



# Waste management

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*Tackling the challenge in emerging countries*

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# Executive summary

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In recent years, emerging nations have witnessed economic growth that has positively impacted living standards, driving up consumption, resources usage, and, consequently, waste production. However, the rapid growth in generated waste volumes and weak regulations to control imported waste have overwhelmed waste management systems and resulted in negative environmental, medical, and economic repercussions. Based on our experience, Arthur D. Little urges waste management authorities to fundamentally rethink their national strategies and governance to tackle these challenges in a pragmatic approach, with the long-term ambition to design waste out of value chains through the circularity concept.

# 1. Context and key barriers to proper waste management

## Context

As illustrated in Figure 1, global municipal solid waste generation is expected to reach approximately 3.4 billion metric tons by 2050. For low- to middle-income countries in particular, the total quantity of waste generated is expected to increase up to threefold from current levels during this period. In many of these regions, most of the waste is disposed of in an unsound manner, such as in open dumps that release toxins into the water and soil and greenhouse gases (GHGs) into the atmosphere (see Figure 2). Improper landfill disposal's proven negative effect on groundwater quality cannot be overlooked, with safe water becoming an ever-increasing concern across the globe.

In addition, the global waste sector was responsible for 1.64 gigatons (Gt) of carbon dioxide equivalent ( $\text{CO}_2\text{eq}$ ) in 2017, which represents more than 80% of the Amazonian forest's yearly absorption rate. Rapid growth, combined with unsound disposal methods, will increase  $\text{CO}_2\text{eq}$  emissions, which are projected to grow 1.5% a year to 2.6 Gt in 2050.

At the same time, the Paris Agreement on climate change aims to curb emissions by 7.6% per year to meet its goal to limit the increase in global average temperature to 1.5°C per year. To meet the agreement's long-term goal of keeping global average temperatures to below 2°C per year, global emissions must be curbed by 2.7% per year.

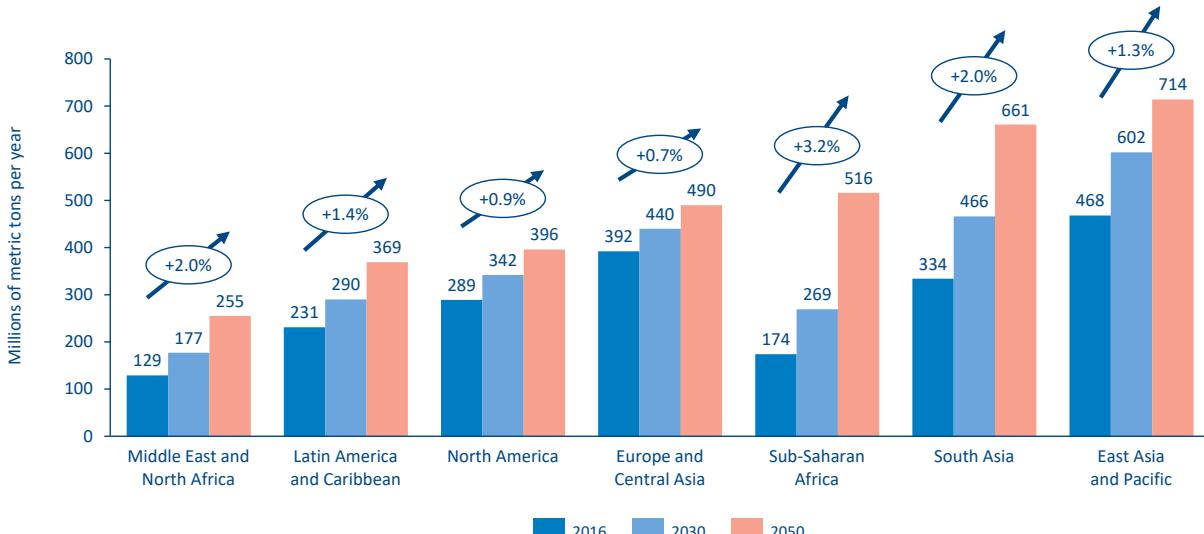
## Six key barriers faced by waste authorities

To avoid some dire scenarios, waste management authorities should take immediate action to overcome six main barriers to effective waste management strategies:

### Inadequate infrastructure

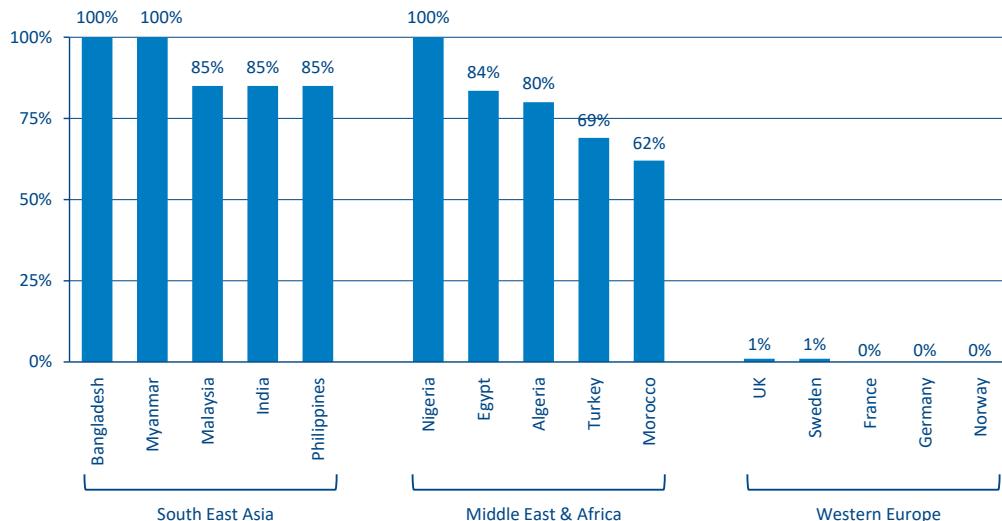
Emerging countries are highly dependent on landfills and open dumps, and the limited treatment facilities that do exist are often managed unsustainably and are missing the proper aftercare strategy and regulation. These countries often lack tools to perform gas recovery and to address leachate, groundwater, settlement, and safety issues. These landfills are also neither landscaped nor repurposed for future use.

Figure 1: Projected waste generation by region



Source: World Bank, Arthur D. Little analysis

Figure 2: Percentage of waste disposed of in an unsound manner (developing nations)



Source: Waste Atlas

### Improper planning and limited technology awareness

Waste treatment and disposal facilities are capital intensive and require significant time to design, approve, finance, and build. In fact, some treatment facilities, such as WTE (waste to energy) plants, require investments of hundreds of millions of dollars, depending on capacity. Countries are typically unaware of the role that the different collection, treatment, and recycling technologies could play in achieving their ambitions. Without proper long-term planning and pooling of resources, these investments can be a heavy burden. These countries typically lack a clear national strategy and/or corresponding roadmap (cascaded down to the level of the local government) to achieve it.

### Social barriers and compliance issues

Two types of social barriers prevent the implementation of long-term waste solutions: awareness/compliance issues and social pressure. The awareness and compliance issues affect the general population as well as the municipalities and regions, which are supposed to be the front line in charge of enforcing the rules. Limited education can result in missed opportunities to valorize waste, pollution damage to soil and water, and climate change. At the same time, social pressure from various civil movements and the “not in my backyard” phenomenon hinder authorities’ ability to make decisions and thus make long-term planning more difficult.

### Limited access to capital

Waste management and environmental safety are typically not on the priority list for governments of emerging countries that already suffer from budgetary constraints. The vast majority of available resources in these countries are allocated to projects that focus on economic development, leaving few opportunities for improved sustainable waste management systems, which in turn perpetuates an increased reliance on landfills. Sustainably managed waste systems have higher system costs than open dump sites, so public and private parties must be ready, willing, and able to pay for the externalities. On the positive side, well-managed waste systems and recycling industries do create significant employment opportunities.

### Weak regulations and enforcement

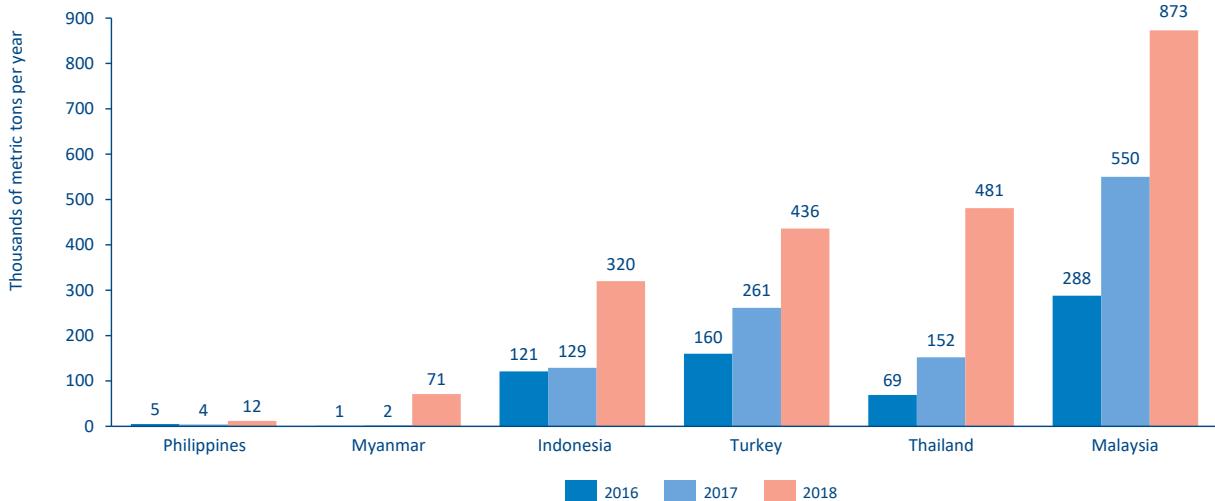
Emerging nations typically lack the integrated legal framework necessary to properly govern the waste sector. Such a legal framework would usually contain two categories of waste regulation: (1) environmental regulation, aimed at limiting the impact of waste on the environment (including emissions control, proper site localization, and soil/water preservation requirements); and (2) operational regulation, aimed at determining the proper cost recovery mechanisms (e.g., extended producer responsibility and taxation/subsidy schemes) and the rules for waste operators and polluters to follow during daily operations and in the aftercare period (once landfill site is at capacity).

### Insufficient controls on imported waste

Developed countries have long exported their waste (mainly plastics, cardboard, and electronics) to emerging nations for processing. When the waste trade practice began, it was marketed as a win-win situation for both parties. For developing countries importing waste, this was a valuable source of income, while exporting waste was a cheap solution for developed nations to help meet treatment and recycling targets and reduce the need for domestic landfilling.

As China imposed limitations on waste imports in 2018, the US and the EU diverted their waste to emerging nations with historically weaker regulations, such as Malaysia, Thailand, Turkey, and Indonesia (see Figure 3). However, it was not long before several of these nations started pushing back and began returning unwanted waste (e.g., Malaysia sent hundreds of containers back to their countries of origin in 2020). While several of the countries that have accepted waste in the past are considering total import bans, they are wary of the negative impact it will have on their local recycling industries.

Figure 3: Annual plastic waste imports



Source: Trademap, Greenpeace, Hurriyet Daily News, Arthur D. Little analysis

## 2. Suggested solutions to overcome the barriers

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Addressing these barriers requires waste management authorities to develop a robust governance system, define a clear vision and strategic direction, and lastly enable the implementation of a successful waste management plan.

### Define a robust governance system

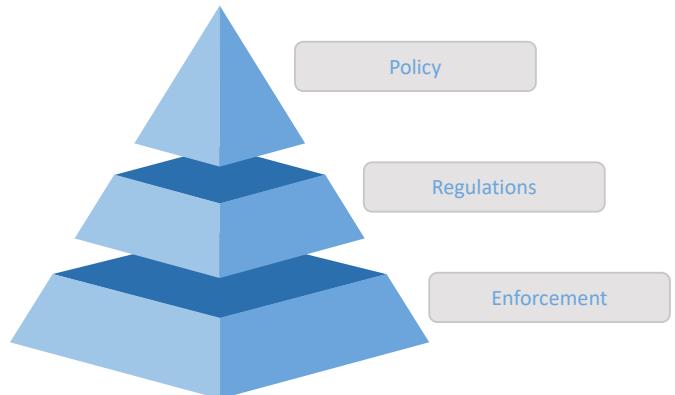
Proper governance of the waste management sector is crucial to enabling long-term solutions that consider the basic components: environmental protection, governmental cost management, socioeconomic impact optimization, and ease of implementation. Three layers of governance are key to implementing such a system (see Figure 4):

1. **Policy making.** Typically assigned to environmental regulators, this layer of governance entails setting the broad policies related to waste as well as the KPIs and targets necessary to achieve the objectives.
2. **Regulation setting.** Waste policies must in turn be detailed in specific regulations that aim at fulfilling the targets. These regulations should describe the various operational restrictions different stakeholders (e.g., waste operators and the general population) must follow.
3. **Enforcement.** Finally, the implementation of all regulations must be enforced through various mechanisms aimed at ensuring compliance.

Beyond governance, the steps of the value chain – from collection to final disposal – can be performed by the public or private sector through various public-private partnership (PPP) arrangements or contractual arrangements or by the private sector through distinct projects. Individual initiatives by private investors and NGOs should also abide by all relevant regulations and policies.

Allocating policy, regulation, and enforcement roles appropriately, as well as establishing proper checks and balances, are vital to the successful implementation of any waste management strategy. To that point, we recommend that waste operators should be removed from these roles to avoid conflicts of interests.

Figure 4: Governance layers



Source: Arthur D. Little analysis

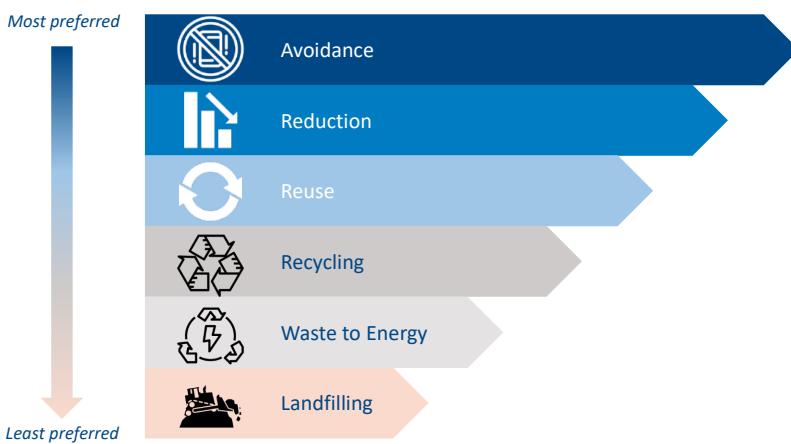
### Define a clear vision and strategic direction

Governments must create a clear vision and strategic direction for what they would like to achieve. Countries that have already developed sophisticated waste management systems and policies, such as Germany and the Netherlands, have oriented their waste hierarchies in line with the EU Waste Framework Directive of 2008 and have been striving to become fully circular economies (as an example, the Netherlands strives to reach that goal in 2050).

According to the waste management hierarchy shown in Figure 5, after avoidance, reduction, and reuse, the largest portion of waste should be recycled (including composting of organics), followed by energy recovery in WTE plants, and the least preferred option of landfilling.

In practice it is challenging to achieve high landfill diversion rates solely through recycling, so large infrastructure WTE plants have been used to divert large portions of waste from landfills. National policies must address and balance two different business models: on one side is the push for recycling (expansion of the recycling industry), while on the other side is the desire to ensure that big infrastructure plants (WTE) are fully utilized.

Figure 5: The waste hierarchy



Source: Arthur D. Little analysis

In countries with WTE overcapacity (such as the Netherlands, for example), WTE plants can be an obstacle to recycling, as these plants have low marginal costs (especially with the currently low oil prices) and long lifespans once implemented. Governments therefore must provide strict regulation and significant incentives to increase recycling and should invest cautiously in WTE capacity to avoid hindering recycling initiatives for decades. In the context of circular economy, energy-efficient WTE capacity will eventually have a limited interim role to play for certain waste streams.

The pathway forward for countries should be to develop an integrated master plan that achieves the best combination of the aforementioned components (overall cost, environmental impact, socioeconomic impact, and ease of implementation).

#### Enable the implementation of a successful waste management plan

Once defined, this national plan will require the support of seven key enablers to ensure its success (see Figure 6).

#### Infrastructure

An integrated waste management framework should aim at increasing treatment rates and diverting from landfills. Therefore, a combination of recycling/composting, WTE, and landfilling is necessary. To support the viability of each of the treatment options, several requirements are needed along the waste value chain, including:

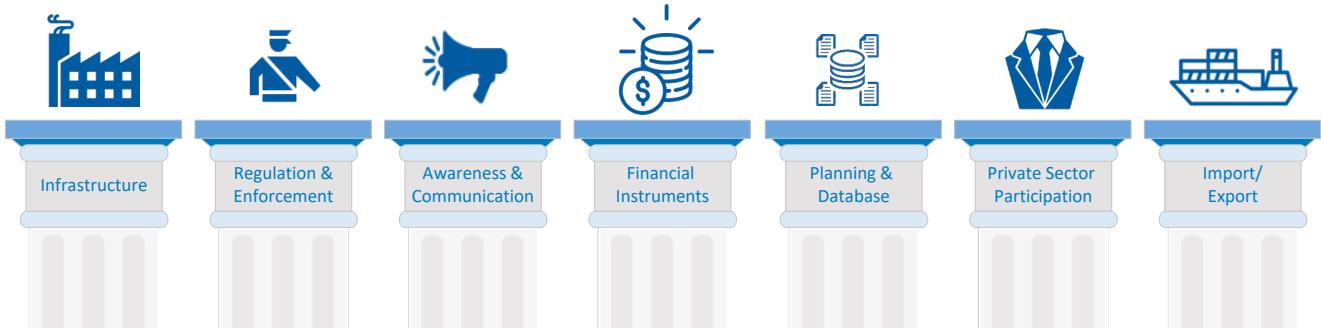
- **Develop a master plan.** A master plan covering the long-term horizon with intermediate checkpoints is essential to enable smart infrastructure investment. Toward that goal, the first step is to conduct a cost-benefit analysis and set

the right mix for treatment by choosing the targets for each treatment type. Master plans should strike a balance between the size and locations of treatment and disposal facilities to, among other factors, maximize the economies of scale and minimize transportation costs (e.g., shared WTE plants close to main cities versus local landfills, use of transfer stations).

- **Sort waste at the household level to maximize recyclable recovery rates.** Household sorting is crucial to maximize recyclable recovery rates. Several options exist for household sorting, ranging from a seven-bin system to a two-bin system (organic and residual waste). Two-bin systems may be more suitable and implementable in densely populated areas or where people live in small homes, particularly when coupled with advanced waste separation and treatment technologies (when household compliance is very low, post-separation systems are especially useful). Such sorting strategies must be strictly linked to the infrastructure plan to ensure the proper capacity utilization of the installations.

- **Establish sanitary landfills and ban open dumping and burning.** Common open dumping practices must be replaced with suitable sanitary landfills for the final and safe disposal of waste. Such landfills would include leachate collection and treatment as well as methane gas collection and flaring/utilization systems. Unsanitary practices must be remediated as soon as possible to alleviate their negative environmental impact. Sustainable landfill aftercare plans must also be developed to ensure necessary funding. A 2018 study by the World Bank in Indonesia reported a reduction in GHG emissions of 21% after increasing waste collection rates from 65% to 85% and introducing controlled landfilling for waste disposal.

Figure 6: Enablers of a successful waste management plan



Source: Arthur D. Little analysis

### Regulation and enforcement

For emerging countries where compliance to established regulations is low, stricter regulations and proper enforcement are crucial to success. Governments must assess existing regulations to ensure they align with a country's defined strategic direction and are tailored to the different sectors (e.g., commercial and industrial sectors may focus on penalties and control systems, while stakeholder engagement may be the focus for the residential sector). Governments should also set up regulation to avoid waste generation in the first place by promoting certain activities, such as circular economy, mono-materialism, and avoidance of secondary packaging. Moreover, to incentivize treatment and recovery, stricter regulations and penalties should be placed on landfilling.

The relevant authorities must have the ability to enforce these regulations and must be equipped with the necessary political support, manpower, training, and tools. Tracking and control systems installed at points of entry (e.g., seaports and land borders) as well as on transport vehicles can enable proper control over illegal dumping or unwarranted deviations.

### Awareness and communication

Waste management authorities should conduct awareness and communication activities to engage the different commercial, governmental, educational, and residential sectors. These should involve a detailed communication plan that utilizes a wide range of channels (e.g., television campaigns, social media, workshops, education programs at schools, and labels on products and receipts) to direct tailored messages aimed at the different stakeholder groups. The objective is to provide guidance on and awareness around proper waste management and sorting, as well as increase the level of transparency and communication between policy makers and stakeholders. Many of the decisions made around policy (e.g., total ban on waste imports) can have wide-reaching repercussions on the industrial sector, so it is important that decision makers fully engage with sector representatives before enacting new policies.

### Financial instruments

Waste-specific financial instruments typically comprise two categories: financial incentives and cost recovery mechanisms. Emerging countries should utilize financial incentives that reflect the waste hierarchy and are aligned with the externalities of the waste material. Across Europe, there are several examples of successful implementations, such as deposit refund systems, financial grants, tax cuts, and discounts.

Authorities should consider cost recovery mechanisms such as "polluter pays" systems and "extended producer responsibility" (EPR) to reduce the financial burden of waste management on the government. Polluter pays systems require that the generator of the waste bears the costs of managing it, through simple mechanisms such as cost-based taxes on residential space. Developing countries can use more advanced collection mechanisms (pay as you throw) and gate fees or tipping fees for using treatment/disposal infrastructure to support the economic viability of treatment facilities (e.g., recycling and WTE) and to favor certain treatment types over landfilling.

EPR, on the other hand, is aimed at recovering waste management costs from the producers and importers of products. Through regulations, these players are expected to form a "producer responsibility organization" that is tasked with supporting the collection, treatment, and final disposal of their products. The EU, for example, has enacted legislation that requires EPR measures from producers and importers of packaging materials. A similar system, if applied in emerging countries, would decrease some of the financial burden on the government and encourage producers and importers to utilize more eco-friendly products.

## Planning and database

Waste authorities should establish a national database that contains the key information (e.g., volumes, capacities, composition, and outputs) stakeholders require to achieve success. Through consistent data analysis, including the tracking of waste streams and the way they are treated, a government can make more effective policy decisions and track the progress of initiatives and targets. In turn, a government can provide the private sector with reliable information about investment opportunities. To achieve this, waste authorities should establish a set of responsibilities and processes to engage, track, and collect the necessary information from the different ecosystem stakeholders.

## Private sector participation

Private sector participation plays a vital role in waste management across the entire length of the value chain. The private sector can support technical and economic efficiency, and the mobilization of private investment can expand the financial resources available for infrastructure. For the private sector to succeed, however, government support is imperative, including a long-term vision and regulatory certainty.

To engage the private sector, authorities must utilize more advanced and technically up-to-date **contract types** (including PPPs) to ensure more attractive opportunities for investors. Waste authorities should also launch initiatives focused on the **ease of doing business** by reducing licensing and setup durations and complexity.

There have been several examples where the private sector has initiated circular business models for selected waste streams (mattresses, paper, and plastics in the Netherlands, for example). Governments should support such initiatives and ensure to align legislations and incentives.

## Import/export

The waste trade is generally governed by international regulations and treaties such as the Basel Convention, as well as EU and local-level regulations and standards. To efficiently manage their waste trade activities, emerging countries must consider numerous factors, including treatment costs, transportation costs, availability of treatment facilities, and local demand for recycled material and expertise. Emerging nations might even consider building a regional recycling hub for specific waste streams that require scale of operations.

## 3. Conclusion

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Waste poses challenges that are anticipated to become increasingly severe for emerging economies unless countries take adequate measures immediately. Improper management can have both local and global adverse effects, including resource contamination, health repercussions, and negative impacts to climate change. A clear, pragmatic national direction and governance, which can be cascaded down to the local government level, can provide a clear path forward to resolving the waste problem in the shorter term and align with the long-term ambition of designing waste out of value chains through the circularity concept. To maximize the chances of success, emerging nations must put in place clear and ambitious KPIs to monitor the progress of the sector and identify risk mitigation actions.

Considering even a moderate case scenario where emerging countries<sup>1</sup> would abandon dumping and embrace a 40%<sup>2</sup> diversion from landfilling, this would result in approximately 194 Mt of CO<sub>2</sub>e reduced – equivalent to the CO<sub>2</sub> emissions in the Netherlands in 2019 – and approximately 14.5 TWh in energy recovered – equivalent to Slovenia's energy consumption in 2019. This can be achieved with a 10-year TOTEX system cost of US \$41/ton.<sup>3</sup>

<sup>1</sup> Including Bangladesh, Myanmar, Malaysia, India, Philippines, Nigeria, Egypt, Algeria, Turkey, and Morocco.

<sup>2</sup> 25% recycling and composting, 15% WTE. The exact number depends on waste composition and technology used.

<sup>3</sup> Capital expenditure plus operational expenditure (does not include transportation costs and is correlated with local cost of energy and labor).

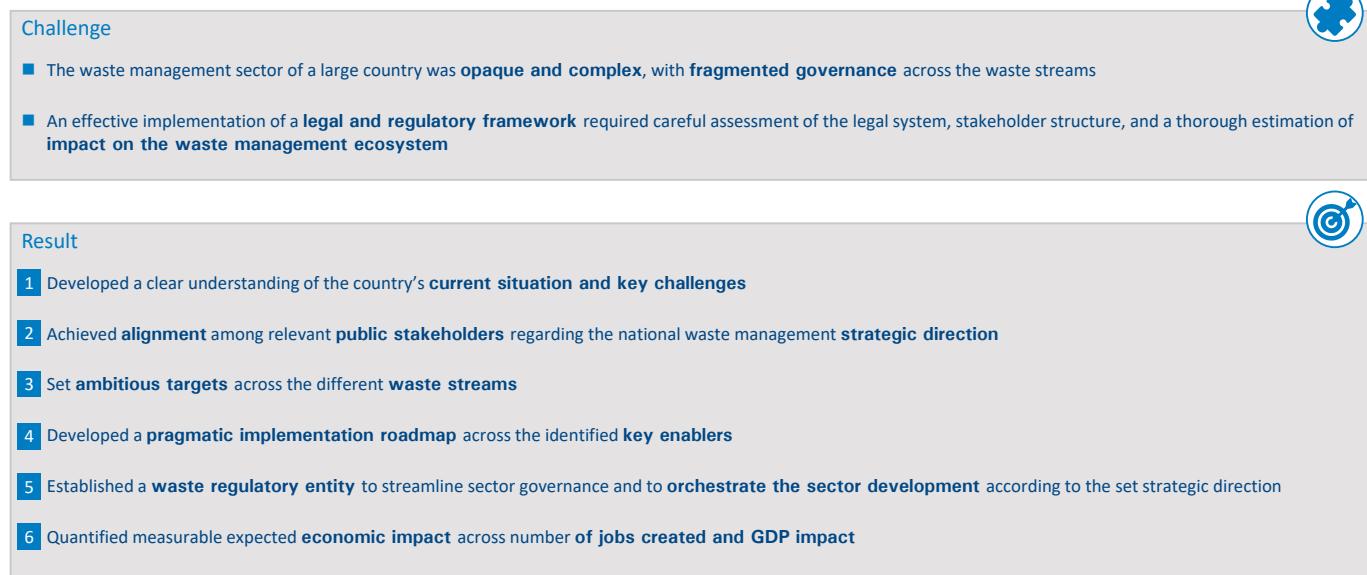


## 4. How Arthur D. Little can help

Arthur D. Little's team of waste management advisory experts can help in all aspects of a country's waste management improvement program. We have unparalleled depth of insight into the trends, drivers, and constraints across countries, as well as in state-of-the-art waste treatment and recycling technologies. We can help governments and waste management operators to (see Figure 7):

- Define overall country **strategies**, including circular economy concepts, and quantify expected **impact across key relevant dimensions** (i.e., environmental, social and economic).
- Detail underlying **sector models** and **necessary policy instruments**.
- Quantify **tariff and waste management cost recovery mechanisms**.
- Structure and define the **organization structures** of public and private waste entities and develop the associated **business processes**.
- Plan necessary **infrastructure**.
- Scout and assess potential waste **technologies** (preventing the implementation of conventional solutions that will become obstacles to moving to a circular economy).
- Develop a **private sector participation roadmap** and support its participation in creating the infrastructure and delivery of services.
- Design **stakeholder engagement frameworks**.
- Prepare **communication/awareness campaign strategies**.

Figure 7: Arthur D. Little project example and lessons



Source: Arthur D. Little analysis

# Notes

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#### Waste management

Tackling the challenge in emerging countries

#### **Arthur D. Little**

Arthur D. Little has been at the forefront of innovation since 1886. We are an acknowledged thought leader in linking strategy, innovation and transformation in technology-intensive and converging industries. We navigate our clients through changing business ecosystems to uncover new growth opportunities. We enable our clients to build innovation capabilities and transform their organizations.

Our consultants have strong practical industry experience combined with excellent knowledge of key trends and dynamics. ADL is present in the most important business centers around the world. We are proud to serve most of the Fortune 1000 companies, in addition to other leading firms and public sector organizations.

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