Overall guidance document on the environmentally sound management of household waste

Developed by the Household Waste Partnership working group

(Draft updated version of 31 January 2023)

Contents

I. Overview of the guidance on ESM of household waste

A. Introduction

1. 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. 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[1] and odours and leach toxic substances into the environment.

2. 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 following table provides an overview of some of the implications of improperly managed household waste.

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

B. Objective of the guidance

3. The objective of the guidance is to improve knowledge of environmentally sound waste management approaches for household waste and to share existing practical solutions for achieving the ESM of household waste. This guidance has been developed for decision makers at all levels of government and industry. 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.

[1] https://www.ipcc.ch/report/ar4/wg3/waste-management/ and https://www.no-burn.org/resources/methane-report/

4. 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. The guidance provided in this document is general in nature: more detailed information is available in the Basel Convention technical guidelines which are referenced throughout. This guidance document was developed by the Household Waste Partnership working group.[2]

C. Waste management hierarchy

5. The waste management hierarchy ranks waste management options according to sustainability[3] and what is best for the environment.[4] The aim of the hierarchy is to optimise resource efficiency and reduce the need for final disposal to the extent possible.

6. As stipulated in the Basel Convention Framework for the environmentally sound management of hazardous wastes and other wastes,[5] stakeholders should respect the waste management hierarchy (prevention, minimization, reuse, recycling, other types of recovery, including energy recovery, and final disposal). Waste prevention should be the preferred option in any waste management policy. By not generating wastes and by ensuring that the wastes generated are less hazardous, the need to manage wastes and/or the risks and costs associated with doing so are reduced. Prevention, however, will not solve all the problems associated with waste management. Some wastes are already, or will inevitably be, generated and such wastes should be managed in an environmentally sound manner. When prevention and minimization possibilities have been exhausted, reuse, recycling and recovery techniques that deliver the best overall environmental outcomes, in accordance with the best available techniques (BAT), best environmental practices (BEP) and a life-cycle approach, are to be encouraged.

D. Environmentally sound management

7. The Basel Convention Framework for the environmentally sound management of hazardous wastes and other wastes[6] 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.

8. 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.[7] 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.[8] 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.[9]

---

[2] http://www.basel.int/Implementation/HouseholdWastePartnership/Overview/tabid/5082/Default.aspx

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

[4] 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)).

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

[6] Ibid.

[7] 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

[8] 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.

[9] 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.

E. Waste definitions

9. The Basel 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.

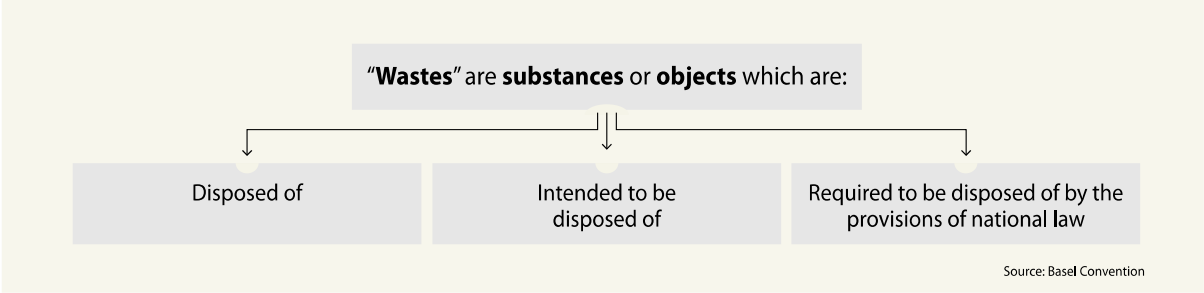


Figure 1. How is waste defined?[10]

10. "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 2.

Figure 2. Disposal operations as defined in the Convention

11. Hazardous wastes are defined as those wastes that 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 or are defined as, or considered to be, hazardous wastes by national legislation.

12. Other wastes are listed in Annex II (as Y46, Y47, Y48 and Y49[11]) 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. Basel Convention tools

13. 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 are outlined at the end of each section in "Essential reading" and should be consulted in

[10] 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

[11] This entry becomes effective as of 1 January 2025.

conjunction with use of this guidance document.[12,13,14]

Essential reading:

Basel Convention on the control of transboundary movements of hazardous wastes and their disposal [15]

Basel Convention Framework for the environmentally sound management of hazardous wastes and other wastes[16]

II. Strategies and frameworks for the ESM of household waste

A. Strategic waste management planning

14. 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.

15. 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.

16. 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 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.

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

[13] http://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/TechnicalGuidelines/tabid/8025/Default.aspx

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

[15] https://www.basel.int/Portals/4/Basel percent20Convention/docs/text/BaselConventionText-e.pdf

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

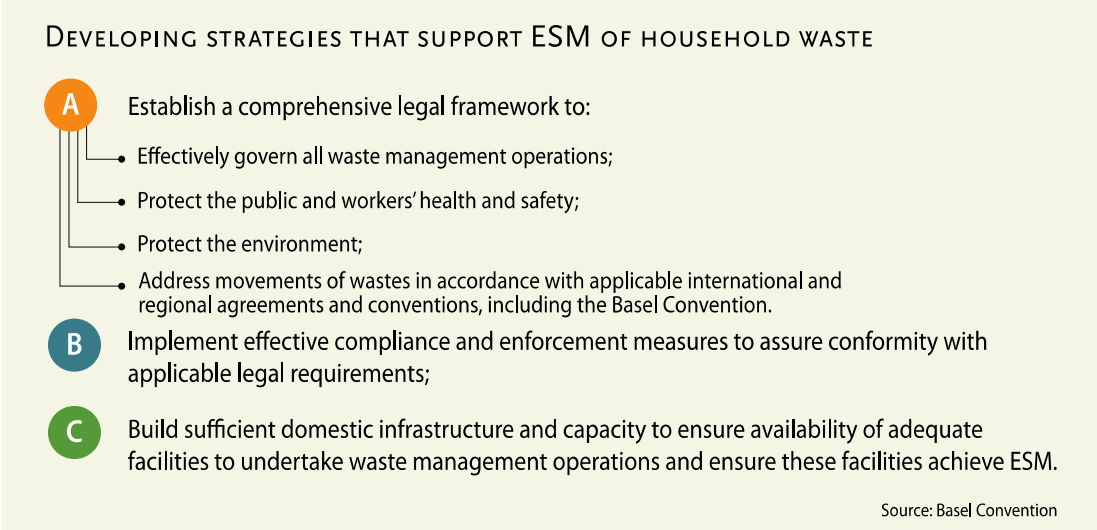


Figure 3. Developing strategies that support ESM of household waste.

B. Key considerations

17. Several aspects should be considered during the strategic waste management planning process.

1. Stakeholders

18. The following stakeholders will 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.

(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.

(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.[17]

(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.

Box 1. Regulatory initiatives and policies in Chile to reduce the use of plastic[18]

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

[17] In countries that are highly dependent on imports, the onus for EPR may fall on importers/distributors.
[18] https://publications.iadb.org/publications/english/document/Plastic-Waste-Management-and-Leakage-in-Latin-America-and-the-Caribbean.pdf

Foundation's Plastics Pact[19] network. El Pacto Chileno de los Plásticos (The Chilean 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[20] (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

19. 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.

20. 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 2).

Box 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[21] which provides a guide for developing inventories of waste.

The European Commission SWA-Tool[22] 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.

3. Regulatory frameworks

21. 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.

22. 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.[23]

23. 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.

24. The Guidelines for Framework Legislation for Integrated Waste Management,[24] also provide a

[19] https://www.newplasticseconomy.org/
[20] https://mma.gob.cl/economia-circular/chile-cero-basura/
[21] 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#.
[22] https://cordis.europa.eu/project/id/EVK4-CT-2000-00030
[23] http://www.basel.int/Implementation/LegalMatters/LegalFrameworks/tabid/2748/Default.aspx
[24] Guidelines for Framework Legislation for Integrated Waste Management, (UNEP February 2016) https://www.unenvironment.org/resources/report/guidelines-framework-legislation-integrated-waste-management

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

25. 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.

26. 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

27. 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.

28. 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.

29. 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.[25]

Box 3. Wecyclers[26]

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

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

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

management infrastructure using mobile tech and cargo bikes, providing incentives for people to recycle their waste.

6. Decoupling waste generation from economic growth

30. 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.

Box 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;[27]
- 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[28] to streamline and digitise daily rosters. This has helped to cut absenteeism. The city 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'[29] 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.[30] A popular technology for organic waste management is the mechanical Organic Waste Convertor[31] that cuts composting time to half. Several waste authorities in India and bulk waste generators have adopted this technology for food waste management.

Essential reading:

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

[28] Integrated Solid Waste Management Solution |Integrated Solid Waste Management Solution | Fingerprint Time Attendance, Access control, Scanner, Software, Biometric Time attendance machine, access control Security system, Fingerprint Reader with SDK, Face & Iris Recognition Products & Services. (n.d.). Retrieved from https://www.bioenabletech.com/integrated-solid-waste-management-solution

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

[30] 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

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

- Basel Convention Framework for the environmentally sound management of hazardous wastes and other wastes[32]
- Practical Manuals on promoting the ESM of wastes[33]
- Tools for the development of legal frameworks[34]
- Guidance on the prevention and minimisation of hazardous and other waste includes steps to develop appropriate strategies[35]
- Guidance to assist Parties in developing efficient strategies for achieving environmentally sound recycling and other recovery of hazardous and other wastes[36]
- Methodological Guide for the Development of Inventories of Hazardous Wastes and Other Wastes[37]
- Guidance on how to address the environmentally sound management of wastes in the informal sector[38]

III. Sustainable financing for the ESM of household waste

A. Waste management financing

31. 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.[39] 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.

32. Environmentally sound management of wastes from households will be optimized by selecting the appropriate economic instruments. 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

---

32 http://www.basel.int/Implementation/CountryLedInitiative/EnvironmentallySoundManagement/ESMFramework/tabid/3616/Default.aspx

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

34 http://www.basel.int/Implementation/LegalMatters/LegalFramework/Tools/tabid/2750/Default.aspx

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

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

37 http://www.basel.int/Implementation/Publications/GuidanceManuals/tabid/2364/Default.aspx

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

39 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

levy or a landfill tax.

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

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

1. Financing of infrastructure[40]

35. 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.

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

(a) Real estate acquisition;

(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.

37. 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.[41]

(e) Private equity.

38. 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 5. 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

[40] 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.

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

waste sector",[42] designed to assist cities to be finance ready; a waste initiative webinar[43] that explains the finance ready toolkit; and a primer[44] 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:

i. The United Nations Framework Convention on Climate Change (UNFCCC) Green Climate Fund (GCF) supports project preparation and large-scale project funding.

ii. The Climate Technology Centre and Network (CTCN) is a technology mechanism of the UNFCCC that can provide technical assistance to develop projects for funding under the GCF or stand-alone projects.

iii. 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.

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.[45]

2. Financing the operation of waste services

39. 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;

[42] 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

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

[44] 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

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

(k) Public education and outreach.

40. 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 6. 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[46] 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

41. 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.[47] 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.

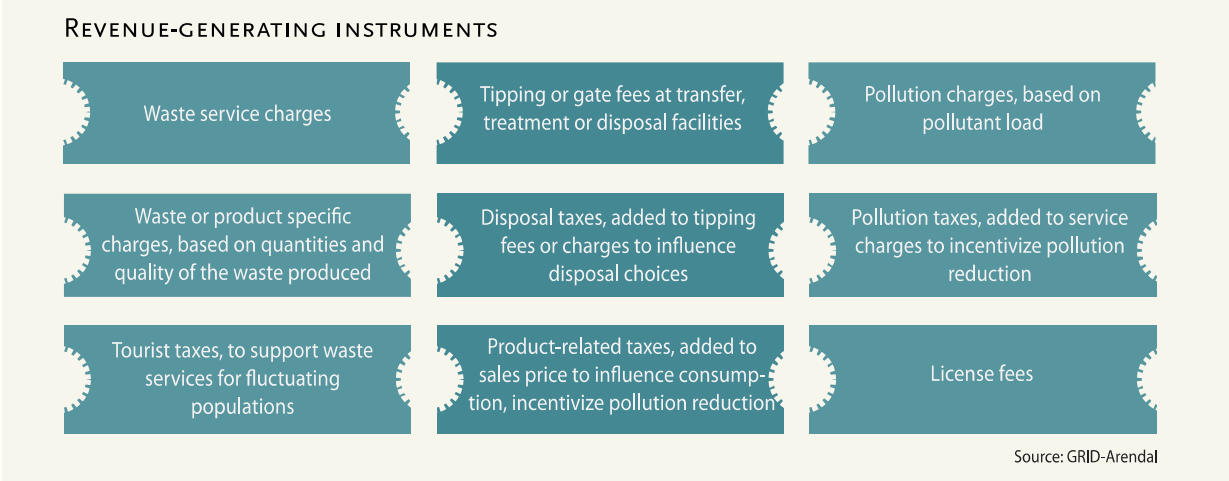


Figure 4. Revenue-generating instruments. Source: GRID-Arendal

[46] 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

[47] 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.

Box 7. Results-based finance (extracted from Results-based financing for municipal solid waste[48]

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 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.[49]

Essential reading:

- Practical manual on extended producer responsibility (EPR) and financing[50]
- Private sector incentives[51]

IV. Prevention and minimisation of the generation of household waste

A. Waste prevention and minimisation

42. 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.

43. 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. 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.

[48] 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.

[49] Coin-Levine & Coad, 2000.

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

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

(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. 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.

Box 8. 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[52] 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 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.

B. Strategies for waste prevention and minimization

44. 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. Mandate change through regulatory action

45. 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.

46. 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)[53] seeks to ensure that electrical and electronic equipment sold on the European market contain less hazardous substances.

2. Educate the public to encourage behavioural change

47. 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

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

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

waste in their daily lives, is a critical first step.

48. Actions undertaken in the area of education and public awareness may focus on aspects such as waste prevention and minimisation techniques, information on chemicals in products and eco-labelling.

3. Motivate industry and incentivise change

49. Motivational measures to promote waste prevention and minimisation include establishing voluntary commitments and implementing environmental management systems.

50. Voluntary commitments to waste prevention targets are generally sector specific, highly effective in achieving agreed goals and increase public awareness of the issue. In the absence of national targets for waste prevention, support through funding, promotion activity and logistical support for voluntary agreements is highly recommended.

51. 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.

4. Promote innovation

52. In promoting innovation, aspects to consider include:

(a) 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.

(b) 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 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.

Essential reading:

- 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[54]

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

A. Separation at Source

53. 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);

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

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

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

54. 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.

55. A household waste separation scheme could focus on a multiple waste stream source separation scheme – paper, plastic, glass etc. (See Figure 5). 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.

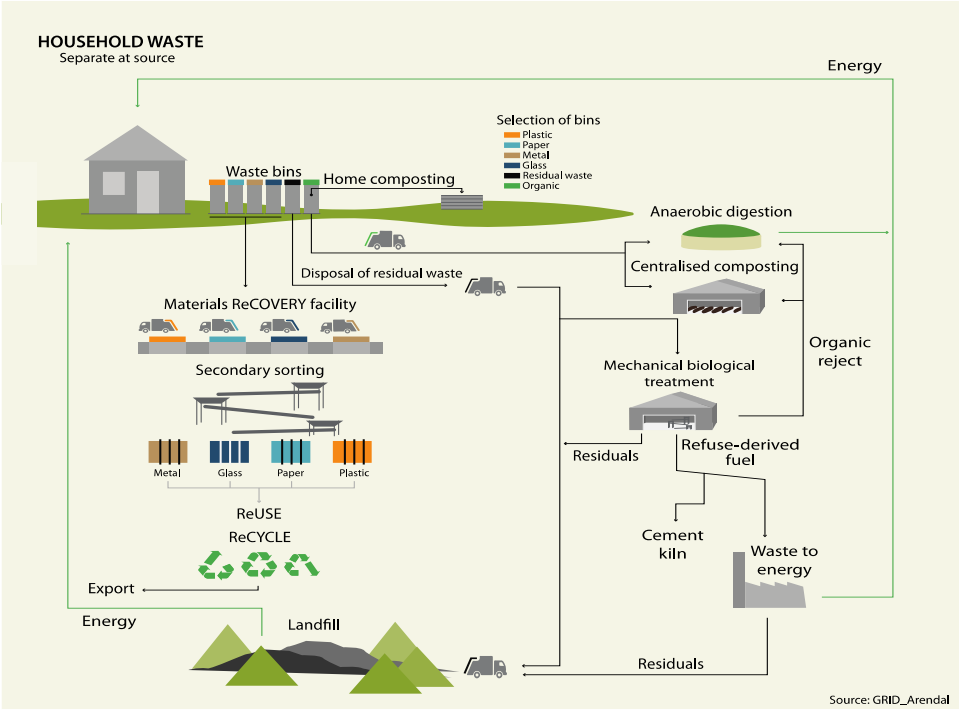


Figure 5. Steps showing different scenarios for source separation, collection and transport
Source: GRID-Arendal

Box 9. Shanghai waste sorting strategy[55]

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)

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

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 10. Organic Waste[56]

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 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.

B. Primary and Secondary Collection

1. Waste collection

56. Primary waste collection is the collection and transport of household waste from point of generation to transfer points or community bins,[57,58] 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.[59]

2. Waste collection methods

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

[57] 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.

[58] 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.

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

57. 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. The most common waste collection methods are:[60]

(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).[61]

3. Frequency of collection

58. 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. It is desirable that the frequency does not vary, so that households and shopkeepers know when their waste will be collected.

Box 11. Waste separation and collection, Zlatograd, Bulgaria[62]

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

59. 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.[63] In designing a WCSC, the charging method, payment vehicle, features of a service package and challenges in implementation should be considered.

60. For more information on waste service charges please refer to section III.

[60] 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

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

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

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

Box 12. ECONIT Programme, Czechia[64]

In 2017, a waste management company designed a new data system, ECONIT, in the Prostřední Bečva municipality (Czechia), 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 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 Czechia, Slovak Republic and Hungary.

C. Equipment for Waste Storage, Collection and Transportation

1. Waste storage

61. 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.[65]

62. 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.

63. A secondary storage waste bin or other storage facility 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.

2. Collection and transfer vehicles

64. 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. 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.

D. Transfer stations

1. Transfer station systems

65. 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

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

[65] 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.

or facilities.[66]

66. 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.

2. Design considerations

67. 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.;[67]

(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.

E. Secondary sorting

1. Sorting recyclables

68. 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.[68]

69. 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. The sorting technique applied (automated or manual) depends on the type of waste input, and recycling market in place. Sorting facilities require a critical mass in order to ensure that they are sustainable and economically viable.

2. Sorting at material recovery facilities (MRFs)

70. 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 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.

3. Sorting centres

71. 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

---

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

[67] 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.

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

instances, these sorting centres deal with plastic waste.

Box 13. Dry Waste Collection Centre[69]

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

72. 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).

73. A review of the informal waste sector[70] 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.

Essential reading:

- Technical guidelines under the Basel Convention on specific waste streams[71]
- Fact sheets on specific waste streams[72]

VI. Reuse

A. Principles

74. 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

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

[70] 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

[71] http://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/TechnicalGuidelines/tabid/8025/Default.aspx

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

parts which are needed for repair; open access to repair manuals; and increasing the availability of affordable tools.

75. 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).

B. Products

1. Textiles

76. 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.[73] 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.[74]

77. 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.[75] It is predicted that by 2030, global apparel consumption will rise by 63 percent, from the current 62 million tonnes to 102 million tonnes.[76] 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.[77]

78. 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:[78]

(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).

2. Furniture

79. 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.

80. 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);

---

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

[74] 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

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

[76] Ibid.

[77] 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

[78] Ibid.

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

Box 14. Waste Exchange (WX) Project, Nelson Mandela Bay Municipality, South Africa[79,80]

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

81. 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.

82. 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.

83. Some jurisdictions (e.g. the European Union) are looking to outlaw the manufacturing of goods with planned obsolescence.[81]

84. 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.

Box 15. SURFACE project in Central Europe

The SURFACE project[82] 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.

[79] https://infrastructurenews.co.za/2014/06/20/dont-dump-it-exchange-it-in-nelson-mandela-bay/
[80] https://www.nelsonmandelabay.gov.za/page/my-waste
[81] https://www.greens-efa.eu/en/article/press/clear-consensus-on-the-need-to-end-planned-obsolescence/
[82] https://www.interreg-central.eu/Content.Node/SURFACE.html

Essential reading:

- 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[83]
- Guidance document on the environmentally sound management of used and end-of-life mobile phones[84]
- Guidance document on the environmentally sound management of used and end-of-life computing equipment[85]
- Practical Manuals on promoting the ESM of wastes[86]

VII. Recycling of household waste

A. Why recycle

85. Under the waste management hierarchy, recycling is the next preferable option following prevention, minimisation and reuse. 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.

B. The recycling process

86. Section V outlines the importance of effective separation of household waste and efficient collection services for the promotion of recycling.

1. Collection and separation of post-consumer recyclable household waste

87. 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.

88. 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.

89. 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.

2. Recycling operations

90. 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 some countries, where material is used once merely for its physical properties (e.g. for backfilling), this

---

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

84 http://www.basel.int/Implementation/Publications/GuidanceManuals/tabid/2364/Default.aspx

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

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

does not amount to recycling.

91. 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.

92. The diagram below shows the pyramidal nature of recycling industries, and of recycling material flows (Figure 6). 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.

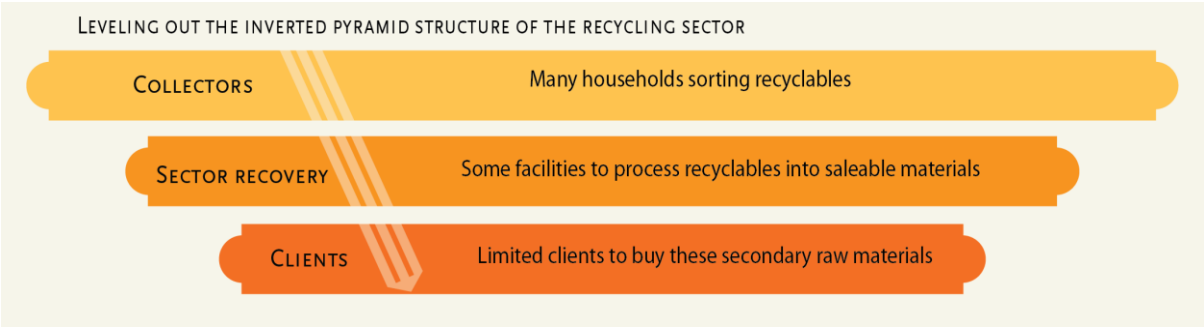


Figure 6. The inverted pyramid structure of the recycling sector. Source: Bureau of International Recycling

93. 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[87] 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

94. 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.

95. The annex to this document provides an overview of the most commonly recycled materials collected from households.

C. Markets for secondary raw materials

1. Demand

96. 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.[88]

[87] https://www.unenvironment.org/ietc/node/44
[88] https://ec.europa.eu/environment/topics/circular-economy_en

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

97. 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, and reducing costs;

(c) Prohibiting landfilling and incineration of recyclable materials.

98. 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

99. 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.

Essential reading:

- Technical guidelines under the Basel Convention on specific waste streams[89]
- Fact sheets on specific waste streams[90]
- Practical Manuals on promoting the ESM of wastes[91]

VIII. Other recovery processes

A. Resource and energy recovery

100. 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.

B. Mechanical and Biological Treatment

101. 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 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.

102. As such, the materials/products from MBT plants are often of lower quality and hence, not easily

---

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

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

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

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.[92]

C. Composting and anaerobic digestion (organic recycling)

1. Composting

103. 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).

2. Anaerobic Digestion

104. 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.

105. 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.

D. Waste-to-Energy Technologies

106. 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.

107. 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.

108. WtE technologies may be classified as either thermo-chemical or biological (Figure 7). Thermo-chemical techniques include incineration, gasification and pyrolysis while biological WtE techniques include anaerobic digestion (see the start of this section for further information on composting and anaerobic digestion).

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

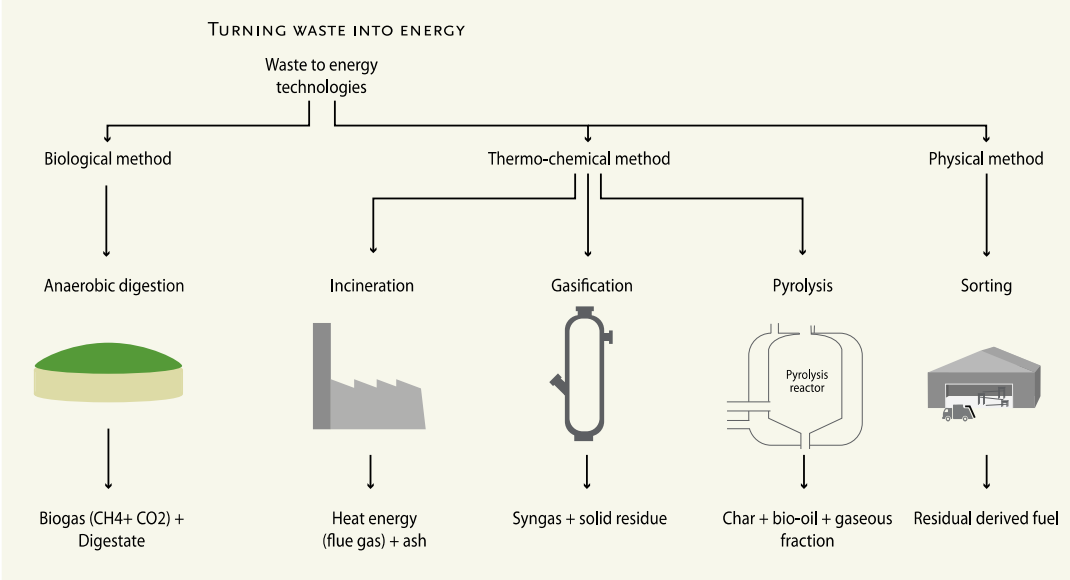


Figure 7. Waste to energy technologies and expected outputs. Source: GRID-Arendal

Box 16. Reppie Project, from waste to energy, Ethiopia[93]

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.

Essential reading:

- Technical guidelines on the environmentally sound incineration of hazardous wastes and other wastes as covered by disposal operations D10 and R1[94]
- Technical guidelines on the environmentally sound disposal of hazardous wastes and other wastes in specially engineered landfill (D5)[95]

[93] https://www.weforum.org/agenda/2018/05/addis-ababa-reppie-trash-into-energy/
[94] Document UNEP/CHW.15/6/Add.4/Rev.1 available at: http://www.basel.int/TheConvention/ConferenceoftheParties/Meetings/COP15/tabid/8392/Default.aspx
[95] Document UNEP/CHW.15/6/Add.5/Rev.1 available at: http://www.basel.int/TheConvention/ConferenceoftheParties/Meetings/COP15/tabid/8392/Default.aspx

IX. Environmentally sound final disposal of household waste

109. The least preferable waste management option in the waste management hierarchy is incineration (without energy recovery) and landfill disposal of waste.

110. 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.[96,97]

Box 17. 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 18. 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

[96] 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)

[97] 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)

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. [98]

Box 19. Permitting for informal waste pickers at a landfill site in South Africa[99]

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.

Essential reading:

- Technical guidelines on the environmentally sound incineration of hazardous wastes and other wastes as covered by disposal operations D10 and R1[100]
- Technical guidelines on the environmentally sound disposal of hazardous wastes and other wastes in specially engineered landfill (D5)[101]

X. Health and safety in waste management

A. OSH measures

111. Essential occupational safety and health (OSH) 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).

112. 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.

113. Informal waste pickers on landfills are exposed to a toxic physical environment.[102] 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

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

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

[100] Document UNEP/CHW.15/6/Add.4/Rev.1 available at: http://www.basel.int/TheConvention/ConferenceoftheParties/Meetings/COP15/tabid/8392/Default.aspx

[101] Document UNEP/CHW.15/6/Add.5/Rev.1 available at: http://www.basel.int/TheConvention/ConferenceoftheParties/Meetings/COP15/tabid/8392/Default.aspx

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

associated with this work stigmatize the sector, which can lead to violence and harassment.

114. 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.[103]

Box 20. Soso Care enterprise, Lagos city, Nigeria[104]

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

115. In many places, there is gender inequality in waste management operations and decision making.[105] 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.[106] Given women's primary responsibility for cleaning, food preparation, family health, laundry, and domestic maintenance, women and men may 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.

116. 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.[107] Understanding gender differences and inequalities can lead to an improvement in household waste management overall.[108]

Box 21. 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

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

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

[105] 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/

[106] 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

[107] GRID Arendal and UNEP (2019). The Gender and Waste Nexus. https://www.unep.org/ietc/news/story/gender-and-waste-nexus-now-available-5-languages

[108] https://www.ctc-n.org/files/resources/gender_and_waste_management.pdf

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.[109] 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 22. Taka Taka Solutions, Nairobi, Kenya[110]

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.

Essential reading:

- Basel Convention Framework for the environmentally sound management of hazardous wastes and other wastes[111]

[109] https://www.wiego.org/gender-waste-project
[110] https://takatakasolutions.com/about-us/
[111] http://www.basel.int/Implementation/CountryLedInitiative/EnvironmentallySoundManagement/ESMFramework/tabid/3616/Default.aspx

XI. Conclusions

117. 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.

118. 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.

119. 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.

120. 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.

121. 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.

122. 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.

123. 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.

124. 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 are outlined at the end of each section in "Essential reading" and should be consulted in conjunction with use of this guidance document.[112,113,114]

---

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

[113] http://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/TechnicalGuidelines/tabid/8025/Default.aspx

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

Annex - Recycling of different household waste streams

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

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).

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.

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

Box A1. 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.

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[115]);

(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.

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

After collection, aluminium beverage cans are usually recycled by the following method:[116]

i. 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.

ii. 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.

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

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

iii. Rolling

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

iv. Converting

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

(b) Process for copper wire recycling

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

i. Collection

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

ii. Sorting

Insulated copper wire is cut from household appliances and collected together.[117] 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.

iii. Processing

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.

iv. 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

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.

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.

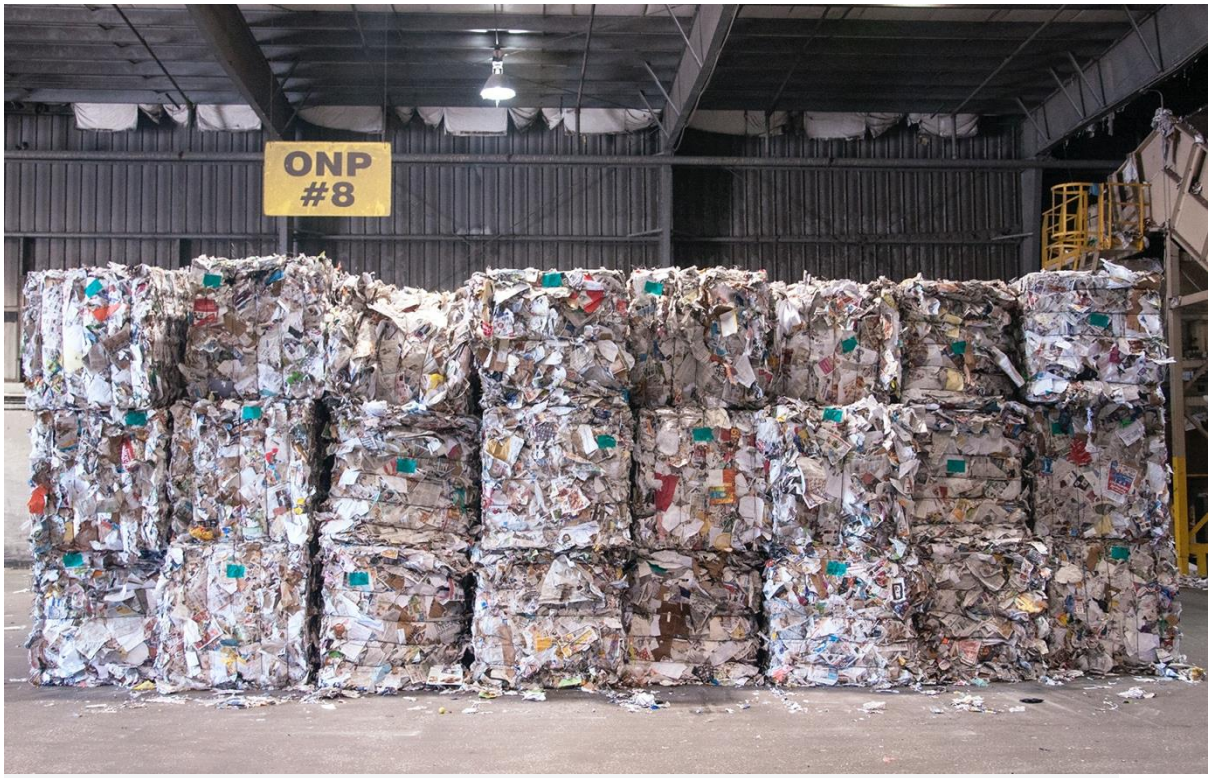
Producing paper from recycled materials instead of virgin wood pulp saves trees and reduces water and electricity consumption. Life cycle studies indicate that even after all energy used to collect, transport and process the used paper is factored in, producing recycled paper uses significantly less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

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

i. Sorting

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.

[117] 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)

ii. Baling

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.

iii. Shredding

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

iv. Washing

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.

v. Bleaching

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

vi. Pressing

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.

vii. Rolling

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

3. Plastics

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.[118] Plastics are predominantly made from oil, manufactured using approximately 4 percent of the petroleum consumed worldwide.[119]

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.

There are six common types of plastic used in packaging products:[120]

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

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.

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.

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.

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.

(a) Process for plastic recycling

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.

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.[121] The mechanical recycling of plastics also leads to savings in

---

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

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

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

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

carbon dioxide emissions, as compared to producing virgin plastic products, but not as compared to emissions averted by reducing plastic production.[122]

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 section VII).[123]

Box A2. EcoPost, Kenya[124]

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

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.

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 section IV).

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.

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

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.[125] The fashion industry:

(a) Produces 20 percent of wastewater;

(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.[126]

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,

[122] 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+

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

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

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

[126] Ibid.

in charity shops, or in marketplaces. There is increasing use of online sales, whether by individuals or by private enterprises.

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.

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.

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 A3. SK-Tex, Slovakia[127]

SK-Tex[128] 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 A4. Ecofibra Chile[129]

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[130] 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.

6. Waste electrical and electronic equipment

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.

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

[127] https://circulareconomy.europa.eu/platform/en/good-practices/sk-tex-slovakian-recycling-company-transforms-old-clothes-insulation-products
[128] https://sk-tex.com/
[129] https://www.ideassonline.org/public/pdf/EcoFibraChile-ENG.pdf
[130] http://www.ecofibrachile.cl/product.html

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.

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.

Household electrical waste can be either repaired and reused (see section VI) 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.

Guidance developed by the Convention's Partnership for Action on Computing Equipment[131] and Mobile Phone Partnership Initiative[132] cover different aspects of the environmentally sound management of WEEE and mobile phones.

7. Hazardous household wastes

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.

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.[133]

---

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

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

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