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BASEL CONVENTION

Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
Fifteenth meeting
Geneva, 26–30 July 2021 and 6–17 June 2022*
Agenda item 4 (e)

Matters related to the implementation of the Convention: Basel Convention Partnership Programme

Basel Convention Partnership Programme

Addendum

Revised draft overall guidance document on the environmentally sound management of household waste

Note by the Secretariat

1. As is mentioned in the note by the Secretariat on Basel Convention Partnership Programme (UNEP/CHW.15/18/Rev.1), the annex to the present note sets out the revised draft overall guidance document on the environmentally sound management of household waste for consideration and possible adoption by the Conference of the Parties.

2. The revised draft overall guidance document referred to above was prepared by the Household Waste Partnership working group. A previous draft of the guidance document was submitted to the online segment of the twelfth meeting of the Open-ended Working Group, at which time the Working Group agreed to invite Parties and others to submit comments on the revised draft overall guidance document by 15 October 2020, and that the draft guidance would then be further revised for consideration and possible adoption by the Conference of the Parties at its fifteenth meeting. The present draft incorporates the comments received in response to the invitation of the Open-ended Working Group.

3. The present note, including its annex, has not been formally edited.

* In accordance with decisions BC-15/1, RC-10/2 and SC-10/2 of the conferences of the Parties to the Basel, Rotterdam and Stockholm conventions, the 2021/2022 meetings of the conferences of the Parties are being held in two segments: an online segment held from 26 to 30 July 2021 and a face-to-face segment to be held from 6 to 17 June 2022 in Geneva.

Annex

Overall guidance document on the environmentally sound management of household waste

Developed by the Household Waste Partnership working group

(Draft updated version of 1 December 2021)

Contents

Overview of the guidance on ESM of household waste

A. Introduction

1. One of the challenges faced by national governments and municipalities, particularly in developing countries, countries with economies in transition, and small island developing States (SIDS), is the environmentally sound management (ESM) of household waste. The ESM of waste is defined as "taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes".[1]

2. This overall guidance document on the environmentally sound management of household waste is developed in accordance with decisions BC-13/14 and BC-14/19 of the Conference of the Parties to the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal (hereinafter referred to as "the Convention"). Household waste is classified under the Basel Convention as requiring special consideration (Basel Convention, Annex II, Y46 "Waste collected from households") because it may contain hazardous wastes, such as unused cleaning products, if not separated at source. This guidance contains case studies and good examples related to the environmentally sound management of household wastes and addresses prevention and minimization of household wastes and separation at source, collection, transport, recovery and final disposal of household wastes, taking into account the waste management hierarchy.

B. Objectives of the guidance

3. This guidance has been developed for decision makers. Local authorities generally have responsibility for waste management within a local area, but a range of industries, businesses, communities and individuals are all involved in waste management. An objective of the guidance is to promote and share existing practical and concrete solutions in order to assist stakeholders in achieving the ESM of household waste (see Figures 1 and 2).

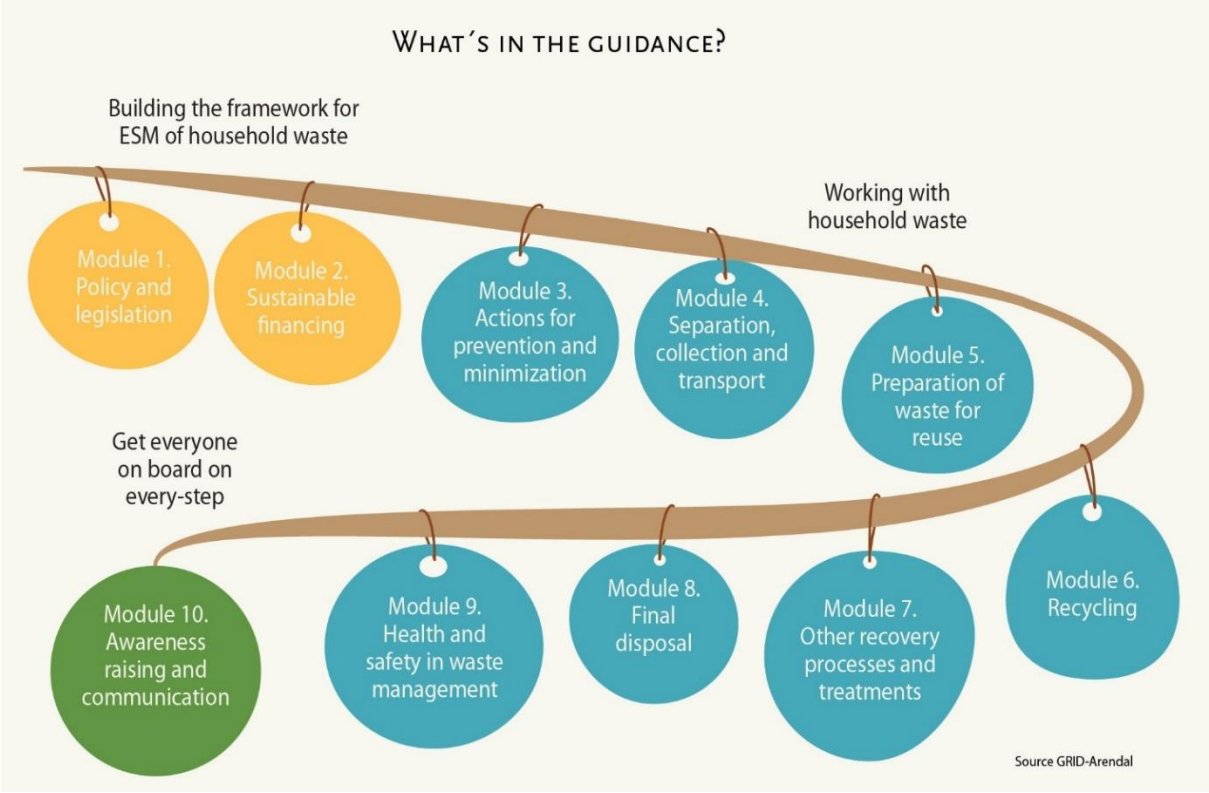

Figure 1. What's in the guidance?

4. The guidance aims to:

(a) Inform planning, investment and management decisions for the ESM of household waste

[1] Article 2.8 of the Basel Convention
https://www.basel.int/portals/4/basel%20convention/docs/text/baselconventiontext-e.pdf

by setting priorities for the ESM of household waste;

(b) Improve knowledge of environmentally sound waste management approaches.

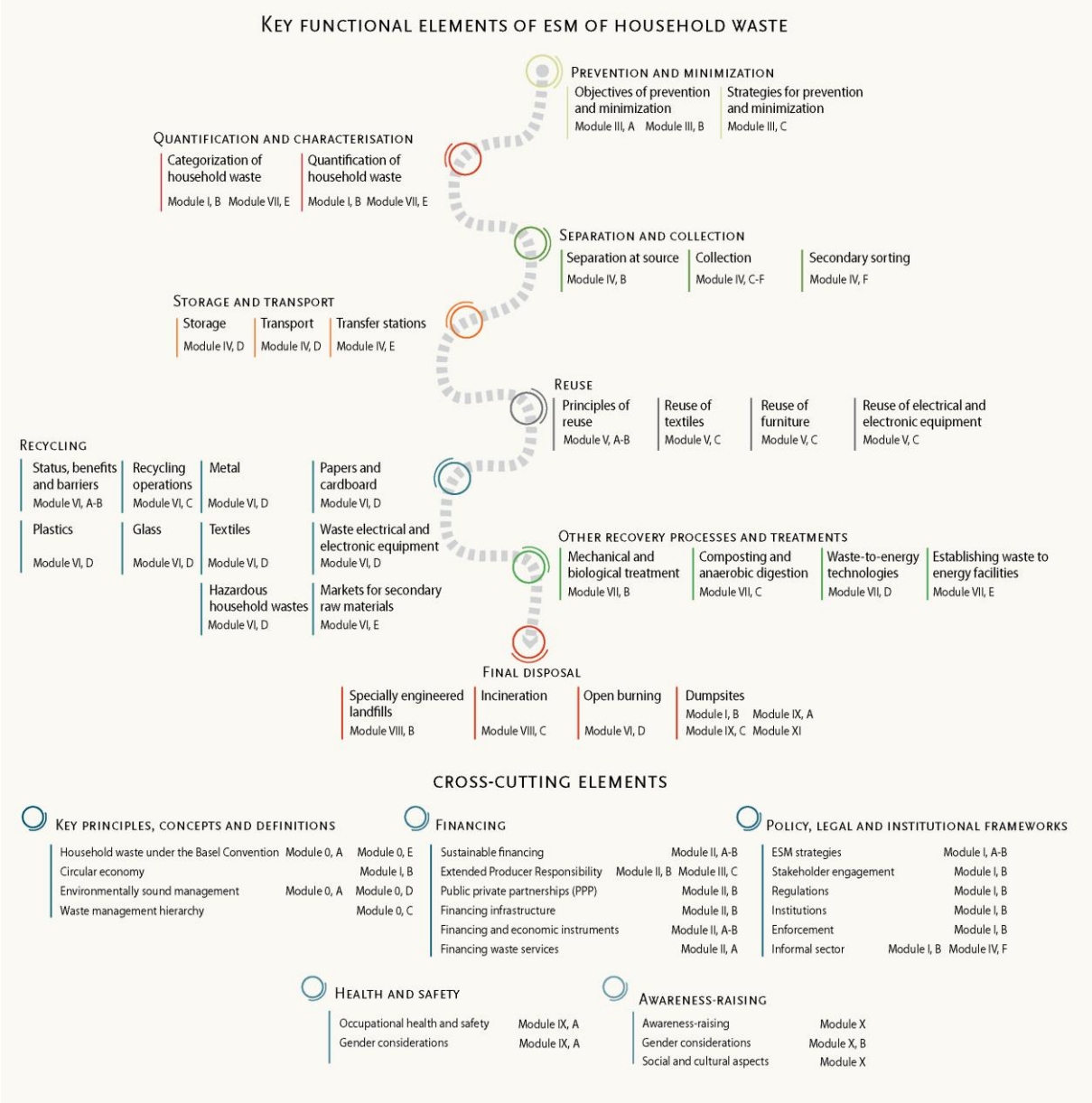

Figure 2. Key functional elements of the ESM of household waste

5. The guidance follows the principles of the waste management hierarchy: reduce the quantity of waste generated; maximise the number of products, objects or substances that can be reused or recycled; recover energy and dispose of only where needed. It references other relevant guidance documents produced under the Basel Convention, including the practical manuals on the promotion of the ESM of wastes and guidance on the prevention and minimisation of waste. These and other tools are compiled in the ESM Toolkit,[2] which has been developed by the Expert Working Group on ESM, as well as the large number of technical guidelines.[3] The guidance provided in this document is general in nature and elements will be relevant to both urban and rural settings, and can be adapted for different scales and locations.

2 http://www.basel.int/Implementation/CountryLedInitiative/EnvironmentallySoundManagement/ESMToolkit/Overview/tabid/5839/Default.aspx

3 http://basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/TechnicalGuidelines/tabid/8025/Default.aspx

C. Waste management hierarchy

6. The waste management hierarchy ranks waste management options according to sustainability[4] and what is best for the environment.[5] The aim of the hierarchy is to optimise resource efficiency and reduce the need for final disposal to the extent possible. Top priority is accorded to preventing and reducing waste production. If waste is not produced, then there is no need for disposal. Conversely, by reusing a product, object or substance that is not a waste, for the same purpose for which it was conceived, possibly after repair or refurbishment, waste generation is minimized. When waste is produced, the hierarchy gives precedence to recycling, then recovery, and last of all, disposal.

7. While some stakeholders may define their respective waste management hierarchies in slightly different ways, this guidance references the waste management hierarchy recognised by the tenth meeting of the Conference of the Parties to the Basel Convention (hereinafter "COP"): prevention, minimization, reuse, recycling, other recovery including energy recovery, and final disposal (see Figure 3).

8. The strategic framework for the implementation of the Basel Convention for 2012-2021, adopted by the COP through decision BC-10/2, features among its guiding principles the need to recognize the waste management hierarchy. It encourages treatment options that deliver the best overall environmental outcome, taking into account life-cycle thinking. Objective 2.2 of the strategic framework is to pursue the prevention and minimization of hazardous waste and other waste generation at source.

9. At its tenth meeting in 2011, the COP adopted the Cartagena Declaration on the Prevention, Minimization and Recovery of Hazardous Waste and Other Wastes[6]. Parties thereby committed to actively promote and implement more efficient waste prevention and minimization strategies, to take measures to decouple economic growth and environmental impacts, and to encourage more systematic and comprehensive global and regional efforts for improved access to cleaner production methods, including through capacity building and technology transfer.

10. In 2013, the COP adopted the Framework for the ESM of hazardous wastes and other wastes through decision BC-11/1[7]. The ESM framework calls on stakeholders to promote an integrated life-cycle approach and highlights that stakeholders should respect the waste management hierarchy. The ESM framework emphasises that waste prevention should be the preferred option in any waste management policy. Meanwhile, the framework also recognises that some wastes are already, or will inevitably be, generated and such wastes should be managed in an environmentally sound manner.

[4] Hansen, W., Christopher, M., and Verbuecheln, M., "EU Waste Policies and Challenges for Local and Regional Authorities" (2002).

[5] The proper application of the waste management hierarchy can have several benefits. It can help prevent emissions of greenhouse gases, reduce pollutants, save energy, conserve resources, create jobs and stimulate the development of green technologies. (See Waste-to-Energy Research and Technology Council (2009)).

[6] Annex IV to the report of the tenth meeting of the Conference of the Parties (document UNEP/CHW.10/28)

[7] Decision BC-11/1 available at: www.basel.int/TheConvention/ConferenceoftheParties/ReportsandDecisions/tabid/3303/Default.aspx

Figure 3. Waste Management Hierarchy[8]

D. Environmentally sound management

11. The Basel Convention Framework for the environmentally sound management of hazardous wastes and other wastes[9] was developed to identify strategies that countries could implement at the national level and collectively to address the challenges of implementing ESM of wastes in a systematic and comprehensive manner. Intended as a practical guide for all stakeholders participating in the management of such wastes, the framework:

(a) Establishes a common understanding of what ESM encompasses;

(b) Identifies tools to support and promote the implementation of ESM;

(c) Identifies strategies to implement ESM.

12. The ESM of household waste contributes to resource efficiency and also provides a mechanism for decoupling waste generation from economic growth and progressing towards sustainable patterns of production and consumption.[10] However, in many countries, authorities are struggling to make the changes necessary to cope with both the increasing volume and changing composition of household waste.[11] To achieve affordable and effective ESM requires significant planning with integrated, circular strategies relating to waste prevention and minimization, separation at source, collection, transportation, treatment, recycling, and disposal.[12]

[8] Decision BC-10/2 available at: www.basel.int/Implementation/StrategicFramework/Decisions/tabid/3808/ctl/Download/mid/11929/Default.aspx?id=1&ObjID=3757

[9] http://www.basel.int/Implementation/CountryLedInitiative/EnvironmentallySoundManagement/ESMFramework/tabid/3616/Default.aspx

[10] United Nations (2012) Resolution adopted by the UN General Assembly 66/288 The Future We Want [online]. Accessed https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/66/288&Lang=E

[11] Kumar, S., Smith, S.R., Fowler, G., Velis, C.J., Arya, S., Rena, Kumar, R. and Cheeseman, C., 2017. Challenges and opportunities associated with waste management in India. *Royal Society open science*, *4*(3), p.160764.

[12] Al Sabbagh, M.K., Velis, C.A., Wilson, D.C. and Cheeseman, C.R., 2012. Resource management performance in Bahrain: a systematic analysis of municipal waste management, secondary material flows and organizational aspects. *Waste Management & Research*, *30*(8), pp.813-824.

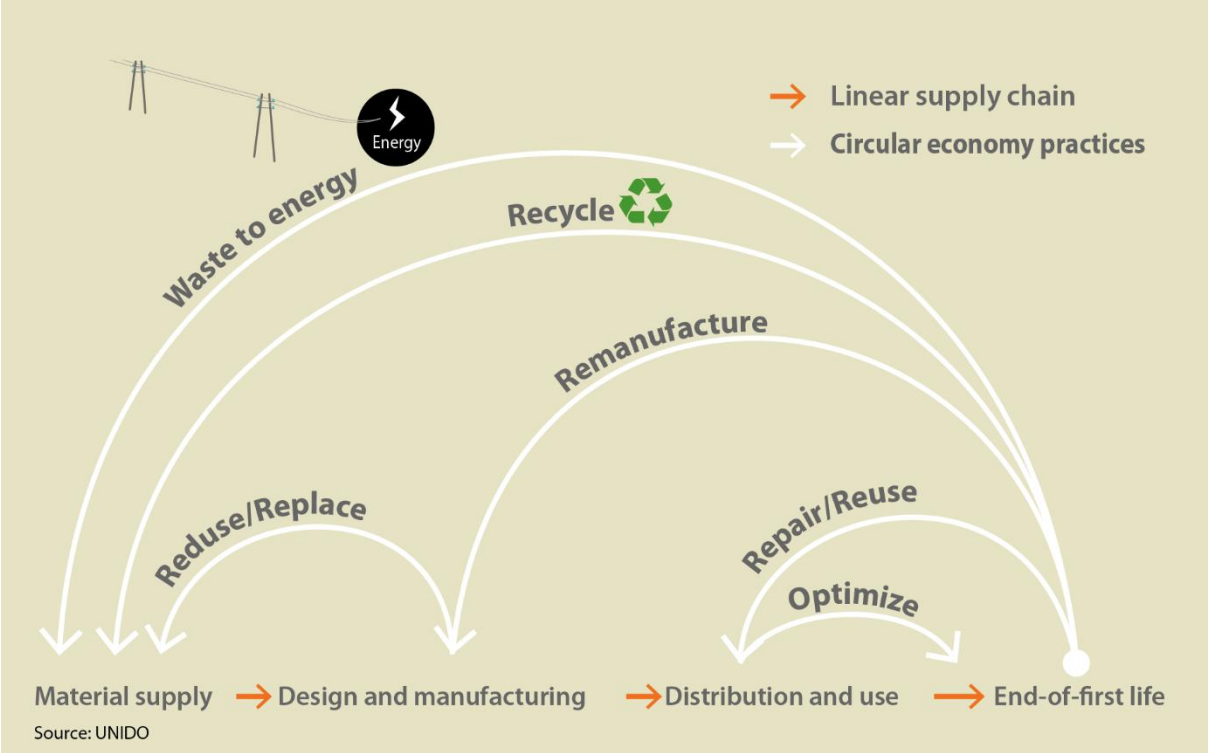

Figure 4. The waste management hierarchy in a circular economy (UNIDO)

E. Waste definitions

13. The Convention defines waste in Article 2(1) as substances or objects which are disposed of, intended to be disposed of or required to be disposed of by the provisions of national law.

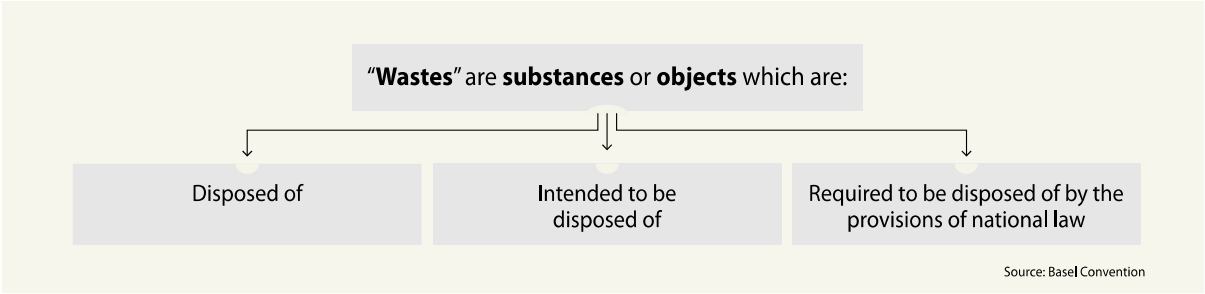

Figure 5. How is waste defined?[13]

14. "Disposal" is then defined in Article 2(4) as any operation specified in Annex IV to the Convention. Annex IV, entitled "Disposal operations", has two sections as pictorially represented in figure 6.

[13] Basel Convention on the control of transboundary movements of hazardous wastes and their disposal. https://www.basel.int/Portals/4/Basel percent20Convention/docs/text/BaselConventionText-e.pdf

Figure 6. Disposal operations as defined in the Convention

1. Hazardous waste

15. Hazardous wastes are defined as those wastes that:

(a) Belong to any category listed in Annex I of the Convention, unless they do not possess any of the characteristics listed in Annex III of the Convention;

(b) Are defined as, or considered to be, hazardous wastes by national legislation.

2. Other wastes

16. Other wastes are listed in Annex II (as Y46, Y47 and Y48[14]) and include the wastes collected from households that require special consideration. These "other wastes" include certain plastics that are technically and economically difficult to recycle or cannot be recycled.

F. Challenges with the ESM of household waste

17. The amount of waste the world produces is growing and without serious intervention it is expected to reach nearly 3.5 billion tonnes a year in 2050 (Figure 7).

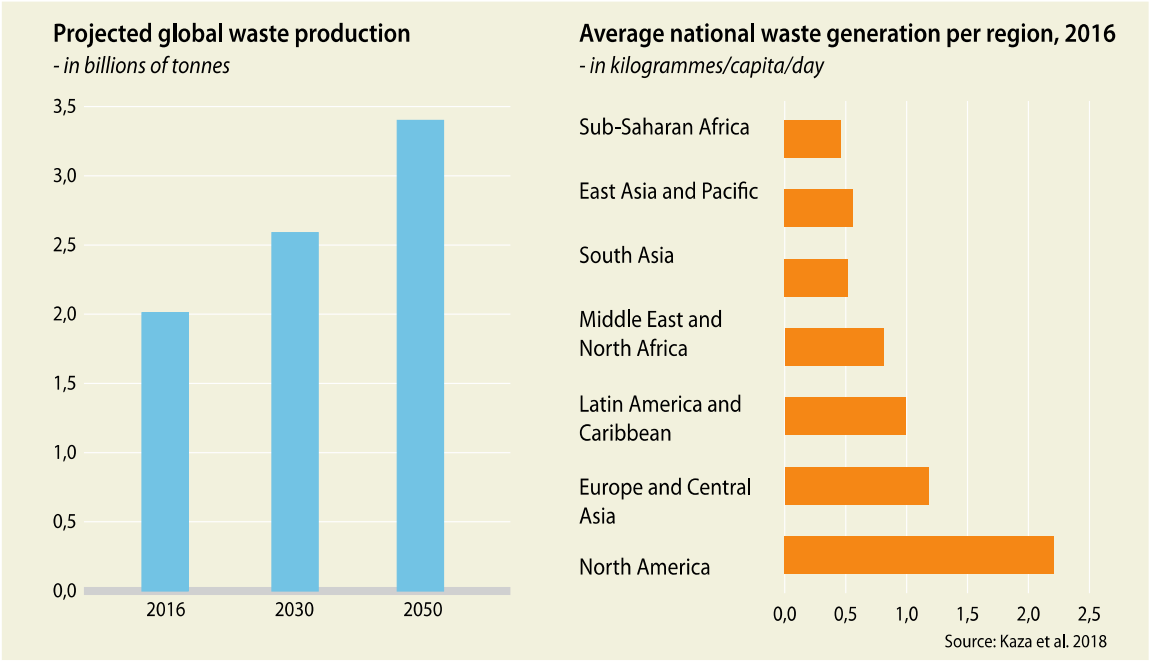

Figure 7. Projected global waste production in billions of tonnes and the average national waste generation

[14] The new Y48 entry became effective from January 1st, 2021.

per region in kilograms, per capita, per day in 2016.[15]

18. Increasing urbanisation and population growth have put enormous pressure on traditional waste disposal methods such as landfills. There is an increased awareness about the fact that poorly designed and maintained landfills pose a significant health hazard, produce large quantities of greenhouse gases and odours and leach toxic substances into the environment (Table 1).

IMPACT OF IMPROPERLY DISPOSED HOUSEHOLD WASTE

WASTE DISPOSAL	CONSEQUENCES	NEGATIVE EFFECT	ECONOMIC IMPACT
UNSANITARY LANDFILL	Contaminated leachate into soil and groundwater	May contaminate drinking water; run-off can contaminate streams and lakes	Loses from reduction in productivity due to ill-health; absence from work; increase in health care costs; may be necessary to drill new drinking water wells
	Requires land that could be better used for food production, housing or public amenity	Removal of habitats; loss of productive land (farm and forest); reduction in human well-being when changing from healthy land to waste fields	Higher food prices; lower land price; increased traffic on roads
	Landscape changes	May impact surface and groundwater flow	Losses from flooding and ecosystem damage
	Degassing	Greenhouse gasses directly into the air; odours from the waste	Contribute to climate change impacts; reduction in land value due to odours; fire hazard
	Wind	Spreading the waste outside the waste area	Potential loss due to spread of disease-causing pathogens
UNCONTAINED WASTE	Blocks drains and clogs waterways	Potential for increased flooding; ecosystem damage	Damage to infrastructure and potential loss of life
OPEN BURNING	Atmospheric pollution which may contain toxic chemicals	Potential to impact a large area	Increased health costs due to respiratory health problems
	Fallout of contaminated soot may pollute waterways and drinking water	Potential human and environmental impacts	Potential loss of income due to spread of toxins and pathogens

Source: GRID-Arendal

Table 1. Impact of improperly disposed household waste. Source: GRID-Arendal

G. Assessment and decision making

19. In setting out on a path to more sustainable waste management practices, decision makers must determine the current status of any existing waste management system, a path towards environmentally sound management within the relevant national context and develop a strategy on that basis and in accordance with the steps outlined in Figure 8. The modules that follow provide guidance on all aspects of the ESM of household waste to provide decision makers and other key stakeholders with the tools to implement an appropriate ESM strategy. Such a strategy should provide a road map for waste management planners and decision makers that is appropriate for their national contexts and the availability of resources.

[15] Kaza, S., Yao, L., Bhada-Tata, P. and Van Woerden, F., 2018. *What a waste 2.0: a global snapshot of solid waste management to 2050*. The World Bank.

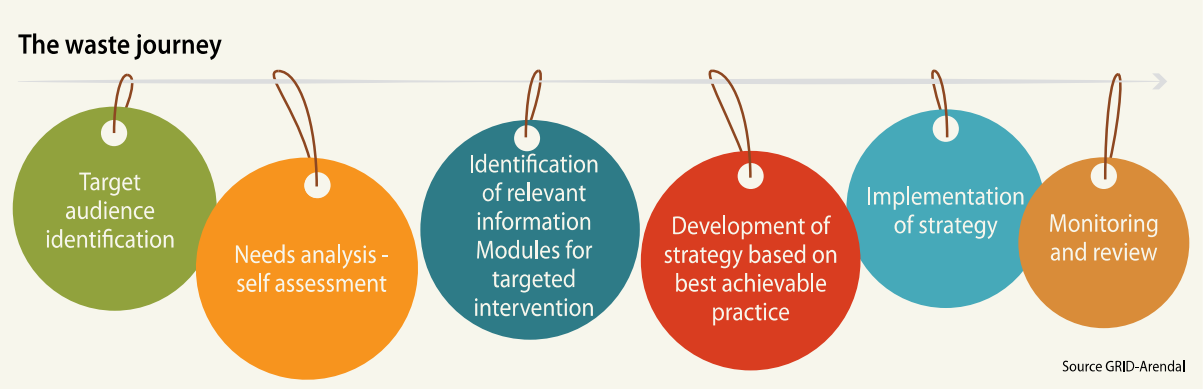

Figure 8. The path to ESM of household waste

I. Policy, legislation and institutional frameworks for the ESM of household waste

A. Introduction

1. This module explores the policy and regulatory framework required for the ESM of household waste. Legislation creates a framework for proper management of waste, including the protection of human health and the environment, and provides a platform for an effective waste management industry. Policies pertaining to waste are many and varied and are dealt with under numerous local, state, federal and international laws, regulations and codes of conduct, depending upon the type of waste and its lifecycle stage. The choice of a policy and regulatory framework will depend on many factors including political, institutional, social, environmental, and economic aspects.[1] Local authorities generally have responsibility for waste management within their local areas. They play an important role in providing household waste collection and recycling services, managing and operating landfill sites, delivering education and awareness programs, and providing and maintaining waste infrastructure.

2. As the development of a waste management system progresses, legislation generally changes focus, from public health and environmental protection, to the minimization of waste and reuse and recycling. Modern frameworks emphasise resource sustainability with waste avoidance, minimisation, resource recovery and the use of a risk-based approach to manage safety and environmental concerns.

B. Strategic waste management planning

3. To achieve sustainable and effective waste management, strategies must go beyond purely technical considerations to include the development of appropriate policies that address the political, institutional, social, financial, economic and technical aspects of household waste management. Developing a policy framework is the first strategic response to the challenges of household waste. The formulation of policy begins with agenda-setting, followed by decision making and finally implementation.

4. Effective strategies should enable policy makers to foster and enhance the implementation of the ESM of household wastes at the national, local and facility levels. These strategies should respect the waste management hierarchy and be reviewed on a periodic basis. Any strategy should clearly define the goals and objectives of each of the strategic areas and the identification of these strategic areas needs to be undertaken in consultation with stakeholders - integrating the interests of communities, businesses and governments. Strategies should also identify the organizations responsible for waste management. Can existing organizations adequately perform the duties envisaged or is a new entity required? Is there one agency with overarching authority for waste management or is the responsibility fragmented? The Basel Convention Guidance on the prevention and minimisation of hazardous and other waste includes steps to develop appropriate strategies[2] which includes determining the scope, objectives, timeframe and priority action areas for a strategy.

[1] McAllister, J., 2015. Factors influencing solid-waste management in the developing world.

[2] Basel Convention Guidance on waste prevention and minimization http://www.basel.int/Implementation/CountryLedInitiative/EnvironmentallySoundManagement/ESMToolkit/Guidanceonwasteprevention/tabid/5844/Default.aspx

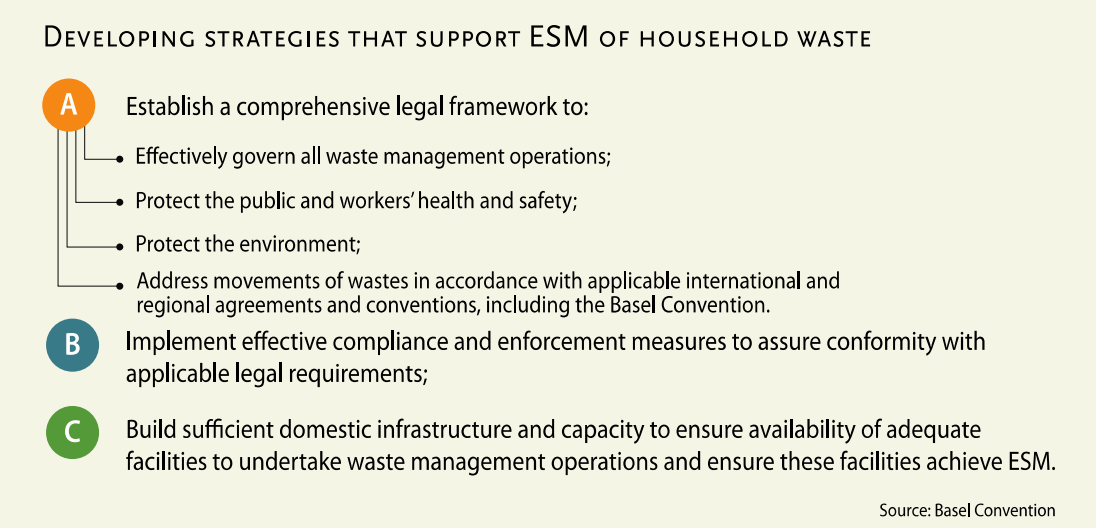

Figure 1.1. Developing strategies that support ESM of household waste.
Source: GRID-Arendal

5. The current state of waste management should be analysed in terms of the types and quantities of waste being generated, the adequacy of the existing infrastructure, the current legal framework and the availability of financing mechanisms. This situation analysis can be used to identify gaps and thus help to determine priority areas for action.

1. Stakeholders

6. The following stakeholders play a pivotal role in developing a waste management strategy:

(a) Government authorities – These authorities include waste authorities, government planning agencies, environmental management agencies, occupational health and safety agencies and public health agencies. Authorities should have waste management high on their respective agendas as the cost of inaction is high. Their commitment can be expressed in a charter or action plan for the ESM of household waste for a country or region.

(b) Households – Household behaviour plays a huge role in minimizing waste and maximising the recovery of resources for recycling. Separating recyclables such as organic waste, glass, plastic, paper and metal at the source ensures more efficient and cost-effective recycling. But recycling is only one part of the story – a shift towards more sustainable consumption is also required. Ideally, purchasing decisions should be based on consideration of the actual need to purchase the product, product durability, recycled content and recyclability.

(c) Waste management industry – There are increasing opportunities to create value from waste as recycling and energy recovery technologies advance. However, governments need to set recycling targets and provide incentives. Recycling is only possible if it is economically viable, which means that a market for recyclables must be present and functioning properly.

(d) Product manufacturers and retailers – Environmentally friendly products often come at a premium to other products. There is a need for shared responsibility to ensure affordability of these products, reduce packaging while ensuring that the quality, durability and safety of the products are maintained, and to make sure products are recyclable. Policy approaches that make manufacturers take some responsibility for the treatment or disposal of post-consumer products (e.g. extended producer responsibility) are required. This provides manufacturers with incentives to prevent waste at the source, promote product design for the environment and support the achievement of public recycling and materials management goals.[3]

(e) Informal sector (particularly in developing countries, LDCs and SIDS) - It is important to capture and reflect the views of those in the informal sector that play a significant role in waste management and also depend on the generation of household to support their livelihoods.

[3] In countries that are highly dependent on imports, the onus for EPR may fall on importers/distributors.

Box 1.1 Regulatory initiatives and policies in Chile to reduce the use of plastic[4]

Since 2018, the Chilean government has developed initiatives against the use and distribution of plastic bags and straws, and it banned plastic bags since the beginning of 2019 for big distributors. In the same year, it launched the Chilean Plastics Pact, the third national initiative joining the Ellen MacArthur Foundation's Plastics Pact[5] network. El Pacto Chileno de los Plásticos (The Latin American Plastics Pact) is led by the Ministry of Environment and the non-profit corporation Fundación Chile. It brings together local businesses, governments, and NGOs to work towards a circular economy for plastics. The Chilean government considers Chile Basura Cero[6] (Chile Zero Waste) part of its official circular economy programme creating regulations and policies that allow for recycling, proper waste management, and citizen involvement to achieve this goal.

2. Categorizing waste

7. The importance of understanding the nature of waste generated in the relevant jurisdiction of a waste authority cannot be overemphasised. Waste characterisation and quantification exercises are the essential building blocks for the development of a waste management strategy and plan. There can be several ways of carrying out such studies and they are best developed and executed in collaboration with the relevant stakeholders.

8. The success of waste management decisions relies on the accurate assessment of waste. Waste characterization and the development of inventories allow authorities to understand the nature and types of waste being generated in their jurisdiction. This provides assistance in planning post collection infrastructure, logistics, etc. The exercise can be carried out in several ways - either at source, at the secondary sorting locations or at the final disposal site. It is important to develop a robust methodology to capture the diversity of streams and materials that flow through the system. The Basel Convention provides guidance on the development of inventories in general and for a number of priority waste streams (see Box 1.2).

Box 1.2 Waste Characterization Methodologies

When categorizing waste, the number and nature of the fractions can be highly variable. The degree of complexity chosen may be influenced by a number of socio-economic factors, such as household income and expenditure, geography and climate, and available management options. The Basel Convention has developed the Methodological Guide for the Development of Inventories of Hazardous Wastes and Other Wastes[7] which provides a guide for developing inventories of waste.

The European Commission SWA-Tool[8] is an example of a comprehensive waste analysis methodology that can be used at a local and regional level to develop characterization and quantification of waste. The methodology describes an approach for the representative sampling of mixed residential and commercial waste.

Examples – developing and developed country contexts

Figure 1.2 illustrates the composition of waste in the city of Bangalore, determined by the Bruhat Bengaluru Mahanagara Palike (BBMP), the agency responsible for the disposal of solid waste.[9]

[4] https://publications.iadb.org/publications/english/document/Plastic-Waste-Management-and-Leakage-in-Latin-America-and-the-Caribbean.pdf

[5] https://www.newplasticseconomy.org/

[6] https://mma.gob.cl/economia-circular/chile-cero-basura/

[7] Development of Inventories of Hazardous Wastes and Other Wastes under the Basel Convention (UNEP 2015) http://www.basel.int/Implementation/Publications/GuidanceManuals/tabid/2364/Default.aspx#.

[8] https://cordis.europa.eu/project/id/EVK4-CT-2000-00030

[9] Naveen, B.P., Sivapullaiah, P.V. and Sitharam, T.G., 2013. Disposal options for solid waste of Bangalore city based on its characteristics. *International Journal of Environment and Waste Management*, *12*(1), pp.77-88.

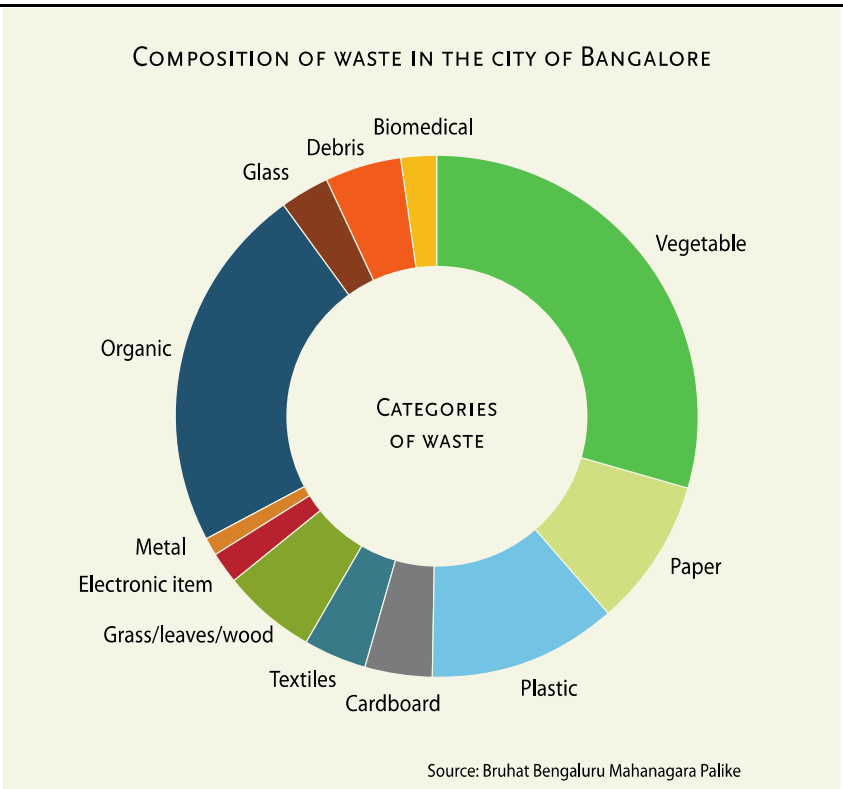

Figure 1.2 Composition of waste in a district of Bangalore

Canada completed a national waste characterisation study of residual municipal solid waste (MSW), which includes a detailed methodology for undertaking such a study, and identified the average national composition of residential residual MSW for 2016, illustrated in Figure 1.3 [10]

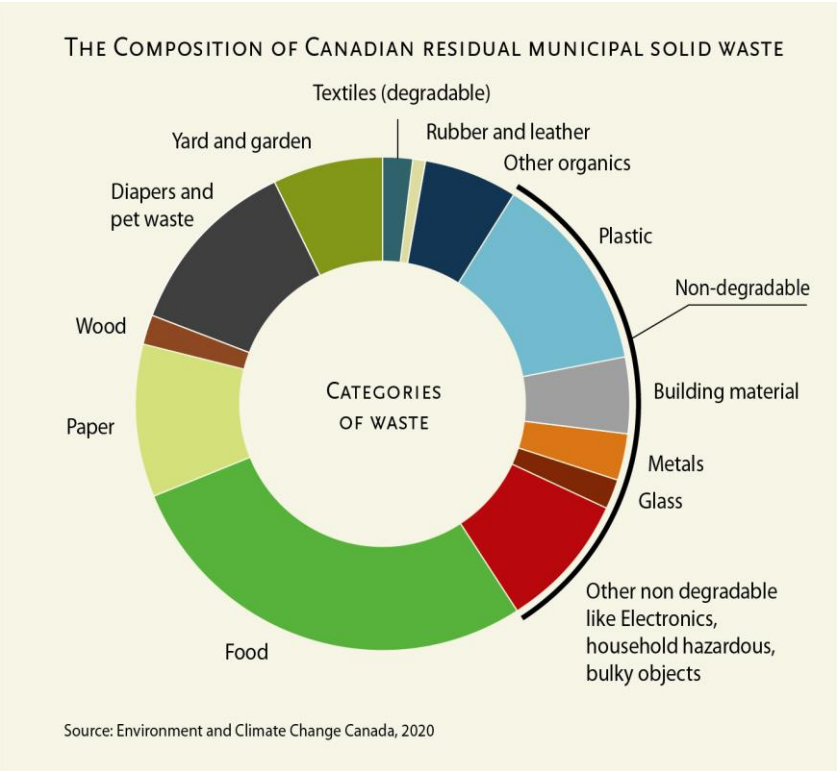

Figure 1.3. National average composition of Canadian residential residual MSW.

[10] Environment and Climate Change Canada, 2020. National Waste Characterization Report: The Composition of Canadian Residual Municipal Solid Waste.

3. Regulatory frameworks

9. Legislation creates a framework for proper management of waste including the protection of human health and the environment and provides a platform for an effective waste management industry.

10. There is a suite of guidance and tools developed and adopted under the Basel Convention that are intended to assist Parties in developing their national legal frameworks, national legislation and other regulatory measures to implement and enforce the provisions of the Basel Convention.[11]

11. As noted in Article 4 of the Basel Convention, each Party shall take appropriate legal, administrative and other measures to implement and enforce the provisions of this Convention, including measures to prevent and punish conduct in contravention of the Convention. The Framework for the ESM of hazardous wastes and other wastes notes that the ESM of wastes requires, among others, monitoring and enforcement and lists among the elements that should be taken into account when establishing, implementing or evaluating ESM regulatory matters (e.g. compliance, enforcement, consistency and complementarity. The Framework further lists effective compliance and enforcement measures to assure conformity with applicable legal requirements among the core goals of strategies to implement ESM.

12. The Guidelines for Framework Legislation for Integrated Waste Management,[12] also provide a framework and examples from a range of existing legislation, which are used to demonstrate how different countries have approached the legislative aspects of waste management.

4. Institutional capacity building

13. The delivery of waste management services requires the appropriate distribution of roles and responsibilities. This requires a degree of institutional capacity. In cases where there is no overarching authority, it will require coordination among the different institutions including ministries/government agencies with the responsibility for the environment and waste management. An organisational structure with a staffing plan (that gives due consideration to gender equality principles) and job descriptions should be developed. Training and human resource development are crucial for an effective household waste delivery service. Therefore, capacity-building measures should be embedded in the plan. This is required in all instances, but is especially important in developing states, where discrepancies often exist between the job requirements and the actual staff qualifications. Waste authorities are often viewed principally as waste collection and disposal authorities, and capacities related to waste diversion and development of appropriate resource recovery strategies are lacking. These issues can be addressed by attributing these roles to the authorities, conducting a training needs analysis and identifying gaps and appropriate actions. The development of waste prevention and recycling plans at a decentralised level can only happen if those on the field are trained to do so. The more diversion from the disposal site occurs, the more this is recognised and compensated.

5. Integrating the informal sector

14. In many developing countries, a significant percentage of waste may be managed by the informal sector. The difficulties found in establishing formal structures for household waste management, such as selective collection, sorting centres and sanitary landfills, result in the disposal of waste at open dumps. These dumps provide opportunities for informal workers to earn a living by scavenging and selling wastes for recycling.

15. A big challenge is to integrate informal waste collectors into formal waste management programmes. Municipalities can integrate waste pickers in the collection of waste at source, including going door to door, at separation and sorting centres, as well as in programs of reverse logistics or extended producer responsibility. Workers can be given rights over recyclables and guaranteed regular access to waste. To assign these rights, municipalities must enter into direct contractual or covenant relations with informal sector organizations. Municipalities or NGOs can provide legal support in establishing cooperatives, providing training, and creating other services to improve working conditions (such as identity cards, access to personal protective equipment and health insurance). Public institutions at the national and local levels can facilitate and integrate the contribution of the informal sector.

[11] http://www.basel.int/Implementation/LegalMatters/LegalFrameworks/tabid/2748/Default.aspx

[12] Guidelines for Framework Legislation for Integrated Waste Management, (UNEP February 2016) https://www.unenvironment.org/resources/report/guidelines-framework-legislation-integrated-waste-management

16. Guidance on how to address the environmentally sound management of wastes in the informal sector has been developed and adopted by the Basel Convention Conference of the Parties in 2019.[13]

Box 1.3 Wecyclers[14]

In Lagos city, Nigeria, improperly disposed of trash tends to clog gutters and drainage canals leading to floods during rainfall. Unmanaged trash can create stagnant water pools that are ideal conditions for mosquitoes and other disease vectors to breed and a burden for community residents who are forced to navigate obstructed roadways and deal with the smoke from frequent trash fires.

Wecyclers is a for-profit social enterprise that promotes environmental sustainability, socioeconomic development, and community health by providing recycling services in densely populated urban neighbourhoods. Households are given a chance to generate value from waste and provide a reliable supply of raw material to the local recycling industry. When the project started in 2012, only 40% of the city's waste was collected and only a mere 13% was recycled. Today, waste collection has increased and recyclable materials are recovered to produce new goods and reduce the flow of materials into landfills.

Collectors can use cargo bikes called "wecycles" to pick up recyclable waste from households and deliver it to collection, sorting, and packaging hubs in the Lagos area. Wecyclers reward collectors with points per kilogram of recycled waste, which they can exchange for essential goods such as food and household items. During the year, motorized tricycles, vans, and trucks were added to reach other areas across the Lagos city to collect materials recyclable into new items like tissue paper, stuffing for bedding materials, sturdy plastic furniture, aluminum sheets, and nylon bags. Wecyclers is a low-cost waste management infrastructure using mobile tech and cargo bikes, providing incentives for people to recycle their waste.

6. Decoupling waste generation from economic growth

17. Breaking the relationship between economic growth and the generation of waste through inefficient resource use is referred to as decoupling. As the world's population expands and resources shrink, it is not sustainable to maintain the "take, use, dispose" model of consumption that underpins the linear economy. A proposed alternative model incorporates the efficient use of resources and waste prevention and minimisation. Transitioning to this more circular economy, where resources are maximized, requires a major shift in institutional, business and consumer thinking – a shift towards recognition of the finite nature of natural resources and the inability of the planet to accommodate increasing levels of waste without significant environmental impact. The ESM of household waste is one of the important elements in the transition to a circular economy that promotes intelligent and equitable growth (Figure 1.4).

[13] http://www.basel.int/Implementation/CountryLedInitiative/EnvironmentallySoundManagement/ESMToolkit/Overview/tabid/5839/Default.aspx

[14] https://www.wecyclers.com/

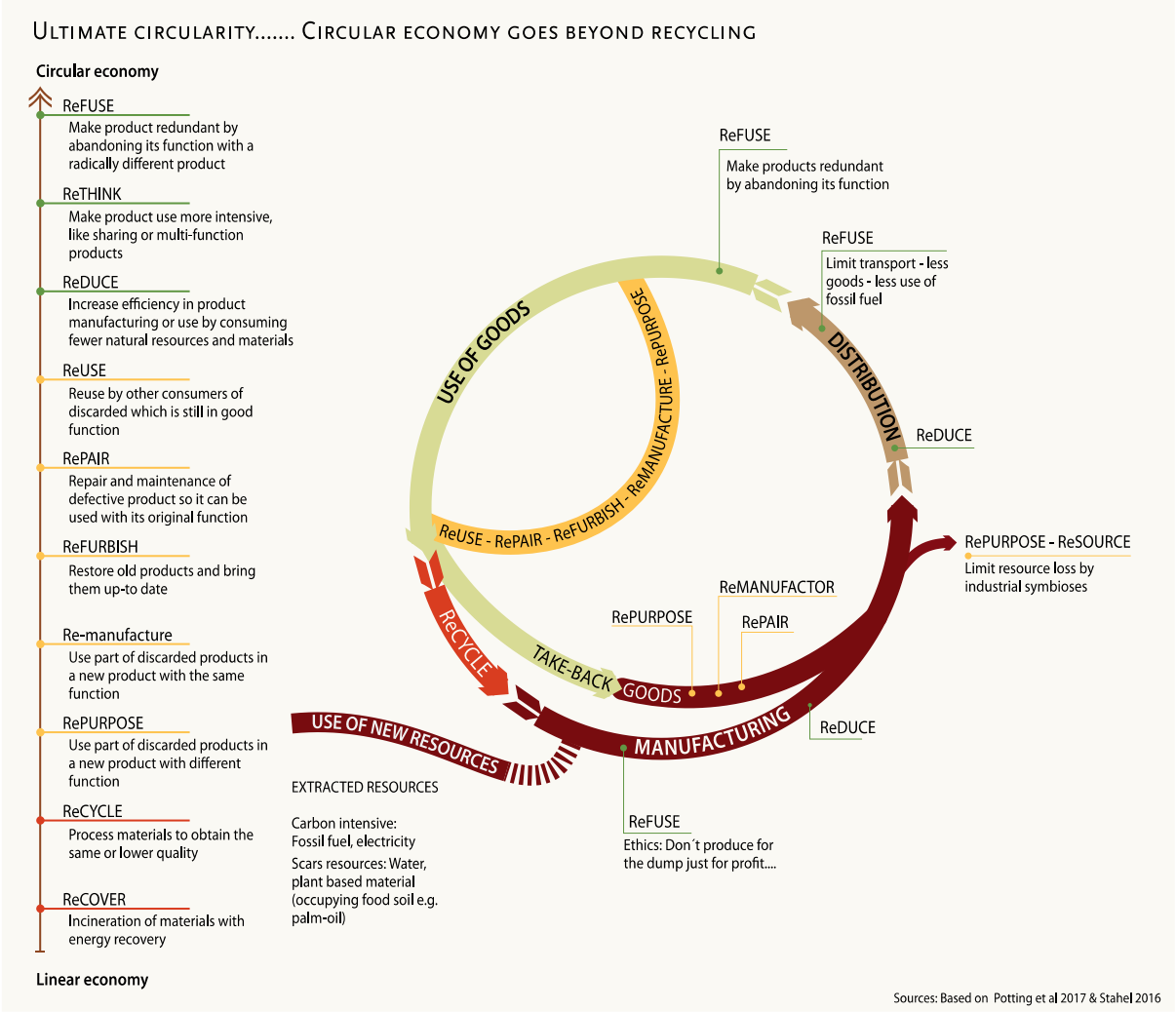

Figure 1.4 ESM of household waste in a circular economy

Box 1.4 Role of technology – examples from India

Typically, waste travels through three initial stages: collection, transportation and aggregation, before it is either recycled, energy is recovered through incineration, or it is finally disposed of, usually in landfills. The increasing complexity of urban waste management in India is generating innovations in the management of waste. It is important to note that the most successful technologies are the ones that have been designed to address specific challenges that emerge during the course of implementing waste plans. Some recent technologies include:

- Waste sorting – self sorting e-bins for businesses that sort and compress waste and communicate with collectors when full;[15]
- Collecting – in-vehicle monitors and cameras that allow drivers to identify contaminated bins before they are tipped into the truck; sensors and bin weights to help households and authorities to monitor sustainability targets and impose fees; electric vehicles that reduce emissions; de-packaging technology that can separate unused expired food and liquids from packaging to recover organic material; technology to separate valuable or toxic metals from household waste; solar powered compactors.

Cities like Pune, Indore and Chennai in India that have scaled up door-to-door collection have witnessed innovations. Interesting examples include Indore, where a mobile device has been developed with a biometric scanner[16] to streamline and digitise daily rosters. This has helped to cut absenteeism. The city

[15] http://www.bine.world/howitworks/

[16] Integrated Solid Waste Management Solution |Integrated Solid Waste Management Solution | Fingerprint Time Attendance, Access control, Scanner, Software, Biometric Time attendance machine, access control Security

of Surat has plans to advance towards a retina scanning technology for the same application. Bangalore has joined with a private IT firm to launch a platform called 'I Got Garbage'[17] with the aim of streamlining and empowering the work of informal sector recyclers who are employed in the city 's dry waste collection centre. Chennai is in the process of improving working conditions by introducing battery-operated tricycles.[18] A popular technology for organic waste management is the mechanical Organic Waste Convertor[19] that cuts composting time to half. Several waste authorities in India and bulk waste generators have adopted this technology for food waste management.

system, Fingerprint Reader with SDK, Face & Iris Recognition Products & Services. (n.d.). Retrieved from https://www.bioenabletech.com/integrated-solid-waste-management-solution

[17] I Got Garbage - I Got Garbage. (n.d.). Retrieved from https://www.igotgarbage.com/

[18] Soon, battery-operated vehicles to clean Chennai- The New Indian Express. (2019). Retrieved from https://www.newindianexpress.com/cities/chennai/2019/may/16/soon-battery-operated-vehicles-to-clean-chennai-1977440.html

[19] https://owc.excelind.co.in/

II. Sustainable financing for the ESM of household waste

A. Introduction

1. The sustainable management of solid waste from cities and communities is essential to the physical and economic health of society. However, the infrastructure and the long-term operation of waste management can be the single highest budget item for many local administrations. Cities in low-income countries are spending about 20 percent of their budgets on waste management, and over 90 percent of waste is openly dumped or burned.[1] As cities grow rapidly, waste management systems and budgets also need to grow in order to manage the increasing amounts of waste generated. Both low- and middle-income countries often face budget shortfalls for waste services and thus a reduction of costs and recovery of fees is integral to the development of the sector.

2. Environmentally sound management of wastes from households will be optimized by selecting the appropriate economic instruments as described in this module. Economic instruments should supplement the regulatory and policy framework and should complement each other. There are various components and many possible combinations. Households may:

(a) Pay a fee or tax for general waste services;

(b) 'Pay as you throw' for separately collected waste streams;

(c) Sell certain waste and scrap material to collection points;

(d) Pay an advance disposal fee or an extended producer responsibility scheme fee when purchasing a product;

(e) Use deposit and refund systems in accordance with their consumption behaviour;

(f) Be subject to additional charges that are aimed at behaviour change such as a plastic bag levy or a landfill tax.

3. The charges and taxes listed above should be earmarked and collected in specific funds to support waste management development.

4. Other conditions defined at the regional or national level may be equally important in the financing of waste management. For example, there may be an incentive or disincentive to develop advanced waste management facilities, such as waste-to-energy plants, depending on the availability of access to the electricity grid or a gas network, the price charged to the consumer (tariffs) and the level of subsidy. The environmentally sound management of wastes from households can only be achieved with the understanding, cooperation and involvement of all citizens. It follows that identifying and then communicating with all stakeholders is essential.

B. Waste management finance

5. Waste management finance is made up of two components – financing of infrastructure and financing of the provision of service.

1. Financing of infrastructure[2]

6. Investments made by the municipality into waste management infrastructure generally include waste collection equipment such as containers, dustbins, collection vehicles, etc., and the establishment, operation and aftercare of waste management and disposal sites and treatment facilities. The investment in infrastructure is generally the largest one-off investment, so municipalities need to develop adequate financing models, which take into account all the advantages and risks associated with the respective investment.

7. Waste infrastructure investment generally includes the following cost items:

(a) Real estate acquisition;

[1] Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development; Washington, DC: World Bank. © World Bank.

What a Waste: An Updated Look into the Future of Solid Waste Management. (2018). Retrieved from https://www.worldbank.org/en/news/immersive-story/2018/09/20/what-a-waste-an-updated-look-into-the-future-of-solid-waste-management

[2] The World Bank publication, "What a Waste 2.0" identifies some benchmark costs (table 5.2, Page 104) that can be used as a guide for countries in comparing the actual costs with international benchmarks.

(b) Planning, project preparation, studies and permits;

(c) Site design and development;

(d) Geological and hydrogeological testing;

(e) Preparation of site and foundations;

(f) Construction works, including access roads;

(g) Machines and equipment;

(h) Measurement and control technology;

(i) Interim finance / interest.

8. These costs occur in different stages of infrastructure projects and can be covered from different sources, which include:

(a) Grants are issued for special purposes, are free of interest and do not need to be re-paid. These can come from national government, international donors, climate funds, development aid, etc.

(b) Loans need to be re-paid, and generally include interest and often have to be secured by guarantees from local or state level. Loan insurance may also be required. Loans can be sourced from (inter)national banks, donors, investors/investment funds.

(c) Bonds can be issued to investors by the city or a state to raise capital for large infrastructure projects. Money is repaid to the bond holders with interest. Bonds can be a cost-effective long-term borrowing strategy for authorities.

(d) Public-Private partnerships.[3]

(e) Private equity.

9. Depending on the source, or the mix of sources, of finance for the infrastructure projects, the total amount for annual repayment can differ considerably. The annual repayment, including interest, are capital costs (CAPEX) which are part of the total annual expenditures for waste management.

Box 2.1 Climate protection related finance

A number of national and global initiatives provide funding for waste management infrastructure projects that support the reduction of greenhouse gas emissions. For example, the Climate and Clean Air Coalition (CCAC, administered by UNEP) has provided over USD 6 million since 2012 in funding to the sector. The CCAC has also produced resources to aid cities wanting to access finance for municipal waste projects. These include a "Financing readiness questionnaire for the municipal solid waste sector",[4] designed to assist cities to be finance ready; a waste initiative webinar[5] that explains the finance ready toolkit; and a primer[6] to help cities make good financial decisions when looking to secure finance for large projects. To assist with planning and feasibility studies, the primer includes a data collection tool for assessing the budget required by a municipality for the allocation of services, as well as its revenue and debt.

Some additional examples of funding resources include:

- The United Nations Framework Convention on Climate Change (UNFCCC) Green Climate Fund (GCF) supports project preparation and large-scale project funding.
- The Climate Technology Centre and Network (CTCN) is a technology mechanism of the UNFFCCC that can provide technical assistance to develop projects for funding under the GCF or stand-alone projects.
- The Nationally Appropriate Mitigation Actions NAMA - Facility is funded by European states to accelerate low carbon development. The facility provides grants for climate mitigation projects.

[3] https://pppknowledgelab.org/sectors/waste.

[4] Financing readiness questionnaire for municipal solid waste sector. Climate and Clean Air Coalition (CCAC), 2018. https://ccacoalition.org/en/resources/financing-readiness-questionnaire-municipal-solid-waste-sector

[5] Municipal Solid Waste Financing Webinar. https://www.waste.ccacoalition.org/seminar/municipal-solid-waste-financing

[6] Primer for Cities for Accessing Financing for Municipal Solid Waste Projects. https://www.waste.ccacoalition.org/document/primer-cities-accessing-financing-municipal-solid-waste-projects

Example of climate protection related finance: Mozambique – Sustainable Waste Management – Laying the Foundations for a Circular Economy

Waste management in Mozambique has not been able to keep pace with the increase in waste volume brought about by rapid urbanisation and economic growth. It is estimated that 98 percent of waste is deposited in uncontrolled dumpsites that release large amounts of greenhouse gases. The NAMA Support project is working to assist the government in designing and implementing a programme of sustainable waste management that supports a circular economy. The assistance includes enhancing the legal and regulatory framework to reduce waste, including implementing the Regulation on Extended Producer Responsibility, the promotion of investment in a broad scale of management and infrastructure projects and awareness raising and institutional capacity building programmes. The initiative, which is in preparation phase, is expected to achieve emission reductions totalling 500,000 tCO_2e by the end of the project in 2024 and 2.8 million tCO2e by the end of 2030.[7]

2. Financing the operation of waste services

10. Financing waste services and annual running costs (operational expenditure referred to as OPEX) of a waste system includes:

(a) Personnel, salaries/wages;

(b) Energy;

(c) Raw material, consumables and auxiliary materials;

(d) Administration;

(e) Taxes, insurance, etc.;

(f) Testing and monitoring;

(g) Equipment rentals;

(h) Repairs, spare parts, maintenance;

(i) Replacements;

(j) Depending on market prices or tariffs, operational financing may include gains from sales of waste materials and/or sales of energy;

(k) Public education and outreach.

11. Annual expenditures of waste services (full costs) = OPEX + (annual repayment + interest for infrastructure development) + expenses for contracted services rendered by third parties/private sector. The total annual expenditures have to be recovered by the application of revenue-generating economic instruments, such as waste service fees/tariffs, gate fees, taxes, etc.

Box 2.2 A tool for estimating the cost of constructing and operating an organic waste management project

The Waste Initiative of the Climate and Clean Air Coalition (CCAC) provides a cost estimating tool for organic waste management. The Cost assessment tools can help modelling future costs in order to support decision making. The OrganEcs tool[8] helps estimate the costs associated with constructing and operating an organic waste management facility. It assists users in determining the expected internal rate of return, user inputs, appropriate gate fees, and the appropriate product sale price requirements (e.g. for compost, energy) in order to meet the specified investor returns.

3. Economic instruments

[7] https://www.nama-facility.org/projects/mozambique-sustainable-waste-management-laying-the-foundations-for-a-circular-economy/

[8] OrganEcs - Cost Estimating Tool for Managing Source-Separated Organic Waste - Version 2.1. https://www.waste.ccacoalition.org/document/organecs-cost-estimating-tool-managing-source-separated-organic-waste-version-21

12. Economic instruments in solid waste management have two major objectives: to cover costs and thus improve service delivery; and to reduce impacts by promoting waste minimisation behaviour by means of the pricing mechanism. Economic instruments do not substitute but complement and strengthen regulatory and other approaches in the respective policy area. From a public administrator's perspective, a distinction can be made between revenue-generating, revenue-providing and non-revenue (guidance) instruments. At each stage of the waste management process, different economic instruments may be appropriate.[9] Some examples include:

(a) Waste charges may create incentives for improved separation and waste reduction;

(b) Deposit-refund systems may improve waste separation and collection;

(c) Advanced disposal fees can provide the revenue so that the share of the recycling of certain materials increases;

(d) Landfill taxes are intended to divert waste from landfill to other waste management facilities (e.g. recycling or energy-recovery) or lead to the prevention of waste;

(e) Favourable energy or fuel tariffs can set a supportive framework for the development of waste-to-energy solutions.

13. A practical manual on extended producer responsibility (EPR) and financing was adopted by the Basel Convention Conference of the Parties in 2019.[10]

(a) An overview of revenue-generating instruments for waste management

14. Revenue generating instruments (Figure 2.1) can be in two forms:

(a) Those used to cover expenditure for waste management, for example:

(i) Waste service charge/user charges for collection, transportation and disposal services;

(ii) Gate fees at the waste management facilities;

(iii) Environmental levies - small fees levied indirectly through accommodation providers and other services, designed to pay for household waste management;

(iv) Licence fees for covering administration costs; etc.

(b) Those used to influence consumer behaviour, and the development of the waste sector, for example:

(i) Charges or taxes on waste generation;

(ii) Landfill or disposal taxes in addition to gate fees;

(iii) Charges or taxes on products at point of sale;

(iv) Fines for littering, illegal dumping.

[9] These will depend on cost-effectiveness, public acceptance, ease of implementation, etc. See https://publications.iadb.org/publications/english/document/Global-Review-of-Economic-Instruments-for-Solid-Waste-Management-in-Latin-America.pdf.

[10] http://www.basel.int/Implementation/CountryLedInitiative/EnvironmentallySoundManagement/ESMToolkit/Overview/tabid/5839/Default.aspx

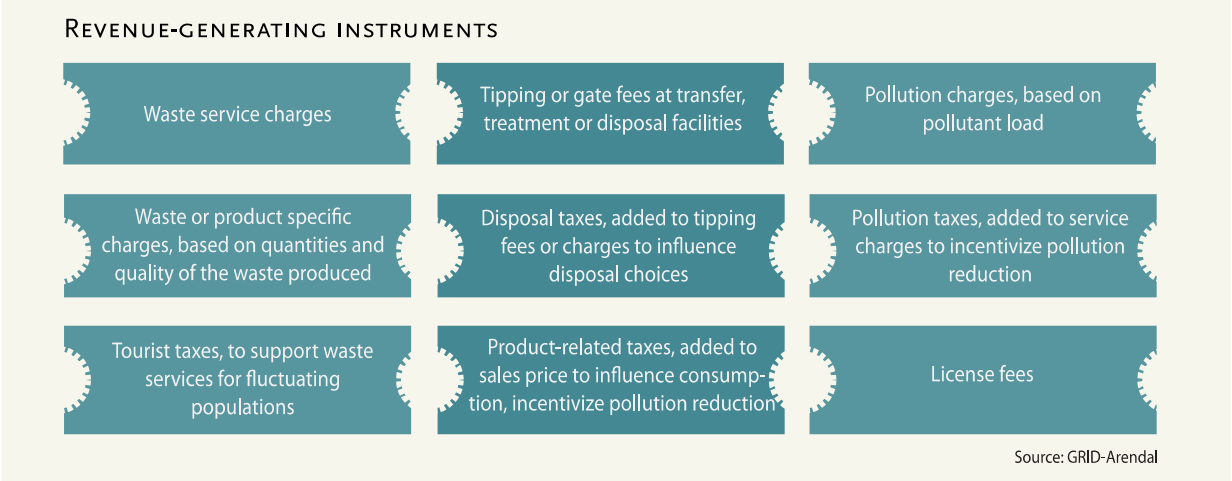

Figure 2.1 Revenue-generating instruments. Source: GRID-Arendal

15. An ideal scenario would be to charge the entire waste service in the form of cost-covering fees to each individual user according to the waste they generate. A waste charging scheme should ensure there is full coverage of the waste management related costs and there is fair allocation of these costs to the population as beneficiaries of the services. However, fee calculations may also need to consider socio-economic aspects and the consumers ability to pay. Covering the full-service costs solely through user charges may result in user charges that are not affordable for the majority of the population. Therefore, the full range of economic instruments need to be in applying economic instruments for sustainable solid waste management in low- and middle-income countries).

(b) Common waste service charging schemes[11]

16. A prerequisite for determining charging rates is to determine the amount of waste being collected and generated and understanding all the cost inputs that go into the waste management process.[12]

17. The most prominent types of waste service charging schemes include the following:

(a) Single flat rate:

This scheme consists of a single flat fee for all households. The fee covers the fixed and variable portions of the waste service and is independent of the amount of waste collected. The single flat fee provides no incentive to reduce waste, but it is transparent and simple to operate. Single flat rates can be implemented as a supplement to existing utility bills or as a separate bill to households.

(b) Multiple component fee:

A multi-component fee can be made up of a basic fee plus an additional fee for service. It can be charged per person, household, property and/or by bin/s provided. The variable charges depend on the service and can relate to waste volume or weight, collection frequency, bin rental, etc. Because multi-component fees include a fixed charge plus a variable fee, they may be complex in administration, but might encourage waste prevention.

18. Common options for determining a waste fee include:

(a) Volume-based (bin/container): charging for a fixed frequency of collection based on the volume of the bin;

(b) Volume-based (waste volume collected): charging based on the waste volume. This requires knowing the volume, either by measuring or schemes like the prepaid bag or tag-a-bag;

(c) Pickup frequency based: charging based on the frequency of emptying of a provided bin. A minimum number of pickups may be applicable;

(d) Weight-based: charging per unit weight of collected waste (typically applying to residual and bio-waste collection). Can be charged in combination with a fee per emptying.

[11] From Best Practice Municipal Waste Management 2018. https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2018-05-30_texte_40-2018-municipal-waste-management_en.pdf

[12] See Full Cost Accounting for Municipal Solid Waste Management: A Handbook. https://archive.epa.gov/wastes/conserve/tools/fca/web/pdf/fca-hanb.pdf.

Box 2.3 An example of linking waste service charging to electricity consumption

A novel scheme to finance waste has been introduced in Maputo, Mozambique. When first introduced, consumers with an electricity connection (90 percent of households) paid a flat fee for waste collection. The system was refined in 2007 with the introduction of a tariff that links the waste charge to electricity consumption. This means that households with above average energy use can pay up to two times more than regular energy users. Qualifying commercial waste producers are also included in the scheme but pay a higher tariff. There is a separate licencing and registration system for non-household waste producers who produce large volumes of waste. While the waste charge is the main financial instrument, revenue is also generated from disposal fees for private operators, fees for additional services and fines for illegal waste generation. The city is working towards full cost recovery – in 2012, the revenue from all sources covered nearly 70 percent of the cost of waste services.

Maputo serves as an example for the effectiveness of attaching the waste fee to a public facility, in this case electricity. It also demonstrates that the method used for collecting the fee is as important as the fee itself. A municipality like Maputo does not have many other sources of revenue and depends on the capacity of its citizens to sustain its services. This means that the quality and quantity of services are determined by their affordability. Here the sustainability model and the cost analysis worked as a protective barrier against unsuitable, unaffordable solutions.[13]

(c) Other financing options

19. Other financing options for the ESM of waste can also be considered. These include:

(a) Gate fees

Gate fees are levied on the volume of waste and type of waste delivered to a waste facility. The calculation of gate fees requires a detailed knowledge of the capital and operational costs of the facility and the development of a charging scheme for the different users of the facility or waste types delivered. Gate fees usually only cover the cost of disposal/processing of waste and not the costs of collection.

(b) Tourist taxes

Tourist taxes can be a mechanism to cover costs for waste management services in tourist areas. The increased volume of waste collection, transport and treatment as a result of visitors to an area can be considerable. This cost can be offset by an environmental tax or eco-tax.

Many countries charge a tourist tax. The tax may be collected at airports on departure, or as a tax included in airline or hotel bills. In the Balearic Islands of Spain, that include the tourist hot spots of Mallorca, Ibiza, Formentera and Menorca, tourists pay a tax of between 1 and 2 euros/day, depending on the length of stay. The revenue from the tax is used to provide infomation and surveillance at significant sites, cleaning of beaches and public sites supporting circular economy activities.[14]

(c) Landfill/disposal taxes

By increasing the price for disposal, landfill/disposal taxes may divert waste from landfill to recycling or energy-recovery. When the tax is collected in a specific fund, the revenue may be disbursed by specific mechanisms to aid waste sector development. An example for this approach is the disposal tax levied in Catalonia, Spain: it includes a landfill tax as well as an incineration tax. Both were introduced to discourage landfilling and incineration of municipal solid waste. The tax earnings from the Catalan disposal tax are earmarked for the Waste Management Fund (Fons de Gestió de Residus[15]) with the stipulation that at least 50 percent of the revenue generated must be used for financing waste pre-treatment. The Catalan Waste Management Fund is the most important instrument for financing waste management strategic goals and infrastructure development in the region.

[13] Economic Instruments in Solid Waste Management. Case Study Maputo, Mozambique. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH., 2012. https://www.resource-recovery.net/en/economic-instruments-solid-waste-management-case-study-maputo-mozambique

[14] Waste Management in the Balearic Islands 2018. https://www.collectors2020.eu/wp-content/uploads/2018/07/2018_09_26_COLLECTORS_Balearic-islands.pdf

[15] http://residus.gencat.cat/ca/ambits_dactuacio/recollida_selectiva/residus_municipals/materia_organica_form_-_fv/perque_sha_de_valoritzar/motius_economics/

20. Where gate fees or disposal taxes are implemented, they must be accompanied by a rigorous monitoring and enforcement program to prevent the illegal disposal of waste be persons not wanting to pay the fees. Landfill, waste or product related taxes, which are collected in a special fund, need defined spending policies and procedures. The spending priorities, and the application and implementation requirements for obtaining financial support from the fund have to be clear and accessible for potential applicants. A transparent disbursement and control mechanism needs to be in place and the replenishing mechanisms of the special fund should be defined and transparent.

(d) Revenue or other incentive providing instruments for waste management

21. Revenue providing instruments are subsidies, which are designed to encourage waste reduction practices such as recycling or improved waste management. These subsidies can be in the form of favourable energy tariffs, tax exemptions and lower prices for material usage such as renting of space or equipment to third parties. They can include schemes for collecting a refund (e.g. for bottles and cans), take-back or buy-back (e.g. the traditional scrap yard) and cap and trade (e.g. for landfill).

22. Deposit systems for packaging containers, such as cans and bottles, ensure that the purchasing price of a product includes a deposit amount that is paid back to the consumer when the container is returned after use. If well managed, the deposit system enables very high collection rates and the potential for high reuse and recycling. A deposit scheme may be run by a system operator on behalf of importers and domestic producers. Barcodes may be used to identify individual goods, to permit their return and to deliver the promised refund that may be in the form of traditional money, a reimbursement in kind, or another asset or a ward. The deposit system in Norway has been running since 1999 and has an efficiency rate of 97 percent.[16] The collection systems are located in shops or petrol stations. Similar systems have been established in a number of developed countries such as Canada, Estonia, Finland, Germany, and Lithuania. Deposit refund systems are also quite prevalent in SIDS, having been established in Barbados, Saint Vincent and the Grenadines, Kiribati, Republic of Marshall Islands.[17]

23. Take-back or buy-back systems may refund part of the original purchase price to encourage citizens to deposit used and end-of-life goods at collection points. Retailers may encourage the return of used and end-of-life with discounts on refurbished or new replacements.

24. Cap and trade systems can operate if, for example, there is a cap on the total quantity of waste that can be landfilled. Individual allowances for landfill are allocated which can be subsequently traded. There are also credit-based schemes for packaging waste, which allocate targets for recycling to industry, and require proof of target achievement through holding of tradable certificates that are produced when a tonne of waste is recycled.

4. Operation models and public private partnerships

25. Transferring municipal waste management tasks to the private sector is common throughout the world. It may involve all services or certain activities such as the operation of recovery facilities or for the collection and onward recovery of certain material streams. Municipalities often own areas or facilities, but outsource operations to the private sector. For example, private companies and charities provide containers on streets in order to organise collections of specific clothing, shoes, toys, for reuse and recycling. Where the containers are on municipal land, agreements with municipalities are made. Municipalities can also form public private partnerships to implement waste management. For example, the construction and day-to-day management of container parks where private companies separate waste within the container park and provide the onward transport and sale of materials to sorting and recycling companies. Local authorities may also register waste facilities in their areas of responsibility to carry out waste management services and then ensure the environmentally sound management of these facilities.

Box 2.4 Results-based finance (extracted from Results-based financing for municipal solid waste[18]

Results-based financing (RBF) is a financial mechanism where payment for solid waste services is tied to the achievement and verification of pre-agreed targets. A basic feature of RBF is that financial

[16] https://www.environmentagency.no/legislation/waste-regulations/chapter6-take-back-systems-for-beverage-packaging/.

[17] Reloop Global Deposit Book 2020. https://www.reloopplatform.org/reloops-global-deposit-book-2020/.

[18] Banna, Farouk Mollah; Bhada-Tata, Perinaz; Ho, Renee Yuet-Yee; Kaza, Silpa; Lee, Marcus. 2014. *Results-based financing for municipal solid waste (Vol. 2): Main report (English)*. Urban development series knowledge papers; no. 20. Washington, DC; World Bank Group. http://documents.worldbank.org/curated/en/237191468330923040/Main-report.

payments or in-kind rewards are provided to a service provider conditional on the recipient undertaking a set of pre-determined actions or achieving a pre-determined performance goal. RBF offers opportunities to innovate in the use of development finance in the solid waste sector and to achieve results. Until recently, RBF principles and designs had not been widely applied in the solid waste sector, apart from the use of some performance-based contracting with private providers of solid waste services and carbon finance for methane mitigation. Given existing weaknesses and the challenges that cities face regarding solid waste management and service delivery, RBF can benefit the sector by ensuring that public funds are used efficiently and transparently.

The RBF model to improve solid waste service delivery and fee collection is an appropriate model for low income countries where service delivery is poor or non-existent or where fee collection to support waste collection and disposal is a major challenge. It is also an appropriate model to jump start the solid waste services in fragile and post-conflict situations. The RBF model to promote recycling and source separation is a good model for cities in middle income countries where the collection of waste is already high but where the effort of the government is focused on improving the financial and environmental sustainability of the sector.

It should be noted that in the absence of the appropriate solid waste management legislation and the needed monitoring, reporting and regulatory framework this particular type of Public Private Partnership (PPP) can be less effective. Other PPP models such as Franchise, Concession and Private Subscriptions may offer more immediate solutions for legislative environments in developing countries.[19]

[19] Coin-Levine & Coad, 2000.

III. Prevention and minimisation of the generation of household waste

A. Introduction

1. Waste prevention contributes to the protection of human health and the environment; more efficient production practices; resource efficiency, reducing the need for primary resources and the resultant economic benefits; and sustainable consumption patterns.

2. This module focuses on the upper elements of the waste management hierarchy, namely, the prevention of the generation of household waste. Prevention means any measure taken before a substance, material or product has become waste and that serves to reduce the quantity of waste, the adverse impacts of waste on human health and on the environment or the content of harmful substances in materials and products. Prevention may include strict avoidance, source reduction and direct reuse.

3. Waste prevention is the highest priority in waste management. Preventing waste eliminates or reduces the need for all subsequent waste management hierarchy steps, such as recycling, energy recovery, other forms of recovery, and final disposal (by either incineration or landfill). It also avoids or reduces extraction of primary resources from the environment. Waste prevention shifts waste management policy from merely an end-of-life approach aimed at pollution remediation and best practice recovery and recycling, to sustainable materials management aimed at avoidance of the depletion of natural resources, pollution and energy use. Waste minimisation and its components are commonly understood to include: strict prevention; reduction at source; product re-use; recycling; and, when appropriate, energy recovery.[1]

B. Approaches to waste prevention and minimization

4. Measures developed to promote waste prevention should focus on promoting the following objectives:

(a) Strict avoidance involves the prevention of waste generation by elimination of the need for a product, or material, or by a reduction of hazardous substances and inputs, or by reducing material or energy intensity in production, consumption, and distribution. Strict avoidance also includes designing products for prolonged life. Waste prevention in this latter context extends the life of products and acts as a diversion of waste flows. In terms of household waste, a strategy that promotes strict avoidance might encompass a prohibition or a ban - for example, a ban on single use plastic.

(b) Source reduction involves altering production processes to minimize the use of toxic or harmful substances, minimizing material or energy consumption and/or substituting primary raw materials with secondary raw materials that result from high quality recycling. Waste prevention in this context reduces or eliminates waste and pollution at source through process changes. With respect to household waste, source reduction includes the promotion of durable, long-lasting goods and ensuring products and packaging are as free from toxics as possible.

(c) Direct reuse means using a product, object or substance that is not waste for the same purpose for which it was conceived without the necessity of repair or refurbishment. There are numerous products, objects or substances from households that may be appropriate for direct reuse, including textiles, furniture and electrical and electronics that are still fully functional. For example, charities take items in good condition for resale or donation.

Box 3.1 Direct reuse in action: reusable deposit system for cups at public events in Tallinn, Estonia

In Estonia, two-thirds of the waste collected from festivals and public events is comprised of disposable cups. Replacing disposable cups with reusable and washable ones significantly decreases the amount of resources needed for collecting and handling waste. The reusable cup service has been widely used at many public events in Europe for over 10 years. CupCycle[2] replaces disposable cups with reusable, cups at public events and in coffee shops and takeaways, etc. CupCycle was founded in December 2015 and during the pilot project in the summer of 2016, they prevented at least 55,000 disposable cups from being discarded.

The customer receives their drink in a reusable cup and, at the same time, pays a deposit for the cup. Used cups can be returned to designated locations at the event, and a new cup may be obtained or the

[1] https://www.oecd.org/env/waste/prevention-minimisation.htm

[2] https://www.interregeurope.eu/policylearning/good-practices/item/2143/reusable-deposit-system-cups-at-public-events/

deposit repaid. The Smart NFC chip on the bottom of the cup enables automated return and mobile deposit repayment on the spot.
CupCycle offers a full service for public events with three different types of cups with logistics, washing up, and if necessary, bringing their own service staff for big events.

C. Strategies for waste prevention and minimization

5. There are a number of strategic options available to decision makers to promote waste prevention and minimization. Throughout the product lifecycle, decision makers should consider the following four strategic areas to promote household waste prevention and minimization:

1. Legislate: mandating change through regulatory action

6. Regulatory strategies are an important tool in promoting the prevention and minimization of household waste. They can take many forms, including creating bans and prohibitions on the production of certain products or materials (strict avoidance) as well as imposing limits on the volume of waste allowed to be generated (source reduction), or landfill bans. Industry will most often be the target of regulatory strategies as they are in the driving seat with respect to product design and composition. Consumers too may be impacted by regulatory strategies such as "pay-as-you-throw" schemes, prohibitions on certain products and landfill bans for certain wastes.

7. Sustainable design requirements, producer/supplier responsibility initiatives and environmental controls through permitting and take-back measures are all examples of regulatory strategies. Other regulations have sought to restrict the use of hazardous substances in new products. For example, the European Union directive on the restriction of the use of certain hazardous substances (ROHS)[3] seeks to ensure that electrical and electronic equipment sold on the European market contain less hazardous substances.

8. The following section outlines the most commonly used regulatory strategies to promote the prevention and minimization of household waste.

(a) Planning measures

9. Planning measures may include:

(a) Disposal bans through which wastes may be excluded from landfill which obliges producers to recycle materials or eliminate them from production processes;

(b) Stringent environmental permitting requirements, requiring business and industry to ensure waste generation is minimized and waste that can't be avoided is properly sorted for recycling and if needed, final disposal;

(c) pay-as-you-throw systems with variable rate pricing for waste collection by weight or volume which ensures the consumer is responsible for the products they buy and the waste they generate;

(d) Support for research and development on consumer behaviour, socio-economic demographics, resource efficiency and sustainable materials management;

(e) Product bans such as bans on the importation and manufacture of single use plastics such as extended polystyrene (EPS).[4]

(b) Taxes and incentives

10. Regulators may consider a package of taxes, fees and charges to incentivize actions towards waste prevention and minimization, including:

(a) Taxes and fees levied on specific waste streams or on final quantities of waste collected (such as in pay-as-you-throw systems);

(b) Tax exemptions or incentives for reuse and repair centres to promote reuse and repair;

(c) Subsidies or incentives that serve to promote eco-efficient products in the market.

[3] https://ec.europa.eu/environment/waste/rohs_eee/index_en.htm

[4] As was implemented in Antigua and Barbuda and several other countries. https://legalaffairs.gov.ag/pdf/bills/External_Trade_Prohibition_of_Plastic_Bags_Order_2017.pdf

Box 3.2 Plastic tax

Some governments have introduced a plastic tax on businesses that produce or import plastic, but there is sometimes pushback from business. Italy had to halve its plastic tax and also exclude products that contain recycled or biodegradable material prior to introduction of the tax in 2020.[5] The United Kingdom is planning to introduce a plastic tax from April 2022 on the production and import of plastic packaging with less than 30 percent recycled content.[6] Tunisia has successfully introduced a plastic packaging import tax on the raw material used for plastic product manufacture.[7]

(c) Extended Producer Responsibility (EPR) policies

11. Extended producer responsibility (EPR) is a policy instrument whereby producers take financial responsibility for their products once they become waste. EPR policies aim to shift some of the costs of disposal back to producers, thereby stimulating investment in material efficiency to reduce the quantity of waste generated, and in eco-design, to extend the lifecycle of products and materials. Further information on EPR can be found in the Basel Convention practical manual on EPR and financing.[8]

Box 3.3 Developing a legal framework for EPR in Chile[9]

Chile has progressed with its proposed EPR regulation on packaging, which includes special incentives to be provided to reusable packaging to be implemented in 2023. The government is also going through the approval process for a law that will limit the delivery of single-use products in restaurants, coffee shops, hotels, and other outlets, promoting reuse and certification of single-use plastics and the regulation of single-use plastic bottles.

(d) Eco-design requirements

12. Eco-design means producing goods and services that use a minimum level of resources and have a minimum impact on the environment and society. Those engaged in eco-design commit to certain principles in product design and development, including:

(a) Using materials with less environmental impact;

(b) Using fewer materials overall in the manufacture of products;

(c) Using fewer resources during the manufacturing process;

(d) Producing less pollution and waste;

(e) Reducing the environmental impacts of distributing products;

(f) Ensuring that products use fewer resources when they are used by end customers;

(g) Ensuring that products cause less waste and pollution when in use;

(h) Optimising the function of products and ensuring the most suitable service life;

(i) Making reuse and recycling easier;

(j) Reducing the environmental impact of disposal.

13. In addition, governments may select particularly problematic waste streams, for example, electronics, and apply a supply side policy, such as an eco-design requirement to increase the durability, reparability and recyclability of products that would otherwise be landfilled.

[5] Italy's plastic tax plan under threat after industry outcry. The Guardian. 4 Nov 2019. https://www.theguardian.com/world/2019/nov/04/italy-plastic-tax-plan-under-threat-after-industry-outcry

[6] Plastic packaging tax - GOV.UK. (2019). Retrieved from https://www.gov.uk/government/consultations/plastic-packaging-tax

[7] Dalberg Advisors, WWF Mediterranean Marine Initiative, 2019. *Stop the Flood of Plastic: How Mediterranean countries can save their sea*. http://awsassets.panda.org/downloads/05062019_wwf_tunisia_guidebook.pdf

[8] http://basel.int/Implementation/CountryLedInitiative/EnvironmentallySoundManagement/ESMToolkit/Overview/tabid/5839/Default.aspx.

[9] https://prevent-waste.net/wp-content/uploads/2020/10/Chile.pdf

2. Educate: public awareness to encourage behavioural change

14. Actions for the prevention and minimization of household waste must involve a change of societal patterns that relate to production and consumption. Creating awareness amongst the general public as well as the business community is fundamental to changing behaviour and introducing new attitudes and habits to the way people consume resources and generate household waste. Sharing practical information and guiding tools about how individuals or companies can prevent and reduce waste in their daily lives, is a critical first step.

15. Actions undertaken in the area of education and public awareness may involve the following:

(a) Access to information on chemicals in products

16. Greater access to information and knowledge of flows, risks and the management of chemicals in products will improve the possibilities for substitution of hazardous substances and enable producers, suppliers and consumers within the supply chain to make informed choices.

17. A link may be made to the Chemicals in Products (CiP) Programme,[10] a global programme providing information on hazardous substances in products that has been developed within the framework of the United Nations Strategic Approach to International Chemicals Management (SAICM). The goal of the CiP Programme is for stakeholders to have access to information on chemicals in products to assist them in making decisions and taking appropriate action on chemicals exposure, risk and management.

(b) Awareness raising campaigns

18. Awareness raising strategies employed by governments, NGOs, industry and other stakeholders have been widely successful in educating the public about the lifecycle, environmental and other benefits of waste prevention. Information campaigns about prolonging product use through choosing durable, rather than disposable products, such as refillable water bottles, reusable tea or coffee cups or reusable shopping bags, are but one example. For example, information campaigns, where public awareness activities over the past decade have led to a transformational shift in attitudes and behaviours include those around single-use bags or containers.

19. Further information on awareness raising campaigns is available in module X on awareness raising.

(c) Information on waste prevention and minimization processes and techniques

20. Information sharing can sometimes be all that it is needed to initiate waste prevention technologies and management processes. For example, in a cleaner production programme in Thailand, students of a number of universities acted as interns in private enterprises to assess and make recommendations on how to reduce resource inputs, energy and waste. This was an educational programme for students while at the same time raising awareness among producers. It is often the case that was prevention results in greater efficiencies and reduced disposal costs. Part of the awareness raising then involves explaining the return on investment to process and product changes. Much work has already been done examining industrial processes for their waste prevention potential. These efforts are often characterized as clean or cleaner production.

(d) Education and training programmes for employees and other stakeholders

21. The inclusion and support of stakeholders is integral to the success of waste prevention programmes.[11] All employees and other stakeholders responsible for the implementation of the programme should receive an appropriate level of training.

(e) Eco-labelling

22. Eco-labelling is another important example of a tool to raise public awareness. Eco-labels help consumers identify environmentally preferable products through voluntary labelling programs. Product labels advertising the absence of toxic or harmful inputs into products such as lead-free paints, phosphorous-free detergents and mercury-free light bulbs or thermometers are all examples. Report cards, which grade consumer products on environmental impacts take a similar approach. The Electronic Product Environmental Assessment Tool (EPEAT)[12] provides a comprehensive registry of

[10] For further information see: http://www.saicm.org/Default.aspx?tabid=5473

[11] Polman, P., and Bhattacharya, C. (2016). Engaging Employees to Create a Sustainable Business. Retrieved from Stanford Social Innovation Review - Informing and inspiring leaders of social change website: https://ssir.org/articles/entry/engaging_employees_to_create_a_sustainable_business#

[12] https://www.epeat.net/

computer equipment brands and models that limit toxic inputs along with other environmental criteria. The tool identifies "sustainable electronics" such as computers, displays, imaging equipment and televisions. Consumers are conveniently and accurately informed and can make choices which prevent and minimise hazardous waste.

3. Motivate: measures that incentivize change or dis-incentivise the status-quo

(a) Support for voluntary agreements

23. Voluntary commitments to waste prevention targets are generally sector specific, highly effective in achieving agreed goals and increase public awareness of the issue. Voluntary agreements, as defined in the EU Packaging Waste Directive,[13] entail a "formal agreement concluded between the competent public authorities of the Member State and the economic sectors concerned, which has to be open to all partners who wish to meet the conditions of the agreement". In the absence of national targets for waste prevention, support through funding, promotion activity and logistical support for voluntary agreements is highly recommended. For example, the UK Government's Courtauld Commitment[14] is a voluntary agreement aimed at improving resource efficiency and reducing waste within the UK grocery sector.

(b) Promotion of reuse, refurbishment and repair

24. Reuse and repair centres provide a crucial service by extending the life of a wide range of consumer products and have significant potential in diverting consumer waste from landfill. They are often operated by social integration enterprises working with disadvantaged groups such as the long-term unemployed, who are trained in technical repair skills, thus also serving a social function. Effective promotion of reuse and repair is strengthened by the provision of early access to the appropriate products for reuse centres, as well as appropriate handling and storage conditions. This supports the overall aims of waste prevention.

Box 3.4 Second Chance events, Maribor, Slovenia[15]

In the city of Maribor, Slovenia, the Company for Waste Management and Other Utility Services, Sanga, has organized "Second Chance events" where people can sell the goods that they do not need any more in small marketplaces. This responded to the need of the city to have a place to store usable waste collected and is an opportunity for small marketplaces in the city to regenerate despite the competition of shopping centres. During such events, people can learn how to repair things (such as bicycles, curtains, etc.), how to make something new from old stuff (such as jeans, shirts, curtains, etc.) The six events organized so far gathered over 500 sellers, including over 80 children. Over 2,500 kg of goods found a new home.

(c) Promotion of environmental management systems

25. An environmental management system (EMS) is a tool providing a structure for evaluating an organisation's environmental impact, and helps in increasing material efficiency, long-term planning and often contributes to the reduction of costs. Propagation of EMSs is the key tool in addressing business, packaging, industrial, and construction and demolition waste. The EU EMAS tool[16] can be widely promoted at larger administrative levels; local authorities may choose to develop or promote simple evaluative tools for specific sectors.

(d) Sustainable consumption and production incentives

26. Clean consumption incentives differ from taxes as economic instruments by motivating waste preventing behaviour without imposing a penalty. The Business Waste Prevention Fund of Alameda County in California,[17] for example, offers a stipend of up to USD 100,000 for investments in waste prevention projects. Successful recipients have purchased reusable shipping and packaging materials that have created substantial annual financial and waste savings.

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[13] Packaging and Packaging Waste - Environment - European Commission. (n.d.). Retrieved from https://ec.europa.eu/environment/waste/packaging/legis.htm

[14] http://wrap.org.uk/content/what-is-courtauld and http://wrap.org.uk/content/what-is-courtauld

[15] https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1604656595.pdf

[16] https://ec.europa.eu/environment/emas/emas_publications/guidance_tools/tools_en.htm

[17] http://www.stopwaste.org/about/news/grants-available-alameda-county-nonprofits-waste-reduction-programs

(e) Promotion and dissemination of research and development

27. Research efforts can help national authorities and decisions makers identify priorities, frame waste prevention programmes to address major issues and select suitable integrated and sustainable waste management systems. Investment in economic and social research formed the first phase of development for the National Waste Prevention Programme of Ireland, organised through the Environmental Protection Agency STRIVE Programme.[18] Their annual National Waste Report helps to inform waste prevention policy and provides detailed information on the composition of municipal waste streams.

4. Innovate: Promoting, funding and rewarding innovation

(a) Design for the environment

28. Design for the environment, or eco-design, is a design approach to reduce the overall human health and environmental impact of a product, process or service, where impacts are considered across its life cycle.

29. For further information, see the eco-design section above.

(b) Promoting alternative materials

30. Developing new materials that consider sustainability, such as biodegradable, compostable or bio-based plastic, could be promoted, but their potential negative impacts must be weighed up against perceived benefits. Research and design, in particular, impact assessments of a material's lifecycle, and its integrated design for reuse, repair, disassembling (when appropriate), recovery and recycling, should precede production and delivery of services.

(c) Product longevity and product services

31. Product longevity and strict avoidance can be enhanced by promoting the leasing of products rather than sale. Businesses that lease rather than sell products have more of an incentive to ensure a product's durability, longevity and reduced impact as they retain ownership at the end of the lifecycle.

32. Further information on prevention and minimization can be found in the Basel Convention Guidance to assist Parties in developing efficient strategies for achieving the prevention and minimization of the generation of hazardous and other wastes and their disposal.[19]

D. For waste that cannot be prevented or minimised

33. The separation of waste in households is an essential step in a cost effective and environmentally sound waste management strategy. Proper sorting directly supports material recovery as it results in the production of a homogenous and ultimately higher value waste stream. Source separation can enable the processing of certain waste streams higher up the waste management hierarchy than would otherwise be possible in a mixed waste stream. It is extremely important when high quality material is required, such as organic wastes which can produce compost and mulch.

[18] STRIVE 2007-2013 Reports: Environmental Protection Agency, Ireland. (n.d.). Retrieved from https://www.epa.ie/researchandeducation/research/researchpublications/strivereports/

[19] http://www.basel.int/Implementation/CountryLedInitiative/EnvironmentallySoundManagement/ESMToolkit/Guidanceonwasteprevention/tabid/5844/Default.aspx

IV. Separation at source, collection and transport of household wastes

A. Introduction

1. This module provides guidance on mechanisms for separation at source, collection and transportation of separated and co-mingled household wastes and onsite separation.

2. In order to capitalise on the valuable components of generated waste streams, countries should first:

(a) Conduct a waste characterisation assessment to determine the quantities and types of wastes being generated (see module I);

(b) Establish collection systems and material recovery mechanisms for various waste streams based on available resources;

(c) Promote separation at source through increased public awareness on the risks and value of certain waste components. Further separation of waste streams could be facilitated through the development of waste sorting facilities and material recovery facilities (MRFs).

3. The separation of material is performed by the users at the source or at a central processing facility. After on-site storage in the household, the next step in the process is collection. The primary collection is from the point where the waste is produced. In some cases, these collection points can be located outside of an individual household, with communal containers serving several households or a general waste bin/skip that takes waste from households in the surrounding areas. With the encouragement of separation at the household level, the communal containers can be labelled and separated according to certain waste streams, often recyclables and non-recyclables. Certain collection days can be allocated for different waste types and drop-off sites can be identified and coordinated for the waste streams not included in the collection system, i.e. bulky waste and electrical and electronic waste.

4. The collected waste may be taken to a final disposal site or sorting facility, material recovery facility or to a transfer station. Secondary collections can occur where the waste from a number of primary collections is taken from the transfer station to the final disposal site. The appropriate frequency of collection will depend on certain conditions. As biodegradable waste, especially food waste, decomposes much faster at higher temperatures and humidity (and may potentially attract disease spreading fauna), under these conditions more frequent collection may be required.

B. Separation at Source

1. Overview

5. Separation at source includes separating household waste into different material streams or categories of material streams for separate collection and transportation. This may be achieved using separate bin collection services, bulky waste collection services, or through direct delivery of specific wastes to drop-off facilities. Household materials commonly targeted for source separation include:

(a) Bio-waste (such as food waste and garden waste);

(b) Packaging (such as cardboard, glass, plastics and aluminium cans);

(c) paper (such as bags, newspapers, magazines, office paper, wrapping and packaging paper, etc.);

(d) Reusable items (such as textiles and clothes, household items and appliances);

(e) Hazardous wastes (such as paint, batteries, chemicals and biomedical items);

(f) Construction and demolition waste (such as concrete, bricks and timber).

6. Separation of waste at households is an essential step in a cost effective and environmentally sound waste management strategy offering the following benefits:

(a) Proper sorting of waste at source directly supports material recovery since this could lead to the collection of homogenous and less contaminated materials which are easier and less costly to recover;

(b) Source separation can enable the processing of certain waste streams, such as food waste, higher up the waste management hierarchy that would otherwise be treated as mixed waste;

(c) Source separation can also enhance behaviour change of households towards waste prevention, recycling, and also a positive change in consumption patterns.

7. Separating household waste is challenging in many countries due to several factors, including:

(a) Rapid urbanisation and increased use of packaging materials;

(b) Absence of an enabling environment to facilitate sorting at the household level;

(c) Lack of space in households for multiple waste receptacles;

(d) Absence of recycling infrastructures in place.

2. Separation at source patterns

8. Separation at source patterns are classified by:

(a) The stakeholder that performs the separation (household, community, informal sector);

(b) The stakeholder that performs the collection (public, private, informal collection);

(c) Targeted waste (recyclables, organic waste, bulky waste, non-combustibles, hazardous waste etc.);

(d) The charging system (see module II for more information);

(e) The collection method (see below).

9. A household waste separation scheme could focus on a multiple waste stream source separation scheme – paper, plastic, glass etc. (See Figure 4.1). In developing economies where resources may be limited, the source separation may be confined to only two streams such as wet and dry waste, or as many as five streams including wet, dry, sanitary, hazardous and garden waste.

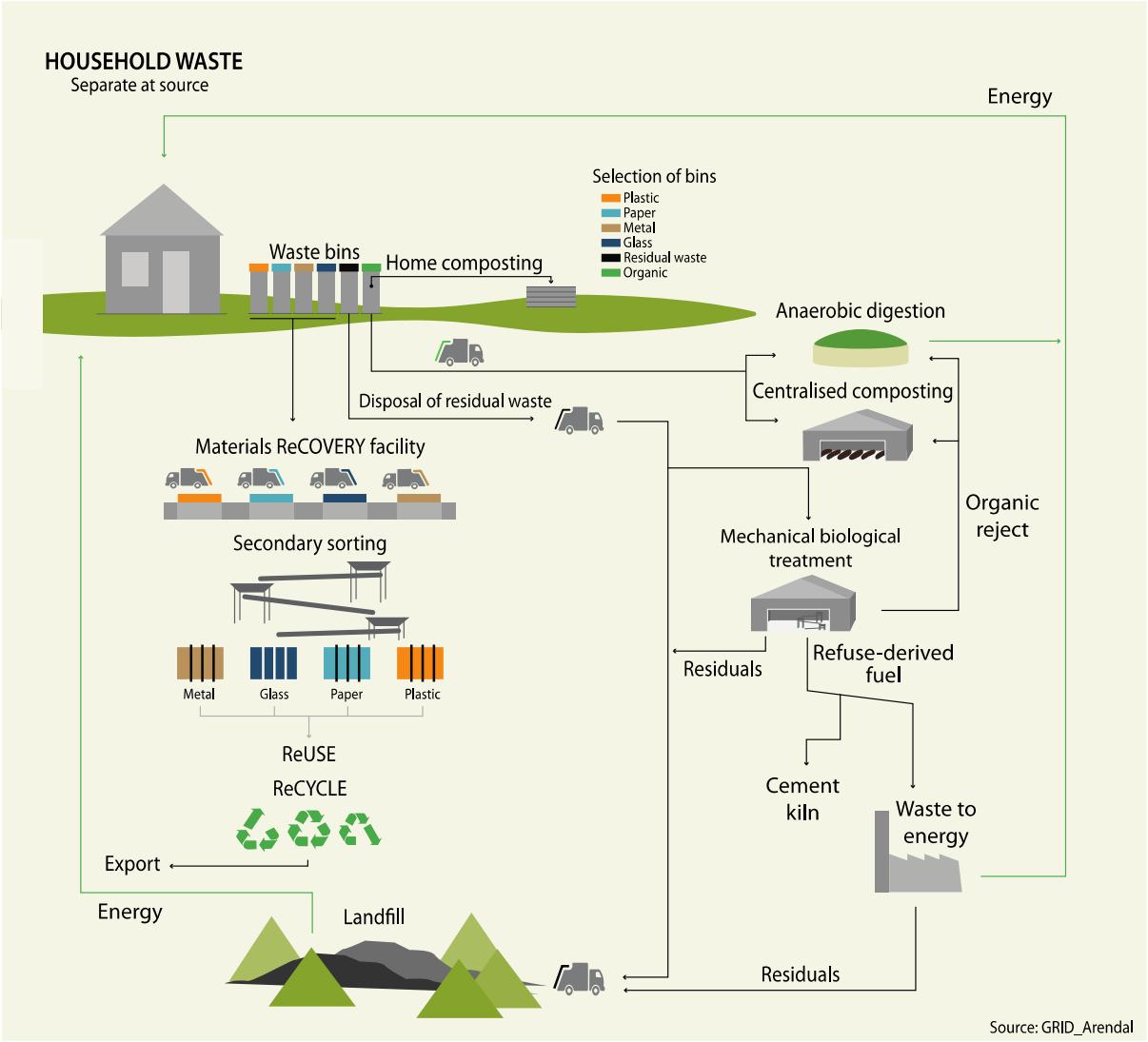


Figure 4.1. Steps showing different scenarios for source separation, collection and transport
Source: GRID-Arendal

Box 4.1. Shanghai waste sorting strategy[1]

On 1 July 2019, the municipal government in Shanghai replaced the voluntary two-tier waste sorting system with a mandatory four category system. All residents, businesses and government bodies are now required to sort waste into labelled bins for recyclable, hazardous, residual, and organic waste.

Fines apply for improper sorting - approximately USD 29 for residents, and up to USD 7,000 for businesses and institutions, with increases for repeat offenders (a number of fines were issued on the first day of the new system). To support the system, the city has installed more than 40,000 public waste bins.

The waste sorting is part of a strategy that includes an ambitious recycling target of 35 percent by the early 2020s - currently in Shanghai 36 percent of domestic waste is incinerated (with energy recovery) and 50 percent goes to landfill, with less than 10 percent being recycled. There are also initiatives to minimise and prevent waste, such as a ban on automatically providing hotel guests with disposable toiletries and restaurant patrons with disposable tableware. Social media enabled waste-sorting networks and renewable-resource recycling networks are also being developed.

There are 46 Chinese cities currently involved in household waste sorting pilot programmes that should be operational by the early 2020s. The Chinese government is investing USD 3.1 billion to build additional waste facilities in these cities.

Box 4.2. Organic Waste[2]

In developing countries, economies in transition and small island developing states (SIDS), organic fractions form the largest part of the waste generated and usually range between 50 to 70 percent of the total waste volume. In high-income countries organics typically account for between 20 to 40 percent.

Organic waste comes primarily from kitchen waste – fruit and vegetable peelings, food scraps and leftovers and garden waste – grass cuttings, hedge clippings, leaves and branches, flowers, etc. Although organic waste is biodegradable, it can still have adverse impacts on landfills. It attracts scavengers such as feral animals and birds and the liquid released during breakdown can carry harmful chemicals from other non-biodegradable waste items into water systems and the soil. Further, organic waste that is dumped in a landfill, undergoes anaerobic decomposition and subsequently generates methane.

Organic waste is a valuable resource that can be recycled to produce compost for home gardeners or collected by the municipality for larger scale compost production. In the absence of home composting,

bins for storage and curb side collection of separated organic wastes are often provided by the municipality, in an effort to divert organic material from going to landfilling as a component of mixed residual waste. Advanced systems also include the use of compostable bag liners, which increase the ease of handling wastes and are fully biodegradable.

Contamination of organic waste with other household waste is an issue in the production of compost. The use of clean source-segregated organic material is preferable, and essential if the (composted) digestate is to meet end of waste criteria and be used for food production. In developed countries, regulations allow the use of waste-derived composts for food production only if clean source-separated feedstock is used. For an organic fraction

[1] https://www.chinadialogue.net/article/show/single/en/11349-Shanghai-s-compulsory-waste-sorting-begins

[2] https://www.worldbank.org/en/research

separated mechanically from either mixed municipal solid waste or from residual solid waste, such as at a mechanical biological treatment plant, the digestate can go through a composting (maturation) step and be used as a compost-like output. Contamination is also a major issue in this process.

C. Primary and Secondary Collection

1. Overview

10. Primary waste collection is the collection and transport of household waste from point of generation to transfer points or community bins,[3,4] while secondary household waste collection is the collection and transportation of waste from transfer points or community bins to waste treatment or disposal sites. An important consideration in household waste collection is that of route optimization. The absence of route optimization systems can lead to inefficient, time-consuming and costly collection systems. Route optimization is best accomplished through the use of route management software, that uses mathematical programming to determine the most efficient routes to be traversed.[5]

2. Waste collection methods

11. Waste collection services may be performed on a small scale, providing primary collection on a neighbourhood level, or on a larger scale, providing either secondary collection or integrated collection services on a municipal level. While the main systems can be distinguished by collect systems and bring systems, the most common systems are outlined below.

12. The most common waste collection methods are:[6]

(a) Door-to-door collection systems: household wastes are frequently collected mixed (co-mingled) or source separated (single streams) in bags, bins and containers collected directly from the households;

(b) Bring points: households bring their waste to community bins and/or containers placed at public fixed points;

(c) Civic amenities / civic amenity sites / green points: households bring recyclables and special waste such as hazardous household waste, bulky waste, waste electrical and electronic equipment, used batteries, construction and demolition waste, solvents, paints etc. to a waste facility;

(d) Deposit and return: typically applied on beverage bottles or cans made of glass, plastic, (metal).[7]

3. Frequency of collection

13. Frequency of waste collection is defined as the number of times in a week or a month that waste is collected. In general, the frequency of waste collection should be higher in developing countries than in temperate industrialized countries, and the frequency should be acceptable to the residents, otherwise waste may be dumped in the streets. Some communities are accustomed to a collection seven days a week, whilst other collection agencies are striving for just once each week. If fly breeding is to be controlled, the waste should be collected twice a week in hot climates. Other factors to consider are the odours caused by decomposition and the accumulated quantities. If residents are accustomed to daily collection, it may not be politically feasible to reduce the frequency to twice a week. In some cities, waste may be collected on the day of rest (Sunday or Friday). Some may collect waste at night, perhaps for cultural reasons or because of the weather or traffic congestion.[8] It is desirable that the frequency does not vary, so that households and shopkeepers know when their waste will be collected. Small

[3] C. Zurbrügg, "Urban solid waste management in low-income countries of Asia: How to cope with the garbage crisis," Present. Sci. Comm. Probl. Environ. Urban Solid Waste Manag. Rev. Sess. Durban, South Africa, no. July 2013, pp. 1–13, 2003.

[4] D. Hoornweg and P. Bhada, "What a Waste. A Global Review of Solid Waste Management," Urban Dev. Ser. Knowl. Pap., vol. 281, no. 19, p. 44 p., 2012.

[5] Refer to https://www.hindawi.com/journals/je/2018/4586376/.

[6] BiPRO/CRI 2015, Assessment of separate collection schemes in the 28 capitals of the EU, Final report, November 2015, Available at: http://publications.europa.eu/resource/cellar/2c93de42-a2fa-11e5-b528-01aa75ed71a1.0001.01/DOC_1

[7] https://www.sciencealert.com/norway-s-recycling-scheme-is-so-effective-92-percent-of-plastic-bottles-can-be-reused

[8] Centre for Integrated Urban Development Services, "Micro and small enterprises involvement in municipal solid waste management in developing countries: workshop papers," pp. 14–18, 1996.

adjustments to collection frequency may be needed because of public holidays, and it is important that generators are informed of these changes in advance.[9]

Box 4.3 Waste separation and collection, Zlatograd, Bulgaria[10]

In Bulgaria, the Municipality of Zlatograd is an example of a local authority actively engaged in optimization of the existing waste management system without increasing the municipal waste fees. To be able to achieve its goals, the municipality was successful in receiving funding from the OP Environment 2014 – 2020 for installation for composting and preliminary treatment of waste at the amount of EUR 3.5 million. The waste collection is based on the "door to door" principle.

The municipality provides waste bins and bags for separate collection and transports waste to a recycling site; it establishes an annual time schedule for collection; manages communication including mandatory instructions for separate collection. The municipality monitors waste collection, measuring the quantity of waste collected by the households and issuing bonds accordingly. The waste generated by businesses is monitored by an external company that shares with the municipality information on waste quality and quantity. As a result of this programme, the waste disposal on the landfill dropped in 2019 by 20 % compared to year 2013 from 2600 tons/year in 2013 to 2100 tons/year in 2019. The positive impact on the environment is demonstrated by reduction of illegal dumping of waste by 50% for the same period.

4. Waste collection service charges

14. A waste collection service charge (WCSC) for mixed waste can be designed to encourage households to reduce their waste load by recycling and composting, whilst financing local authorities.[11] In designing a WCSC, the charging method, payment vehicle, features of a service package and challenges in implementation should be considered. A charging method can be:

(a) A flat rate (fixed): the same tariff is applied to all households;[12]

(b) A quantity-based charge: where households are charged according to the amount of waste (weight or volume) or frequency of collection;[13]

(c) A variable charge differentiated according to household income: different charge categories or proportionately rising charges could be based on water/electricity consumption or size of the household or residential area;[14]

(d) Combination of options 1 and 2 or 1 and 3.

15. For more information on waste service charges please refer to module II.

Box 4.4 ECONIT Programme, Czech Republic[15]

In 2017, a waste management company designed a new data system, ECONIT, in the Prostřední Bečva municipality (Czech Republic), to reduce the high quantities of mixed municipal waste. The programme asks residents to scan their rubbish with QR codes. Information on the quantity and types of waste produced is used by the local waste management agencies to improve collection and recycling rates.

After some time: 12% more plastic, 73% more glass, 90% more paper and 1 860% more cardboard packaging were collected. The new system has reduced mixed waste by 31%. The money saved by the municipality was given to residents in the form of a voucher and the monthly fees for waste collection

[9] UN-HABITAT, Collection of Municipal Solid Waste in Developing Countries. Nairobi, Kenya, 2010.

[10] https://www.interregeurope.eu/policylearning/good-practices/item/4156/support-for-improvement-of-waste-management-system-in-zlatograd/

[11] UNEP and ISWA, Global Waste Management Outlook. 2015.

[12] E. Gunsilius, "Economic Instruments in Solid Waste Management," Dtsch. Gasellschaft für, 2012.

[13] United Nations Environment Programme (UNEP), SOLID WASTE MANAGEMENT: (Volume I). 2005.

[14] E. Gunsilius, "Economic Instruments in Solid Waste Management," Dtsch. Gasellschaft für, 2012.

[15] https://circulareconomy.europa.eu/platform/en/good-practices/scan-your-rubbish-econit-improve-waste-management-and-collection

were reduced. Ever since, the JRK Waste management solutions company have had a positive impact on over 500,000 inhabitants and the company is partner to more than 450 villages and towns in the Czech Republic, Slovak Republic and Hungary.

D. Equipment for Waste Storage, Collection and Transportation

1. Overview

16. Widespread problems, which continue to plague solid waste services especially in developing economies, include the use of inappropriate equipment for waste storage, collection and transportation, transfer capacity and unreliable waste collection frequencies. These issues can lead to overfilled vehicles and uncollected waste.[16] Selecting adequate waste storage, collection and transportation equipment in terms of type and size could potentially increase collection efficiencies of waste in terms of volume collected and costs of logistics.

2. Waste storage

17. Primary waste storage can involve temporary containers, such as cardboard boxes, plastic bags, baskets and a range of different types of waste bins (plastic bins, oil drums, galvanized bins, etc.), that could be placed within households. Secondary, community waste storage includes waste bins, carts and/or containers that are filled either directly by the households or by primary collection vehicles (such as tricycles or handcarts) and could be either stationary (fixed) or portable.

18. A secondary storage waste bin or other storage facility (fixed or portable; Figure 4.2) must satisfy a number of requirements:

(a) The storage volume must be adequate to the needs of the implemented waste management programme. The size of the storage depends on the type of waste collected, family type and collection frequency;

(b) Loading of the waste into the collection vehicle should be economical, hygienic, and safe;

(c) The containers should be sufficiently durable, resistant to mechanical damage, corrosion, etc.;

(d) Storage should ensure that animals (e.g. rats or insects) have no access to the waste, and that it is protected from weather conditions such as heavy rain fall.

Bag for mixed waste

Blue bag for recyclables

Compostable bag for organic waste

Box for recyclables

Household waste recycling bags

Metal or plastic cans

Rear loading cart/bin (small – medium)

Rear loading bin (large)

[16] N. Yukalang, B. Clarke, and K. Ross, "Barriers to effective municipal solid waste management in a rapidly urbanizing area in Thailand," Int. J. Environ. Res. Public Health, vol. 14, no. 9, pp. 9–14, 2017.

Bell-shaped recycling bin for glass

Underground waste bins

Front-end loader bins

Figure 4.2. Examples of household waste storage means

3. Collection and transfer vehicles

19. The size and type of vehicles used are normally determined by the level of service desired, the amount of waste generated, and the type of waste being collected (Figure 4.3). In case there is a need to upgrade the waste collection system in place, there may be a need to also upgrade the vehicles used to transport the waste. In many developing countries, the purchase of vehicles to collect waste represents a major investment. Usually purchasing decisions are made based on the capital costs of the equipment only. However, to ensure the best return on investment, other factors should be considered in addition to capital costs. These include operating and maintenance costs, availability of replacement parts, availability of skilled labour to undertake repairs and suitability of equipment for climate and terrain.

20. Besides the vehicles themselves, it is important to pay attention to the system to be used to monitor the performance of these vehicles and to ensure that, firstly, all waste is collected along the stipulated routes and secondly, the collected waste is deposited at the approved disposal site. Failure to adequately monitor this can result in inadequate collection and/or illicit disposal of waste. The use of GPS systems to track vehicle movements is one way of monitoring the collection activities.

Hand carts/trolleys

Waste collection tricycle

Tricycle waste collection vehicle (electric)

Enclosed light truck

Rear Loader Compactor

Semi-automated Rear Loader

Side Loader Compactor

Automated Side Loader

Front-end loader

Dual Compartment Rear Loader

Open-top Self-unloading Trailers -Top loading transfer stations

Compaction Trailers-Compactor transfer stations

Figure 4.3. Examples of collection vehicles

E. Transfer stations

1. Overview

21. Transfer points or stations are facilities where household waste is unloaded from small collection vehicles or containers into larger or faster vehicles for long-distance transportation to final disposal sites or facilities.[17]

22. There are several reasons for constructing a transfer station:

(a) Economics**:** A transfer station or point needs to be considered when destination of the wastes is far away from the area in which they are collected in order to improve the costs of logistics;

(b) Service*:* For municipalities without a waste collection service in place, a transfer station is often provided as a service to residents, so that they do not have to drive far to drop off their wastes;

(c) Transfer stations make solid waste collection more efficient and reduce overall transportation costs, air emissions, energy use, truck traffic, and road wear and tear;

(d) Modern transfer stations designed to collect wastewater, control spills, and minimize blowing litter, odour, and dust have a minimal impact on the environment.

23. However, transfer stations can also have negative impacts such as:

(a) Environmental**:** Transfer stations could be a source of pollution from blowing litter, dust, spills, if operations are not controlled. In addition, transfer stations may attract disease vectors such as rodents, insects or birds. It is therefore important that operators of the transfer station shall monitor and control daily operations to limit environmental and health hazards. Fires, intentional and unintentional, could also be a hazard;

(b) Safe working**:** Scavenging at transfer stations in developing economies could be a serious challenge to the operation of transfer stations and so should be prohibited. However, if special arrangements have been made to set aside an area for the drop-off and safe storage of goods and materials, then controlled salvaging should be encouraged.[18]

2. Transfer station systems

24. Transfer stations can be divided into two basic categories, as follows:

(a) **Open top transfer stations** at which waste is either unloaded directly into the "open top" of the trailer or on the tipping floor to allow for materials recovery and waste inspection;

(b) **Compactor transfer stations** which have stationary compactors using a hydraulic ram to compact waste and increase capacity of transfer trailers.

25. In addition, based on their equipment, transfer stations may be either fixed (stationary) or mobile. Some of the most common systems employed at transfer stations around the world are:[19]

(a) **Direct discharge transfer stations:** waste is unloaded directly into the transfer vehicle or container from the collection truck;

(b) **Inverting bin system:** waste is unloaded into a bin that in turn empties into the transfer vehicle;

(c) **Push-pit transfer station:** waste is unloaded from collection vehicles onto a concrete floor (tip floor) then pushed into the transfer vehicle;

(d) **Compactor transfer station:** waste is either unloaded directly into a compactor feed hopper or onto a tip floor and pushed into the feed hopper; the compactor then loads into the transfer vehicle.

3. Design considerations

[17] S. Kumar, Municipal solid waste management in developing countries, 1st edition. CRC Press, 2016.

[18] Guidelines for Establishing Transfer Stations for Municipal Solid Waste, Section 4: Operational Guidelines. Available at: https://www2.gov.bc.ca/assets/gov/environment/waste-management/garbage/guidelinesestablishingtransferstationsmunicipalsolidwaste.pdf

[19] United States Environmental Protection Agency, 2002, Waste Transfer Stations: A Manual for Decision-Making. Available at: https://www.epa.gov/sites/production/files/2016-03/documents/r02002.pdf

26. Transfer stations should be carefully located, designed and operated to avoid impacts to nearby dwellings, and any environmental or health hazards. Considerations that need to be taken into account in the design phase of a transfer station are, in brief:

(a) Types of transfer stations;

(b) Transfer station equipment (which can be either fixed or mobile);

(c) Site layout including the size of the unloading area, access, storage for peak volumes, etc.;[20]

(d) Location, in terms of distance from the collection area and final disposal sites, minimum public objections, convenient haul routes, etc. Often transfer stations are established at a landfill site after it has been closed and rehabilitated, because residents have already connected the location to waste management activities;

(e) Capital and operation costs.

F. Secondary sorting

1. Overview

27. When recyclable materials are not recovered at the household level, it is advisable to sort waste for recycling at waste sorting units or at transfer stations. Sorting can be either performed manually, mechanically or a combination of both. In emerging economies, the material's value alone can be sufficient to drive formal or informal collection and sorting of some waste fractions.[21] This is mainly applicable to metals, glass, paper and cardboard. However, for many types of plastics and paper, the intrinsic value of the materials is not sufficient to justify recycling from a purely financial viewpoint.

28. Waste sorting facilities work in parallel with the waste collection infrastructure. They act as a means to further segregate waste in order to obtain sorted material fractions that can be diverted directly into manufacturing or sold as commodities on the local or global market.

29. The sorting technique applied (automated or manual) depends on the type of waste input, and recycling market in place. In developing countries, manual and/or low-tech solutions for sorting waste are the common practice due to expensive capital and maintenance costs of more sophisticated infrastructures and the lack of technical expertise to maintain and repair the equipment. Developed countries, with better market structures, apply more sophisticated technology-based sorting solutions. If there is a component of manual sorting, this usually occurs in conjunction with mechanical sorting techniques at the pre-sorting stage. Manual sorting is employed to remove unwanted or contaminated input materials and increase the efficiency of downstream automated processes. In addition, manual sorting can be used as part of the quality controls at the end of the sorting process to ensure that sorted materials (e.g. plastic) meet the technical specifications of the market.[22]

30. Sorting facilities require a critical mass in order to ensure that they are sustainable and economically viable.

31. Secondary sorting is essentially required in order to:

(a) Store recyclable material for reuse separately;

(b) Ensure that waste which can be processed for recovery of material and energy (through suitable technology such as composting) does not become co-mixed with undesirable elements;

(c) Store hazardous material for disposal in hazardous waste landfills or appropriate processing separately;

(d) Minimise the waste and ensure reduction in landfill space for final disposal.

2. Sorting at material recovery facilities (MRFs)

32. Material recovery facilities can further separate clean, source segregated dry materials for either recycling or to produce fuel. They may use automated or manual sorting systems or in some cases, a combination of the two. They are used widely in developed countries in conjunction with the source

[20] Design must also take into consideration the acidic nature of decomposing waste and the wear and tear on the transfer station surfaces. Chemical/abrasion resistant coatings should be considered at the design stage to reduce premature degradation of the surfaces.

[21] UN-HABITAT, Collection of Municipal Solid Waste in Developing Countries. Nairobi, Kenya, 2010.

[22] McKinnon, D., Fazakerley, J., Hultermans, R., (2017), Waste sorting plants – extracting value from waste, Vienna, Austria: ISWA

separation of mixed recyclables. The main function of the MRF is to maximize the quantity of recyclables processed, while producing material that will generate the highest possible revenues in the market. MRFs can also process wastes into a feedstock for biological conversion through composting and anaerobic digestion. 'Dirty' MRFs accept mixed waste from which dry recyclable materials are separated out from the organic fraction. Specific purpose MRFs are specialized material recovery facilities and these generally treat specific waste streams, such as e-waste, construction and demolition waste, or plastic waste.

Type of input waste	Type of sorting in developing economies
Mixed municipal waste	MRFs - "dirty" sorting - removing primary metals, plastic and glass
Mixed dry recyclables	MRFs "regulated" sorting - removing primary metals, plastic, paper and glass
Source separated recyclables (e.g. plastics)	e.g. plastic recycling facilities - fine-sorting - removing individual material fractions

Table 4.1 Type of input waste and sorting in developed economies[23]

33. A typical sorting process includes several sorting stages to separate materials from the initial stream. The design of a sorting plan for material in developed countries may vary from place to place, but typically the following sorting methods are applied.

Sorting methods	Scope	Technologies	Comments
Manual sorting	Removal of bulky items, cardboard and films		Employees are positioned beside the conveyor and manually remove materials
Screen	Removal of small/light materials such as film, paper Removal of heavy pieces such as glass and stones	Trommel screen	An angled rotating cylinder with holes that allow waste of a given size to fall through
		Disk Screen	A bed of vertical-spaced discs that transports large waste items but allows smaller items to drop through the gaps.
		Oscillating screen	A vibrating/oscillating declined bed that allows smaller waste to pass through while transporting larger waste to the end.
Air classifiers	Removal of small/light 2D materials such as film, paper Removal of heavy pieces such as glass and stones	Zigzag air classifier	Waste is dropped through an upward air current in a zig-zag shaped flue. Light waste is blown to the top, while heavier waste falls to the bottom
		Rotary air classifier	A trommel screen separator with an air current that captures the lightweight fraction.
		Cross-current air classifier	Waste is fed on a conveyor and dropped through an air stream. The light components are blown horizontally to a collection point and the heavy components drop through.
		Suction hood	Sucks light weight waste directly from the conveyor belt.
Ballistic Separator	Removal of small/light 2D materials such as		A steeply inclined bed with a perforated plate screen deck, with alternate vibrating elements. Light

[23] McKinnon D, Fazakerley J, Hultermans R, (2017). Waste sorting plants – extracting value from waste, Vienna, Austria: ISWA

	film, paper Removal of heavy pieces such as glass and stones		fractions are lifted by cams to the top of the bed, heavy fractions fall to the bottom
Overband magnet	Removal of ferrous metals		Magnets either lift ferrous metal from the waste or hold ferrous metal to the conveyor while other waste is allowed to drop.
Eddy current separator	Removal of aluminium		Eddy currents are used to push non-ferrous metals with magnets into separate collection points, with non-metallic waste falling into another
Optical sorting	Removal of 2D items such as paper and cardboard from 3D items such containers	NIR (Near infrared)	Used to differentiate between plastics (PET, HDPE, PVC, PP and PS).
		VIS (Visual spectrometry)	Used to identify materials based on colour.
		XRF (X-ray Fluorescence)	Used to differentiate between metals / alloys (for example, copper from steel).
		XRT (X-ray Transmission)	Identifies materials based on atomic density – for example, halogens and organic components.
		EMS (electromagnetic sensor)	Identifies metals based on their conductivity.

Table 4.2 Sorting technologies per separation method that could be found in an MRF[24]

3. Sorting centres

34. These facilities primarily exist in developing countries. For example, the city of Pune in India has set up a number of mainly manual waste sorting centres which serve to integrate the informal sector into the mainstream waste management system. Centres which involve the informal sector but use a mix of manual and mechanical sorting are common in Brazil and some other countries. In many instances, these sorting centres deal with plastic waste.

Box 4.5 Dry Waste Collection Centre[25]

Dry Waste Collection Centres (DWCCs) are an important aspect of decentralized waste management. Bangalore became the first municipality in India to set up DWCCs. The concept, modelled around neighbourhood recycling centres, aims to facilitate the collection and buy back of all recyclable dry waste from local residents, contract workers, and waste workers or scrap dealers, including informal waste workers. The centres operate with zero subsidy from the municipality, so need to be financially viable. The operation prevents recyclable material and other non-biodegradable material, which can be alternatively processed, from going to landfill. The centres integrate the many informal workers through employment opportunities and provide a locality for recycling that serves as a dissemination point for information. The consolidation of recycling activity creates economies of scale and back-end integration, as well as provides an interface for engagement with industry. This engagement helps facilitate actions on extended product responsibility.

4. Sorting by the informal sector

35. In developing countries, the informal sector often plays a significant role in waste collection, but the contribution of these workers to waste recycling is poorly understood. The challenge in developing countries includes integrating informal waste collectors into formal waste management programmes and providing them with access to training on the risks associated with improper waste sorting and waste handling. Municipalities or NGOs can provide legal support in establishing cooperatives, providing training, and creating other services to improve working conditions (such as identity cards and access to health insurance).

[24] Ibid.

[25] https://bangaloremirror.indiatimes.com/bangalore/civic/30-new-centres-to-help-store-bengalurus-dry-waste/articleshow/81372336.cms

36. A 2012 review of the informal waste sector[26] found several conditions important for successful integration of informal waste workers into the formal system, including:

(a) Inclusion of the contribution of informal waste workers into public policies, regulations, and procedures;

(b) Organisation of informal workers;

(c) Recognition of the technical and managerial capacity these workers have as economic actors;

(d) Recognition of the networks they establish with formal companies and other institutions, like providers of business or financing services.

Benefits	Actions required to improve conditions for workers and sustainability of livelihoods
● Efficient – 70 percent of waste recycled in Santiago de Chile; 80 percent of waste recycled in Cairo ● Labour intensive solution as opposed to capital intensive, so easier to establish in developing countries ● Provides jobs and income for people ● Reduces pollution, diverts recyclables from landfill or entering waterways ● Reduces raw material costs for local industries by providing recycled material ● Saves municipalities the cost of collection and transport fleets	● Government recognition as workers, and formal inclusion in waste management ● Strengthening organization through the establishment of co-operatives to improve working conditions ● Develop supportive and inclusive policies and laws that enable both formal and informal systems of waste management and recycling ● Development of programs that provide stability of employment – need to be considered when considering the adoption of other technologies such as incineration that displace waste pickers and reduce recycling

Table 4.3 Benefits of integration and actions required to improve work conditions and promote sustainable livelihoods for the informal sector

[26] Sector Project Recycling Partnerships, G. (2011). *Recovering resources, creating opportunities: Integrating the informal sector into solid waste management*. Retrieved from https://www.giz.de/de/downloads/giz2011-en-recycling-partnerships-informal-sector-final-report.pdf

V. Reuse (except direct reuse)

A. Introduction

1. From the point of view of the circular economy, it is most desirable to reuse goods, as far as practically possible. Goods that are directly reused are not normally classified as wastes. For example, a mobile phone that passes from one person to another to be reused does not become a waste in that process. However, those wastes collected from households that require preparation for reuse through repair and refurbishment may be considered wastes in some jurisdictions. Examples of household goods that may no longer be wanted by the household but can become available for reuse after repair and refurbishment are electrical and electronic equipment, domestic appliances and consumer electronics, furniture and textiles.

2. The Basel Convention's Annex IV, Section B on "operations which may lead to resource recovery, recycling, reclamation, direct re-use or alternative uses", does not include "preparation for reuse (e.g., checking, cleaning, repair, refurbishment)". However, a proposal submitted by the European Union to amend Annex IV, for consideration by COP-15, includes a new operation "preparing for reuse (e.g. checking, cleaning, repair, refurbishment)".[1] Irrespective of the revision to the Basel Convention, reuse, refurbishment and remanufacturing should be encouraged where appropriate as these operations are at the core of the circular economy and similar sustainability concepts.[2] Each of the three defined elements of the circular economy are related to reuse: (i) closing material loops; (ii) slowing material loops; and (iii) material efficiency. Regarding material efficiency, consumer preferences should be directed towards accepting used products that have been repaired and refurbished. Also, consumer preferences for purchasing longer life products that are also repairable should be encouraged. At the core of the circular economy is the repair and refurbishment of goods, and also their remanufacturing. Clearly, a well-functioning circular economy will require well-functioning markets for the repaired, remanufactured and refurbished goods.

B. Principles

3. A core focus of the circular economy is to keep products in use. Many countries have an existing culture of repair, however, growing consumption patterns require a more comprehensive approach. Enabling conditions may include: allowing consumers to fix their own products; providing access to parts which are needed for repair; open access to repair manuals; and increasing the availability of affordable tools.

4. Reuse of products can be stimulated by taking actions such as:

(a) Product design (e.g., making consumer product parts easily accessible and replaceable; making the spare parts available);

(b) Access to information (e.g., access to appropriate product information so that repair and reuse is possible);

(c) External support (e.g., simulating reuse by financial incentives).

5. These principles are usually economically beneficial to other community objectives as well, and they can provide job opportunities or social support. For example, in Belgium, 'De Kringwinkel',[3] a social enterprise chain of second-hand shops, uses the income from its sales to give people, who have little or no chance to enter the labour market, a suitable job. In this way, they gain experience and a future perspective.

6. Consumer products such as electrical and electronic devices are increasingly being designed for short-time usage (obsolescence). Better design of products for longevity and reparability will keep products in use longer and so mitigate impacts of their disposal or recovery, and of their replacement. Industry should design goods to ensure that all the materials in the product are recyclable without loss of quality, thereby reducing the impact of the product when it becomes a waste. There are also concerns that upon repair, components being replaced and discarded could have an unwanted environmental impact if not designed for recycling.

7. Free access to repair service documentation should enhance product repair. The principle of 'supply and demand' applies to repaired goods. Without a demand for repaired or refurbished goods, repair or refurbishment activities will not be economically viable. Without higher general awareness

[1] Document UNEP/CHW.15/13/Add.1.
[2] e.g., Zero waste concept, cradle to cradle concept
[3] https://www.kringshop.be/shop/muurdecoratie.html#c

about unsustainable consumption patterns, there could be little acceptance or demand for refurbished goods.

8. There are grassroots repair movements that promote circular economy goals. For example, Repair Cafés are free 'community-centred workshops' for people to bring consumer products in need of repair where they can work together with volunteer fixers, to repair their broken products. In addition to repair, many Repair Cafés provide assistance with product modification.

9. A move towards more sustainable patterns of consumption through enhancing the reparability of products can be stimulated by economic instruments such as tax incentives. Examples can be sourced from a number of European countries.[4] For instance, in Sweden, the government introduced a 50 percent tax reduction of labour costs for repairs of large size household appliances.[5] This financial instrument was put in place to reduce throwaway behaviour, which is commonly practiced in many societies.

C. Products

1. Textiles

10. According to the UK House of Commons Environmental Audit Committee, textile production contributes more to climate change than international aviation and the global shipping industry.[6] It uses gigantic volumes of freshwater in cotton production, large quantities of chemicals, consumes energy and finally, leads to pollution of the environment. As a result, synthetic fibres are being found in the deep sea, in Arctic sea ice, as well as in fish and shellfish.[7]

11. The garment industry is reportedly one of the world's biggest manufacturing industries. In 2016, it generated USD 1.65 trillion in revenue from apparel and footwear items.[8] It is predicted that by 2030, global apparel consumption will rise by 63 percent, from the current 62 million tonnes to 102 million tonnes.[9] However, the way clothes are made, used and thrown away is unsustainable. In Europe, about half of the used clothes are collected for reuse or recycling, but very little is recycled into new clothes.[10]

12. The lifetime of clothes has been shortening over time, putting an increasing pressure on natural resources and waste management. Ideas to prolong the lifetime of clothing include:[11]

(a) **Slow fashion:** In contrast to fast fashion, slow fashion encourages consumers to buy fewer clothes of better quality;

(b) **Improve collection for reuse, repair and upcycling**: (e.g., second-hand clothes in regular shops; repair programmes that allow consumers to send their worn or lightly damaged clothing to be repaired, to charity shops and for sale in markets);

(c) **Fashion as a service:** (e.g. clothes rental services, renting wedding clothing or special occasion clothing, or clothes subscription services).

13. There is an increasing trend for people to sell their unwanted clothes as used or second-hand clothing over internet trading platforms. Shops selling second-hand clothing are fairly common in major cities: certain shops specialize in designer clothing of high value, others sell clothing as individual items, or by weight. Some shops selling second-hand clothing and other goods are linked to or owned and operated by charities.

14. Textiles that are not directly reusable, but can be reused after repair or refurbishment, may be classified as waste in some national legislation. Textiles from households that are only fit for material recycling, for fibre recycling, are commonly classified as waste. Textiles from households that are only fit for final disposal by incineration or landfill are generally classified as wastes. The Basel Convention

[4] Reuse (2017). Reduced taxation to support re-use and repair. Available from: http://www.rreuse.org/wp-content/uploads/RREUSE-position-on-VAT-2017-Final-website_1.pdf

[5] Ibid

[6] https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/1952/report-summary.html

[7] House of Commons Environmental Audit Committee (2019). Fixing Fashion: clothing consumption and sustainability. Available from: https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/1952/1952.pdf

[8] Global Fashion Agenda & The Boston Consulting Group (2017). Pulse of the Fashion Industry.

[9] Ibid.

[10] European Parliament (2019). Briefing. Environmental impact of the textile and clothing industry. What consumers need to know. Available from: http://www.europarl.europa.eu/RegData/etudes/BRIE/2019/633143/EPRS_BRI(2019)633143_EN.pdf

[11] Ibid.

Annex IX[12] List B has under entry B3030 "worn clothing and other worn textile articles". Whilst the Convention listing is coherent with the World Customs Organisation Harmonised System code "6309 00 00: Worn clothing and other worn articles", used clothing from households is commonly collected together with shoes and accessories that may not be made of only textiles, and may be collected with other used textiles goods such as tablecloths, curtains, etc.

15. People are encouraged to put their textiles for reuse into on-street containers. Some on-street container collections provide income for charities. People may also take their unwanted textiles to collection points in charity shops, schools or community centres. The onward sale of such items commonly provides income for charitable activities. Textiles can also be collected from households. To prepare for door-to-door collections, free collection bags are delivered beforehand, so people have time to sort out unwanted textiles such as clothing, cloth, footwear, etc. The filled bags are then collected at a designated time.

16. Collected textiles should be sorted to determine those that are suitable for reuse from those that can be recycled or need to be disposed of. Textiles that cannot be recycled are usually destined for waste-to-energy recovery, incineration or landfill.

2. Furniture

17. Household furniture comes in many shapes, sizes and materials. These items can be made of single materials such as wood, bamboo, rattan, metal and plastic or a mixture of different materials. It is important to ensure that furniture for reuse is free of hazardous materials, such as lead paint, and free from prohibited flame retardants and flammable materials. Most furniture when broken may be repairable, much depends on the severity of the damage and the materials and skills available to affect a repair. Repair and reuse of furniture is not a new activity, after all, the antiques trade has been around nearly as long as the antiques themselves.

18. As with other waste streams, there are several ways to reduce the volume of furniture sent to landfills:

(a) Furniture repair and refurbishment;

(b) Eco-labelling criteria (e.g., information that supports recycling);

(c) service providing concept (e.g., furniture rental solutions, furniture leasing).

19. Households may sell furniture for reuse or donate it to charities. Private enterprises may collect furniture from households or purchase furniture with a view to selling it after necessary repair and refurbishment. Used furniture is sold in charity shops, in second-hand shops, at specialist auctions and online.

Box 5.1 Waste Exchange (WX) Project, Nelson Mandela Bay Municipality, South Africa[13,14]

In South Africa, to facilitate the exchange of re-usable materials, the Nelson Mandela Bay Municipality manages a Waste Exchange (WX) Project creating a system where potential buyers can contact potential suppliers and source available material. It is a web-based free online service available to business, industry, non-governmental organizations, schools and individuals who generate materials that others may have a use for. This initiative assists with the marketing of unwanted material and the matching with users, re-users and recyclers. Available and wanted items are listed on the web site. This project was initiated in an effort to increase the re-use of waste and to reduce the dumping, for example, of builder's rubble and other waste in the municipal area. The success of the project is measured by the number of successful exchanges made.

3. Electrical and electronic equipment

20. Electrical and electronic goods in the home comprise of domestic appliances - such as cookers, washing machines, refrigerators, freezers, and consumer electronics such as televisions, computers, games consoles. Reuse of electrical and electronic equipment is the preferred option in the waste management hierarchy, but ensuring these appliances are fit for reuse can be problematic. Domestic

[12] Wastes contained in Annex IX will not be wastes covered by Article 1, paragraph 1 (a), of this Convention unless they contain Annex I material to an extent causing them to exhibit an Annex III characteristic.

[13] https://infrastructurenews.co.za/2014/06/20/dont-dump-it-exchange-it-in-nelson-mandela-bay/

[14] https://www.nelsonmandelabay.gov.za/page/my-waste

appliances may require electricians to service and repair them, whilst the repair of consumer electronics generally requires a different level of technical knowledge and skill.

The reuse of electrical and electronic equipment largely depends on:

(a) Product design;

(b) The freely available information on how to carry out repairs;

(c) The availability of spare parts and tools.

21. Some jurisdictions (e.g. the European Union) are looking to outlaw the manufacturing of goods with planned obsolescence.[15]

22. Local authority waste management services may include less frequent kerbside collection for domestic appliances and consumer electronics. Whether these are then destined for repair or refurbishment or final disposal depends on the waste management service and whether the goods are at 'end-of-life' or not. People who no longer want them may deposit them in container parks or at collection points. Also, under arrangements with retailers, old domestic appliances and consumer electronics may be collected when their replacements are delivered and installed.

23. Households may sell domestic appliances and consumer electronics for reuse or donate them to charities. Private enterprises may collect them from households for free or purchase them with a view to selling them after necessary repair and refurbishment. Used domestic appliances and consumer electronics may be sold in charity shops, in second-hand shops, and online.

24. Repair and refurbishment, including of domestic appliances and consumer electronics, are covered by the Basel Convention technical guidelines on transboundary movements of electrical and electronic waste and used electrical and electronic equipment, in particular regarding the distinction between waste and non-waste under the Basel Convention.

25. The Mobile Phone Partnership Initiative under the Basel Convention produced a guidance document on the environmentally sound management of used and end-of-life mobile phones.[16]

26. The Basel Convention Partnership for Action on Computing Equipment (PACE) published a guidance document on the environmentally sound management of used and end-of-life computing equipment.[17]

Box 5.2 SURFACE project in Central Europe

The SURFACE project[18] brought together 10 partners from Central Europe with the aim to set up Multi-Stakeholder based Smart Re-Use parks as a possible solution for increasing sustainability in selected functional urban areas. The involved regions benefitted from the transnational cooperation through know-how-exchange and learning from best practice examples. The results helped to improve environmental management and quality of life of the involved partners through reducing waste streams, creating jobs, offering new trainings and boosting investments, creating a set of tools for harmonized and evidence based decision-making in the field of waste prevention and re-use.

D. Reuse statistics

27. Collecting information on all product reuse is expensive and time consuming. Some countries report on waste reuse (e.g. Australian Government National Waste Report)[19] which notes that although the volume of waste reuse is relatively low, the ratio of jobs and dollar value per thousand tonnes of material sold per year is much higher than for recycling.

[15] https://www.greens-efa.eu/en/article/press/clear-consensus-on-the-need-to-end-planned-obsolescence/

[16] http://www.basel.int/Implementation/Publications/GuidanceManuals/tabid/2364/Default.aspx

[17] http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/PACE/Overview/tabid/3243/Default.aspx

[18] https://www.interreg-central.eu/Content.Node/SURFACE.html

[19] Pickin, J., Randell, P., Trinh, J., Grant, B., Richmond, L. (2018). *Prepared for Department of the Environment and Energy: National Waste Report 2018 Client Department of the Environment and Energy Status Final*. Reviewers, J. P., & Wardle, C. Retrieved from https://www.environment.gov.au/system/files/resources/7381c1de-31d0-429b-912c-91a6dbc83af7/files/national-waste-report-2018.pdf

28. Some countries set targets for reuse for certain product groups. To evaluate progress against pre-defined targets requires data collection and analysis. Targets for reuse are most commonly associated with Extended Producer Responsibility Schemes.

VI. Recycling of household waste

A. Introduction

1. Household waste generation and resource depletion have been major concerns in many countries, and increased household recycling is seen as a means to reduce these problems. Currently, about 2.01 billion metric tons of municipal solid waste (MSW) is produced annually worldwide, from which only 13.5 percent is recycled and 5.5 percent is composted. The World Bank estimated that annual global waste production could increase by 70 percent by 2050 if current conditions persist.[1]

2. Under the waste management hierarchy, recycling is the next preferable option following prevention, minimisation and reuse. The Basel Convention Glossary of Terms stipulates that Recycling operations involve the reprocessing of waste into products, materials or substances, though not necessarily for the original purpose. An example is used lubricating oil re-refined which could result in high grade oil which is valuable for its chemical properties and hence that would be a recycling operation. Once the operation is complete, the substance or object is no longer waste. Some recycling operations are listed in Annex IV to the Convention.[2]

3. Recycling of household waste could play a major role in the sustainable management of waste and could be regarded as a replenishment of the available anthropogenic stock of a resource, decreasing extraction rates from the natural environment and introducing secondary raw materials to the industry. Recyclables make up a substantial fraction of waste streams, ranging from 16 percent paper, cardboard, plastic, metal, and glass in low-income countries to about 50 percent in high-income countries. As countries rise in income level, the quantity of recyclables in the waste stream increases, with paper increasing most significantly.[3]

4. In many industrialized countries, sophisticated recycling programmes have been introduced for household waste. Nevertheless, too many valuable resources are still being wasted through inadequate separation, collection and recovery systems. In some developing countries, components of waste streams are usually segregated and used. The recycling of household waste can have a major impact on the economies of these countries. Individuals involved in informal waste segregation activities can be brought into the formal sector and be remunerated for their work. Valuable items or "pickings" can be sold through intermediaries to small recycling entrepreneurs. The entire recycling activity - including transportation - generates employment, and the economic status of all those employed in recycling is improved.

5. This module serves as a guideline for the implementation of household waste recycling with a focus on collection and processing of different recyclables. In addition, emphasis is placed on the economics of recycling, and the markets for secondary raw materials.

B. Benefits and barriers

6. The benefits of recycling waste streams are well documented. Some benefits of recycling are summarised below:

(a) It saves raw materials (preserves large volumes of water, reduces energy and minimizes the demand for non-renewable resources during manufacture);

(b) It reduces our impact on the climate (e.g. paper recycling reduces emission of methane from landfill);

(c) It is possible to bypass air, water and soil contamination during mining and disposal (dumps, incinerators);

(d) It is a cost-effective use of resources (recycling aluminium saves 90 percent of the energy

[1] Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development, Washington, DC: World Bank. https://elibrary.worldbank.org/doi/abs/10.1596/978-1-4648-1329-0

[2] http://www.basel.int/Implementation/LegalMatters/LegalClarity/Glossaryofterms/SmallIntersessionalWorkingGroup/tabid/3622/Default.aspx

[3] Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development, Washington, DC: World Bank. https://elibrary.worldbank.org/doi/abs/10.1596/978-1-4648-1329-0

required to make new aluminium from bauxite[4]);

(e) It creates jobs.

7. Conversely, the main barriers to recycling in the separation at source phase are:

(a) Lack of information or communication regarding what is recyclable;

(b) Households' attitudes towards recycling - some households are not willing to participate because it requires diligence and extra effort;

(c) Low political priority assigned to it;

(d) Limited materials flows (for example in SIDS) making recycling economically unfeasible;

(e) A lack of a market for secondary materials;

(f) Investment costs required for separation at source programmes.

8. Incentives to recycle, besides 'doing the right thing', include economic incentives. For example, households can be paid by scrap collectors for metals, with the price dependent on the type and quality of scrap being sold for recycling. Legislation which sets recycled content requirements on manufacturers can increase the demand of recyclables and so increase collection. Other incentives can come from legislation or policies that set targets for recycling.

C. The recycling process

9. As outlined in module IV on separation at source, collection and transport, effective separation of household waste and efficient collection services are at the core of the ESM of household waste.

1. Collection of post-consumer recyclable household waste

10. When recycling, households are advised to present the waste in an appropriate manner. This may include putting the waste into separate containers for door-to-door collection, putting designated wastes into on-street containers, taking end-of-life goods and materials to deposit or sell to recycling centres/scrap yards, or returning designated end-of-life goods to retailers who have take-back schemes for consumers buying new items.

11. Collection of post-consumer recyclable household waste may be performed in:

(a) Mono-material collection systems where a specific recyclable is segregated at source as one material fraction;

(b) Co-mingled collection systems where several types of source separated dry recyclables (e.g. metals, glass and plastics) are collected together;

(c) Mixed waste collection systems where recyclables are collected together with the rest of household waste and often are contaminated by the presence of organics and other impurities.

12. Recyclables collected with other municipal waste can be a cheap collection option, however it takes a lot of effort to separate recyclables from mixed waste and remove contaminants. To obtain clean recyclables it is generally preferable to collect the wet fraction of municipal waste separately. Separate collection schemes of recyclables enhance the capture of clean material securing low levels of contamination from other waste such as organics. However, even separately collected wastes from households commonly need further sorting to separate the different types of recyclables, as well as to remove any impurities. In contrast, waste collected from households through take-back deposit-refund systems are of a higher quality, since the individual items need to be evaluated for the refund payment. It is also common for some hazardous wastes to be generated from households - such as medicines, garden pesticides, paints and batteries - which are advised to be separated and separately collected.

13. Separating waste for collection reduces the cost to the household by reducing the onward cost of recycling, other forms of recovery, and/or final disposal.

2. Recycling operations

14. Recycling operations comprise the reprocessing of waste into products, materials or substances, though not necessarily for the original purpose. Resources are saved by recovering material benefits from the waste. Recycling is to be distinguished from operations that recover energy from the waste. In

[4] https://www.aluminum.org/sustainability/aluminum-recycling

some countries, where material is used once merely for its physical properties (e.g. for backfilling), this does not amount to recycling.

15. The overall aim of the recycling processes is to add value to the wastes by removing hazardous and unwanted materials. Much of this can be done by manual sorting and mechanical processing. During sorting, the unwanted material is removed, resulting in a secondary raw material that can substitute for a primary raw material in the marketplace. These secondary raw materials are sold to manufacturing industries that make new goods. Bulk transportation of the secondary raw materials to industrial consumers is the most economic option. Industrial consumers need a steady infeed, as few are set up to accept infrequent small deliveries of variable quality from many suppliers.

16. The diagram below shows the pyramidal nature of recycling industries, and of recycling material flows (Figure 6.1). The many "collectors" includes separate collection from households, whereas fewer recovery sector facilities are sorting and processing the waste and scrap, to meet industry specifications. The secondary raw materials are then delivered to the relatively small number of manufacturing industries.

Figure 6.1 Scheme: The inverted pyramid structure of the recycling sector. Source: Bureau of International Recycling

17. Small island developing States cannot be expected to have every type of facility to recover every waste fraction collected from households (see the Small Island Developing States Waste Management Outlook[5] for more information). It follows that, after collection, wastes for recycling will have to be exported in order to reach recycling facilities. The provision of regional solutions for the recycling of certain wastes have been established in some countries and are being explored in others.

3. Illegal or undesirable recycling operations

18. International agreements such as the Montreal Protocol on Substances that Deplete the Ozone Layer, the Minamata Convention on Mercury, and the Stockholm Convention on Persistent Organic Pollutants prohibit the recycling of certain chemicals such as ozone-depleting substances, mercury, and persistent organic pollutants, respectively. Regional and national laws may also specify other substances which may not be recycled. Objects comprising of or containing these substances or materials which should not be recycled may be collected from households. Appropriate steps need to be taken to ensure these non-recyclables do not enter the recycling stream.

D. Recycling of different household waste streams

19. The most commonly recycled materials collected from households are ferrous metals (e.g. steel cans) and non-ferrous metals (e.g. aluminium cans), paper and cardboard, plastic and glass. At the time of writing, many new legislative interventions are being made to increase plastic recycling around the world and to reduce the volumes of difficult to recycle and unrecyclable plastics.

1. Metal recycling

20. Metals represent one of the most valuable waste streams and can be recycled numerous times without degradation of quality. There are two principal categories: ferrous (e.g. steel, iron) and non-ferrous (e.g. aluminium, copper, zinc).

21. The main recycling steps for metals are collection, manual or mechanical sorting, followed by processing to an industrial commodity grade specification for delivery to a foundry or metalworks that manufactures metal goods.

22. It is important to note that depending on the volumes of metal scrap available in a country, the facilities that carry out the main recycling steps of collection, sorting, and processing will be established

[5] https://www.unenvironment.org/ietc/node/44

by private entrepreneurs. However, few countries will likely have a foundry or metalworks for every metal or metal alloy.

> Box 6.1 Guidelines on best available techniques
>
> Guidelines on best available techniques and provisional guidance on best environmental practices relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants, Section VI.L concerns smouldering of copper cables. It observes that scrap copper is often recovered by open burning of plastic coatings from electrical cables and wiring. Chemicals listed in Annex C of the Stockholm Convention are probably formed from plastic and trace oils with copper as a catalyst at smouldering temperatures between 250°C and 500°C. It concludes that the smouldering process is not a best available technique or best environmental practice and should not be practiced. Best available techniques include mechanical cable chopping and stripping.

23. The most common metals at household level that are included in recycling programs are:

(a) Empty aluminium food and drink cans. (For example, in the United Kingdom the average household uses 600 aluminium food cans and 380 aluminium metal drinks cans each year[6]);

(b) Aerosols;

(c) Aluminium foil trays and household foil;

(d) Non-packaging metal items that include electrical items such as irons, or bulky items such as bicycles and pans, paint cans, nuts, etc.

24. Collection schemes of metals at household level include: (i) kerbside collection, (ii) household waste recycling centres (also known as civic amenity sites), and (iii) bring sites/banks.

(a) Process for beverage can recycling

25. After collection, aluminium beverage cans are usually recycled by the following method:[7]

(a) Sorting

Cans are separated from the household waste stream or mixed recyclables either manually or mechanically using an eddy current separator at a material recycling facility, sorting facility or a transfer station.

(b) Reprocessing

Bales of aluminium cans are then taken to a reprocessing facility. Processing of aluminium involves four stages: shredding, de-coating, melting, and casting. At the final stage, the molten metal is cast into large ingots.

(c) Rolling

Ingots are transported to rolling mills and rolled out to make sheet aluminium, from which new packaging can be made.

(d) Converting

Aluminium sheet is converted into a diverse range of packaging items.

(b) Process for copper wire recycling

26. The steps in recycling copper wires from household appliances are illustrated below:

(a) Collection

Collection of household appliances at a collection centre. Many of these items have an electric cable and plug that contains copper.

(b) Sorting

[6] https://www.recyclingbins.co.uk/recycling-facts/

[7] https://alupro.org.uk/industry/aluminium-nothing-goes-to-waste/

Insulated copper wire is cut from household appliances and collected together.[8] For transboundary movement, the classification of these wires can be in Annex IX List B (B1115), waste metal cables coated or insulated with plastics, not included in Annex VIII list A A1190, excluding those destined for Annex IVA operations or any other disposal operations involving, at any stage, uncontrolled thermal processes, such as open burning. Certain national standards set quality requirements for imports of wire and cable scrap.

(c) Processing- Stripping of the insulation from cables

The processing step of stripping insulation from wires and cables can be done by hand with simple instruments. However, this is labour intensive. Simple cable stripping machines are readily available. Depending on the volumes of cable to be processed, complete cable granulation systems may be employed.

(d) Exporting to end-user

Sorted and processed copper wire can be delivered to local metalworks or foundry, or exported. There are a limited number of destinations for high quality copper in this form, as not every country has a copper smelter, re-smelter or foundry. Therefore, trade routes and destinations are well known within the metals industry.

2. Paper and cardboard

27. Household waste recycling programs for post-consumer paper recovery includes printed matter (e.g. magazines, newspapers, books etc.), writing paper and paper packaging (e.g. cardboard). Collection of paper at the household level can include kerbside collection, collection at household waste recycling centres (also known as civic amenity sites) and bring sites/banks.

28. Globally, the majority of paper is landfilled. In 2012, the transboundary trade of waste paper was approximately 40-50 MT, which accounted for about 10 percent of total global production. It is not possible to recycle 100 percent of all the paper produced because there is a loss of mass during storage and a shortening of fibres during re-pulping. Shortening of fibres reduces the strength and hence the quality of the paper. Therefore, recycled paper needs to be mixed with virgin pulp to compensate.

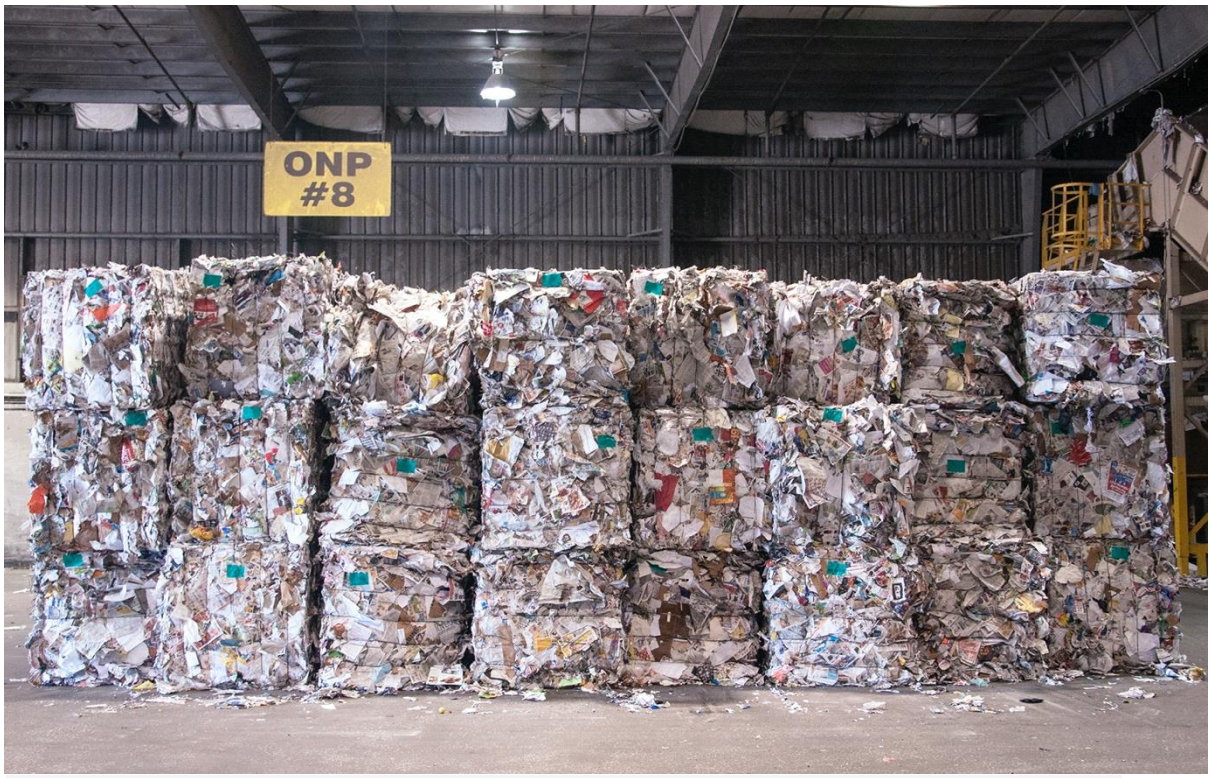
29. Producing paper from recycled materials instead of virgin wood pulp saves trees and reduces water and electricity consumption. Life cycle studies indicate that even after all energy used to collect, transport and process the used paper is factored in, producing recycled paper uses significantly less total energy than producing virgin paper and results in lower greenhouse gas emissions, as well as air and water pollution.

30. The recycling of paper follows a series of steps which may vary depending on the type of paper and its degree of deterioration.

(a) Sorting

31. Paper products must be separated according to their composition and degree of deterioration. Different types of paper can sometimes be mixed, others, such as paperboard, are recycled using a single-grade process, meaning that no other type of paper can be mixed in during its processing.

[8] Informal methods of removing the outer casing from copper cables involve open burning of the materials for the casings to burn off so that only the copper remains. Such practices are environmentally unsound.



Sorted, baled and ready to transport from a waste management centre in Chicago (photo credit: Chris Bentley)

(b) Baling

32. Large quantities of paper are packed using hydraulic machines that apply enormous pressure to compact recovered paper into blocks that are easier and more cost-effective to transport. Two common types of balers are vertical balers and horizontal balers. Vertical balers are usually cheaper in cost, but do not provide the compaction that horizontal balers do. A cost benefit analysis comparing the increased capital costs for a horizontal baler against the increased returns that can be achieved due to greater bale weights can decide on the choice of baler to be used. For most recycling facilities the process ends at the baling stage after which the bales of paper and cardboard are shipped/transported to paper mills where the rest of the processes are carried out.

(c) Shredding

33. Recovered fibre is shredded into smaller pieces and mixed with water to make pulp.

Shredded paper for processing (Photo credit: Tony Webster)

(d) Washing

34. The pulp is washed, refined and cleaned, then turned into a slush that is processed to remove contaminants such as ink, clay, dirt, plastic and metals. Dyes, coatings and other additives can be introduced during this process. Water is continuously drained and cleaned for reuse.

(e) Bleaching

35. In order to whiten paper, the pulp can be bleached using hydrogen peroxide and chlorine.

(f) Pressing

36. The resulting paper sheet, known as 'web', is pressed between massive rollers to extract as much of the remaining water as possible and to ensure uniform smoothness and thickness. The semi-dry web is then passed through heated dryer rollers to remove any remaining water.

(g) Rolling

37. The finished paper is processed into large rolls ready to be manufactured again into new consumer products.

3. Plastics

38. The global rates for plastic recycling are low – with estimates that only 9 percent of the 6300 MT of plastic waste produced by 2015 has been recycled. The majority (79 percent) has been sent to landfill.[9] Plastics are predominantly made from oil, manufactured using approximately 4 percent of the petroleum consumed worldwide.[10]

39. Post-consumer plastic packaging (e.g. disposable plastic cups, plates, takeaway containers, plastic bags etc.) is usually the major component sorted for recycling by households. These items can be made from a number of different plastics, most of which are not biodegradable.

40. There are six common types of plastic used in packaging products:[11]

(a) **HDPE (High-density polyethylene)**: the most widely used type of plastic, used for packaging many household products e.g. shampoo, detergent, milk;

(b) **LDPE (Low-density polyethylene)**: flexible and transparent, used mostly in films e.g. shrink wrap, garbage bags, coatings for paper products such as drink cups;

(c) **PET (Polyethylene terephthalate)**: clear and strong, used in beverage containers e. g. water and soft drink bottles;

(d) **PP (Polypropylene)**: strong, high melting point, used for containers e.g. take away food, ice cream containers, yogurt, medicine bottles;

(e) **PS (Polystyrene)**: versatile as can be rigid or foamed, used for protective packaging, food containers e.g. plastic cutlery, cups, bowls, meat trays;

(f) **PVC (Plasticised Polyvinyl chloride or polyvinyl chloride)**: can be rigid or flexible, e.g. blister packs, juice or squeeze bottles.

41. Plastics can be classified into different groups for collection and subsequent sorting. Collection advice often differs from city to city, region to region and country to country.

42. Curb side recycling programmes generally recycle PET, HDPE, and PP plastic products. The recycling of other types of plastic packaging is uncommon. Some types of plastic are not recycled because it is not economically feasible to do so.

43. Household plastic waste such as plastic furniture (e.g. broken plastic chairs) and household equipment made of plastic at the end of their life may also be included in plastic recycling programs.

44. It is desirable that the household manually removes food and other product residues from the plastics before putting them in collection systems. Plastic recycling faces issues from contaminants and foreign items, such as organic waste. The mixing of different types of plastics can also pose problems. It can affect certain features of the subsequent mixed recycled plastic, properties such as its strength and flexibility, and also affect the decision on the most appropriate plastic waste treatment technology to use. The quality of plastic scrap for recycling also affects marketability and the price of secondary plastics.

[9] Geyer et al. 2017. https://advances.sciencemag.org/content/3/7/e1700782?ijkey=60ef468a560c16dc5fbaff578a85e1e74f1e1c1c&keytype2=tf_ipsecsha

[10] The Globalist, 2015. The Rise of Plastic. The past, present and future of plastic production. https://www.theglobalist.com/the-rise-of-plastic/

[11] https://www.plasticpackagingfacts.org/plastic-packaging/resins-types-of-packaging/

(a) Process for plastic recycling

45. Plastic recycling refers to the process of recovering waste or scrap plastic and reprocessing it into plastic (material recycling). Material recycling can be further sub-divided into mechanical recycling (the most common practice) and chemical recycling.

46. Mechanical recycling is the most common plastic recycling processes around the world. The simplest methods of reprocessing involve collecting, sorting, granulate-shredding, washing and drying, extrude-melting, cooling, and pelletizing-cutting.[12] The mechanical recycling of plastics also leads to savings in carbon dioxide emissions, as compared to producing virgin plastic products, but not as compared to emissions averted by reducing plastic production.[13]

47. Chemical recycling is the depolymerization of long polymer chains into monomers through a chemical reaction by means of heat and/or chemical agents to produce monomers, which are used to produce recycled plastic products chemical raw materials and/or fuels. In practice, depolymerization processes yield fuels or petrochemicals and are therefore not recycling, but chemical or thermal recovery (see module VII).[14]

Box 6.2 EcoPost, Kenya[15]

EcoPost is a social enterprise founded in 2009 by a young female entrepreneur, to propose an alternative solution to plastic waste management in Kenya. The company collects plastic waste and manufactures commercially viable, highly durable and environmentally friendly fencing posts. EcoPost provides a commercial alternative to timber and it created over 300 jobs, generated revenues, saved over 250 acres of forests and has taken more than one million kilogrammes of plastic waste out of the environment.

4. Glass

48. In 2018, glass containers accounted for around 45 percent of the glass produced worldwide, while fiberglass products only accounted for six percent of the world's glass production in that year.

49. Household glass bottles and jars are commonly collected door to door in separate, or co-mingled collections (co-mingled collection is not recommended, as broken glass contaminates other recyclables). Otherwise, glass is collected through on-street containers, or containers in recycling parks (see module IV).

50. The process for glass recycling is as follows:

(a) The glass is broken into smaller pieces called cullet;

(b) This cullet is then separated and washed (manually);

(c) The cullet is then introduced into a furnace to be re-melted for production of new bottles for sale.

51. Cullet helps extend the furnace life as it melts at lower temperatures. Once contaminants are removed there is no quality loss of glass in recycling, however, once coloured cullet is mixed then the quality is lowered.

5. Textiles

52. The apparel industry consumes more energy than the aviation and shipping industry combined, accounting for 10 percent of global carbon emissions. Chemicals from dyes make their way into the environment, polluting the air, water, and also harming marine life.[16] The fashion industry:

(a) Produces 20 percent of wastewater;

[12] Ragaert, K., Delva, L., Geem, K., (2017), Mechanical and chemical recycling of solid plastic waste, Waste Manag., vol. 69, pp. 24–58

[13] A. Ballinger and D. Hogg (2015), "The Potential Contribution of Waste Management to a Low Carbon Economy", Eunomia, Zero Waste Europe, Zero Waste France and ACR+

[14] Grigore, M., (2017), Methods of Recycling, Properties and Applications of Recycled Thermoplastic Polymers, Recycling, vol. 2, no. 4, p. 24

[15] https://www.ecopost.co.ke/

[16] https://www.un.org/sustainabledevelopment/blog/2019/08/actnow-for-zero-waste-fashion/#_edn1

(b) Is responsible for 8-10 percent of the world's greenhouse gas emissions;

(c) Has an estimated USD500 billion lost every year due to clothing underutilisation and lack of recycling.[17]

53. Used clothing and accessories, household textiles, toys and shoes are collected door to door, or at textile banks. The textiles are taken to sorting centres where they are sorted by material (wool, cotton, synthetic), by type (dress, shirt, trousers) and judgements are made about reusability, reparability, item value and future marketplace. Second-hand clothing and accessories may be sold in second-hand shops, in charity shops, or in marketplaces. There is increasing use of online sales, whether by individuals or by private enterprises.

54. If there is no reuse value, the used textiles goods are sold to the 'flocking' industry. Mills grade incoming material according to their type and colour. The colour sorting means no re-dying is needed, saving energy and avoiding pollutants. Textile materials are shredded or pulled into fibres. Depending on the end use of the yarn, other fibres may be incorporated. The blended mixture is carded to clean and mix the fibres. The yarn is re-spun ready for later weaving or knitting. Depending on the final application, fibres sometimes do not need to be spun into yarns, they can simply be compressed to create new textile fillings.

55. In the case of polyester-based materials, the recycling starts by cutting the garments into small pieces. The shredded fabric is then granulated and turned into polyester chips. The chips are melted and spun into new filament fibres used to make new polyester fabrics.

56. Knitted or woven woollen and similar materials are reused by the textile industry in applications such as car insulation, roofing felt, loudspeaker cones, panel linings and furniture padding. Cotton and silk are used to manufacture paper and wiping and polishing cloths, for a range of industries from the automotive to the mining sector. Other types of textiles can be reprocessed into fibres for upholstery, insulation, and even building materials.

Box 6.3 SK-Tex, Slovakia[18]

SK-Tex[19] recycles clothing into car seat upholstery filling, furniture insulation and ECO building insulation. It started with products made from secondary raw materials, targeted at the automotive sector: textile panels and mats used for noise reduction in cars or for lining car boots.

It now specializes in construction materials: Ekosen HMC, a recycled product used as an alternative to insulation based on inorganic fibres, such as mineral and glass wool. It is used for interior and exterior insulation and for prefabricated wall panels. SK-Tex's insulation can be recycled again when removed from buildings.

Box 6.4 Ecofibra Chile[20]

In Chile, in the municipality of Alto Hospicio in the Tarapacá Region, to face the problem of the huge quantities of textile waste generated from the import of used clothes, the company Ecofibra[21] recycles and transforms textile waste into ecological panels for thermal and acoustic insulation of buildings. In the Free Zone, 80% of the used clothing that arrives in the region ends up in clandestine dumps near the city. The activity of recycling contributes to eliminating from the dumps a large part of the textile waste that generates environmental problems (clandestine dumps, fires, etc.); the use of ecological thermal insulation panels helps to save up to 35% of electricity consumption due to the reduction in the use of heating or cooling the air inside homes. The ecological insulating panels allow the replacement of current materials that are used in the construction industry, such as glass wool. The process for the production of these panels is completely circular: at the end of use, the thermal panels can be returned to the company, which recycles them without generating any waste.

[17] Ibid.

[18] https://circulareconomy.europa.eu/platform/en/good-practices/sk-tex-slovakian-recycling-company-transforms-old-clothes-insulation-products

[19] https://sk-tex.com/

[20] https://www.ideassonline.org/public/pdf/EcoFibraChile-ENG.pdf

[21] http://www.ecofibrachile.cl/product.html

6. Waste electrical and electronic equipment

57. There are numerous different types of household waste electrical and electronic equipment (WEEE). Items such as hair dryers, kettles, computers, toasters and other kitchen items are classed as small household appliances. This type of electrical waste will probably be the most common type that will be generated.

58. Another type of electrical waste generated in the household are larger electrical items such as TVs, fridges, washing machines, etc. The hazardous components from a fridge or television require specialist treatment compared to that of small household appliances. Large household appliances usually have a longer life span, but when they break or are replaced, they are less easy to transport for recycling.

59. The last type of electrical waste that households generate are batteries and light bulbs. As with any electrical waste, these items should not be placed into the general waste bin. These items contain hazardous materials that can pollute and harm the environment without proper treatment.

60. Household electrical waste can be either repaired and reused (see module IV) or recycled. Local recycling facilities may offer an array of different recycling services with most accepting electrical waste. Recycling facilities often separate out small household appliances, fridges, TVs, batteries and bulbs into separate containers prior to treatment.

61. Guidance developed by the Convention's Partnership for Action on Computing Equipment[22] and Mobile Phone Partnership Initiative[23] cover different aspects of the environmentally sound management of WEEE and mobile phones.

7. Hazardous household wastes

62. Hazardous wastes from households comprise items such as solvents, acids, alkalines, batteries, photo-chemicals, pesticides, mercury and chlorofluorocarbon containing waste, inedible oil and fat, paint, inks, adhesives and resins, detergents, cytotoxic and cytostatic medicines, electrical and electronic equipment and contaminated wood.

63. It is important to establish separate collection and management systems for the most common household hazardous wastes. Thereafter, such hazardous wastes should be disposed of separate to other municipal waste streams and according to ESM specifications.[24]

E. Markets for secondary raw materials

1. Demand

64. Recycled materials are in competition on the market with primary raw materials. The material consuming industries, manufacturers of semi-products and products often have a choice to use either primary raw materials or secondary raw materials. Such choices are principally economic and so most industrial consumers will buy secondary raw materials when they are priced lower than the competing primary raw materials. The consequence is that there is most often a price ceiling for secondary raw materials. Other incentives may be used to encourage manufacturers to use secondary raw materials rather than primary raw materials - for example, by setting recycled-content targets for manufactured goods.[25]

65. The point in the supply chain that secondary raw materials substitute for primary raw materials is precisely "in the marketplace", that is, before consumption by the manufacturing industries that make new products.

2. Measures to establish and optimize markets for secondary raw materials

66. The following legal measures may be used to optimise the markets for secondary raw materials, and thus stimulate the chain of recycling activities:

(a) Setting recycled content requirements in new goods;

(b) Setting requirements for the composition and quality of recycled material and legally binding targets for recycling to increase the supply of recycled materials, enabling economies of scale,

[22] http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/PACE/Overview/tabid/3243/Default.aspx

[23] http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/MPPI/Overview/tabid/3268/Default.aspx

[24] http://www.basel.int/Implementation/CountryLedInitiative/EnvironmentallySoundManagement/ESMToolkit/Overview/tabid/5839/Default.aspx

[25] https://ec.europa.eu/environment/topics/circular-economy_en

and reducing costs;

(c) Prohibiting landfilling and incineration of recyclable materials.

67. Other non-legal measures may be taken to boost the market for recycled materials, such as:

(a) Raising public awareness and concerns to create a demand for recycling, reducing dumping and waste and environmental damage;

(b) Using public sector procurement to buy goods made out of recycled materials or with high recycled content.

3. Quality standards for recycled materials

68. Recyclers depend on a marketplace for their recycled materials. Industry standards and specifications are used to set the quality of secondary raw materials so they may be purchased and used by consuming manufacturing industries, and thus substitute primary raw materials.

F. Economics of recycling

69. A comparison of the costs of running a co-mingled collection against the cost of running a single stream collection system, and the subsequent downstream costs of each would be informative. However, there are very many variables, such as the frequency of collection itself, which may be a significant factor. Policies that seek to increase recycling will certainly create jobs, as recycling requires more personnel than either landfilling or incineration.

70. The principle of continual quality improvement and its effect on the value of collected and sorted material are illustrated in Figure 6.2, which shows value linked to contamination, where the more contamination by unwanted or deleterious materials in the waste and scrap, the lower the value.[26] This example shows that the value of collected waste and scrap can become negative in the absence of a market; in such a case, the recycling, energy recovery or disposal of the waste has to be paid for. Furthermore, as plastics are predominantly made from crude oil, it is most unlikely that the price of recycled plastic pellets could pass that ceiling.

Figure 6.2 Prices of plastic film destined for export

[26] Plastic ZERO - Public Private Co-0perations for Avoiding Plastic as a Waste, n.d., Report on assessment of relevant recycling technologies, LIFE program

VII. Other recovery processes and treatments

A. Introduction

1. Household waste has a huge potential for resource and energy recovery. The organic fraction of the waste is suitable for composting or anaerobic digestion, the recyclable fractions for reprocessing into new materials, while the remaining fractions may be utilised for energy recovery. Based on the waste management hierarchy, composting, anaerobic digestion and other recycling should be favoured followed by waste-to-energy (WtE) solutions. Any sustainable solid waste management system must be integrated in line with the waste management hierarchy, prioritising waste prevention, minimisation, reuse, recycling, energy other recovery, with disposal as the last option.

B. Mechanical and Biological Treatment

2. Mechanical and biological treatment (MBT) is comprised of mechanical segregation followed by a biological treatment process like composting or anaerobic digestion. The plants operate as material recovery facilities and accept co-mingled household wastes and sort the waste streams into the individual components (organics, paper, plastics, glass, metals, etc.). The recyclable fractions may be sold to recyclers while the organic fraction is recycled by composting or through an anaerobic digestion process. While the MBT system eliminates the need for source separation of household wastes and the associated costs of source segregation, this system has several drawbacks. Often the household wastes are collected mixed, meaning that the input material is often contaminated. Subjecting contaminated organics to composting or anaerobic digestion plants may hinder the biological processes while the compost produced may also not meet stringent standards. Besides, the quality of recyclables such as paper is greatly reduced when these come into contact with wet organics.

3. As such, the materials/products from MBT plants are often of lower quality and hence, not easily marketable. In this context, it is preferable to source segregate household wastes into at least two fractions (wet and dry) to improve the subsequent recovery and treatment processes. An example of successful implementation is Phitsanulok in Thailand where an MBT system of capacity of 100 tonnes/day of mixed municipal waste has been in operation for more than a decade.[1]

C. Composting and anaerobic digestion (organic recycling)

1. Composting

4. Composting is the decomposition of organic matter in the presence of oxygen by a microbial population to produce a humus-like product (compost) that has high nutrient content (nitrogen, phosphorus and potassium). The compost can be used as a soil-amendment to improve nutrient content, water retention capacity, drainage and porosity of the soil, while also acting as a buffer to the soil pH. Composting can be centralized (e.g., large scale municipal composting) and/or decentralized composting (e.g., local domestic composting).

5. The main benefits of composting include:

(a) **Finances**: A financially affordable option in most countries, as it can be started with very little capital and low operating costs. It also allows savings as it increases overall waste diversion from final disposal, especially since as much as 80 percent of the waste stream in low- and middle- income countries is compostable.

(b) **Socio-economic**: There is potentially a high recycling culture to facilitate separation at source. The recycling culture may also lead to waste with high organic content. Composting can also integrate existing informal sectors involved in the collection, separation and recycling of wastes.

(c) **Policy**: Composting may help countries to reach national goals and targets (e.g., in lowering greenhouse gas emissions from the waste sector). It also enhances recycling and incineration operations by removing organic matter from the waste stream.

6. Conversely, the main barriers to composting include:

(a) **Physical barriers**: composting requires land, which may be in short supply in some countries particularly small island developing States and mountainous countries.

(b) **Finances**: there can be a limited market for the final compost, however the market can be stimulated by financial incentives such as reduced payment for domestic waste services.

[1] https://www.waste.ccacoalition.org/participant/phitsanulok-thailand

(a) Suitability of the Composting Process

7. The composting process is mostly suitable for wastes with a high organic matter content and a moisture content between 40 to 60 percent. Materials that may be composted include food wastes, yard wastes, paper and other organic waste streams. The composting process can be carried out at the household level (e.g. local domestic composting) or on a larger scale, such as windrows composting, aerated static pile or in-vessel composting (e.g. municipal scale).

(b) Local domestic composting or household composting

8. Household composting is an effective way of reducing the quantity of waste collection. Diverting waste from the landfill offers a number of benefits, namely reduction in the release of methane and leachate, savings in transportation and disposal costs, minimal ongoing capital expenditure after the purchase of the compost bins and no market is required.

9. Encouraging households to take up composting requires effective planning and a trial phase. The following steps may be useful:

(a) Selection of the target area for the trial scheme;

(b) Assessment of the benefits and feasibility of offering and distributing composters;

(c) Advertisement of the benefits of composting;

(d) Assessment of the current level of composting know-how;

(e) Provision of backup support for problems and clarification;

(f) Monitoring of the success of the scheme.

(c) Operating a large-scale composting plant

10. Large-scale composting generally will follow the process outlined below:

(a) Acceptance of organic wastes at the facility;

(b) Shredding of organic wastes to achieve a suitable particle size;

(c) blending of the wastes while also adjusting for the C:N ratio and moisture content;

(d) Laying of the waste:

(i) for windrows composting: laying the blended wastes into long piles "windrows" and aerating at regular intervals;

(ii) for aerated static pile: laying the wastes into piles over pipes connected to air blowers; blow air at regular intervals to ensure aeration of the static pile;

(e) Fine shredding of the compost material;

(f) Testing of the final compost to ensure that it meets with applicable regional or national compost standards;

(g) Packaging of the final compost for sale.

2. Anaerobic Digestion

11. Anaerobic digesters are alternatives to managing organic residual materials, with the benefit of energy recovery. The degradation process takes place in an oxygen-free environment with anaerobic bacteria (bacteria that don't require oxygen). The digestion produces biogas (methane, carbon dioxide and water) which can be converted into energy and digestate - solid remnants of the original input material, which can be taken for composting or used as fertilizer. Rigorous source separation and an effective collection system are necessary in order to provide good quality source material.

12. Systems for anaerobic digestion require supporting legislation and regulations to be in place. These are linked to the energy sector (such as linking to energy grids), regulating the quality of material, etc. While anaerobic digesters keep organic material out of landfill, they require a considerable investment. The digestate produced needs to be marked and quality controlled.

(a) Operating an anaerobic digestion plant

13. The anaerobic digestion plant, also referred as a biogas plant, consists of a multitude of unit operations namely feed/preparation tanks, conveyors, shredders, pumps, bio-reactors or digesters, biogas holders, dewatering equipment, gas scrubbers, waste heat boilers, generators, among others. Commissioning of a biogas plant requires specific skills, techniques and knowledge. Considering that a

biogas plant has high investment costs, it is important that the pre-requisites prior to setting-up of such a plant are satisfied. Once these pre-requisites are satisfied and the biogas plant has been set-up, the following steps are generally applicable:

(a) Acceptance of the organic wastes;

(b) Preparation of the waste streams (shredding, adjustment of pH, C:N ratio, moisture content, temperature);

(c) Feeding of the prepared substrates into the bio-reactor;

(d) Mixing in the bio-reactor to ensure effective contact between the substrates and the microorganism;

(e) Recuperation, cleaning and storage of the biogas produced;

(f) Combustion of the biogas to produce electrical energy;

(g) Recuperation and treatment of the digestate produced or use as bio-fertiliser.

D. Waste-to-Energy Technologies

14. Thermal and chemical recovery technologies, particularly thermo-chemical systems (incineration, gasification or pyrolysis), must be preceded by a well-established waste-to-resource system through recycling, including composting and anaerobic digestion. The wastes that can be recycled must be recycled with only non-recyclables sent to the waste-to-energy system. In addition, any residual waste from the recycling process can also be subjected to thermal or chemical recovery. Any thermal or chemical recovery should thus only be implemented once the collection and recycling system is well-established and fully operational.

15. Recycling and thermal or chemical recovery must complement, rather than compete, with each other. Waste-to-energy (WtE) systems must only compete with landfilling, since this is the least favoured option of the waste management hierarchy.

16. WtE technologies may be classified as either thermo-chemical or biological (Figure 7.1). Thermo-chemical techniques include incineration, gasification and pyrolysis while biological WtE techniques include anaerobic digestion (see the start of this module for further information on composting and anaerobic digestion).

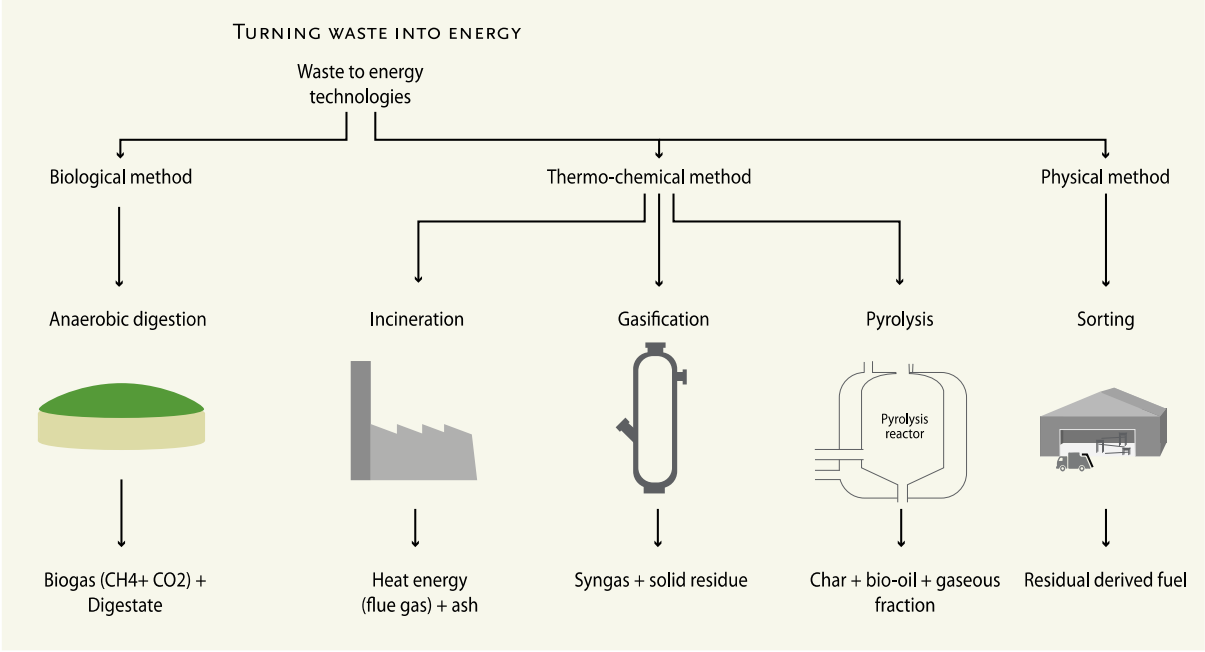


Figure 7.1. Waste to energy technologies and expected outputs. Source: GRID-Arendal

1. Landfill gas to energy

17. Guidelines for the environmentally sound operation of engineered landfills, including gas extraction, are found in the updated technical guidelines on the environmentally sound disposal of

hazardous wastes and other wastes in specially engineered landfill.[2] Landfills produce gases as a product of microbiological decomposition of landfilled waste. These gases consist of around 50-55 percent methane and about 40-45 percent carbon dioxide with nitrogen, oxygen, complex organic compounds, hydrogen sulphide and other sulphur compounds accounting for the rest. Landfill Gas (LFG) also has odorous, toxic, and carcinogenic trace components. It is potentially flammable and explosive when concentrated in confined spaces. Long-term exposure may have harmful health effects and can damage vegetation.

18. The combustibility of methane can be viewed as an asset and a liability. An asset when the gas becomes a source of energy recovered (it can be used in place of conventional fossil fuels) and a liability when subsurface migration of the gases results in hazardous conditions. LFG can be removed from the site using an extraction method, such as a series of wells and pumps that channel the collected gas to processing. This involves a vertical extraction well, horizontal gas collection trenches, condensate handling equipment, blowers/compressors, scrubbers, flares and flame arrestors and/ or engine generator sets or energy recovery facilities.

2. Incineration for energy recovery - heating and cooling

19. Guidelines for the environmentally sound incineration of hazardous wastes and other wastes are found in the updated technical guidelines on the environmentally sound incineration of hazardous wastes and other wastes as covered by disposal operations (D10 and R1).[3] Incineration is the controlled burning of waste for production of ash and hot flue gas that can be used to produce steam for electricity generation via a turbine and generator. Incineration may result in waste volume reduction of 90 percent (mass reduction of approximately 70 percent). Globally, there are a growing number of high temperature waste-to-energy (WtE) plants.

20. These plants recover the energy from municipal solid waste for power and/or heat and can recover non-combustible solids such as glass and metals from the bottom ash. Bottom ash itself can also be further processed for use as a construction material (replacing the use of virgin aggregates).

(a) Suitability of incineration

21. Incineration, like all thermo-chemical WtE technologies, is suitable for wastes having a relatively low moisture content as well as a high calorific value. As indicated in a World Bank report,[4] the net calorific value of a waste stream must be on average 7 MJ/kg (but never less than 6 MJ/kg) for the incineration process to be sustainable. To ensure that a waste stream is combustible, the Tanner diagram may be used whereby any waste stream falling in an area with an ash content <60 percent, a moisture content <50 percent and combustible content >25 percent is deemed self-combustion.[5] For any waste stream not within the area boundary of these 3 parameters, an auxiliary fuel (e.g. fuel oil) is required to assist in the combustion of the waste stream.

(b) Operating an incineration plant

22. An incineration plant is a complex facility consisting of several unit operations including a bunker, hopper, grate, furnace, boiler, turbine, generator, scrubber, etc. Considering the high investment costs of such a facility, several prerequisites need to be satisfied prior to considering the implementation of this technique on a large scale. Once these prerequisites are satisfied and the incineration plant has been commissioned, the following steps are generally applicable:

(a) Waste reception;

(b) Waste pre-treatment (e.g. sorting, mixing, and shredding);

(c) Waste storage in bunker;

(d) Waste feeding into furnace via the hopper and feeding grate;

(e) Collection of ash and management;

(f) Waste flue gas to waste heat boiler;

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[2] UNEP/CHW.15/6/Add.5. Draft updated technical guidelines on the environmentally sound disposal of hazardous wastes and other wastes in specially engineered landfill (D5)

[3] UNEP/CHW.15/6/Add.4. Draft updated technical guidelines on the environmentally sound incineration of hazardous wastes and other wastes as covered by disposal operations (D10 and R1)

[4] Rand, T., Haukohl, J. and Marxen, U., 2000. *Municipal solid waste incineration: requirements for a successful project* (Vol. 462). World Bank Publications.

[5] Tanner, V.R., 1965. Die Entwicklung der Von-Roll-MÃ1=4llverbrennungsanlagen (The development of the Von-Roll incinerators) (in German). Schweiz Bauzeitung 83, 251–260. http://dx.doi.org/10.5169/seals-68135

(g) Generation of steam in the boiler;

(h) Production of electrical energy via turbine and generator;

(i) Wastewater management (air pollution control devices use water for flue gas cleaning and generate wastewater);

(j) Environmental monitoring (includes pollutants in the flue gas, ash, wastewater, etc.);

(k) Monitoring and treatment of flue gas.

(c) Ash Processing and Management

23. Ash is a by-product of the waste incineration process and may be classified as bottom ash, boiler ash and fly ash. For incineration processes, approximately 230-280 kg of ashes are produced per ton of municipal solid wastes incinerated[6] with 80-90 percent of the ashes being bottom ash and the remaining 10-20 percent consisting of fly ash and air pollution control residues.[7] Both bottom and fly ash may consist of heavy metals and as such, may be classified as being hazardous. Fly ash is more hazardous since it may contain dioxins as well as a higher concentration of heavy metals.[8] Considering the potentially hazardous nature of fly ash, it should be managed in an environmentally sound manner, so as to minimise any environmental and health impacts.

24. Fly ash should therefore be subjected to suitable treatments prior to utilisation or disposal. Some of these treatment methods have been reviewed by Lam et al. (2010).[9] As for bottom ash, it has been commonly used as aggregate in concrete or as road base. However, it should comply with existing standards for use as aggregates or construction materials.

25. For more guidance on the setting-up and operation of a waste incineration plant, refer to the guidance developed by The World Bank (1999)[10] and the Basel Convention technical guidelines on the environmentally sound incineration of hazardous wastes and other wastes as covered by disposal operations (D10 and R1).[11]

3. Biofuels (gasification and pyrolysis)

26. Gasification and pyrolysis are two thermo-chemical WtE processes that are used for biofuel production from biomass or waste materials. Gasification is the thermal conversion of carbonaceous waste materials in sub-stoichiometric amounts of oxygen into syngas (CO, H_2 and CH_4) and a solid residue. The syngas can be combusted to produce energy while the solid residue must be managed in an environmentally sound manner.

27. Pyrolysis is the thermal decomposition of organic matter in an oxygen-free environment to produce gaseous, liquid and solid fraction. Pyrolysis may be sub-classified as slow pyrolysis or fast (or flash) pyrolysis. Slow pyrolysis results in a higher solid fraction (char) while fast pyrolysis results in a higher liquid fraction (bio-oil). Both fractions can be combusted to produce energy, but the solid residue produced as a result of the char combustion must be managed in an environmentally sound manner.

(a) Suitability of gasification and pyrolysis processes

28. Gasification and pyrolysis are not suitable for processing co-mingled household wastes due to their heterogeneous nature. As such, it is not recommended to treat co-mingled household waste via either the gasification or pyrolysis processes. Nonetheless, these two processes may be used for treatment of the homogenous fractions of the household waste stream if this is sorted at source.

E. Establishing WtE facilities

29. Additional information on establishing WtE facilities is included in the Basel Convention technical guidelines[12] however, in general the development of WtE facilities has to go through a project

[6] ISWA, 2006. Management of Bottom Ash from WtE Plants: An overview of management options and treatment methods. Working Group on Thermal Treatment of Waste, pp. 4. International Solid Waste Association.

[7] Lynn, C.J., Ghataora, G.S., Obe, R.K.D., 2017. Municipal incinerated bottom ash (MIBA) characteristics and potential for use in road pavements. International Journal of Pavement Research and Technology, 10, 185-201.

[8] Lam, C.H.K., Ip, A.W.M., Barford, J.P., McKay, G., 2010. Use of Incineration MSW Ash: A Review. Sustainability, 2, 1943-1968.

[9] Ibid.

[10] The World Bank, 1999. Municipal Solid Waste Incineration. World Bank Technical Guidance Report.

[11] UNEP/CHW.15/6/Add.4. Draft updated technical guidelines on the environmentally sound incineration of hazardous wastes and other wastes as covered by disposal operations (D10 and R1).

[12] Ibid.

cycle consisting of a feasibility phase, a project preparation phase and a project implementation phase.[13,14] These 3 phases are essential for any new projects to ensure that, once implemented and operated, the project is successful.

1. Feasibility phase

30. A feasibility study is an important prerequisite to the setting-up of any large-scale facility as it helps assess the potential success or failure of a project. A pre-feasibility study may be carried out prior to an in-depth feasibility study to perform a preliminary evaluation of the project viability. However, a pre-feasibility study should not be a substitute for an in-depth feasibility study which should include the following components:

(a) Quantification of household waste streams

31. The amount of household wastes available to be subject to the composting or WtE process is fundamental to the setting-up of facilities. A critical mass is required to make any system economically viable. If no data is available on the amount of household waste that is generated, estimates may be used as an indicative measure, but these need to be refined when carrying out a feasibility study. A survey may be carried out over a sampled number of households and the waste generation rate determined accordingly. This data can be used to calculate the total amount of wastes generated over a selected region. Alternatively, if all wastes are directed to a particular disposal site, the amount of waste disposed may be determined via the use of weighbridge systems at the entrance to the disposal site.

(b) Composition of household waste streams

32. The waste composition is another factor that is necessary to determine prior to deciding on the recovery or treatment option to be implemented. A waste with high organic matter content is better suited to the composting or anaerobic digestion process, while a waste with a higher fraction of paper or plastics is better suited to a thermo-chemical WtE process. For countries where the composition of the household waste stream is unknown, it is recommended that a waste audit study be commissioned. The waste composition of unsorted household waste may be determined as per ASTM D5231.[15]

(c) Characteristics of household waste streams

33. Similar to the composition, the characteristics of a waste stream decides the appropriate treatment or recovery process. Often, the composition of the waste stream dictates the characteristics. For instance, a waste stream consisting of a high volume of organics tends to have a high moisture content and lower calorific value. Likewise, a waste stream consisting of high amount of plastics will have a lower moisture content and higher calorific value. The characteristics of the waste are important to the choice of the treatment technique, since it is not viable to subject a waste with low calorific value (or low energy content) to WtE. Some of the analyses that are required prior to choosing a particular treatment technology are:

(a) Moisture content (after determining total solids content): ASTM E1756;[16]

(b) C:N ratio (applicable for composting and anaerobic digestion): Determine organic carbon content (C) as per the Walkley-Black method and nitrogen content (N) by the Kjeldahl method;

(c) Calorific value (applicable for thermo-chemical WtE): ASTM D5468;[17]

(d) Choice of technology based on composition and characteristics of the household wastes (composting plant or biogas plant or thermo-chemical WtE plant);

(e) Choice of system for the chosen technology (e.g. incineration (mass-burn, fluidised bed, etc.), gasification (ultra-high temperature) or pyrolysis (slow or fast));

(f) Preliminary sizing and conceptual design of the facility and of its unit operations based on the amount of household waste to be processed;

(g) Cost-benefit analysis of setting-up and operation of the facility;

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[13] Rand, T., Haukohl, J., Marxen, U., 2000. Municipal Solid Waste Incineration: Requirements for a Successful Project. World Bank Technical Paper No. 482. The World Bank.

[14] The World Bank, 1999. Municipal Solid Waste Incineration. World Bank Technical Guidance Report.

[15] ASTM D5231. Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste.

[16] ASTM E1756. Standard Test Method for Determination of Total Solids in Biomass.

[17] ASTM D5468. Standard Test Method for Gross Calorific and Ash Value of Waste Materials.

(h) Capital and operating costs of the plant;

(i) Market for sale of biogas or electricity and revenues derived therein;

(j) Any other costs or revenues (tipping fees for waste disposal) to ensure that the project is financially sustainable;

(k) Financing mechanism: Design-Build-Own-Operate (DBOO), Build-Operate-Transfer (BOT), Build-Own-Operate (BOO), etc. For more details on financing, refer to module II;

(l) Siting of the facility: When siting any such facility, it must be ensured that the distance of waste transportation is minimised while environmental and social aspects of the project are considered;

(m) Environmental Impact Assessment: to evaluate any bearing that the project might have on the environment through a consultative process with stakeholders.

2. Project preparation phase

34. Once the feasibility study has been carried out and the project is deemed viable, the project may then move to the preparation phase which consists of the following:

(a) Setting-up of an institutional framework

35. An institutional framework consisting of all relevant authorities involved in the project needs to be established to oversee implementation of the project. This framework should consist of, but not be limited to, the following:

(a) Waste management department: for waste supply agreement;

(b) Energy department (wherever applicable): for power purchase agreement;

(c) Environment department: for environmental impact assessment;

(d) Finance department: for financial aspects;

(e) Non-governmental organisations: for assisting in the evaluation of social impacts.

(b) Setting-up of a regulatory/legislative framework

36. The setting-up of a regulatory framework is essential for ensuring that the facility is operating within a legal boundary. This framework should ensure that the required legislation is in place within the host country and may include standards for air emissions from WtE plants.

37. Refer to module I for more details on the institutional and regulatory/legislative framework.

(c) Preparation of bidding documents

38. Expressions of interest may be launched to evaluate the market interest for investing in any waste recovery or treatment facility. The expression of interest may also be limited to only WtE processes. Following the expression of interest, a request for proposals is sent to a list of shortlisted bidders and the bids should be evaluated in a transparent manner.

3. Project implementation phase

39. Once the bids have been evaluated, the Contract is awarded to the successful bidder. This initiates the detailed design and construction works of the composting or WtE facility, which can be a lengthy process depending on the choice of technology. Following completion of the construction works, the whole plant is then commissioned, and the process is started (start-up).

Box 7.1 Reppie Project, from waste to energy, Ethiopia[18]

The Reppie project consisting of a municipal solid waste incineration plant built on the Koshe landfill site, close to Addis Ababa, has been one of the first examples of a waste-to-energy facility in the region. The plant burns the capital's rubbish at a temperature of up to 1,800 degrees Celsius and converts it into 185 million KW hours of electricity per annum. Modern gas treatment technology reduces the release of toxins during the process and operates within the emission limits established by the European Union.

[18] https://www.weforum.org/agenda/2018/05/addis-ababa-reppie-trash-into-energy/

VIII. Environmentally sound final disposal of household waste

A. Introduction

1. This module covers the least preferable waste management option in the waste management hierarchy – incineration (without energy recovery) and landfill disposal of waste. The waste management hierarchy prioritises waste prevention, minimisation, reuse, and recycling, so that only the residual fraction remains for final disposal. However, in many places, landfilling is the only waste management option. There may be regular leakage and occasional collapse at poorly managed non-engineered waste deposit sites. Therefore, transitioning to a well-managed engineered landfill and improvement in management and operation of existing landfills, is crucial.

2. Detailed guidance on the environmentally sound disposal of household waste in specially engineered landfills and incinerators can be found in the Basel Convention technical guidelines.[1,2]

B. Specially engineered landfill

3. Developing a specially engineered landfill (also referred to as a sanitary landfill; see Figure 8.1), regardless of community size or the quantity of waste handled, requires that the best practically feasible environmental option, based on appropriate and affordable technology, is chosen. Specially engineered landfills should be placed in an area that has a sufficient geological barrier, is able to bear the load of the engineered landfill and is way from geologically unstable areas where there is any risk of flooding, subsidence, landslides, and avalanches. Avoiding contaminating surface and ground water sources is particularly important, therefore non-point discharges must be avoided and any discharged leachate needs to be treated to meet appropriate water quality standards. Landfills should also not be located at sites where they will have high visual impact.

4. Residue waste should be disposed of at an engineered landfill in a manner that results in an adequate compaction and air-space utilisation. The following will be key aspects to consider in this regard:

(a) Waste should be deposited in thin layers for good compaction;

(b) Daily working areas should be kept as small as possible in order to minimise the area of waste material exposed during the operating day;

(c) Each layer of waste deposited should be compacted to reduce the likelihood of instability and settlement problems in future, and to give the best density;

(d) To avoid creating large voids within the waste disposal site, bulky waste such as old furniture, baskets, cages, packaging, etc. should be crushed before compacting and spreading;

(e) Final cover should be applied to all surfaces where the final approved elevation has been reached and, on all surfaces, when the waste disposal operation is closed.

5. Where cells are used for depositing wastes, temporary bund walls are built up to provide sides and an end to each cell. The bunds are constructed of spoil or other inert waste. The initial bund should be of fairly low permeability material in order to prevent surface water infiltrating into the cell.

6. Equipment operations represents a major cost factor for landfill managers, and can influence the condition and life of the landfill. Equipment commonly required at a landfill site include compactors, bulldozers and a weighbridge to ensure the incoming waste (and outgoing recovered materials) are measured. Other equipment such as wheel wash facilities and/or wash-bay facilities for trucks may also be required.[3]

[1] UNEP/CHW.15/6/Add.5. Draft updated technical guidelines on the environmentally sound disposal of hazardous wastes and other wastes in specially engineered landfill (D5)

[2] UNEP/CHW.15/6/Add.4. Draft updated technical guidelines on the environmentally sound incineration of hazardous wastes and other wastes as covered by disposal operations (D10 and R1)

[3] SPREP/JICA (2012) Volume 1, A practical guide to landfill management in Pacific Island Countries and Territories provides detailed information on equipment requirements.

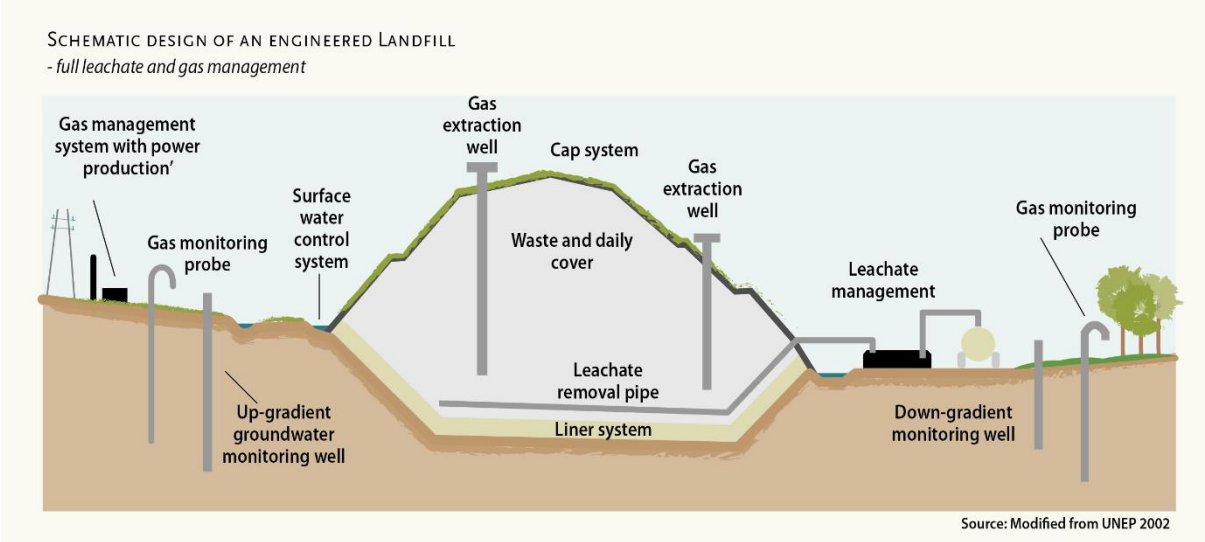

Figure 8.1. Schematic design of an engineered landfill

1. Upgrading of existing sites

7. Waste disposal sites that do not meet environmentally sound management criteria, ideally should be upgraded or closed. This would likely be done in a phased, gradual approach so as not to impact negatively on the overall waste management operations in an area.

8. While upgrading an existing waste disposal site into an improved waste disposal site may be an option for a government or local authority, the phased closure of an existing site might be the environmentally appropriate decision to make. In deciding whether to upgrade an existing waste disposal site, strict criteria should be applied. These criteria should be comparable to criteria used in the assessment of a new disposal site. Upgrading a site should also consider if the lifespan of the site after the upgrade would be comparable to the expected lifespan of a new site. If then the existing site fulfils all the criteria - environmental, technical and social aspects, then planning and design should be done as if it were a new site.

9. While the planning and designing for the upgrade are occurring, a number of actions can be made in the short term to improve an existing site:

(a) Site drainage improvement, so as to divert runoff around the site;

(b) Extinguishing all fires that may be on site by making a trench around them. The use of water should be avoided as this would contribute to the creation of more leachate and groundwater pollution;

(c) Levelling so as to stabilize the waste but also promote storm water drainage;

(d) Cover material should continuously be applied;

(e) Fencing the site if it's not already fenced ensures that there is no further encroachment on the land, the control of windblown litter and management of what comes onto the site. Any locally appropriate fencing material may be used as a fence including bamboo or brick mortar.

Box 8.1 Successful closure of waste dumps and construction and operation of engineered landfill

Mauritius is an island off the east coast of the continent of Africa with a population of 1.4 million people. Through concerted efforts by the local authorities, the waste management industry and the general public, Mauritius has made significant strides in managing its solid waste. A decision was made in 1994 by the Mauritian Government to:

(a) close all open waste dumps in the country;
(b) construct sanitary landfills;
(c) construct additional transfer stations and upgrading of existing ones;
(d) increase the collection, coverage and frequency of waste;
(e) dispose of specific types of solid hazardous waste in specially designed cells;
(f) increase public awareness on waste management.

In 1990, there were 21 open waste dumps spread over the island, representing not only an eyesore but also an environmental and a public health issue. In May 2009, an agreement for a landfill gas to energy project was signed between the private sector represented by the operator of the Mare Chicose landfill and the Government of Mauritius.

The agreement entailed:

(a) enhancing the capture of landfill gas (LFG);
(b) using the Clean Development Mechanism (CDM) provisions of the Kyoto Protocol to sell Certified Emission Reductions (CER's) acquired through the project;
(c) use of gas by the landfill operator to produce electricity through generators (instead of flaring) and sale of electricity through a Power Purchase Agreement (PPA).

The project was a success because the policy, legal and institutional framework combined with the national solid waste management plan ensured the mobilization of resources. The biggest obstacle was securing land for the engineered landfill. A key driver towards the development of the landfill gas project was the strong public-private partnership relationship.

Box 8.2 Sound management of a non-engineered waste disposal site

Dhankuta, with a population of 50,000 in 2019, is a small municipality located in the hills of eastern Nepal covering 42.81 square kilometres. The municipality has made progress towards improved waste management with limited resources and despite having a non-engineered waste disposal site. Dhankuta has introduced a system of household waste separation into biodegradable and non-biodegradable waste fractions. Non-degradable waste is carried to the landfill site by the municipality, while biodegradable waste is used as animal fodder and agricultural manure. In city areas, the manure is used for kitchen garden and rooftop farming. To avoid harmful health impacts that could arise as a result of working at the landfill, the municipality has adopted safety measures, employees undergo periodic medical check-ups and are also insured.

Although Dhankuta's landfill site is situated near a dense city settlement and just 150-300 meters away from human settlement, there have been no complaints. Dhankuta has successfully turned the decommissioned part of landfill site into a park, planting more than 40 species of flowers on the site. This remediation ensures that there is no smell from the site, which is heavily utilised by local residents and visitors. The municipality charges an entrance fee of 50 rupees (US$0.40) and earns around Rs 4 million from the sale of old wires, paper, iron, zinc sheets, glass and plastic disposed by households every year. The landfill site has become a national model and the city has been recognised by the Nepalese Government for its cleanliness. [4]

2. Landfill site restoration and aftercare

10. Landfill site restoration and aftercare, including monitoring and surveillance are also covered in the Basel Convention technical guidelines on the environmentally sound disposal of hazardous waste

[4] http://www.hakahakionline.com/en/5053/dhankuta-municipality-sets-example-in-waste-management/

and other waste in specially engineered landfills (D5),[5] are important final processes in the management of waste. Environmentally sound restored landfill sites can be used to the benefit of the local community. Sites can serve as open spaces for sports and recreational purposes. Structures should not be built on formerly closed landfill sites until complete stabilisation has taken place and this process can take several decades. Legislation in certain countries does not allow any structures to be built on restored sites even when stabilization has taken place because of the potential landfill gas generation. It is therefore critical that activities are restricted to those that do not pose a hazard and settlement, soil quality, water quality, and air quality should be considered before the authorization of any new development of the site.

11. The closure plan that is approved as part of the original environmental impact assessment process should be updated to reflect current site conditions, and should cover:

(a) Final shaping and landscaping;

(b) Final waste disposal cover or cap design;

(c) Permanent storm water diversion measures and runoff control;

(d) Anti-erosion measures;

(e) Infrastructure relating to the selected end-use.

12. Aftercare including monitoring and surveillance is required once the operation of a landfill site has ceased. National policy should spell out the minimum time a landfill site needs to be subjected to aftercare. Generally, the larger the site, the longer the aftercare requirements. The operating procedure and maintenance manual of a landfill site, agreed upon with the regulator of the landfill site, should provide details of the specific aftercare requirements and procedures to be followed. This ensures liability for restoration and aftercare is in place.

13. Monitoring and surveillance are important as they ensure that the final state of the site is environmentally sound, especially as it relates to any surrounding water bodies, final cover, capping, top-soil application and vegetation. Surveillance requires substantial financial and technical resources, and these should be accounted for at design stage and controls like monitoring boreholes and sampling points to monitor the quality of groundwater installed at site preparation stage.

14. Restricting the amount of water getting to the landfill reduces the amount of leachate produced, affects the rate and level of degradation of wastes and the final stabilisation of the landfill site. Measures taken to reduce leachate include carefully designing the placement and compaction of final cover, the selection of suitable vegetation types and effective drainage. Managing the surface run-off is equally critical not only in reducing the amount of leachate but also in controlling flooding, which could de-stabilise slopes and cause landslides.

15. Gas is inevitably generated as organic waste decomposes. It will start to be given off within a few weeks of wastes being deposited and may be generated for many decades after the site is closed. Waste disposal gas can migrate considerable distances from the landfill site and measures should be taken to monitor landfill gas migration. The methane gas produced may pose a hazard and flaring it has greenhouse gas implications.

16. The final closure and rehabilitation plan should ensure that the waste has stabilised physically and chemically before the final cover is applied. Monitoring and surveillance should only cease after a complete audit of the site is completed by authorities using an approved system or criteria . Post-closure care should end when monitoring confirms there is no longer a risk to the environment. This time period is typically 30 years, but can vary on a site-by-site basis.

3. Informal waste pickers

17. The presence of waste pickers at many sites in developing countries and SIDS is commonplace and allowances should be provided for their activities. Rules can be established under which the pickers can be allowed to operate. Such rules could include:

(a) Avoidance of contact with or being in the direct path of landfill equipment;

(b) Moving recovered items a minimum distance away from the working tip;

(c) Removal of recovered items on a regular basis;

[5] UNEP/CHW.15/6/Add.5. Draft updated technical guidelines on the environmentally sound disposal of hazardous wastes and other wastes in specially engineered landfill (D5).

(d) No burning of materials on the landfill site.

Box 8.3 Permitting for informal waste pickers at a landfill site in South Africa[6]

Poorly operated landfill sites have consequences on the environment and on the communities living close-by. In South Africa, many municipal landfill sites are not permitted or do not always operate according to their permit conditions. In order to improve compliance with its permit conditions, at the landfill site of Bitou Municipality, a foreman ensure that permit conditions are respected and all necessary tasks are executed using a checklist, improving the general housekeeping at the site. At the Vryheid landfill in Abaqulusi Municipality, women and children were often going to pick recyclable waste at the dumpsite and incidences of fighting over recyclables were reported. To better manage the situation, the municipality established a permitting system for waste picking at the dumpsite. A security guard controls access to the site and all pickers have to obtain a permit from the waste manager. Waste reclaiming companies also require a permit. The permit also specifies the type of waste that can be collected. A copy of the permit together with a copy of the picker's ID book is kept on file at the municipality. Pickers have to wear protective clothing and children and animals are not allowed on the site.

C. Environmentally sound incineration for final disposal of household waste

18. Incineration is a thermal treatment process in which wastes are converted into gases and incombustible solid residues. The Basel Convention technical guidelines on environmentally sound disposal of hazardous waste and other waste for incineration on land (D10/R1)[7] provide more detailed guidance.

19. Environmentally sound incineration can be selected to treat household waste that cannot be recycled reused or incinerated for energy recovery. Incineration needs to meet the applicable local legislation including standards related to air pollution and planning.

20. Household waste with the following characteristics is not recommended for incineration:

(a) Pressurized gas containers;

(b) Reactive chemical wastes;

(c) Silver salts and photographic or radioactive waste;

(d) Halogenated plastics such as polyvinyl chloride;

(e) Waste with high mercury or cadmium content, such as broken thermometers, used batteries and lead-lined wooden panels.

21. Typically, household wastes to be incinerated would have the following characteristics:

(a) Low heating value;

(b) Content of combustible matter above 25 percent;

(c) Moisture content below 50 percent;

(d) Ash content below 60 percent.[8]

22. The use of incinerators for the disposal of household waste can be a n option, particularly if energy is recovered. However, the use of an incinerator, its maintenance and management can be a challenge if the construction, siting, operation and management of these units is not up to standard. These deficiencies can result in poor performance of the incinerator, e.g. low temperatures, incomplete waste destruction, inappropriate ash disposal, high smoke emissions, fugitive emissions, etc. The use of an incinerator in the disposal of household waste may be the preferable option if unsecured pits or landfills, or (uncontrolled) burning in drums or pits is the alternative. However, the combustion of

[6] https://www.csir.co.za/sites/default/files/Documents/Waste_Management_Toolkit_0.pdf

[7] UNEP/CHW.15/6/Add.4. Draft updated technical guidelines on the environmentally sound incineration of hazardous wastes and other wastes as covered by disposal operations (D10 and R1)

[8] Tanner, V.R., 1965. Die Entwicklung der Von-Roll-MÃ1=4llverbrennungsanlagen (The development of the Von-Roll incinerators) (in German). Schweiz Bauzeitung 83, 251–260. http://dx.doi.org/10.5169/seals-68135

household waste can form particulate matter, dioxins, furans and other toxic air pollutants and controlling these needs to be considered before incineration is adopted as an option.

23. Because of the environmental challenges, incineration should only be considered when environmentally sound disposal is guaranteed and there will be adequate emission control, reduced occupational exposure and reduction of other hazards. This will entail adherence to the following key elements:

(a) Effective waste reduction and waste segregation, ensuring that only the smallest quantity of appropriate waste types is incinerated;

(b) An engineered design, ensuring that combustion conditions are appropriate, e.g., sufficient residence time and temperatures to minimize products of incomplete combustion;

(c) Siting incinerators away from populated areas or where food is grown, thus minimizing exposures and risks;

(d) Construction following detailed drawings, thus avoiding flaws that can lead to incomplete destruction of waste, higher emissions, and premature failures of the incinerator;

(e) Proper operation, critical to achieving the desired combustion conditions and emissions, e.g., appropriate start-up and cool-down procedures; achievement and maintenance of a minimum temperature before waste is burned; use of appropriate loading/charging rates (both fuel and waste) to maintain appropriate temperatures; proper disposal of ash; and various actions and equipment to safeguard workers;

(f) Periodic maintenance to replace or repair defective components, e.g., including inspection, spare parts inventory, record keeping, etc.;

(g) Enhanced training and management, possibly promoted by certification and inspection programs for operators, the availability of an operating and maintenance manual, management oversight, and maintenance programs.

IX. Health and safety in waste management

A. Introduction

1. This module provides a pathway to improved health and safety conditions in the waste sector, including gender considerations.

2. Essential occupational health and safety measures include the following:

(a) Supporting legislation;

(b) Supporting infrastructure;

(c) Proper training of workers;

(d) Establishment of an effective occupational health programme including appropriate response to injury and exposure;

(e) Provision of appropriate protective gear (PPE).

3. The waste management sector, like any other sector, requires a safe working environment – both physically and mentally. Unfortunately, this is not the current situation in many parts of the world, especially in developing countries. During the collection of waste, workers often have little or no protection, so are directly exposed to waste loads.

4. Informal waste pickers on landfills are exposed to a toxic physical environment.[1] Bare-hand waste picking is a common practice. In addition, dumpsites in many places around the world often exceed their carrying capacity and are at risk of collapsing. In general, working conditions and hazards associated with this work stigmatize the sector, which can lead to violence and harassment.

5. In the recycling sector, where there is use of machinery, unsafe operations can cause injuries and fatalities. In the United States, the recycling sector is reported to have a higher rate of injury than other waste management and remediation services.[2]

Box 9.1 Soso Care enterprise, Lagos city, Nigeria[3]

SOSO CARE is a low cost social enterprise in Lagos city, Nigeria, which aims to use recyclable garbage as a financial resource enabling millions of uninsured slum dwellers, mostly pregnant women and children, to access micro health insurance and gain points on food stamps. About 40% of the population of the city live below the poverty line in the urban slums. The city generates over 14 000 metric tons of solid waste daily. Problems related to waste have consequences on millions of people living in the slums. To face the problem, Soso Care decided to link waste to health and food stamps. In this way, access to healthcare to reduce infant and maternal mortality in the area, improves sanitation in slums and creates jobs for the distribution network and waste collectors and gives the possibility to receive food stamps. Partnerships with waste management companies were established to ensure that collection points can be used as registration points for health insurance access.

B. Gender considerations

6. In many places, there is gender inequality in waste management operations and decision making.[4] These include inequality in employment, access to resources, participation in community decision making and exposure to household chemicals such as cleaning products. Waste generation and management in the home is influenced by gender roles.[5] Given women's primary responsibility for cleaning, food preparation, family health, laundry, and domestic maintenance, women and men may

[1] ISWA (2015). Wasted health. The Tragic Case of Dumpsites. https://www.iswa.org/blog/wasted-health-the-tragic-case-of-dumpsites/?v=1ee0bf89c5d1

[2] GAIA (2015). Sustainable ad Safe Recycling: Protecting Workers Who Protect the Planet. https://www.no-burn.org/wp-content/uploads/Safe-Recycling-Report.pdf

[3] https://www.urbanagendaplatform.org/best-practice/soso-care

[4] Cynthia Ng, 2018, No Messing About with Women of Waste. Available at: https://www.awanireview.com/articles/2019/01/02/news/no-messing-about-with-women-of-waste-561/

[5] Seager J., Shalem Y, Baker E, Thygesen K, Schoolmeester T, and Bhakta D., What's Gender got to do with it? Global Gender & Environment Outlook - Consumption & Waste Story Map. GRID-Arendal, 2019. https://www.grida.no/publications/441

view domestic waste and its disposal differently. They may have different definitions of what is waste or garbage. They may also manage waste differently and put different priorities on its disposal.

7. According to a 2019 report on the Gender and Waste Nexus, households, which currently have the least formal engagement with the waste sector's power and policy structures, may be the pivotal site for reform. Households have tremendous collective capacity to reduce the flow of waste into the system, both through consumption practices and waste management and recycling strategies. Household needs and structures must be included in all waste management plans. Methodologies should be developed to assess the value of sustainable ecoservices that are currently provided on an unpaid basis by women managing waste in households and communities. This will enable policies to be based on a more accurate view of the waste value chain.[6] Understanding gender differences and inequalities can lead to an improvement in household waste management overall.[7]

Box 9.2 Gender & Waste Project, Brazil

The Gender & Waste Project was developed in Brazil, with the two-fold objective of identifying women waste pickers' concerns regarding gender inequalities in the waste picking sector through participatory research of women's practical and strategic needs and fostering discussions on how such inequalities are present not only in these women's work environments, but also at home and in their national workers' movements.

The project contributes to capacity building of women waste pickers enabling them access to different initiatives that can increase their knowledge about recycling and improve managerial and communication skills essential for running cooperatives. In addition, the project disseminates information on gender inequality that may prove useful for the waste picking sector. A series of resources and reflections on the different stages of the process was published.[8] More recently, the project is focusing on building the capacity of women's knowledge about plastic pollution and climate change in order to contribute to greater resilience of informal workers.

Box 9.3 Taka Taka Solutions, Nairobi, Kenya[9]

In Kenya, current waste disposal methods are harmful to human and environmental health: 50% of the 4,000 tons of waste produced in the Nairobi Metropolitan Area every day remain uncollected. The remaining 50% is dumped at various dumpsites. Less than 10% of the waste is recycled. TakaTaka Solutions is a social enterprise that is trying to change this method by recycling 95% of the waste they manage. It pays attention to gender balance employing women for the 50% of its staff (350 people).

Taka Taka Solutions proposes a vertically integrated model of waste collection, sorting, recycling, composting and incineration in line with sustainability standards. It invests into their recycling infrastructure to ensure that almost every waste material gets a second life. It recycles all plastics (other than PET bottles) at an in-house plastic recycling plant.

C. Managing the hazards associated with household waste management

8. The exposure of solid waste workers to hazards is significant at all stages of waste handling, treatment and disposal. Workers are exposed to risks that vary from contamination by biological or chemical agents (including gas) and physical injuries related to dust, noise, extreme temperatures and handling heavy loads. In addition, they are exposed to accidents during transportation, and unloading of waste at treatment and final disposal facilities as well as to fires, and/or explosions.[10]

1. Supporting legislation

[6] GRID Arendal and UNEP (2019). The Gender and Waste Nexus. file:///C:/Users/swingfield/Downloads/GaWN.pdf

[7] https://www.ctc-n.org/files/resources/gender_and_waste_management.pdf

[8] https://www.wiego.org/gender-waste-project

[9] https://takatakasolutions.com/about-us/

[10] Midlands State University, 2017, occupational safety and health hazards associated with solid waste management in Bindura, ZIMBABWE. https://pdfs.semanticscholar.org/b2c4/71633458518aa918132b80b5bb03e4c3d279.pdf

9. Waste management is often shared between the formal and informal sectors. Workers in the formal sector are usually protected by domestic regulations in contrast to labourers in the informal sector who have no protection.

10. Supporting instruments that promote safety in the waste sector include:

(a) Legislation dictating working conditions and social benefits (e.g., sick leave, parental leave, access to childcare, equal remuneration, health support);

(b) Legislation stimulating organizational and economic support (e.g. creating cooperatives, access to credit);

(c) Introducing voluntary concepts e.g., Corporate Social Responsibility (CSR).

11. The International Labour Organization promotes sustainable enterprises for innovation, growth, and better jobs.[11] These are relevant to waste sector and the organization has recommended action to its Member States, specifically focusing on e-waste management.[12]

12. There are a number of national guidelines developed by the public and private sector which could serve as inspiration in increasing safety in the workplace e.g., Health and Safety Issues in the Solid Waste and Resource Industry, New Zealand.[13]

2. Protective gear

13. The type of protective clothing used will depend upon the risk associated with the task, but the following measures may support safety in the workplace:

(a) Labourers working near moving traffic or machinery should wear high visibility jackets to be visible to drivers and operators;

(b) Labourers working near machinery and transportation should wear protective headgear, eyewear and ear protection against possible injury;

(c) Where there is a risk of lung irritation from dust and odour, dust-masks are recommended;

(d) Appropriate footwear should be worn;

(e) Use of protective gloves to avoid hand injury;

(f) Wear appropriate clothing including sun protection.

3. Supporting infrastructure

14. Supporting infrastructure should include sanitary toilets and safe hand washing and drinking water, as well as change and lunch room facilities.

4. Safety - Health guidelines and rules

15. The associated waste management department/division must develop, maintain and publish guidelines for the safe management of household waste at all stages.

16. There should also be rules established to minimize hazards. For example, it is possible for the general public to access to dumpsites in many countries. Unregulated dumpsites are dangerous to humans, animals and the environment and access should be restricted to authorised personnel (see Module VIII).

5. Waste management training

17. The staff working in the waste management sector, either on public, private or informal sites, need to receive training in handling and disposing of the waste. This may include training in:

(a) Waste segregation;

(b) Storage requirements;

[11] ILO (2007). Conclusions concerning the promotion of sustainable enterprises. International Labour Conference, June 2007.

[12] ILO (2019). Global Dialogue Forum on Decent Work in the Management of Electrical and Electronic Waste (e-waste).

[13] Department of Labour in Te Tari Mahi (N/A). Health and Safety Issues in the Solid Waste and Resource Industry. https://www.wasteminz.org.nz/wp-content/uploads/Health-and-Safety-Issues-in-the-Solid-Waste-and-Recoverable-Resources-Industry.pdf

(c) Transportation requirements;

(d) Labelling;

(e) Emergency procedures;

(f) Spill control;

(g) Awareness of all associated hazards.

18. Training on waste management fundamentals should be provided initially with refresher training provided on a periodic basis. Additionally, the use of tool-box meetings should be encouraged where staff are invited to share their concerns about health and safety systems and practices at the workplace.

6. Response to injury and exposure

19. Emergency planning and procedures to deal with emergencies involving household waste have to be established at all stages of the waste management cycle. These occupational health and safety procedures could involve:[14]

(a) Immediate first-aid measures;

(b) An immediate report of the incident to a designated responsible person;

(c) Medical surveillance;

(d) Recording of the incident;

(e) Investigation of the incident, and identification and implementation of remedial action to prevent similar incidents in the future.

[14] Health and safety practices for health-care personnel and waste workers, Available at: https://www.who.int/water_sanitation_health/medicalwaste/140to144.pdf?ua=1

X. Awareness raising and communication

A. Introduction

1. If household waste is not stored, separated, collected, and disposed of properly there can be threats to public health and the environment. It is therefore important to promote the best practices for the environmentally sound management (ESM) of household waste with the target audiences through awareness raising and communication. Therefore, effective communication is paramount and needs to be tailored to suit different stakeholder groups and their different behaviours and motivations.

2. The implementation of successful awareness campaigns that promote waste avoidance and responsible waste disposal behaviour can be challenging, particularly if the required behaviour involves changing long standing attitudes and habits. Population groups can be defined according to age, gender, education, occupation, income, and many other factors. These groups may each require a different approach, with different messages, delivered in different ways. In addition, any awareness campaign needs to avoid adverse public reaction or opposition from different parties.

B. Communication campaigns

3. This module provides guidance on the design and implementation of an appropriate awareness raising and communication campaign to promote best practices for the environmentally sound management of household waste. Communication campaigns must be linked with and aligned to the overall waste management strategies.

1. Aims and objectives

4. The overall aim of a communication campaign is to be persuasive, comprehensive and robust in the communication of desired household waste management practices, in a manner that is palatable for the wide cross section of society.

5. Objectives should be measurable, identifiable and quantifiable. The main objectives may include:

(a) Generating awareness about the health and environmental impacts of the improper management of household waste;

(b) Education and the exchange of information on good practices for the management of household waste.

2. Audience

6. Improper household waste management affects us all. To improve the management of household waste, all stakeholders need to be engaged. This includes Parties to the Basel Convention, businesses (including manufacturers and retailers), decision makers (including practitioners, municipalities, policy makers) and household members (including adults with purchasing and disposal responsibilities and children).

7. In order to successfully target specific groups, it is important that we define residents. This can be achieved based on factors such as level of interest/participation in recycling and waste prevention and current collection systems. In addition to residents, it is also important to consider and identify wider stakeholders to ensure that communication and joint working opportunities are maximised. These can be categorised as internal and external stakeholders.

(a) Primary target audience

8. The primary target audiences should be engaged in order to present, promote and communicate the ESM guidance document and supplementary information to support the best practices in household waste management.

(a) Parties to Basel Convention – general awareness of the guidance and accompanying website etc.;

(b) Policy makers – to inform for consideration in developing policies, making decisions, designing plans, investing or developing legislation;

(c) Government institutions (waste management authorities and other government agencies) – to guide on best practices;

(d) Municipalities – to guide on best practices;

(e) Waste practitioners (collectors and transporters, recyclers and disposal, private/public) -

to guide on best practices;

(f) Private sector (manufacturers and retailers) - to guide on best practices.

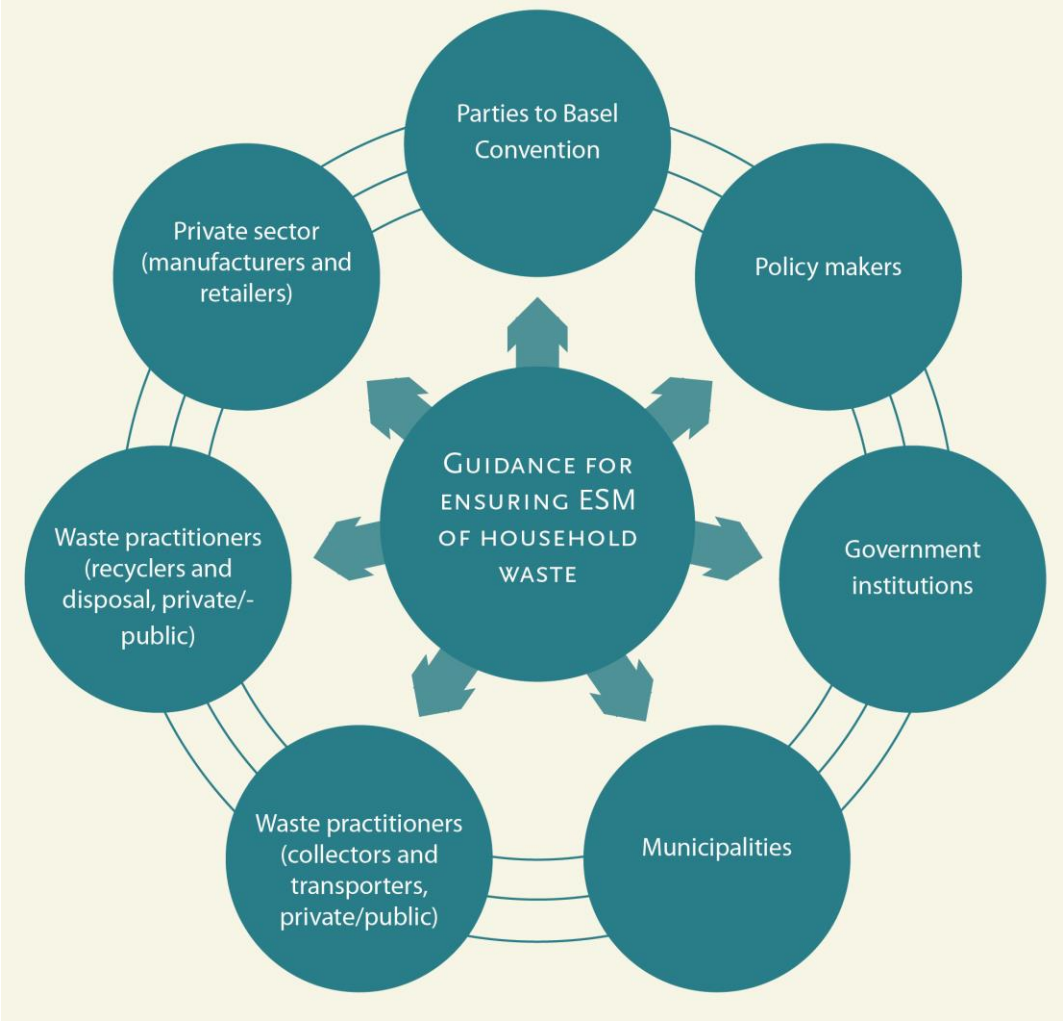

Figure 10.1 Primary target audience

(b) Secondary target audience

9. The secondary target audience should be engaged in order to translate the key messages of the ESM guidance and the focus is to enable behaviour change. These stakeholders may include:

(a) The informal sector (waste pickers, waste workers) – to communicate on health and safety;

(b) Households – to communicate the direct impacts of improper household waste management and improve awareness on the best management practices;

(c) Educational establishments, e.g. schools and colleges (these are the upcoming generations who will also generate waste and potentially enter the field of waste management in the future);

(d) NGOs – to support and promote the awareness and communication.

Box 10.1 Vistula District Communication Campaign

Over the last few years, Vistula bank in Warsaw has become a place where young people like to spend their free time: summer fun, culture, art, sport, music, dancing, parties, but the area is covered with waste after weekend nights.

To face the problem, the Warsaw City Council, in partnership with a public relations agency, different NGOs and stakeholders in 2015 ran a project, Vistula District, to involve people in taking care of the space, through educational activities and communication campaigns including social media, cultural festivals, video art, combining all interests and visions (boaters, ecologists, owners of nightclubs and the authorities). The project included the Vistula District Eco Festival – an eco-event, which lasted one week. It included concerts, workshops, meetings and exhibitions.[1]

3. Communication tools

10. Messages to promote the ESM of waste can be communicated through websites, events, news articles, leaflets, message embossed sustainable products, blogs, social media, schools, documentaries and video games (see United Nations report: Playing for the Planet[2]). Celebrities, influencers and other public figures can be used to promote important issues such as recycling and reuse. Figures 10.1 to 10.4 offer examples of good communication practices to promote the environmentally sound management of waste.

<table>
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<td>Management of household waste on the newspaper the Waikato Regional, New Zealand
Source: https://www.bbc.com/news/uk-49280709</td>
<td>The use of flyers to promote initiatives on best practice of household waste management
Source: https://sutton.ca/en/services-to-citizens/public-works/waste-management/</td>
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[1] https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1553777482.pdf
[2] https://www.unenvironment.org/resources/publication/playing-planet

Figure 10.2 Examples of infographics on household waste

Figure 10.3 TV programme series on waste management in India, supported by celebrity Aamir Khan.
Source: https://youtu.be/lS0_FCBzI_wc

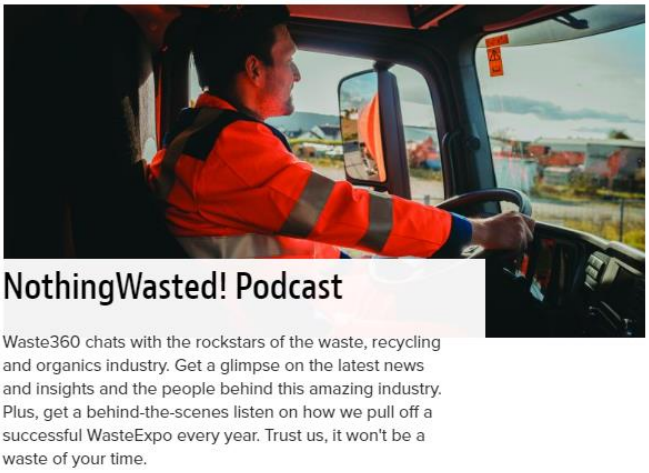

Figure 10.4 Podcast on waste management. Source: https://youtu.be/80kjYZLNVtA

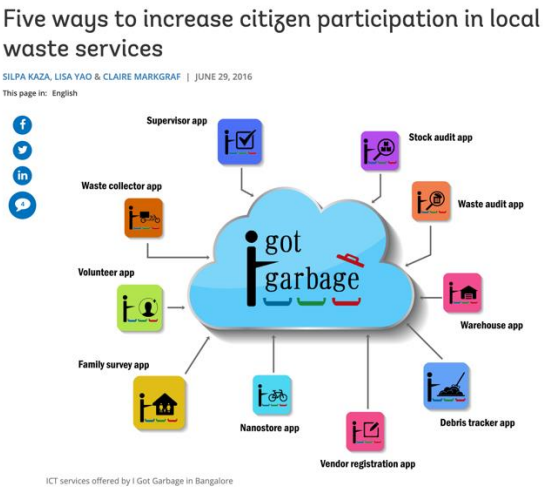

Figure 10.5 World Bank infographics promoting citizen participation in local waste services Source: https://blogs.worldbank.org/sustainablecities/five-ways-increase-citizen-participation-local-waste-services

(a) Key messages on how to manage your household waste

11. On reducing your garbage:
    (a) Minimise the use of plastic bags and other single-use plastic;
    (b) Buy food that has less packaging;
    (c) Do composting;
    (d) Don't use bottled drinks unless you have to;
    (e) Reduce your paper usage;
    (f) Consider making your own household cleaners and detergents.
12. On reusing and recycling:
    (a) Donate items when possible;
    (b) Reuse containers;
    (c) Follow your city's recycling policies;
    (d) Dispose of trash and hazardous waste properly.
13. On composting:
    (a) Save your food scraps and yard cuttings from the trash;
    (b) Create a compost site.
14. On waste management services:
    (a) Service days for collection of waste and recyclables;
    (b) Opening hours of disposal and recycling facilities;
    (c) Instructions for preparing recyclables for collection;
    (d) Acceptable and non-acceptable wastes.

(b) Messaging considerations

15. There are a variety of options available that can aid in developing the most appropriate messages for the different audience considerations. These include, using images/graphics/infographics and less words (as images tend to be universally understood and take up less space). It may also be useful to translate information into key languages, using culturally sensitive translation services.

16. For face to face engagement, the use of interpreters can be beneficial e.g. dealing with stakeholders who may have a mix of cultural and language backgrounds or when dealing with the general population e.g. door to door knocking campaigns. Good interpreters can aid the communication process, especially as they can help build trust and a good rapport.

17. What is important to remember is that having a diverse population also means that you have access to different perspectives and new ways, ideas and communications when it comes to reducing, reusing and recycling waste and refusing plastic waste.[3]

18. Principles of gender responsive communication[4] should be considered when developing content. This can help guide the development of messages to ensure gender representation and the use of inclusive language:

(a) Eliminate gender inequalities and stereotypes. This means that all genders are represented equally in all forms of media;

(b) Challenge gender stereotypes - ensuring that fair visibility for all genders will assist in reducing the use of inaccurate representations. This means that communication material should not limit men and women to specific vocations or gender roles that have been previously associated with men or women;

(c) Avoid exclusionary forms - these include using the words "he" or "she" when referring to women and men. By using "they", gendered pronouns can be avoided;

(d) Use equal forms of address. It is also important to avoid using stereotypes related to traits, behaviours, activities and the appearance of women and men;

(e) Create a gender balance - avoid using generic nouns and pronouns. A neutral language is recommended;

(f) Promote gender equity throughout titles - gender sensitive language should be used for more inclusive and equitable representations of both genders.

(g) Don't make ageist, racial or religion-based assumptions.

4. Communication materials/wording

19. 'Right stuff-right bin'-style campaigns are aimed at reducing contamination in recycling bins and trying to ensure residual (non-recyclable) bins only have items that cannot be recycled.[5]

20. There are good examples of public, private, charity, voluntary and community groups working in partnership on waste, recycling and resources, with awareness raising being a key. For example, the Marks & Spencer Shwopping Scheme, where 'Your Shwopped' items are resold, reused or recycled with funds distributed to the charity Oxfam to support projects around the world.[6] These Shwopping awareness raising campaigns can also be run in workplaces by linking in with charities. Oxfam have recently started a new campaign called 'I'm doing Second-hand September', to raise awareness of the volume discarded clothes.[7]

5. Complaints, monitoring and evaluation

21. An important aspect of a communications strategy is to have a system for the receipt and response to customer complaints. Standard practice for many waste management companies is to have a website form for customers to file their complaints directly to the company. However, each has varying procedures. For example, the Toronto City Solid Waste Management Service has a specific number for missed waste collection, a procedure for compliments on the service and a 3-step complaint process.[8]

22. A monitoring and evaluation system should be established to ensure that the stated aims and objectives of the communications strategy are being met.[9]

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[3] The following is a link to ESOL (English for speakers of other languages) resources used by a British organisation: https://recycleforgreatermanchester.com/education-and-learning/esol-resources/.

[4] https://www.unicef.org/rosa/media/1786/file

[5] http://www.mynewsdesk.com/uk/rochdale-borough-council/pressreleases/prestigious-recycling-award-for-right-stuff-right-bin-campaign-1016621

[6] https://www.marksandspencer.com/s/plan-a-shwopping

[7] https://www.oxfam.org.uk/shop/second-hand-clothes

[8] https://www.toronto.ca/city-government/accountability-operations-customer-service/city-administration/staff-directory-divisions-and-customer-service/solid-waste-management-services/solid-waste-management-services-complaints-compliments/

[9] https://www.zerowastescotland.org.uk/sites/default/files/Improving%20Recycling%20Through%20Effective%20Communications_ZWS_0.pdf

XI. Conclusions

1. The ESM of household waste should follow the principles of the waste management hierarchy: prevention, minimization, reuse, recycling, other recovery including energy recovery, and final disposal. Put simply, one should aim to reduce the quantity of waste generated; maximise the number of products, objects or substances that can be reused or recycled; recover energy and dispose of only where needed.

2. To achieve sustainable and effective waste management, a strategy for the ESM of waste, including household waste, should go beyond purely technical considerations to include the development of appropriate policies that address the political, institutional, social, financial, economic and technical aspects of waste management. To achieve affordable and effective ESM requires significant planning with integrated, circular strategies relating to all steps of the waste management hierarchy.

3. Transitioning to a circular economy, where resources are maximized, requires a major shift in institutional, business and consumer thinking – a shift towards recognition of the finite nature of natural resources and the inability of the planet to accommodate increasing levels of waste without significant environmental impact. The ESM of household waste is one of the important elements in the transition to a circular economy that promotes intelligent and equitable growth.

4. Environmentally sound management of wastes from households can be optimized by selecting the appropriate economic instruments. Economic instruments should not be mutually exclusive but complement each other.

5. In many developing countries, a significant percentage of waste may be managed by the informal sector. The difficulties in establishing formal structures for household waste management, such as selective collection, sorting centres and sanitary landfills, result in the disposal of waste at open dumps. These dumps provide opportunities for informal workers to earn a living by scavenging and selling wastes for recycling. Any strategy for the ESM of household waste should incorporate the role of the informal sector.

6. It should be recognised that there may be gender inequality in waste management operations and decision making. These include inequality in employment, access to resources, participation in community decision making and exposure to household chemicals such as cleaning products. Waste generation and management in the home is influenced by gender roles. Understanding gender differences and inequalities can lead to an improvement in household waste management overall.

7. If household waste is not stored, separated, collected, and disposed of properly, there can be threats to public health and the environment. It is therefore important to promote the best practices for the ESM of household waste with the key stakeholders through awareness raising and communication. Effective communication is paramount and needs to be tailored to suit different stakeholder groups and their different behaviours and motivations.

8. The Basel Convention is rich with tools to assist Parties and other stakeholders in implementing the provisions of the Convention. There is an array of technical guidelines, guidance documents, practical manuals and factsheets providing further guidance on the ESM of hazardous and other wastes. These tools should be consulted in conjunction with use of this guidance document.[1,2,3]

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[1] http://www.basel.int/Implementation/Publications/GuidanceManuals/tabid/2364/Default.aspx

[2] http://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/TechnicalGuidelines/tabid/8025/Default.aspx

[3] http://www.basel.int/Implementation/CountryLedInitiative/EnvironmentallySoundManagement/ESMToolkit/Overview/tabid/5839/Default.aspx