has hardly any engineered landfill sites. Despite the availability of land acquired specifically for such sites, site development was often not undertaken.

Recycling

The recycling of segregated household waste is almost never a profitable activity and at best, cost-neutral. Recyclables are more easily recovered from the commercial, institutional, and industrial (CII) sector and the process is less costly. The government should consider the option of placing the responsibility for the recovery of materials on the producers and importers of such materials, to reduce the financial burden on the public sector.

[6] Landfills established by the Punjab Municipal Development Fund Company (PMDFC) under donor-funded projects in different intermediate and smaller cities, and by the Lahore Waste Management Company (LWMC).

Intermediate Treatment Options

Once full collection coverage and environmentally sound disposal practices are in place, and wherever affordable, institutional-level waste separation and recycling should be considered as the next step up in the gradual upgrading of the sector. Waste reuse, recycling, and recovery are policy choices that bring essential environmental benefits. Currently, significant resource recovery and recycling has been taking place, mostly in the informal sector. Establishing citywide biogas generation and composting plants, especially in large cities, with economies of scale in mind, would gradually move the country up the waste hierarchy. This step would be even more feasible if provinces opt for regional waste treatment and disposal facilities. Some nongovernment organizations (NGOs) and start-ups have been supporting the local governments in large cities. These including the Karachi-based TrashIt (TrashIt, n.d.) and Gul Bahao (Gul Bahao, n.d.), and Lahore-based Waste Busters (Waste Busters, n.d.), must be encouraged. Large-scale composting and refuse-derived fuel (RDF) facilities were set up in Lahore, Multan, and Wah Cantonment by the private sector under public–private partnership (PPP) financing. However, because of several factors, these interventions are operating at much lower capacity or have even closed down. Full operations could resume with dedicated attention from the provincial and local governments concerned.

A reasonably large-sized project being planned in Karachi would involve running the city's Red Line Bus Rapid Transit (BRT) system on bio-compressed natural gas (bioCNG), to be produced from about 2,000 tons of waste from some 200,000 animals at the Bhains (buffalo) Colony.[7] The biogas plant is expected to produce enough gas to generate 2.4 megawatts (MW) of power and 20 tons per day of biomethane. In addition to these products, the plant can also turn out 50 tons per day of liquefied carbon dioxide (CO_2), 410 tons of compost, and 740 cubic meters per day of water effluent of adequate quality to be discharged to rivers or used as non-potable water.

Extended Producer Responsibility

Introducing the extended producer responsibility (EPR) policy approach[8] to the capture of recyclables such as packaging waste, electric/electronic waste, end-of-life vehicles, and batteries is an effective way of meeting the objectives of the "polluter pays" principle. It takes time (often more than 5 years) to develop comprehensive schemes in cooperation with key parties, such as manufacturers of consumer products and packaging materials.

Financing

Financing is the backbone of waste management. Waste management is not an economic activity done to generate income but a public service requiring financing for cost recovery. It is thought that most countries charge households and other establishments fees to cover the cost of waste collection and disposal. However, some countries cross-subsidize to help poor households or subsidize the sector partially or substantially from general revenue. Regardless of the sources of funds, sufficient financing is essential to run the waste management system. However, it is important that subsidies create a sustainable waste management system.

[7] From the feasibility report on the Karachi Breeze Biogas Plant for the ADB-funded Karachi Bus Rapid Transit Red Line Project (ADB, n.d.).
[8] The EPR environmental policy approach makes the producer responsible for the post-consumer stage of a product's life cycle.

Private Sector Involvement

Private sector involvement makes sense only if sufficient and reliable financing is available to the sector, and if the public sector has the capacity to provide meticulous contract enforcement and supervision of private activities. The private sector may improve efficiency on the margins and bring in private capital but will rarely be able to solve larger sector issues; a gradual and calculated approach is advisable. The recently concluded 7-year-long waste collection and transport contracts in Lahore provide a good case study with lessons to learn.

Legislation

The waste management system should be guided by appropriate legislation and controlled at the national, regional, and local levels, but responsibility for actual service delivery and implementation should be left to the local authorities. Adequate staffing capacity is required at all levels. There are no tax incentives for private sector work in the waste management sector. For example, a zero-rated tariff is currently imposed on machinery and vehicles for solid waste management (SWM) imported by municipal bodies, but not on similar imports by the private sector. Likewise, plants and machinery for waste-to-energy (WTE) plants can be imported at a zero tariff rate by municipal bodies (FBR, Pakistan, 2020). The tariff for WTE projects therefore needs to be subsidized. So far, not a single WTE plan has been successfully negotiated in the country.

6 Steps in Developing the Road Map

The recommended steps in developing the road map for upgrading the municipal solid waste (MSW) management process in Pakistan are presented below. The individual steps are not meant to be viewed in isolation, as there will be overlapping elements.

Understand the Current Waste Management Framework

It is estimated that almost 40% of the total urban waste in Pakistan is disposed of in dumpsites that are designated as dumping grounds by the municipal authorities. The rest ends up in unauthorized open dumps, water bodies, and other open spaces in and around the cities (Ferronato and Torretta 2019).

Open burning of waste or open disposal is commonly practiced in Pakistan, although data on the amounts of waste disposed of via this route are currently very limited (Mahar et al. 2007). The practice is generally more prevalent in the rural areas and small cities, where there is little infrastructure and collection/transport facilities are negligible or nonexistent. For example, in Faisalabad, only about 56% of the generated waste is collected; 43% is disposed of in open dumping sites without precautionary measures or treatment (Yasin et al. 2017). In the seven large cities in Punjab province[9] and five cities in Khyber Pakhtunkhwa[10] where WMCs operate, there are higher levels of collection and transport to designated open dumping sites.

Gather Data for Sustainable Management

Data collection is the foundation of sustainable management. The Ministry of Climate Change (MOCC) should therefore set up a data collection system at the federal level to get data on the amounts of waste generated, its composition, and the methods of waste disposal. This national system could be integrated with a similar system at the provincial departments of local government.

The waste management/utility companies in Punjab and Khyber Pakhtunkhwa provinces have relatively reliable data collection and recording systems, including weighbridge stations at the landfill sites. These companies can provide real-time data on waste collection and disposal if a framework for data management is established. In the future, data should be collected through this route, if possible,

[9] Bahawalpur, Faisalabad, Gujranwala, Lahore, Multan, Rawalpindi, and Sialkot.
[10] Abbottabad, Kohat, Mardan, Mingora, and Peshawar.

to increase the accuracy of estimates. These data-flow systems would work best if the MOCC had a monitoring dashboard, vertically integrated through the provincial departments, down to the municipalities and the WMCs. This dashboard could be made part of the current Clean Green Pakistan Index initiative (MOCC, Pakistan, n.d.).

One other way forward would be for the MOCC to develop standard guidelines for carrying out waste analysis and characterization (WAC) studies across all cities. This should help standardize and enhance data collection systems and improve the accuracy of GHG estimates.

Develop a National Waste Management Strategy

Pakistan is a federation, where waste management is primarily a provincial concern and is carried out at the local level. To align the objectives, goals, targets, and outcomes of this road map, the country must have a national-level waste management strategy, prepared and adopted after full consultation with all the national, provincial, local stakeholders, including the private and nongovernment sectors.

Professional collection and disposal services that include full collection coverage in urban areas, full or substantial coverage in rural areas, and sound environmental standards at disposal sites should be provided by local authorities at a minimum. The strategy should be followed by a robust implementation plan, to ensure access to waste management services and environmental protection, in all urban and rural areas.

Develop an Institutional Framework

The MOCC is Pakistan's coordinating ministry for waste management at the national level. In the provinces, the local government departments are the managing entities for the local governments and municipalities, which provide services at the local level. Following some institutional reforms over the last decade, this responsibility in the large cities has been delegated to public sector WMCs. In Punjab, for example, the function of solid waste management has been assigned to the eight WMCs, and in Khyber Pakhtunkhwa province, the seven water and sanitation services companies manage waste on behalf of the local governments. Sindh province, in a bid to enhance its technical and professional capacity, has established the Sindh Solid Waste Management Board (SSWMB). These three provinces have urban units within their planning and development departments—technical wings with professional staff. A key function of these entities is to collect data and carry out research in the urban sector. The MOCC can coordinate with these units, build their capacity, and engage with them for the collection and analysis of waste-related data.

A sound institutional framework, from the local level to the federal level, must be developed. This process would include developing the road map, drafting policies, producing the required legislation and national waste strategy and plans, developing a waste database, implementing the strategy and plans, and monitoring implementation. Countries often underestimate the amount of work required when setting up a comprehensive waste management process. Rather than having staff with waste management as one of many areas of responsibility, the MOCC should form a dedicated team with a leader focused solely on waste management. If this is not feasible in the short term, the ministry could engage a local consulting company for a few years to do the work on its behalf. Among its tasks, the company could be asked to train government departments and local governments and build capacity, while implementing the reform agenda under the auspices of the ministry.

Form a Steering Committee or Working Group

A committee or working group should be established to discuss developments, approve strategies and plans, and oversee their implementation. This should include key stakeholders and could have the following members:

- MOCC (chair);
- provincial local government departments;
- chief executive officers (CEOs) of urban units (in Balochistan, Khyber Pakhtunkhwa, Punjab, and Sindh);
- provincial environment protection departments (EPDs);
- selected NGOs in the waste management sector;
- academia (environment department of at least one university in each of the four provinces);
- private sector representatives in the waste sector;
- some co-opted professionals with expertise in waste management, the environment, or climate change; and
- chief officers / CEOs of WMCs in provincial capital cities.

Introduce Adequate Incentives and Regulatory Oversight

The World Bank report on MSW management (World Bank 2018) suggests a "carrot and stick" approach to establishing a set of incentives and enforcement mechanisms for local governments responsible for service delivery. The following options, among others, could be considered:

- **Project financing linked with key performance indicators (KPIs).** Financing for infrastructure development is provided in almost all cases by the federal and provincial governments, but at times it may be donor funded. This financing must be linked to the achievement of institutional reform KPIs in the right direction.
- **Solid waste management law and rules.** A law specific to SWM (a provincial law, under MOCC guidance) should be developed, followed by detailed rules and guidelines for the management of industrial waste, hospital waste, plastic waste, and electronic waste, to support the entire waste management sector, including private sector waste management. This law would compel all public and private operators to collect structured data on waste collection and share the data at regular intervals with the local and provincial governments. Product manufacturers and waste producers would also be required to adopt an extended producer responsibility (EPR) framework, both in the production phase and in post-consumption management.
- **Rationalized waste-to-energy tariff.** The WTE tariff, especially for non-incineration technologies, must be rationalized. This move could even attract international financing.
- **Industry status for integrated solid waste management.** The integrated solid waste management (ISWM) sector provides serious business opportunities, both in waste recycling/ recovery and in the provision of collection and transport services. The industry status of these businesses should be formalized, so that financing, leasing, and tax incentives can be provided, leading to better outcomes. The sector has severe environmental and public health externalities.

Move Up the Waste Management Hierarchy

After establishing a well-functioning collection and disposal system and obtaining a good understanding of the costs, in terms of both consequences and financing, the first item in the waste management hierarchy (waste reduction) should be considered. Legislation limiting the amounts and types of waste material from manufacturing could then be passed.

Following that, a system of separation at source may be developed for dry recyclables (paper/cardboard, plastics, metals/cans, glass) and possibly other priority waste streams like electrical/electronic waste, and various options for the management of hazardous waste and for energy recovery from MSW can be considered.

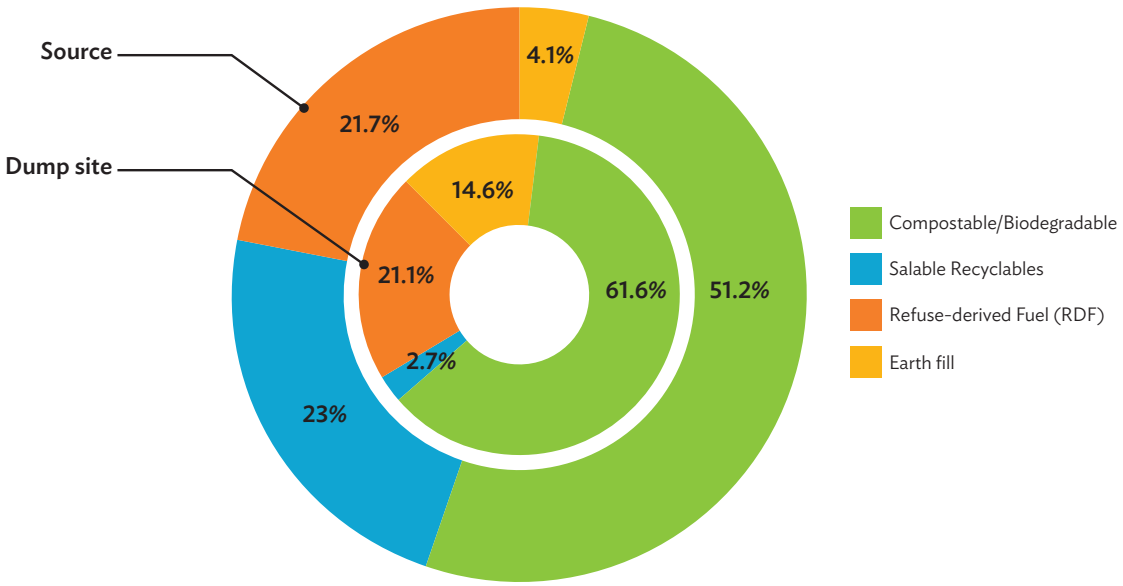
Separation at Source for Recycling

In Pakistan, much dry inorganic waste is recovered for recycling. This occurs at many levels, starting with the housewives and domestic workers at source, followed by quick sorting into separate bags by the collecting crew, and then foraging by the thousands of scavengers found in every city, who even reside with their families at the dump sites, most of which are open sites. This whole cycle, though part of the informal sector, is quite efficient: hardly any worthwhile recyclables are "wasted." But a unified database of human resources in the informal sector and the size of the sector is not available. According to the Polymer Waste Importers and Recyclers Association in Punjab province, up to 90% of the polyethylene terephthalate (PET) bottles in urban waste are collected and recycled (Haider et al. 2015). Moreover, WAC surveys (Figure 2) carried out at source and at dump sites revealed that more than 80% of the valuable recyclables (paper, plastic, glass, metal, and rubber) are taken away by the informal sector before they reach the dump sites (JICA 2015).

In Karachi, about 9% is recycled at the source and sold to local scrap dealers (kabarias) by household or office staff; the rest of the waste is directed to the empty plots (kachra kundis) in the area. It is estimated that 50%–60% of the waste is picked up by the local municipal council from these places and transported to the closest landfill (Ali and Hasan 2001).

A city-level waste sorting, recycling, and composting plant, with a waste processing capacity of 200 tons per day, was recently inaugurated by the Prime Minister at Sahiwal, a medium-sized city. The plant is still in trial operation. In Khyber Pakhtunkhwa province, waste sorting, recycling, refuse-derived fuel (RDF), biogas, and composting plants at the city level have been designed under the Asian Development Bank (ADB)–financed Khyber Pakhtunkhwa Cities Improvement Projects and are likely to be operational by 2022.

Figure 2: Role of Waste Pickers and the Informal Sector in the Recovery of Recyclables



Source: ADB Compilation.

Some NGOs and small-scale private operators collect waste and reprocess it into fertilizer, plastic bottles, and Tetra Pak cartons. Among these community-based facilities is the Integrated Resource Recovery Center in Islamabad, sponsored by the Akhtar Hameed Khan Memorial Trust (The News 2021). In Lahore, a private firm produces RDF at its recycling facility. Similarly, an NGO in Karachi gets people to sell their waste to the NGO, which prepares soil-conditioning fertilizer from the waste collected. Yet another NGO collects urban waste in major cities in the country, squeezes it dry, and then produces waste pellets from the dried waste material, to be sold in local markets as liquid nutrients for plants (State Bank of Pakistan 2016). Cities could sponsor this type of small-scale collection and recycling initiative, especially in small towns and even in rural areas. Cities and municipalities could also formalize the informal sector, through local NGOs or small-scale local private operators. Evidence shows that this could be a win–win situation. Scavengers now working unsupervised in unhealthy surroundings and living on the margins of society would benefit from better wages and a regulated work environment (Silva, Weins, and Potinkara 2019). The cost of waste management would also be optimized, as the streets are less littered with waste.

To reduce the burden on collection services and formalize the recycling activity, a system of separation at source may be developed for dry recyclables (paper/cardboard, plastics, metals/cans, glass) and possibly other priority waste streams like electrical/electronic waste. Given the exponential increase in industrial and electronic waste (including up to 50 metric tons of imported e-waste), there is a pressing need for aggressive measures to implement the 3R hierarchy of waste management (reduce, reuse, recycle), emphasizing the circular economy framework. Close collaboration with the Ministry of Industries and

Production would be needed to ease the process and regulate the industries, which would have to make 360-degree improvements in product design and manufacture to facilitate the efficient, eco-friendly disposal of products. Furthermore, data should also be gathered to record the size of the informal sector, including small, medium, and large enterprises recycling polyethylene terephthalate (PET), glass, aluminum, and other materials, as well as the human resources associated with informal waste management.

Recycling of Organic Waste

Pakistan has hardly any large-scale composting or biogas generation facilities. The state of recycling and composting in the country is outlined below:

- A composting plant was set up in Lahore in 2006 but abandoned in 2016. In Karachi, there is no formal composting of organic waste. Several projects were initiated but did not progress beyond the pilot stage because the organic waste from households was not enough to make the projects economically viable (UNESCAP, IUCN, and UN-Habitat 2012).
- Cow dung from organic waste in rural areas, small cities, and peri-urban areas of large cities is largely used either as organic fertilizer/soil enrichment material or as domestic fuel, after it is dried and made into fuel cakes. Many local small-scale biogas plants have also been installed under various projects and schemes, and are operating at various levels of efficiency.
- Karachi also receives support under a World Bank–financed program that includes recycling and biogas production projects. Under the ADB-financed Karachi Bus Rapid Transit (BRT) Red Line Project, a biogas plant that will generate fuel-quality gas for the BRT is being designed (ADB, n.d.).
- In the province of Khyber Pakhtunkhwa, four or more cities will be provided with integrated waste management systems, including sorting of mixed waste, anaerobic bio-digestion facilities to generate biogas for use as energy source, and composting of the residue, under the ADB-funded Khyber Pakhtunkhwa Cities Improvement Projects. The systems will cover at least 90% of the city waste in Abbottabad, Kohat, and Mardan, and 30% of the waste in Peshawar.

Disposal of Waste Electrical and Electronic Equipment

Pakistan is not only a user of products that end up as electrical and electronic waste but also a WEEE importer. Most of the disposal takes place in the informal sector, where scavengers, by and large children, are employed to extract and recover valuable materials, often with hazardous heavy metals like lead, mercury, and cadmium. This waste category and the business process must be regulated with specific policy, legislative, and regulatory mechanisms like those in India's E-waste (Management and Handling Rules 2010 (MOEFCC, India, 2011). More specifically, there is a need to develop an action plan for the effective disposal of e-waste in Pakistan through handling and dismantling procedures at the various levels of government, public awareness raising, e-waste categorization at the municipal level, and safe disposal of e-waste by original equipment manufacturers (OEMs), which understand best how parts can be reused (Akbar, Khan, and Jamal 2020).

Disposal of Health-Care Waste

Though the Hospital Waste Management Rules (2005) have been in place for many years, waste disposal in cities and rural areas varies from highly dangerous operations (in most rural areas and small towns) to state-of-the-art services (in several large private and public sector hospitals) (LWMC, n.d.(a); Department of Health and Family Welfare, Punjab, Pakistan, 2015). The rules must be translated into more flexible guidelines, allowing the adoption of locally feasible options, ranging from controlled landfilling in smaller towns to two chamber incinerators, autoclaves, or other similar technologies in large cities (WHO, n.d.). Sustainable health-care waste management has more to do with segregation at source, to separate the infectious 15% from the municipal waste that is generated in the wards (Ali, Wang, and Chaudhry 2016). Special care and measures must be taken in the post-COVID-19 period, as the quantity and composition of health-care waste will have significantly changed in most countries, and stringent action will be required. Key measures that must be adopted include the following (ADB 2020a):

- Reschedule municipal solid waste collection frequency according to workforce availability.
- Reallocate available assets for the management of infectious medical waste.
- Avoid recycling activities to prevent human contact with potentially infectious domestic and medical waste.
- Treat all municipal waste as nonrecyclable and dispose of it in an autoclave/incinerator or sanitary landfill. Landfill sites with informal waste picking will need tighter management and security.

Waste Incineration, with Electricity/Heat Production

Waste-to-energy (WTE) technologies provide a convenient solution to environmental loading and energy problems, especially in distributed energy models (ADB 2020b). Business models are based on the availability and type of waste, energy needs, and technology solutions. However, care should be taken in applying off-the-shelf solutions to particular projects—each project should be evaluated on its own terms (ADB 2020b). The primary advantage of mass-burn facilities is the amount of energy they produce. But the potential for releasing significant amounts of air pollutants, including heavy metals and dioxins during combustion, is a notable disadvantage. Modern incinerators are, however, fitted with advanced air pollution abatement equipment, so this aspect is now of much less concern.

In addition, the ash resulting from combustion must be disposed of. When opting for the MSW incineration, it is important to weigh its advantages against the significant capital and operating costs, potential environmental impact, and technical requirements of its operation. In 2013, the Global Waste-to-Energy Research and Technology Council (GWC) submitted a pre-feasibility study of a WTE project in Lahore with a design capacity of 4,000 metric tons/day of municipal waste and a power generation capacity of 245 MW. According to the study, the average net calorific value (NCV) of MSW at Lahore over extended periods of time was 2,278 British thermal units per pound (BTU/lb) and a reasonable range for operations would be between 1,700 BTU/lb and 3,000 BTU/lb. To handle MSW with very high moisture content (values of 70% and above), a design allowing for co-combustion of coal or the use of high-tech presses for some mechanical dewatering of MSW was proposed. The project did not materialize, however, because of technical, political, and legal complications, aside from the low calorific value and high moisture content of MSW and low tariff structure (LWMC, n.d.(b)).

The success of an incineration plant is determined by the type of waste that is treated. Listed below are the parameters:

- **MSW quantity.** This should be over 100,000 metric tons per year, or 275 metric tons/day (GIZ 2017).
- **Energy content.** The lower calorific value (LCV) must average at least 3,000 BTU/lb throughout the seasons (Rand, Haukohl, and Marxen 2000; Azam et al. 2020)
- **Chemical composition.** The MSW should be checked for the presence of highly combustible material, low moisture, and low inert gas or ash content. Sorting should be done: there should be no minerals or hazardous materials, or only small fractions of such wastes should be present.
- **Physical composition**, e.g., particle size

Greater variability among these parameters increases the costs of pre-treatment of waste and downstream operations such as flue gas cleaning. Considering the current state of mixed municipal waste—its high organic and high moisture content and low calorific value—direct incineration is not a viable WTE option at present. Waste incinerators are among the major sources of dioxin and furan emissions. Reducing such emissions from thermal WTE plants calls for suitable combustion conditions. The combustion temperature should be at least 850°C, with a minimum retention time of 2 seconds (European Commission 2018).

Thermal WTE, if used as an alternative to open burning, and landfilling, can reduce GHG emissions. These energy recovery technologies can help avoid methane gas production from organic waste and prevent environmental pollution from leaching. But WTE plants have a lock-in effect that requires a dedicated investment in the project, and a fixed volume of waste to be incinerated over the plant's life. The lock-in effect could undermine waste prevention, reuse, and recycling policies and programs if there are not enough funds to develop those systems, or if "put or pay" contracts mandate a fixed or minimum guaranteed amount of municipal waste to the incinerator and exact a fine for noncompliance. These conditions pose a risk to the waste management hierarchy, and can hamper waste reduction, and in turn dampen the potential boost to local economies from waste reduction, reuse, recycling, and composting (European Commission 2018).

Landfilling

As stated earlier, engineered landfill sites are virtually nonexistent in Pakistan. Most of the country's urban waste is dumped on open ground or left uncollected. More landfill sites, built to a high standard, are therefore urgently needed. Regional landfill sites would be preferable to smaller units for each city, given the country's size and its population of more than 220 million people, spread out over 700,000 square kilometers. A comprehensive study and long-term plan would have to be prepared to secure the necessary financing.

7 Waste Management and Greenhouse Gas Emissions

Strengthen Estimates of Annual GHG Emissions from the Solid Waste Sector

In the Intergovernmental Panel on Climate Change (IPCC) guidelines, GHG emissions from the solid waste sector are grouped into the following categories, each one with different data requirements, to enable the preparation of GHG emission estimates, according to the Tier 1 methodology:[11]

- **Solid waste disposal (IPCC code 4A).** Annual amount of municipal solid waste disposed of in managed anaerobic or semi-aerobic, and unmanaged deep or shallow, landfill sites; waste composition; amount of scavenging at landfill sites, in terms of the amount of waste remaining at the sites and the waste composition; GHG emission estimates for both urban and rural areas (current estimates cover only urban areas).
- **Biological treatment of solid waste (4B).** This is likely to be a very small source of GHG emissions in Pakistan. Only a few pilot projects are currently being undertaken, as discussed in Section 6's *Recycling of Organic Waste*.
- **Incineration and open burning of waste (4C).** Annual quantity of waste burned in the open and, ideally, its composition; estimates of emissions from this waste source, which is not included in current inventories. No MSW incineration occurs in Pakistan at present.

Estimates of GHG emissions from the Pakistan waste sector are part of the country's National Communications and Nationally Determined Contribution (NDC). But given uncertainties in some activity data, accuracy of the estimates could be improved. Data flows could be set up with the help of data supply agreements (DSAs) and/or memorandums of understanding (MOUs)[12] between local government departments or the WMCs responsible for waste collection and disposal and the MOCC, to ensure the timely provision of good-quality data (see Section 6's *Gather Data for Sustainable Management*). A template is provided in the Appendix.

[11] Although a higher-tier method should ideally be used, as GHG emissions from solid waste disposal are likely to be a key category, having a complete inventory for the Pakistan waste sector is more important at this stage and should be given priority.

[12] The data supply agreement is a formal agreement. But gathering data sets on a voluntary basis from other government departments is also common practice. While a voluntary approach can be used, however, it would still be helpful to include clear specifications, preferably documented in an MOU, rather than a DSA.

Develop GHG Emission Projections

Once more accurate GHG emission estimates for historical time series data become available, these will feed through to improvements in the emission projections. When considering waste sector projections, it is important to understand the following:

- how national waste generation (quantities and types) is likely to change in future years;
- how the utilization (percentage share) of treatment, disposal, and recycling systems is expected to evolve;
- whether waste parameters and emission factors could change, as a result of technological advances, for example, or through the planned uptake/retrofit of abatement systems; and
- to what extent the WMCs and municipalities would choose to optimize waste collection to reduce fuel consumption.

Mitigation actions could affect one, or all, of these aspects. It is therefore important to understand potential co-dependencies and relationships between treatment pathways. Considering the current and future mass flow of waste may assist projection compilers in this regard.

Care should also be taken to ensure that emissions resulting from the generation of electricity from waste (if it is among the waste management options chosen for future consideration) are accounted for in the energy sector and not double-counted.

Compile Actions to Reduce the Environmental Impact of Waste in Pakistan

Solid waste management is a significant factor in environmental sustainability, and improper disposal can lead to health hazards and damage to local ecosystems and wildlife. In Pakistan, the waste sector is a major source of GHG emissions. The latest study available estimates GHG emissions from the country's solid waste sector at 10.5 metric tons of carbon dioxide equivalent ($MTCO_2e$) (Stiebert 2016), with open dumping contributing around 73% of this total (Ilmas, Mir, and Khalid 2018). GHG emissions from the SWM sector make up about 3% of the total GHG emissions from various source sectors in Pakistan (Mir, Purohit, and Mehmood 2017).

No waste mitigation actions are presented in Pakistan's NDC. Laws related to industrial, domestic, and hazardous waste management must be passed and enforced, and sound policies, plans, and systems must be implemented, to mitigate the environmental impact of the waste sector in Pakistan. Measures that should be taken in this regard were discussed earlier in this report and are summarized below.

Integrated Solid Waste Management

Integrated solid waste management (ISWM) is the fundamental policy requirement. An integrated system encompasses a well-designed network of components for segregated waste storage at the point of generation, door-to-door collection of waste to avoid littering and storage at curbside, closed vehicles for environment-friendly waste collection and transport, waste sorting to secure recyclables, use of composting technologies for waste treatment and disposal, and gas or energy production or engineered land filling with proper leachate collection and gas capturing mechanisms. At the institutional level, an

integrated system includes policies, laws, regulations, guidelines, institutions, capacities, and resources that match the requirements for the effective implementation of this integrated waste management system and facilities.

The open trucks and other vehicles that currently transport waste in many cities must be replaced with covered or closed vehicles to completely prevent any spreading of waste or foul smells as it is transported to a treatment or disposal facility. In large cities, studies must be done and the most efficient collection routes must be designed with the use of geographic information system (GIS) maps and computers. Many disposal facilities in such cities are more than 20–25 kilometers away from the city center. To minimize traffic on the roads and reduce fuel/energy consumption, and thus avoid indirect emissions, the option of having waste transfer stations should be carefully evaluated.

Reduce, Reuse, Recycle: The 3Rs of Waste Management

The production of waste should be reduced as much as possible, through awareness raising, technological interventions, and the replacement pf plastics with biodegradable materials. Waste is a product that is not useful to the person generating it. But it could serve as raw material for another industry or be useful in other ways. Therefore, at the next level of the waste management hierarchy, whatever waste is generated should be reused as much as possible. The third-level strategy could be recycling of the waste products for reuse as alternatives to fresh raw materials. Recycling reduces the waste going into landfill sites, and hence also reduces GHG emissions. At the same time, it decreases the use of energy in the production of fresh raw materials, and is also a mitigation measure for that reason.

In urban areas, especially large cities, there is a significant amount of construction debris that needs to be recycled instead of being transported to landfills. Recycling construction debris and reusing the recycled materials in road and pavement construction reduce landfilling capacity and the need for energy to produce fresh raw materials.

Production of Refuse-Derived Fuel

Converting inorganic waste into RDF to be used in cement factories, brick kilns, or other fuel-intensive industries can reduce dependence on fossil fuels and minimize the need for landfilling.

Composting and Biogas Production

The organic component of waste can be transformed into compost (land conditioner for agriculture and horticultural purposes) or generate biogas for use as fuel or for electricity generation.

Landfilling

In cases where treatment/transformation is not possible or feasible, engineered landfill sites are the last option. Uncontrolled dumping must be avoided at all costs, as it pollutes groundwater and is a potent source of water and land contamination. An engineered landfill has suitable measures for leachate control, gas collection vents, and regular soil or dry compost cover. Landfilling management requires technical and financial resources. A policy of developing and maintaining regional landfill sites (with a minimum capacity of 1,000 metric tons per day) to serve many cities and towns must be adopted. A regional landfill site, together with transfer stations at the city level, provides better options for land selection and reduces the cost per metric ton of waste management. Estimates suggest that composting waste and reclaiming landfill gas could save about 0.75 million $MTCO_2e$ per year by 2030 (Stiebert 2016).

Treatment of Hazardous Waste

Hospital waste should be treated according to the standards. Hazardous waste should be segregated from municipal waste, for secure incineration or autoclave treatment.

Some industrial waste is toxic, and the chemicals can contribute to air, water, and soil contamination. Industries should be made to pay for the cost of treatment on a "pay-as-you-throw" (PAYT) basis.

8 Capacity Building for the Implementation of the Road Map

A key constraint on the implementation of an integrated system of waste management in line with this road map is the lack of human and technical capacity, not only among municipalities at the implementation level but also at the policy, planning, management, supervision, and monitoring levels. An adjunct plan for a medium-term comprehensive capacity enhancement program, coupled with a redesigned incentive structure in the public sector for the retention of trained, capable personnel, is strongly recommended.

Citizen Cooperation and Behavior Change Communications

Accessible online platforms, applications, and citizen surveys are shaping how solid waste management services are conducted around the world, and they show that, for proper waste management, having waste infrastructure alone is simply not enough. These interactive platforms provide incentives, quantify actions, and increase pressure on service providers, and thereby improve waste management with greater citizen engagement (Kaza, Yao, and Markgraf 2016). A case can be made for integrating these information communication tools into the overall waste management framework.

9 Financing the Waste Management Road Map

Once a basic level of services is functioning adequately, what the sector can realistically afford in order to move up in the waste hierarchy and the time frame needed for progress in that regard should be examined.

Waste Management Services Costs and User Charges

There are very few estimates of the cost of setting up and running a proper waste management system in Pakistan. From data obtained from WMCs in Punjab and utility companies in Khyber Pakhtunkhwa, as well as project feasibility studies for donor-funded projects, unit cost estimates for SWM services delivery were developed and are provided in Table 4.

Cost Assessment and Fee-Setting Practices

Economic instruments in support of the waste hierarchy include, among others, landfill taxes / tipping fees (which increase the cost of disposal), "green tariffs" for waste-derived products, and fiscal relief. In the European Union (EU) and Japan, landfilling has steadily decreased and as a result, recycling and recovery have increased over the past 15 years. The combination of regulatory instruments and economic incentives has also caused a spike in research and development, and investments in new and more efficient waste treatment technologies. Moreover, in light of actual operating costs and willingness-to-pay surveys, local governments should levy user charges to recover direct operating costs (at least) and could increase cost recovery targets incrementally.

Table 4: Unit Cost of Solid Waste Management and Associated Services (Operational Cost)

Settlement Area / City	Population (million)[a]	Waste Generation		Primary and Secondary (Transportation) Collection, Sweeping, Washing, and Management Costs ($ per metric ton)	Intermediate Treatment cost/ton ($ per metric ton)	Disposal cost/ton ($)	Overall Waste Management Cost	
		Daily (kg per capita per day)	Yearly (million metric tons per year)				Cost per City/Rural Community ($ per metric ton)	Cost Range per Settlement Type ($ per metric ton)
Medium-Sized and Small Cities								
Bahawalpur	0.68	0.42	0.14	28.19		0.13[b]		27–66
Sialkot	0.65		0.13	27.23		0.01[b]	27.24	
Mingora	0.33		0.07	28.89	7.31	6.49[c]	42.70[e]	
Mardan	0.37		0.07	29.20	17.71	8.29[c]	55.22[e]	
Kohat	0.23		0.05	33.04	22.72	9.84[c]	65.61[e]	
Abbottabad	0.122		0.02	31.26	19.53	8.69[c]	59.48[e]	
Rural Communities								
		0.32		5.71			5.71	5.71

[a] Cost of waste treatment, at facilities managed by private entities (e.g., Dera Ghazi Khan Cement Co. Pvt. Ltd. for refuse-derived fuel [RDF] production and Lahore Compost Pvt. Ltd. for compost production), is not included in total operating cost.

[b] Dumpsite operation and maintenance costs, based on data collected from waste management companies (WMCs).

[c] Estimated cost of sanitary landfill operation, including depreciation expense for infrastructure assets.

[d] Cost of compost unit operations is borne by Lahore Compost Pvt. Ltd.

[e] Includes the depreciated capital costs of the infrastructure.

Sources: 2017 census (for the population figures); data from WMCs/utilities/departments; waste analysis and characterization (WAC) studies of 15 cities, published in the last 20 years (for waste generation rates); 3-year (2014–2017) averages of financial data from WMCs in the Punjab (authors' analysis); solid waste management (SWM) system design reports for cities under the Khyber Pakhtunkhwa Cities Improvement Projects, 2019–2020; and Department of Health and Family Welfare, Punjab, Pakistan (2015).

10 Summary and Conclusions

With its population growing and the country rapidly urbanizing, Pakistan is expected to generate a considerably higher amount of municipal solid waste in the coming years. Only about 50% of its MSW total is collected overall, but there are substantial variations between locations. Because the country has few managed landfill sites, most of the waste is either left uncollected or dumped on open ground. To boost the health of its people, decrease the contamination of land and water sources, reduce GHG emissions, and improve aesthetics, Pakistan would need to strengthen its waste sector management. This will involve preparing more accurate GHG emission estimates, historical as well as projected, and putting in place mitigation actions to reduce emissions from this sector and contribute to the achievement of the goals of the Paris Agreement. This report sets out a road map that covers both the management of waste and assessment of its GHG impact.

The report presents key factors to take into account when setting up a waste management system. The first priority is to ensure a basic level of collection and disposal of solid waste across the country. Only after this basic level of service provision is available to the population should the country consider investing in more sophisticated infrastructure and technologies. Waste analysis and characterization (WAC) studies would be useful in determining the types of waste being generated and putting in place the most appropriate disposal options. Modern landfill sites will have to be constructed. The development of regional landfill sites, rather than smaller units for each individual city, is recommended for Pakistan, given the spatial distribution of its population. Sufficient financing will be needed to run the SWM system that is developed.

The steps in developing the road map are then put forward. These include the following:

- **Gain a better understanding of the current status of Pakistan's waste collection and disposal system and possibilities for improvement.** For this purpose, Pakistan could set up a data collection system for local governments so that information about the amounts of waste generated, waste composition, and disposal routes can be gathered. It is recommended that the MOCC undertake this work or oversee it.
- **Set up an institutional framework** to ensure that the system is effective and that progress can be made. Forming a dedicated team with a leader focused solely on waste management is highly recommended. If this is not feasible in the short term, then a local consulting company could be hired for a few years to set up the framework on behalf of the ministry.
- Once a national waste management strategy has been developed, **form a steering committee** to oversee progress and implementation, and then discuss options for reducing the amounts of waste generated and look at options for reusing materials and increasing recycling rates in line with the waste hierarchy. Suggested participants in this committee are listed in Section 6's *Form a Steering Committee or Working Group*.

- **Introduce adequate incentives and regulatory oversight.** For example, project financing, often provided by the federal government or donors, should be linked with KPIs. Rules and guidelines for the management of industrial, hospital, plastic, and electronic wastes are also needed, and WTE tariffs must be reviewed and made comparable to renewable energy options. The legal framework could likewise require all public and private operators to collect structured data on waste collection and share it periodically with the local and provincial governments. This would compel the products and waste producers to adopt an extended producer responsibility (EPR) framework. It is suggested that a dedicated waste team within MOCC take the lead in these aspects.
- **Identify ways of moving up the waste hierarchy.** Recycling at source, organic recycling, WEEE disposal, and health-care waste disposal are some examples.
- Finally, once waste production and disposal amounts have been minimized as much as possible, **consider landfilling, composting, and waste incineration (with heat/electricity recovery) options.**

Estimates based on a few studies and projects indicate that around PRs139 billion ($818 million) is needed to upgrade the country's ISWM system, while the operational cost of providing waste management services in Pakistan varies from $22 to $66 per metric ton of waste. Improving the collection of data on the quantities and types of waste being generated will help ensure more accurate estimates of the GHG emissions from this sector in Pakistan. Projections for this sector can then also be made with greater accuracy and the impact of different mitigation actions can be quantified.

The next step is for the MOCC, in collaboration with a steering group, to set a timeline for achieving the above actions and putting in place the required legislative and other requirements in order to improve the waste management process in Pakistan.

Appendix: Memorandum of Understanding Template

The following template can be used in setting up an agreement between two organizations, typically between a provider of data to the national/regional Greenhouse Gas (GHG) Emissions / Air Quality (AQ) Inventory and the organization developing the inventory (United States Environmental Protection Agency n.d.). The template will need to be adapted to suit the specific requirements.

MEMORANDUM OF UNDERSTANDING

between

_____ **[MINISTRY X]** _____

and

_____ **[MINISTRY Y]** _____

on

The National Greenhouse Gas Emissions / Air Quality Inventory and Program [A, B, C, etc.]

I. OBJECTIVES

The objectives of this Memorandum of Understanding (MOU) between [Ministry X] and [Ministry Y] are:

1.
2.

Examples:

1. To develop a system of data sharing between Ministry X and Ministry Y, to support the development of the National Greenhouse Gas (GHG) Inventory (for United Nations reporting obligations (e.g., National Communication, Biennial Update Report (BUR), and/or national policy purposes). Ministry X has been tasked under [degree, law, act, etc.] to coordinate the development of the national GHG inventory.
2. To commit to working together to develop and jointly implement a program that will slow the growth of GHG emissions.

II. AUTHORITIES AND RELATED ACTIVITIES

Nothing in this agreement alters, or is intended to alter, the legal and regulatory authorities of Ministry X and Ministry Y. This agreement is solely intended to facilitate the fulfillment of legal requirements and cooperative efforts.

A. The National Greenhouse Gas Inventory

1. **The Program**
   Describe the program in question within the context of this MOU.

2. **Authorities**
   Describe the national authorities that are relevant to this MOU.

B. Program B (If necessary)

1. **The Program**
   Describe the program in question within the context of this MOU.

2. **Authorities**
   Describe the national authorities that are relevant to this MOU.

III. PROVISIONS

A. The National Greenhouse Gas Inventory

It is mutually agreed:
1. to...;
2. to...

Ministry Y agrees:
1. to make available supporting technical reports, models, and data that may form the basis for the guidelines; and
2. to provide, in advance, a schedule for the review of the draft and final materials, including, to the extent possible, adequate time for review and comment.

Program B (If necessary)

It is mutually agreed:

Ministry X agrees:

Ministry Y agrees:

IV. MEETINGS AND CORRESPONDENCE *(optional)*

To accomplish the goals and activities set forth in this MOU, Ministry X and Ministry Y will, to the fullest extent possible:

1. meet regularly for the purposes of program planning and for the monitoring and evaluation of outcomes;
2. respond to correspondence by telephone or e-mail in a manner and within a time frame that promotes efficiency and the timely progress or completion of objectives and tasks, consistent with the goals and activities described above; and
3. agree on specific meeting or call times and dates as far as possible in advance of the appointed occasion.

V. POINTS OF CONTACT

The points of contact for the MOU on the National Greenhouse Gas Inventory are:

Ministry X	**Ministry Y**
Position	**Position**

Points of contact may be re-designated by the signatories.

VI. DURATION OF THE AGREEMENT

This MOU may be amended by written agreement between Ministry X and Ministry Y. The agreement takes effect on the date of signature by both parties. It shall remain in effect for a _____ year term from the effective date. This MOU may be terminated by mutual written agreement between X and Y, or by either party with _____ days' notice to the other party.

This memorandum of understanding is entered into
On the _____ day of _____ in the year _____.

Signatures:

_____	_____
Name	Name
Position	Position
Ministry X	Ministry Y
Date of Signature	Date of Signature

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Solid Waste Management Sector in Pakistan

A Reform Road Map for Policy Makers

This publication suggests how Pakistan could strengthen solid waste management and in doing so reduce its greenhouse gas (GHG) emissions. It provides guidance on improving and expanding waste collection and disposal services for municipal, industrial, electronic, and hospital waste. It outlines waste management options and key considerations in setting up a waste management system. The publication also discusses consolidating data on the waste generated, developing a waste management strategy, calculating historical emissions from the waste sector and projections, and establishing an institutional framework.

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