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Reduction of UPOPs emissions by improving waste management practices at landfills

Source Separation and Collection of Waste

Core Methodology and Principles

Resources & Waste Advisory Group SCE

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List of Acronyms

BAT	Best Available Technology
BCRC-Caribbean	Basel Convention Regional Centre for Training and Technology Transfer for the Caribbean
BEP	Best Environmental Practices
BM	Brian McCarthy (Team Leader)
BSFL	Black Soldier Fly Larvae
CAPEX	Capital Expenditure
CBO	Community Based Organisation
CDW	Construction and Demolition Waste
CRT	Cathode Ray-Tube
DG	Diana Gheorghiu (Deputy Team Leader)
ELV	End-of-Live-Vehicles
EPR	Extended Producer Responsibility
ESM	Environmentally Sound Management
FAO	Food and Agriculture Organisation
GHG	Green House Gas
HDPE	High Density Polyethylene
HFO	Heavy Fuel Oil
HHW	Household Hazardous Waste
HR	Human Resources
HWISF	Hazardous Waste Interim Storage Facility
ICI	Institutional, Commercial and Industrial
IEC	Information, Education and Communication
ISWM	Integrated Solid Waste Management
LDPE	Low Density Polyethylene
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
NGO	Non-Governmental Organisation
NiCd	Nickel-Cadmium
NiMH	Nickel-Metal Hydride
OPEX	Operational Expenditure
PAYT	Pay As You Throw
PET	Polyethylene Terephthalate
PLA	Polylactic Acid
POPS	Persistent Organic Pollutants
RDF	Refuse Derived Fuel
RWA	Resources and Waste Advisory
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
SME	Small to Medium sized Enterprise
SWM	Solid Waste Management
Q&A	Questions and Answers
UK	United Kingdom
ULABs	Used Lead Acid Batteries
UPOPs	Unintentionally produced Persistent Organic Pollutants
WACS	Waste Analysis and Characterisation Study

WEEE Waste Electrical and Electronic Equipment

Definitions

Builders Rubble / Inert CDW - refers to the inert (stable and non-reactive) waste produced during the construction, alteration, repair or demolition of any structure, and includes rubble, earth, brick and rock. This waste can be separated and re-used as fill material during construction.

Bulky Waste - refers to large items of solid waste, which because of their bulkiness / size, require special collection and management. Examples include furniture, garden play equipment, and large appliances from residential and commercial sources.

Commercial and retailers – business premises including offices and small to medium warehouses and companies that trade, import, market and sell products.

Construction and Demolition Waste (CDW) - refers to the inert waste (excluding hazardous waste) produced during the construction, alteration, repair or demolition of any structure, and includes plasterboard, lumber, flat glass, packaging, concrete, etc. This waste can be separated and re-used as fill material during construction.

Door-to-Door Collection / kerbside collection - a system where waste bins/containers are usually collected from the street in front of (or very close to) the houses. Does not necessarily mean physical collection from the door. In apartment buildings, the waste bins may also be collected from a communal area (e.g. in back yards used by all inhabitants of the building).

Encapsulation – a process whereby hazardous waste is sealed in an impervious and non-reactive container, so it can be safely transported, stored, and buried.

Inertized - a form of encapsulation that involves grinding and mixing pharmaceutical waste with a mix of water, cement and lime to form a homogenous paste. The paste is transported in a liquid state by concrete mixer truck to a landfill and decanted into the normal urban waste, where it sets as a solid mass dispersed throughout the municipal solid waste. All packaging materials including paper, cardboard, plastic, and blister packs must be removed from the pharmaceuticals prior to mixing. Worker protection in the form of protective clothing and masks is required as there may be a dust hazard.

Institutions – an established official organization having an important role in a society such as Government offices and facilities; primary, secondary and tertiary education facilities; and religious facilities.

Material Recovery Facility - is a specialized plant that receives, separates and prepares recyclable materials for marketing to end-user manufacturers. The aim is to divert as much waste as possible from landfill sites and to facilitate economically viable recycling.

Municipal Solid Waste - means waste, excluding hazardous waste, which emanates from premises that are wholly or mainly for residential, governmental, educational, health care, sport or recreation purposes.

Separate Collection - the collection where a waste stream is kept separately by type and nature so as to facilitate a specific treatment.

Source Separation - refers to the practice of setting aside fractions of the waste stream at the point of generation so as to prevent them from entering the waste stream that is destined for landfill.

WEEE - this is also referred to as electronic waste and includes batteries, computers and computer parts, electric wires, electrical equipment and appliances, remotes, watches, mobile phones, bulbs, tube lights, and compact fluorescent lamps. These pollutants are classified as hazardous waste.

1 Introduction

The conventional approach to waste management, a one-dimensional or linear collect-transport-dispose approach (Figure 1), for many reasons, is not sustainable. Landfill sites are becoming overwhelmed with increasing quantities and types of waste, which make ongoing landfill maintenance a challenge for staff and the available equipment. This leads to uncompacted waste susceptible to fire, scattering of wind-blown litter, water ingress and resultant leachate production. Engineered sanitary landfills are expensive to construct and are rapidly filling with waste streams that are not major polluters, have potential value to the economy, and therefore do not require landfilling (e.g. green waste and builders' rubble). Public acceptance of landfills is difficult, and land suitable for establishment of future landfills in extremely short supply, meaning existing landfill space must be conserved. Overwhelmed, poorly managed or unlined landfill sites are substantial environmental and public health liabilities. With disposal of hazardous waste mixed with all other wastes, the incidences of waste fires, toxic leachate, and POPs / UPOPs emissions to land, water bodies and air contribute significantly to the degradation of the environment and human health.

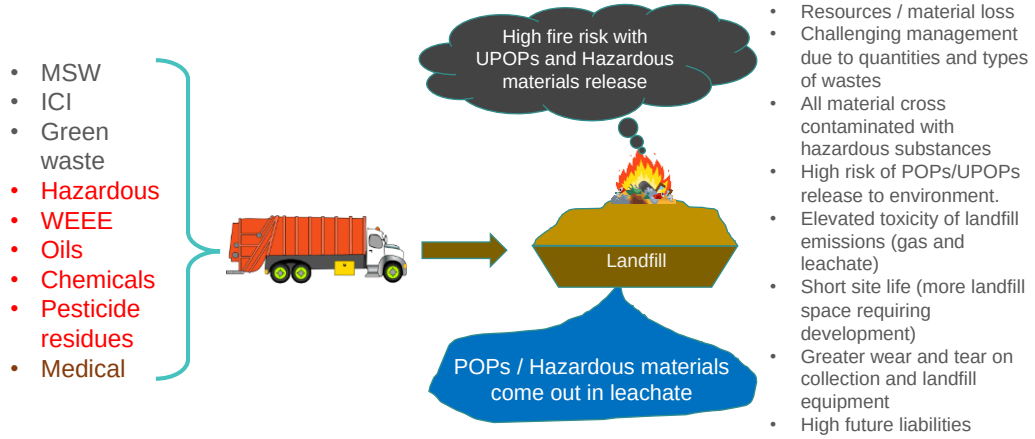

Figure 1: One dimensional / linear approach to waste management

In recognition of these environmental, health and economic realities, the global political agenda is encouraging the adoption of 'waste as a resource', 'circular economy', 'zero waste' and 'zero landfilling' concepts. In order to realise these goals, a multi-dimensional integrated waste management system with source separation of waste (Figure 2) is becoming a necessity in all waste management systems including those in SIDS.

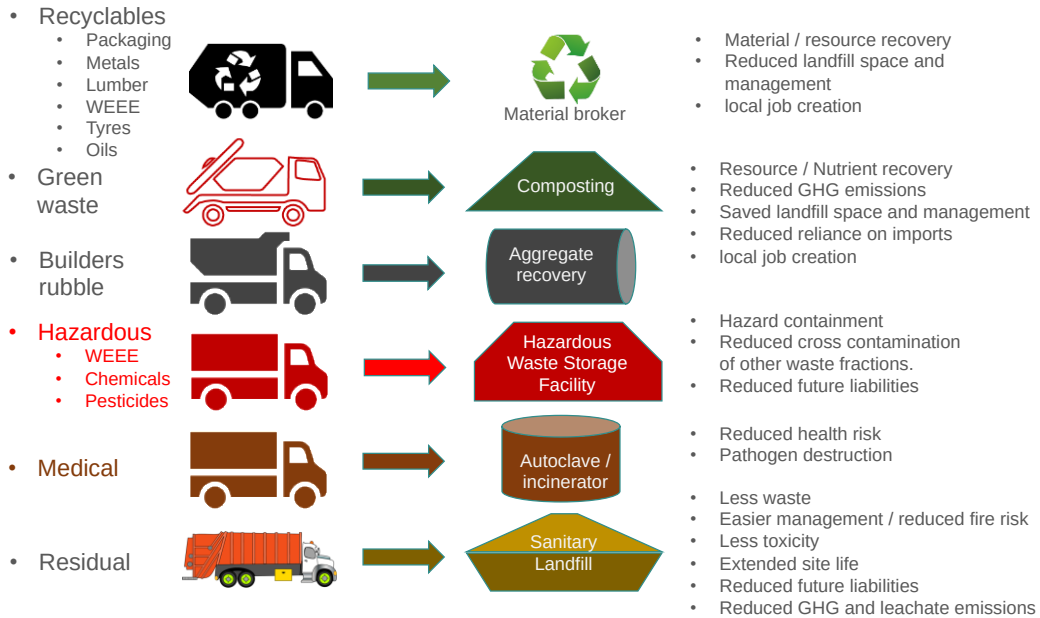

Figure 2: Example multi-dimensional / Integrated approach to waste management with source separation

While every continent, country, region, town and community have their own unique opportunities and challenges with regard to managing waste resources, there are several common principles which influence the success or demise of establishing and sustaining an integrated solid waste management system with source separation initiatives.

Separation of waste at the source of its generation is an essential step in a successful integrated solid waste management system. Implemented correctly, source separation can:

- Support recycling by producing homogenous and less contaminated material streams, which are easier and less costly to recycle; and
- Reduce the quantity, and toxicity, of waste going to landfill, which in turn reduces the environmental impact of landfills.

When looking to implement source separation of waste, lessons can be learned from existing initiatives, helping to overcome some of the inherent challenges associated with changing a waste management system.

This report aims to present these common guiding principles and concepts, provide guidance on how to plan a source separation initiative within an integrated waste management system, and present international examples of best practice in implementing source separation of waste fractions.

This report is intended for waste managers and policy makers to help support the design and implementation of source separation programs. A “Decision Tree” is provided in Figure 3 (and Annex 1) to assist navigate and use this document when planning a source separation initiative. This report also complements individual source separation methodologies produced for Antigua and Barbuda, Saint Lucia and Barbados which will support pilot initiatives to reduce UPOPs emissions at landfills.

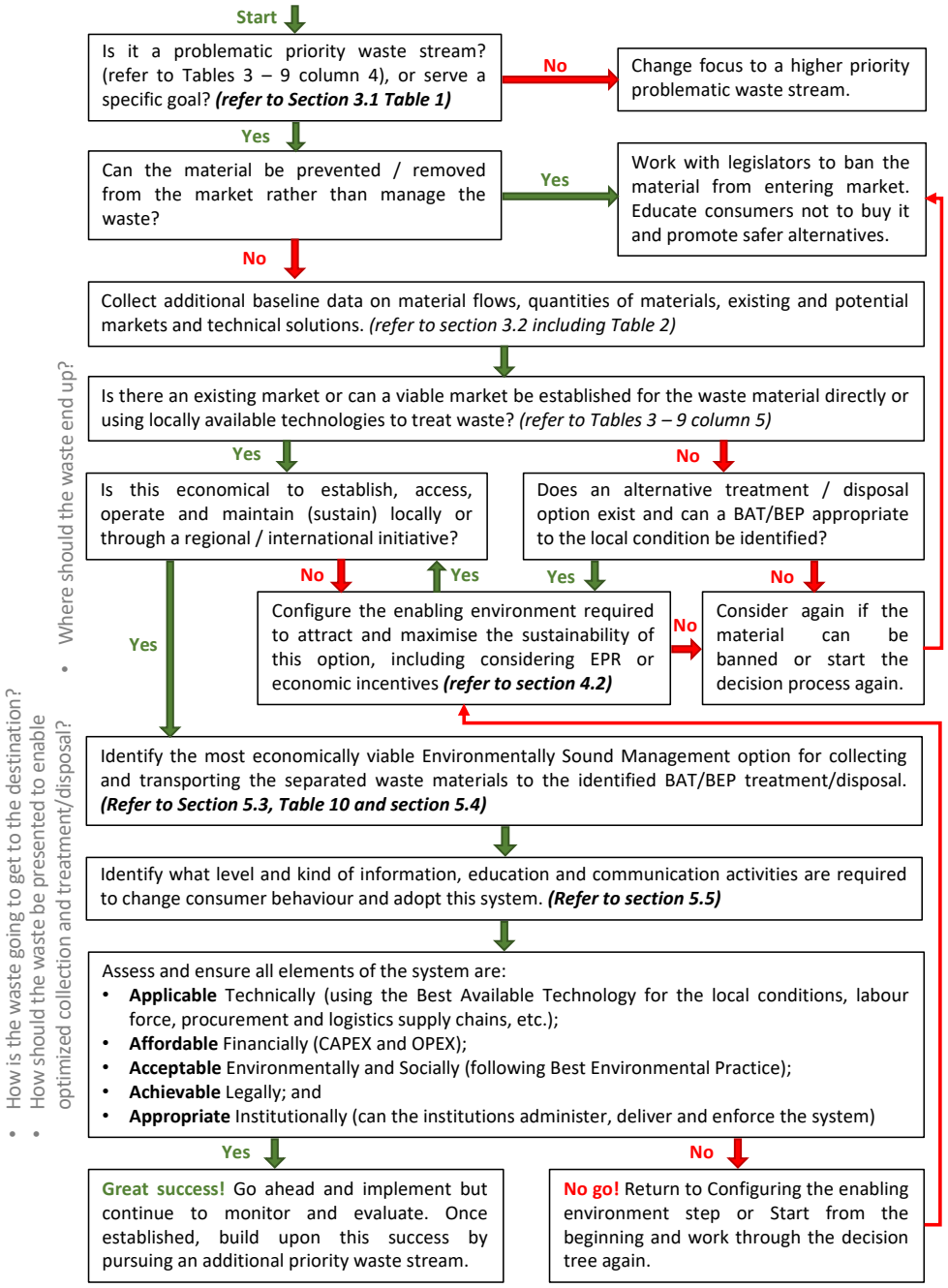

Figure 3: Source Separation Guideline Decision Tree (larger version in Annex 1).

2 Common guiding principles and concepts

There are three main guiding concepts / principles (Figure 4) recognised internationally for developing waste management strategies that incorporate and support the need for source separation of various waste streams.

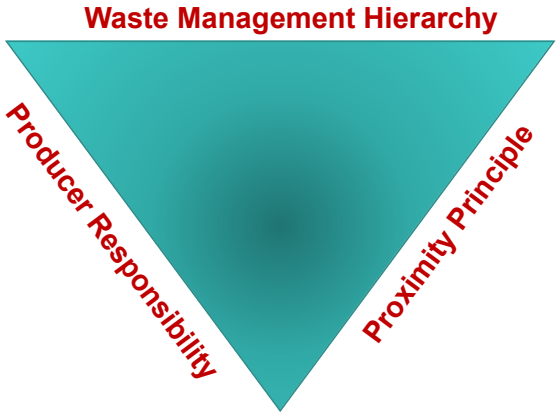

Figure 4: The three main guiding principles for source segregation waste management strategies.

2.1 Producer Responsibility

The first concept is **Producer Responsibility**, making the producer of waste responsible (physically and/or financially) for the waste they produce including its safe handling and **Environmentally Sound Management**. This implements the **Polluter Pays Principle** whereby the producers of waste are held accountable for financing measures to prevent or mitigate the risk of damage to the environment by their waste, or of remediating any damage they cause. Holding the polluter accountable for the costs of the environmentally sound management of their waste, incentivises the polluter to produce less waste, move to less harmful products/waste that are easier/cheaper to manage, and segregate waste streams well to reduce waste management costs and environmental impact.

A tool that assists implement the producer responsibility principle is the **Duty of Care** concept. This is implemented, for example, in the UK [1] where anyone who produces, imports, keeps, stores, transports, treats or disposes of waste is required to take all reasonable steps to ensure that their waste is managed safely, responsibly and in accordance with local laws from the moment it enters their custody until that custodianship is officially transferred to an authorised party or facility. This is proven through a "**Waste Transfer Note**" attached to each waste consignment (primarily used for business and commercial wastes) that tracks the transfer of responsibility from one party to the next to ensure transparent accountability[2]. Similar systems exist in other countries for specific waste streams and/or generators and are applied at varying scales.

Applying the Polluter Pays Principle further up the product supply and manufacturing chain to the original producer of the material (or as close to as possible) through introduction of **Extended Producer Responsibility** systems, can further assist with the financing of the waste management system for specific waste streams (e.g. packaging, tyres or others), as well as influence the selection and design of materials and products that are easier to recycle at end of life.

[1] An overview of the UK Duty of Care concept is available at: https://www.gov.uk/managing-your-waste-an-overview

[2] An example form for a duty of care waste transfer note for moving waste used in England is available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296502/LIT_7584_697773.pdf

2.2 Waste Management Hierarchy

The waste management hierarchy is a widely accepted guiding concept that prioritises a series of actions to reduce and manage waste from most favourable (top of Figure 5) to least favourable (bottom of Figure 5). The priority is to reduce / prevent waste from being generated in the first instance which also includes reducing the hazardous nature of products that will become waste, followed by recovering products from the consumer cycle for reuse or material recycling, recovering energy, and finally disposal being the least preferred action.

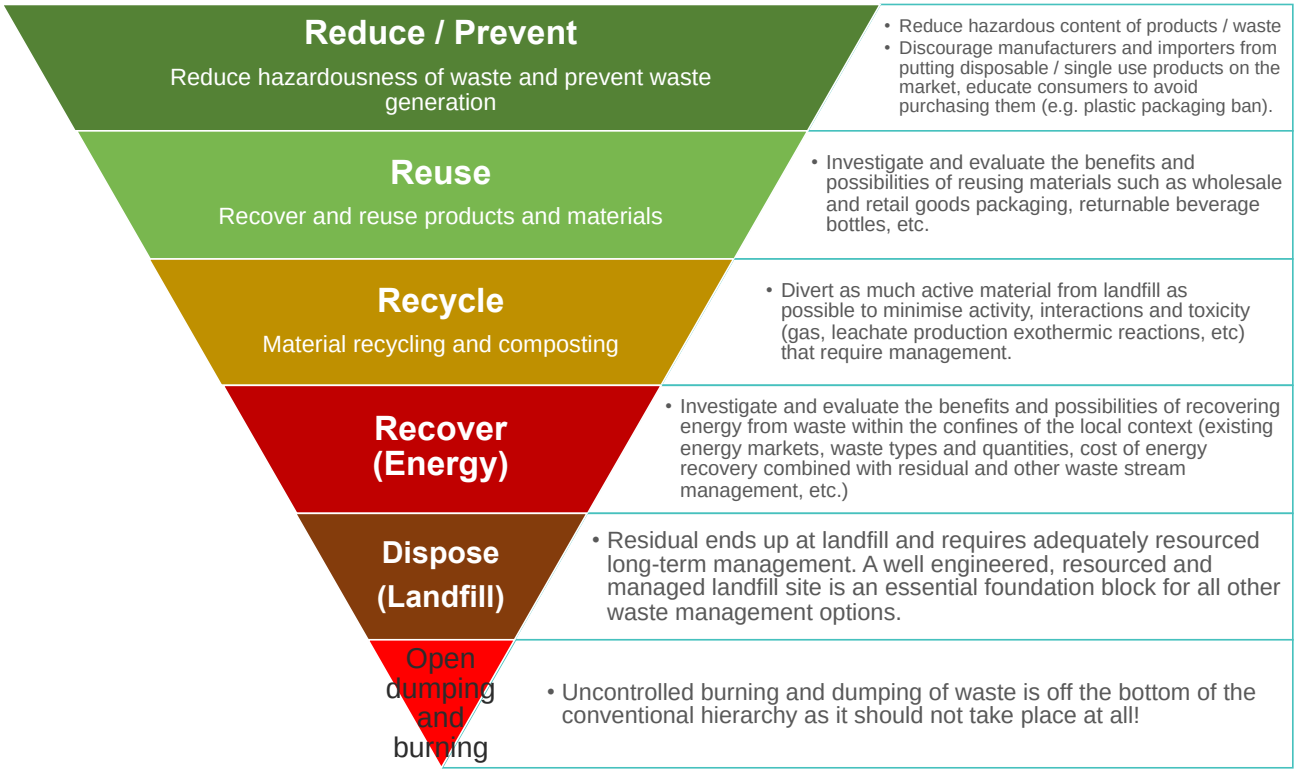

Figure 5: The waste management hierarchy

The hierarchy concept acknowledges that not all waste can be prevented, reused or recycled, but rather provides an order of which action should be prioritised over others. Where the higher action cannot be achieved, the next achievable action should be undertaken. Generally, the higher the hierarchy action, the greater the need for clean, homogenous source separated materials.

2.3 Proximity Principle

Waste should generally be managed as near as possible to its place of generation. This is intended to ensure that the environmental impact and cost of transporting waste is minimised, but also serves to ensure the management of the material is not just swept “out-of-sight out-of-mind” that there remains local accountability and acknowledgement of the waste management actions. This in-turn can incentivise the source separation of waste materials to aid the environmentally sound management of the waste resources. Ultimately, the closer to the source that separated waste is managed, the more quickly it can be managed and the less likely it is to become contaminated with foreign materials..

2.4 Additional guiding principles in waste management

Other noteworthy principles and concepts to guide the management of waste in the context of source separation and mitigating the emissions of POPs and UPOPs include:

Precautionary Principle

Lack of scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation. When dealing with potentially hazardous waste, it must be assumed that waste is hazardous until proven to be safe. Where it is unknown what the hazard may be, it is important to separate it from other waste materials and take all the necessary precautions to protect human health and the environment.

Principle of cooperation and participation

Ensuring all stakeholders are invited to, are able to, and do cooperate and participate in initiatives to improve waste and resource management is essential to achieving cross sector buy-in and with full commitment and participation in implementing the management system.

3 Defining the baseline and purpose

Having introduced the common principles and concepts that guide the development of source separation strategies, the next step is to incorporate these into the system, design and implementation of source separation initiatives. It is important to acknowledge that this process is iterative rather than linear. For example, upon analysing data on existing quantities of a certain type of waste, stakeholders involved in decision making may determine that the quantities are insufficient to justify the costs of system implementation and potential benefits, the market for recovered materials may change, or the enabling environment (including governance, finance, policies, regulations, systems and procedures) needs strengthening. As such the initially envisioned purpose may be revisited, the scope of the programme may change or alternative means of management of non-separated waste need to be pursued.

Some of the steps described within this guide would need to be revisited also in the case of geographically expanding/ scaling up successfully implemented pilot initiatives.

3.1 Defining the purpose and scope

As briefly introduced previously in Figures 1 and 2, there are several practical reasons to implement source separation of waste. Some of the most common are summarised in Table 1.

The reason/s to implement a source separation initiative often stems from a National Waste Management Strategy / policy, or may be identified by any sector stakeholder due to market conditions or as a consequence of implementing a business, national strategy or policy. Either way, once the purpose/s of source separation is identified, the scope of implementation needs to be defined and the feasibility of full implementation assessed.

As a rule of thumb, a stepwise approach in terms of both scale of application and waste streams targeted tends to have better chance of success than setting very ambitious targets.

It is useful to keep in mind that the scope can be further increased, and the separation programme refined once sufficient time has passed for the initially established practices to be consolidated prior to introducing changes. It is also worth noting that once initiated, with the waste producers being educated and conditioned to implement a system, it is very difficult to change that guidance and behaviour without the waste producers becoming confused, losing interest and trust in the waste management authority.

Table 1: Common source separation initiative purpose, waste stream focus and waste material

Common Source Separation Purpose / Goals	Typical source separation initiative target waste streams	
	Focus	Typical materials
Reducing environmental pollution and associated health impacts due to poor waste management practices	Wastes that account for greatest volume and/or toxicity of emissions (particularly Gas and Leachate)	• Organic (green and food) • Hazardous wastes • Waste Electric and Electronic Equipment (WEEE) • Wet wastes (cooked and uncooked food items)
Diverting / protecting waste streams from improper disposal	Materials that are incompatible (due to environment, health or safety) with the disposal/treatment methods available or have a unique waste management (storage, treatment, disposal, destruction) requirement	• WEEE • Hazardous Waste • Tyres • ULABS • Used oils
Prolonging the life of existing waste disposal facilities	Least polluting with highest volume	• Green Waste • Inert builder's rubble • Bulky Wastes
Improving the efficiency and effectiveness of landfill operations (particularly layering and compaction)	High volume, low density wastes that are challenging to compact or overwhelm landfill equipment. Materials that can interfere with and damage mechanical components of landfill equipment.	• Construction and Demolition waste • Green Waste • Bulky waste (Mattresses, foams, white goods)
Recovering valuable materials from mixed waste and returning them to the economy	Highest market value (existing or potential market)	• Recyclables • Green waste • ULABS
Establishing the conditions to facilitate or attract improved resource recovery opportunities	Capturing a single waste material to attract investment in treatment technology as the challenge of collection is removed, or removing difficult wastes so the remaining waste is more suitable for a technology investment – (e.g. collecting food waste might attract nutrient recovery / biogas investment while the now cleaner residual dry fraction may attract investment in material recovery of recyclables due to their higher value without contamination)	• All Hazardous and medical • Batteries • Wet waste (food and green) • Nappies/diapers
Collecting cleaner, less contaminated waste fractions to enable effective and efficient processing of materials with minimum risk to health and environment	Remove small volume high toxicity / hazardous / health impacting wastes at source so remaining waste is not contaminated and can be recovered further down the waste service/value chain	• Hazardous Waste • Medical waste (hazardous and sharps) • Nappies/diapers • Glass
Optimising waste collection and /or treatment operations	Separate bulky wastes that don't compact well in collection vehicles and / or wet wastes that are heavy and corrode equipment; wastes that decompose fast/generate odours	• Green waste • Cardboard • Food • Containers with liquid waste
Facilitating producers to take responsibility for their waste production	Materials that can be readily managed under Extended Producer Responsibility legislation	• Beverage containers • Packaging • Tyres
Business strategy / directive and or Corporate Social Responsibility	Materials that help a business meet its sustainability/environmental goals, social responsibilities, or legal obligations as part of a mandated waste management plan	• Hazardous Waste • Recyclables (cardboard, plastics, metal) • Food and or Green waste • Tyres

Common Source Separation Purpose / Goals	Typical source separation initiative target waste streams	
	Focus	Typical materials
Aligning to international environmental standards in waste management	Materials that assist compliance with international environmental conventions, initiatives and standards	• Plastics (reduce marine litter) • Hazardous (e.g. mercury, POPs/UPOPs producing) • Organics (reduce GHG emissions from landfill)

3.2 Collecting and analysing meaningful data

Knowing the **baseline** or 'Business as Usual' conditions of the waste management sector and of the target waste streams in particular is an essential first step in planning any intervention. **Collecting and interpreting meaningful data** is critical to enabling **evidence-based decision making** and ensuring both the source separation and the subsequent management programmes are adequately designed and scaled. The data needs can span the length and breadth of the waste management service chain (Figure 6).

Figure 6: Waste management service chain

There are multiple data sources including: importation statistics (e.g. beverage bottles) from customs and revenue departments; periodic waste composition and characterisation studies undertaken at point of waste production or waste treatment/disposal sites; daily data on waste quantities, type and source collected by a vehicle weighbridge at a waste production, treatment or landfill facility; building and demolition site audits to estimate construction waste ahead of demolition; economic and consumer spending habits; and population data.

Accurate and comprehensive data and information on multiple aspects of the waste management system is required by many sector stakeholders, from on the ground service operators to international initiatives such as the UN Sustainable Development Goals. With limited resources available, the data collection process can be challenging, therefore it is important to use data collection strategies take full advantage of any and all data collection initiatives to capture and publicise as much data as possible. For example, if the quantity of waste being delivered to landfill is being recorded by a weighbridge, maximise the data value by recording as much data on each load as possible (source, composition, frequency, density (volume to weight), etc.). A very useful exercise is to put all data into a **Waste Flow Diagram** which illustrates the quantities of specific waste stream/material quantities at all stages of the waste service chain and how they flow through the system. This can help to identify potential challenges and leakages of materials from the formal waste management system.

Table 2: Example data sets

Data set	Data details	Data sources	Data collection strategies
Waste generation at source	• Waste types, quantities measured for each sector (e.g. households, institutions, commercial and industrial sector)	• Periodic Waste Analysis and Characterisation studies (WACS) – see Annex 2	• Collect data on a regular basis and over several years to allow observation of seasonal variations* • If appropriate, require specific generators or facilities to report waste data on a regular basis
Waste composition	• Composition of waste streams for each sector (e.g. households, institutions, commercial and industrial sector)	• Periodic Waste Analysis and Characterisation studies (WACS) – see Annex 2	

Data set	Data details	Data sources	Data collection strategies
Waste collection & transport	• Unit time and costs involved in collecting and transporting waste from source of generation to disposal	• Time and motion study	(e.g. as a condition of a business or environmental licence). • Look for opportunities to piggy-back on other surveys (e.g. population census, household income and expenditure surveys)
Waste capture and management (for waste flow diagram)	• Types and quantities of waste disposed of by generator and mode of disposal (e.g. medical waste processed by hospitals on own premises; home composting initiatives; residents burning own waste in backyards) • Types and quantities of waste diverted from disposal • Waste management operations performed • The numbers, types, and capacities of waste management facilities • Source and destination of such waste	• Questionnaires and surveys	
Waste disposal	• Waste quantities and types disposed of by different sources (e.g. households, institutions, etc)	• Weighbridge records aggregated monthly by source (e.g. and waste stream	
Willingness to pay	• Public willingness to participate in programs (e.g. home composting) or pay for services	• Tailored surveys	

**Note: seasonal variations could be based on climate variations (e.g. dry/wet/hurricane seasons), festival/cultural seasons (e.g. carnival season); and economic activities (e.g. high/low tourist season).*

Table 2 presents some examples of required and useful data sets. The type of data required when planning a waste separation initiative will depend on factors including whether:

- there is a specific waste stream or issue pre-identified to target;
- whether it is a municipal (household or institutional), commercial, industrial waste, or present in all;
- whether it is a wider waste management strategy / plan development for which source separation is a component; or
- whether it is for a commercial venture with specific waste stream quantity and quality needs, etc.

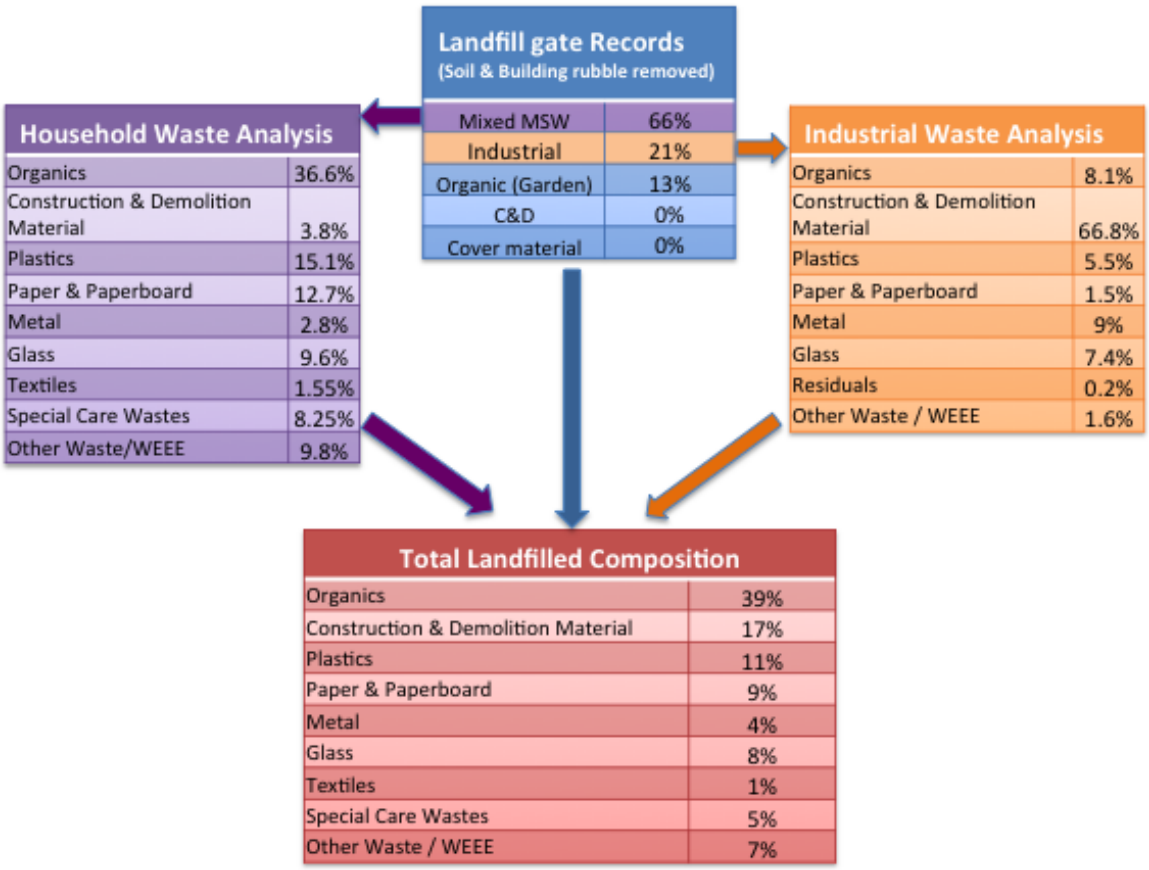

Figure 7: Example landfill weigh bridge data merged with WACS data for improved material specific data.

Figure 7 illustrates how landfill weighbridge data can be combined with WACS data to provide more accurate information on quantities of waste materials available for alternate treatment. In this example[3], daily data is captured at the weighbridge for loads containing Municipal Solid Waste, Industrial / commercial waste, Green waste and Construction and Demolition waste. In this example, a WACS was performed separately on vehicle loads classed by the weighbridge as Municipal (household) waste and those classed as Industrial Waste. Loads with only organic green waste were recorded at the weighbridge as green waste and no further WACS was required. Knowing the quantity of MSW and Industrial wastes arriving on site from weighbridge data tells us very little regarding the specific waste materials but is easy and quick to record daily. Identifying what exactly is in the waste is much more difficult and costly. Conducting periodic WACSs on these two waste streams gives far greater information on what types of waste are coming from where. If only one WACS was performed on all waste entering the site, the data would be much less accurate and would not have a source to correlate a separation intervention to. The combination of data sets improves accuracy and usefulness.

Pre-demolition audits are a preliminary information gathering process that provides stakeholders involved in decommissioning, deconstruction and demolition of structures (including treatment and disposal of such) with important information on the existing building inventories that will become waste in the future. Such audits can identify opportunities for reusing and recycling that can be assessed based on specific details given on the quantities and accessibility of building materials, thereby providing the critical information on what treatment systems to invest in ahead of time to stimulate the separation of materials for recovery.

[3] Example presented is from the Municipality of Rustenburg in South Africa conducted in 2016 by RWA Group & JG Afrika on behalf of GIZ and the South African Department of Environmental Affairs.

In addition to waste related data, relevant information on the enabling environment needs to be collected and analysed, highlighting opportunities and gaps in the implementation of the source separation programme.

Other information needed in designing a successful source separation programme includes:

- Information on existing collection infrastructure and practices for waste collection
- Information on population size and housing structure, neighbourhood layout and road infrastructure

Example: Lack of information on neighborhood architecture and road infrastructure has in some cases led to municipalities/operators purchasing collection vehicles that were too large to fit on narrow streets in some areas of municipalities, leading to waste piling up or being illegally disposed of in absence of alternative waste collection means.

4 Configuring the enabling environment

The enabling environment (including the governance, institutional, administrative, political, social and economic/financial, market and consumer activity conditions or arrangements) directly influence whether a waste management initiative is feasible or not. A system that works well in Europe, will possibly not succeed in the Eastern Caribbean SIDS due to differences in the enabling environment.

4.1 Legal framework

In order to implement a successful waste management initiative, there must be a robust legal framework. It is the legal framework which makes any legislation available, accessible, enforceable and therefore effective and contains the following aspects[4]:

- the international obligations
- the legislation
- the legislature
- the judicial system
- the regulators
- the regulated
- the beneficiaries (public)
- the social support mechanisms
- the political commitment to implement the law
- the resources to apply and enforce the law

An effective legal framework is ‘good’ only if it helps to achieve a particular objective such as source separation and subsequent environmentally sound management of specific waste materials; it will fail for a whole number of different reasons, e.g. (a) where sound legislation exists on paper but the regulator is weak and ineffective and/or poorly resourced; (b) where the judicial system is not strong and independent; (c) where legislation exists but few if any of the key stakeholders are aware of its existence or understand what it means. As previously mentioned, implementing waste management initiatives is an iterative process, therefore the legal framework must be flexible and adaptive utilising standards and guidelines where possible rather than technically prescriptive laws that take substantial time, money, and effort to adjust.

The legal framework must also embrace inter-related sectors - i.e. not only the regulation of solid waste collection and disposal / treatment, but also pollution control, resource management, public & environmental health, land-use planning and development control, social services, education, etc. This involves a wide range of people and institutions. As a minimum, the legal framework to enable effective source separation initiatives should include:

[4] Referenced from “Regulating Public and Private Partnerships for the Poor. Regulatory tools: legal & policy framework. Cranfield University, for DfID Knowledge and Research Contract R8320. October 2006.”

- **Clear definitions** for:
    - What is ‘waste’ under the law
    - Identification of waste types
    - Definition of Hazardous and non-hazardous waste
    - Establishment of who owns the waste throughout the waste management cycle
- **Clearly designate roles and responsibilities** – determine who is responsible for establishing the Policies, Planning, Employing / Contracting service provider, Operating the service, Financing the service, and Regulating the systems for each waste stream and link in the waste management chain from waste generation to final treatment/disposal.
- **Identify and define accountability** of stakeholders responsible for the management of waste, per waste type, throughout the management cycle (institutional setup) and including public and private waste management facility minimum operating standards and associated regulators – preferably incorporating producer responsibility and duty of care.
- Define waste **management responsibilities per stakeholder, per type of waste.**
- Enable the **setting of tariffs** for waste management and tariff collection mechanism – utilising the polluter-pays principle where possible.
- Mandate **data reporting, monitoring and verification mechanism**, with data interpretation and use in evidence-based decision making – including weighbridge data collection and periodic WACSs.
- Facilitate **consequences for non-compliance**.
- Establish **enforcement mechanism** and stakeholders responsible for enforcement.

4.2 Enabling Factors

Other aspects of the enabling environment that should be considered during the planning phase of source separation initiatives include:

- **National Waste Management Strategy and Sector Plans** – required within the context of the legal framework, and that incorporate the principles outlined previously, to provide unified guidance and sector direction to all stakeholders. (These should consider and incorporate all the following aspects).

- **Social acceptance** - The initiative must have buy-in and be accepted by the target community / waste producer (a feasibility assessment of the target recipients’ willingness to pay / willingness to accept service changes to be conducted to ensure they will accept and pay for the service (whether directly or indirectly)). Additionally, the informal recycling sector should be fully engaged so as not to adversely impact the vulnerable sector stakeholders.

- **Political commitment** - required at all levels of government to boost investor, regulator and participant confidence that the initiative will be supported by the governing bodies.

- **Laws, Norms and Standards** - that clearly enable coherent direction and information on what should be done where and when by each waste producer with each waste stream and material and consider enacting and enforcing a landfill ban or gate fee for specific materials with alternative management option clearly defined and enforced (including anti-dumping mechanisms).

- **Inter-departmental support** – waste management requires input and collaboration from a cross-sector of government departments, from law enforcement and emergency services to analytical services. Clear commitment of support from all government departments is required.

- **Incentives** – with careful consideration given to where in the production, consumption and waste management service and value chain these should be to incentivize source separation and what those incentives could be ensuring there is no adverse interference in the market. These could include:

    - **Economic Instruments / Market Incentives** to separate materials at source, for example:

        - **Deposit refunds** (EPR) typically used on beverage containers, tyres, and pesticide containers to encourage specific product material returns.
        - **Subsidies, tax breaks, grants** typically to support innovation in importing more environmentally sound products or waste management technologies, or assist material recovery brokers and treatment initiatives to become established.
        - **Gate fee at landfill / Increased collection cost** used to recover actual cost of managing landfills and stimulate the financial viability of alternate treatment (move away from zero financial cost of landfilling and assist make commercial operations like composting, that cost to operate, more competitive) or incentivize separation of material (higher gate fee for mixed loads, lower for clean homogenous that can be diverted directly to alternate treatment).
        - **Reward schemes –** providing non-financial rewards for people who separate specific waste products is gaining popularity. An example is partnering with a mobile telephone service provider to give mobile phone credit in return for old phones / electronics.
        - **Pay As You Throw (PAYT) schemes** – Waste producers (including households) are charged according to the amount of residual waste they generate with subsidized collection of separated waste.
    - **Voluntary codes and commitments** – typically implemented by manufacturers / importers to self-regulate import of difficult waste stream products or industries / commercial group such as tourism association promoting “green tourism” e.g. green/food or plastics waste separation and treatment.
    - **Convenience –** ensuring any initiative maximise convergence with / minimise divergence from existing practices and habits to incentivise waste producers’ transition from linear collect and dispose to integrated waste management system without significant additional effort.
- **Enforcement** with appropriate Institutional mandates and resources to ensure the responsible institutions can administer and enforce system.
    - **Punitive measures** – introduce fines / other punishments for non-compliance.
    - **Strong contract administration** with Key Performance Indicators - enabling the client of outsourced services to enforce standards through contract management.
- **Information, Education and Communication** (IEC) are essential to ensure all stakeholders know their roles and responsibilities within the sector and to stimulate behaviour change. IEC campaigns must be consistent and continuous and include the following considerations:
    - Identify who needs to be engaged, what information they need, which waste stream is the target, where do they best absorb information and need to put the waste, when do they best absorb information and need to present their waste, how should the information be delivered, and how should they present their waste for collection.
    - IEC campaigns must also include publication of environmental monitoring and test data to ensure the decision makers and civil society understand the impact of the waste management system to motivate change.
    - IEC campaigns should be delivered by and targeted at official government and civil society stakeholders.
- **Financing** – Ensuring there are appropriate cost recovery mechanisms to adequately and sustainably finance capital expenditure (CAPEX) and operational expenditures (OPEX) of the entire system, including

all items listed above, including equipment/infrastructure for collection, sorting, treatment/disposal, IEC campaigns, enforcement, data collection and interpretation.

- **Equipment / Infrastructure** – preferable to be available locally with spare parts and maintenance expertise appropriate to the location and local conditions (geographical, financial, administrative, competency, etc.).
- **Operator model** - it is necessary to know the **operator model(s)** in place and investigate the changes the programme is likely to bring into the existing waste management system. The decision-making process needs to involve all stakeholders that will be affected and identify which entity is best placed to operate the source separation system. In many instances, collection of source separated materials, and more so the management and treatment of the materials once separately collected, is not a core strength or focus of the waste management authority due to:

    - Insufficient in-house personnel (lacking the number of employees required)
    - Human Resources (HR) challenges (administrative costs, or long-term employment liabilities including insurances and pensions)
    - Inadequate infrastructure
    - Budget and procurement constraints
    - Lack of know-how and staff qualified in specialist disciplines (i.e. chemists for hazardous waste)

    Due to these constraints, it is worth considering partnering or outsourcing activities to a third-party service provider (including NGO, CBO, SME Business, National or International Corporation) while the government agencies focus on regulating, administrating, monitoring, enforcement and generally creating the enabling conditions to stimulate the market to invest and operate such initiatives themselves, rather than governments operating or forcing the operation of such initiatives. **Delegate non-core functions so you can focus on your strengths** but take the time to fully evaluate potential outsourcing partners so that an entity with the relevant expertise and sustainable business model is engaged. Third-party service providers need to be scalable, continuously innovate to improve processes, and deliver according to the expectations and requirements of the client.

    Example: In many countries in Europe, charities, social enterprises and professional collectors perceive that their activities are threatened by direct collection of textile waste by municipalities. These collectors are often the actors with best knowledge of global markets for used textiles.

    Integrating operators in the system or clearly defining waste streams to be collected by each entity and communicating this to generators can help avoid competition and conflict.

5 System Planning and Design

5.1 Guiding questions for planning and design phase

As detailed in this guidance document's Decision Tree (Annex 1), during the planning and design phase of a source separation initiative, the following questions should be asked and answered to help guide the planning process and ensure feasibility:

1. Is it a problematic priority waste stream?
2. Can we prevent / remove the material from the local consumer market rather than manage the waste?
3. Is there a potentially viable market or can a viable market be established for the waste material (includes assessing the volumes involved)?
4. If so, does the market require support to realise this potential and is it viable?
5. If not, what alternative treatment / disposal options exist and of these what is the BAT/BEP or effective steps to get there?
6. Is this economical to establish, access, operate and maintain (sustain) locally or through a regional / international initiative?
7. What is the most economically viable Environmentally Sounds Management option for collecting and transporting the separated waste materials to the identified BAT/BEP treatment/disposal?
8. What level and kind of information, education and communication activities are required to change consumer behaviour and adopt this system?

Alongside answering these planning questions, it is useful to consider the entire waste management service process flow in reverse, starting with the end goal answering the additional questions posed in Figure 8 – this is especially useful when you know the target waste stream.

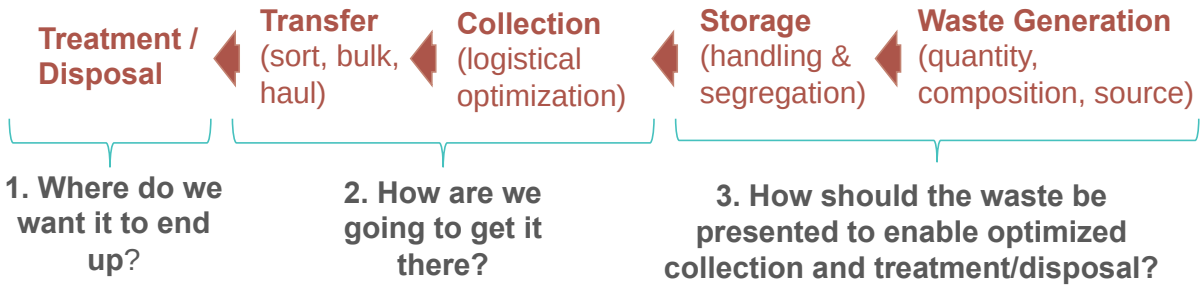

Figure 8: Planning the waste management service process flow in reverse

Tables 3 to 9 in the following sub-section present a number of waste streams / materials and potential treatment / disposal options for each. When assessing and identifying opportunities in the waste management system, it is essential to consider and assess the sustainability of all system components within local context including whether it is:

- **Applicable** Technically (using the Best Available Technology);
- **Affordable** Financially;
- **Acceptable** Environmentally and Socially (following Best Environmental Practice);
- **Achievable** Legally; and
- **Appropriate** Institutionally (can the institutions administer, deliver and enforce the system)

5.2 Waste streams, their impact potential and source separation treatment options

The following tables present examples of waste streams and materials to target for source separation, typical locations the waste is produced, the impact the waste material has when landfilled, focussing on planning with the end in mind, and the potential treatment options / uses for the separated waste material.

General Waste - Municipal Solid Waste (household and institutional) and Industrial and Commercial wastes collected during regular waste collection service

Table 3: Source Separation opportunities from General Waste

Waste Stream	Example waste products / Materials	Source (Point to target segregation)	Impact / cost of landfilling (reasons to separate)	Potential use / destination following source segregation
Food waste	• Kitchen food scraps – includes processed and unprocessed, cooked and uncooked food, vegetables, meat, dairy, fish, grains.	• Households • Institution canteens • Commercial kitchens - Restaurants & Hotels • Vegetable markets	• Greenhouse Gas production • Leachate production (acidic, leaching heavy metals and toxins from other wastes) • Odour production • Vermin/disease vector attraction	• Composting (centralised, community or home) • Nutrient upcycling - Animal feed – Black Soldier Fly Larvae (BSFL), vermicompost • Anaerobic digestion (Energy recovery)
	• Condemned food – Expired / out of date retail food	• Food Retailers - supermarkets		
Packaging - Postconsumer (Recyclable)	• Aluminium cans • Plastic Bottles (PET, HDPE) • Cardboard and Paper • Steel cans • Glass bottles • Plastic Film / Foils - LDPE • Rigid plastic pots, tubs, trays	• Households • Public / Street bins • Shopping / retail centres	• Wasted resource (material loss) • Consumes landfill void space. • Breakdown within landfill to release potentially toxic chemicals	• Clean Material Recovery Facility • Material Recycling • Promote reusable packaging • Target for product bans • Refuse Derived Fuels
	• Compostable Plastic (note that PLA - plant-based plastics – does not compost)	• Households • Public / Street bins • Shopping / retail centres	• Wasted resource (material loss) • Consumes landfill void space	• Cannot be recycled with PET and other conventional plastics and must be separated from PET • Industrial composting
Packaging – Commercial wholesale / retail (pre-consumer)	• Wooden Pallets • Cardboard • Plastic Film / Foil- LDPE • Plastic and Metal Barrels • IBC Containers	• Commercial retailers and wholesalers • Agricultural sector • Industries and manufacturers	• Wasted resource (material loss) • Consumes landfill void space • Many materials difficult to compact in compaction collection vehicles reducing collection efficiencies	• Recycling • Promote returnable / reusable packaging • Target for product bans • (Refuse Derived Fuels) • Repurpose (non-hazardous) containers (rainwater harvesting, waste containers, etc.)

Textiles	• Clothing • Shoes • Bags	• Households	• Wasted resource (material loss) • Consumes landfill void space • Leaching of potentially hazardous chemicals from textiles treated with flame retardants	• Second-hand clothes market • Repurpose as cleaning textiles / mechanic rags. • (Refuse Derived Fuel)
	• Bed sheets	• Hotels • Hospitals		
WEEE – Small to medium sized consumer electronics	• Irons, toasters, kettles, vacuum cleaners, radios, lamps and light fixings, Mobile telephones, laptop computers, headphones, charger cables, small T.V.s and monitors, remote controls, power tools, games and toys. • CRT T.V.s and Monitors are hazardous wastes	• Households • Institutions • Hotels and commercial properties	• Potentially hazardous materials (heavy metals, flame retardants in plastics leaching into watercourses, POPs/UPOPs release from informal combustion). • Wasted resource (material loss) • Consumes landfill void space	• Repair and resell • Disassemble for material recycling (metal components) • Capture hazardous components in Interim Hazardous Waste Storage and subsequent treatment/disposal.
WEEE – Batteries **(dry cell, consumer batteries)**	• NiCd and NiMH common over the counter single use batteries (AA, AAA, button batteries, etc), • Lithium Ion and Lithium Polymer batteries mainly found in battery packs from laptops, mobile phones and power tools.	• Households • Institutions • Hotels and commercial businesses	• Toxic heavy metals leaching out into water courses • Risk of short circuit sparking / overheating with spontaneous combustion causing landfill fires	• Interim Hazardous Waste Storage prior to onward international shipment for treatment
WEEE – Lightbulbs (Gas discharge)	• fluorescent tubes • compact fluorescent • metal halide • mercury blended • high pressure and low-pressure sodium lamps	• Households • Institutions • Hotels and commercial properties	• Toxic heavy metal release into air, soil and watercourses with human and animal exposure.	• Specialist bulb crusher with gas capture
Pharmaceutical and Medical waste (Household / small producer)	• Expired, unused, contaminated drugs and vaccines and containers / packaging containing residues.	• Households • Veterinarian practices • Dental and primary medical practices • Care homes • Hotels	• Small doses of Antibiotics being consumed by microbes in landfill facilitating antibiotic resistance in bacteria and diseases.	• Provide designated segregated and robust containers. • Return to pharmacy • Follow directions of Chief Pharmacist.

	• Sharps: razors, needles (diabetics, vaccines, etc)		• Cytotoxic and other drugs toxic to humans and animals • Health hazard to sanitation workforce	
Other Household Hazardous / special wastes	• Corrosive, flammable, ignitable or reactive materials • Household cleaners, bleach, drain cleaners • Pool chemicals • Solvents, paints, adhesives • Herbicides, weed killers, insecticides, pesticides, fertilisers • Certain smoke and carbon monoxide detectors	• Households • Hotels • Commercial activities	• May react with other wastes to cause landfill fires • Toxic / harmful substance release into leachate, water courses and soil • Inhibit microbial decomposition in landfill resulting in more harmful leachate	Interim Hazardous Waste Storage prior to: • Local treatment • Return of chemicals to manufacturers • Burial of encapsulated or inertized waste in engineered, controlled and secure landfill • onward international shipment for treatment
	• Cooking Fats, Oils, and Grease (FOG)	• Households • Institution canteens • Commercial kitchens - Restaurants & Hotels • Sewerage networks / septic tanks	• Largest impact is blocking drainage and sewer systems and entering watercourses if disposed down drains – less of an impact when collected with solid waste and disposed to landfill. • Odour production	• Conversion to diesel (energy recovery) • Dispose to landfill (reduced impact on sewerage system and water courses)
	• Nappies / Diapers • Sanitary pads	• Households • Hotels • Care homes • Nurseries	• Odour production • Pathogen spread / health and safety risk to collection and landfill workforce.	• Proper containment for storage and collection prior to disposal to landfill (until suitable alternative developed).
Residual	All other wastes not included elsewhere	All Households, Institutions, Commercial and Industrial operations	• Potentially hazardous or contribute to landfill / waste fires presenting potential sources of UPOPs when combusted • Wasted resource (material loss) • Consumes landfill void space	• Landfill with proper landfill operation, management and oversight. • (Refuse Derived Fuel)

Green / Parks and Gardens Waste

Table 4: Source Separation opportunities from Green Waste

Waste Stream	Example waste products / contents	Source (Point to target segregation)	Impact / cost of landfilling	Potential use / destination following source segregation
Garden Green Waste	• Grass cutting • Plants • Tree trimmings • Leaves	• Households • Hotels and commercial properties • Road verges • Public Beautification (Parks and Gardens) • Electrical line clearances	• Greenhouse Gas production • Leachate production • High-volume low-density difficult to compact – increasing fuel use of landfill compactor, overwhelms landfill staff and equipment, increases oxygen content in landfill and provides fuel source increasing fire risk. • Wasted resource (nutrient loss) and consumes valuable landfill void space.	• Composting / Mulching • Biochar

Large / Bulky wastes

Table 5: Source Separation opportunities from large / bulky waste

Waste Stream	Example waste products / contents	Source (Point to target segregation)	Impact / cost of landfilling	Potential use / destination following source segregation
WEEE – White goods (Bulky Waste)	• Fridges, Freezers, Dishwashers, Washing Machines, tumble dryers, microwaves, stoves/ovens, air conditioning units, large TVs • CRT TVs and Monitors are hazardous wastes	• Households • Institutional, Commercial and Industrial premises • Ships and other vessels	• Potentially hazardous materials (heavy metals, flame retardants in plastics leaching into watercourses, POPs / UPOPs release from informal combustion) • Wasted resource (material loss) • Consumes landfill void space. • Potential POPs containing flame retardants in foams and fabrics • Foams are high-volume low-density difficult to compact – increasing oxygen content in landfill and provides fuel source increasing fire risk • Metals and other materials can interfere and damage landfill compaction equipment	• Repair and resell • Disassemble for material recycling (metal, wood components) • Capture hazardous components for interim storage and subsequent treatment • Shred or crush and landfill
Bulky Wastes	• Furniture (Beds, Sofas, tables/desks, chairs)			
	• Large sports equipment • Bicycles, • Garden toys - trampolines, playhouses, slides, etc.			
	• Mattresses			• Shred and landfill (Shredded wastes can be integrated into landfill cover material)
	• Carpets			

Automotive and Energy sectors

Table 6: Source Separation opportunities for Automotive and energy sector wastes

Waste Stream	Example waste products / contents	Source (Point to target segregation)	Impact / cost of landfilling	Potential use / destination following source segregation
Tyres	Tyres from Trucks, vans, trailers, cars, motorcycles and bicycles	• Vehicle mechanic /tyre shops • Commercial and Public Institution motor pools • Port authorities	• Cause instability within landfill as tyres "float" up through landfilled waste • Create breeding locations for mosquitos and other disease vectors • Present substantial fire risk when stockpiled with significant UPOPs production if combusted	• Fire bunded and regulated storage (loose or baled) • Coarse shred and utilise shredded material can be integrated into landfill cover material • Fine shred recover metal and utilise rubber crumb in asphalt or similar production • Refuse Derived Fuel
End-of-Life Vehicles	Trucks, vans, trailers, cars, motorcycles, boats	• Households • Car dealers • Commercial businesses • Public institutions • Port, fire and other national authorities	• Fuel, coolant liquid, engine and hydraulic oil leaks - One drop of oil can contaminate 100 litres of fresh water and suffocate and restrict aquatic and bird life • Flame-retardant POPs in foams, electrical components, and plastics leach into soil and water and release to atmosphere if burned.	Depollute – remove/safely trigger air bags, remove batteries, remove heater controls, wheels and tyres, remove fluids and other hazardous items (engine oil, transmission oils, hydraulic oils, coolant, screen washing fluid, fuel tank, suspension system, catalysts, air conditioning refrigerant, switches containing mercury, etc.) • Bale and export for Metal recycling • Separate plastics and foams containing or suspected to contain flame retardants – when confirmed or in lack of possibility to confirm, manage as hazardous waste • Residual (foams) to sanitary landfill

Used Lead Acid Batteries (ULABS)	Lead acid batteries	• Lead Acid Battery retailers • Vehicle maintenance Mechanic shops	• Lead (toxic heavy metal) • Sulphuric acid is corrosive and oxidising (may result in spontaneous combustion of waste)	• Drain acid and treat locally, exporting housing and lead for recycling. • Export whole (as hazardous waste) for recycling
Waste Oils	• Engine lubricant oils • Hydraulic oils	• Vehicle, generator and boat / ship mechanics • Households • Garages and fuel stations • Motor pools • Marinas and ports	• One drop of oil can contaminate 100 litres of fresh water and suffocate and restrict aquatic and bird life. • Low flashpoint material that can spontaneously ignite waste mass.	• Use as fuel in industrial boilers (rum distilleries, laundries, etc.) (Energy recovery). • Conversion to diesel • Establish EPR with regional oil wholesalers to takeback and reprocess.
Oil and fuel filters	• Used oil and Fuel filters from internal combustion engines.			• Utilise recovered oil as above • Recycle filter housing metal
Other oil contaminated materials	• Rags used by mechanics for cleaning up oil • Spillsorb or other oil spill absorbent • Any material contaminated with oil and disposed of.			• Containerise – Hazardous Waste Interim Storage Facility • Co-incinerate in medical waste or similar incinerators
Oil Sludge	Heavy Fuel Oil (HFO) Sludge	• Electrical Generation Companies • Petrochemical distributors		• Landfarming • Thermal processing

Construction and Demolition Waste

Table 7: Source Separation opportunities construction and demolition wastes

Waste Stream	Example waste products / contents	Source (Point to target segregation)	Impact / cost of landfilling	Potential use / destination following source segregation
CDW Inert rubble and soils	• Concrete, bricks, roofing tiles, excavated soil, glass	• Construction and demolition companies • Hotels and commercial real-estate companies	• Causes damage and excessive wear and tear on landfill compaction equipment if not pre-treated and segregated for use as cover material. • Wasted resource (material loss) • Consumes landfill void space.	• Crushing for use as aggregate or backfill in new construction
CDW Lumber	• Wood		• Presents fire risk within landfill with readily combustible fuel • Wasted resource (material loss) • Consumes landfill void space.	• Recover and repurpose lumber. • Shred and utilise as animal bedding or in composting process. • Refuse Derived Fuel
CDW Recyclables	• Metals (steel, aluminium), plastic foils, cardboard,		• Wasted resource (material loss) • Consumes landfill void space.	• Bale and export for recycling
CDW PVC Plastic	• Windows, • Doors, • Pipes and plumbing		• Combustion of PVC presents significant source of UPOPs production.	• Landfill separately
CDW Hazardous Liquids	• Solvents, paints and chemicals		• Low flash point materials that may spontaneously combust or catch fire from landfill equipment or another ignition source.	• Treat locally • Contain in HWISF • Burial of encapsulated or inertized waste in engineered, controlled and secure landfills
CDW Hazardous Solids	• Asbestos, insulating materials		• Substantial respiratory health hazard to humans and animals	• Bag and deep disposal in purpose excavated area of landfill

Hazardous Wastes

Table 8: Source Separation opportunities for Hazardous Wastes

Waste Stream	Example waste products / contents	Source (Point to target segregation)	Impact / cost of landfilling	Potential use / destination following source segregation
Hazardous Chemical Waste	• Expired/discarded laboratory or industrial chemicals (solid, liquid or gaseous) that are deemed hazardous (toxic, corrosive, flammable, oxidising, etc.)	• Hospitals, primary medical and dental facilities, veterinary labs, undertakers etc. • High school and University laboratories • Private and Government Laboratories • Various industry sectors	• Toxic, corrosive, flammable, oxidising materials all pose significant hazards on landfill from increasing fire risk to increasing toxicity or catalysing formation of hazardous substances releases in the environment	• Burial of encapsulated or inertized/neutralised waste in engineered, controlled and secure landfills • Return of chemicals to manufacturers • Waste exchange operations (industrial symbiosis)
Signal Flares	• Expired or damaged distress signal flares from boats and ships	• Shipping ports • Marinas	• Explosive and incendiary devises present significant risk to setting waste on fire. Landfill equipment driving over flare are likely to set them off • Risks safety of landfill workers	• Safe destruction by designated national service (military, police, fire service, etc.)
Pressurised containers	• Containers or aerosol cans with pressurised liquids, gas or powder (if not fully discharged or unknown) including - • Fire extinguishers • welding gas • hospital gasses (O_2, N_2O, etc) • cooking gases • insecticide sprays, etc.	• Hospitals • Institutions and Commercial buildings	• Pressurised containers can explode when compacted on landfill causing damage to machinery and landfill staff	• Depressurise (release all container contents) if safe to do so and recycle metal casing or ruse. • For gaseous contents, specialised gas container puncture with gas extraction equipment exists. • If not possible, contain vessels safely in appropriate conditions with HWISF.
Agricultural pesticide residues and used containers	• Liquid pesticide bottles and dispensers • Pesticide impregnated plastic films	• Importers and distributors • Agriculture and Horticulture • Household gardens • Hotels and commercial premises with large gardens	• The indiscriminate disposal poses a risk to the environment and public health. Empty containers of pesticides with residues are considered hazardous. The	• Follow FAO guidance on triple rinsing and puncturing

			presence of chlorine in organic form in the empty containers may lead to thermal formation of PCDD/ PCDF during burning process in case of combustion.	

Health Care Waste

Health Care Waste Management is a specialist discipline that requires designated attention to prevent spread of disease or other risk to human and animal health, environment and general safety. There should be in place national and facility Health Care Waste Management Plans. Where guidance is lacking, the World Health Organisation provides general guidance. Some basic training on the subject is available at https://www.who.int/water_sanitation_health/facilities/waste/training_modules_waste_management/en/

Table 9: Source Separation opportunities for Health Care Wastes

Waste Stream	Example waste products / contents	Source (Point to target segregation)	Impact / cost of landfilling	Potential use / destination following source segregation
Infectious Waste	• Any waste containing any bodily fluids or other host of pathogens (or their toxins) in sufficient concentration to cause transmission of disease	• Hospitals • Large primary medical facilities • Medical teaching universities • Animal testing facilities • Veterinary facilities	• Small doses of Antibiotics being consumed by microbes in landfill facilitating antibiotic resistance in bacteria and diseases • Cytotoxic and other drugs toxic to humans and animals • Health hazard to sanitation workforce	• Follow approved national or facility Health Care Waste Management Guidance • Sterilisation by autoclave, microwave, or incineration
Pathological and anatomical waste	• Organs, tissues, body parts or fluids such as blood, whether infected or not			
Hazardous Pharmaceutical waste	• Expired, unused, unknown/lost label, spilt or contaminated pharmaceutical products, drugs and vaccines including containers and delivery equipment with residues			• Follow directions of Chief Pharmacist
Chemotherapeutic Waste	• Cytotoxic and genotoxic drugs that reduce/stop growth of living cells.			
Sharps	• Needles, scalpels, razors, etc.			• Sterilisation by autoclave, followed by encapsulation and deep burial in landfill

5.3 Schemes for collection of source separated waste

There are a wide range of practices throughout the world for collection of source-separated waste materials. Source separation does not necessarily require the waste material to be collected by a waste collection crew at point of waste production. A range of systems are available from collection at source to separate handling of the separated material at the landfill site as well as multiple combinations of schemes being employed. Some of the most common collection systems for source-separated waste materials are summarised in Table 10[5] with additional photo examples in Annex 3.

Table 10: Common collection schemes for source-separated waste materials

Collection Scheme	Description	Common Materials Collected
Door-to-door collection systems	Adding an additional bag, special bag, bin, container to the existing household waste collection service to collect recyclable / compostable materials separately from mixed residual wastes. Two or more recyclable materials are commonly collected in the same container and subsequently sorted to homogenous materials at a clean Material Recovery Facility (MRF) – this requires additionally infrastructure, equipment and resources. A three-bin system is common – 1) Wet Waste (food and garden waste), 2) mixed Dry Recyclables, and 3) Residual (for disposal) – all three fractions require separate collection vehicle or compartments – commonly wet waste collected weekly (or more frequently) with dry recyclables and residual collected once every two weeks.	• Metal packaging • Plastic packaging • Paper • Glass packaging • Food • Green garden • Residual
	Regular kerbside collection services, provided by an organisation or private collector in partnership with the local authority – as above but operates independently from the residual waste collection service.	
	Dedicated waste stream collection, either on demand (call and collect) or as a regular (e.g. monthly or quarterly) service.	• Metal • Cardboard • Bulky goods – Furniture, large WEEE and White goods • Green garden
	Ad hoc collections via sacks left by organisation or private sector collectors to the generator.	• Textiles (clothing) • Toys and Games • High value recyclables • Green waste

[5] The list is not exhaustive, several other operations may exist, or a combination of operations, depending on local conditions

Collection Scheme	Description	Common Materials Collected
Mobile collection containers / trailers on pre-planned routes	Rather than kerbside collection or permanent collection points, this is a mobile scheme periodically serving communities for them to bring specific waste streams to. This can be used to access densely populated communities with challenges locating permanent containers or target specific problematic / hazardous waste streams that require careful handling or where other collection methods may be impacted by vandalism.	• Household hazardous and other problematic wastes (paint, printer cartridges, oils, smoke detectors, batteries, light bulbs, gas canisters, etc) • Food waste (on-board shredding and rapid drying / pre-composting unit onboard) • Higher value recyclables (metal, PET plastic bottles).
Bring points - separate containers for different material fractions at strategic locations in public places	Designated material containers located at permanent public roadside, community hubs, supermarket parking lot, etc. locations for waste producers to bring their separated materials to. Most commonly used for packaging, particularly glass and cardboard, and often supported by packaging waste Producer Responsibility Organisations. These can be misused, with vandalism or open dumping of non-target waste around bins being common challenges.	• Glass bottles • Plastic bottles • Paper • Cardboard • Metal (steel and aluminium) cans
Take back - to retailers which initially put the products on the market	Retailers that sell products offering a take back system for the products they sell. Implemented through mandatory EPR legislation (e.g. retailers that sell certain volumes of electrical goods and batteries in EU countries are legally obliged to accept used batteries and WEEE), or on a voluntary basis (supermarkets increasingly offering packaging returns and using reverse supply chains to ship materials back to producer consolidation centres).	• Packaging • WEEE • Batteries • Lightbulbs • Tyres • Beverage bottles • Pesticide containers • Pharmaceuticals
Postal return to retailer / producer	Some IT companies such as Hewlett Packard offer a service whereby used IT equipment can be mailed back to them for reprocessing.	• Printer cartridges • Computer equipment
Smaller containers within generators premises, housing schemes and children's institutions (if applicable)	Locating specific containers in strategic locations where waste is often produced to capture difficult wastes (e.g. cooking oil containers at school canteens for collecting oil produced in the school as well as offering the collection to parents).	• Cooking Oil • Motor oils • Oily rags and filters • Batteries • Light Bulbs
Deposit refund systems	Typically applied as part of an EPR scheme on beverage bottles and cans, but other schemes including tyres exist whereby a consumer pays a set fee when purchasing the product that is returned to the consumer on return of the product to a designated location.	• Packaging (mainly beverage bottles) • Tyres

Collection Scheme	Description	Common Materials Collected
Civic amenity sites (also called Community Drop-off Centres / Community Recycling Centres / Resource Recovery Centres)	Community level permanent waste collection facilities often staffed, where local residents can take their recyclable or difficult household wastes for free or small charge. A number of different schemes and set-ups exist. Most are manned, accessible by car, provide multiple containers for different waste streams and require users to separate their waste materials into the specific material containers. Different zones for recyclables, WEEE, insulation materials, Tyres, Hazardous waste (oils, solvents, batteries, smoke detectors). These are often located within easy access of each major community and often located alongside transfer stations, landfills and other waste management infrastructure.	All materials, including: • Recyclables • Hazardous waste, solvents, oils, etc. from households • Bulky waste • Waste Electrical and Electronic Equipment (WEEE), • Used batteries, • Construction waste, (lumber, inert rubble, glass, etc.) • Green waste
Bring to reuse centres/entities	Similar to Civic amenity sites as described above (and often located with each other), accept unwanted products that are in good condition or can be reconditioned for resale and reuse.	• Textiles • Furniture • Toys and games • Garden equipment and tools

In all the systems identified, the frequency of collection depends on the waste fraction which is separated at source and the climate. This is particularly the case for separate collection of organics in warm and humid climates, needing more frequent collection (twice per week) as degradation can lead to public nuisance and pests.

An assessment of separate collection schemes in the 28 capitals of the European Union[6] conducted by Bipro in 2015 and focussed on household waste only, identified the following main conclusion:

- It is crucial to extend both the technical infrastructure as well as inform and motivate the users of the collection systems.
- The percentage of recyclable materials increases when municipalities introduce door-to-door collection systems. Door-to-door collection systems provide the highest recycling rates and the best quality of recyclables. Collection costs for such schemes are higher than alternatives, but collection rates and revenues are also usually higher, and the resultant rejection rates and treatment costs lower.
- Bring systems with drop-off containers often struggle to encourage the inhabitants to separate their waste and result in a larger percentage of impurities. However, bring systems are a reasonable solution for certain fractions (e.g. glass).
- Co-mingled collection of recyclables is widely practiced and tends to result in lower costs. Two-stream co-mingled collection (e.g. plastics and metals) is a reasonable way to reduce costs and maintain good material quality. Mixing several fractions together, however, can result in a higher incidence of cross contamination, and the quality of recyclables tends to be lower and rejection rates higher.
- When separate collection of biodegradables was included in the door-to-door system, the overall sorting of dry recyclables (and other fractions) increased.

[6] Referenced document available at https://ec.europa.eu/environment/waste/studies/pdf/Separate%20collection_Final%20Report.pdf sourced on 1 April 2020

- Civic amenity sites have the potential to improve the overall recycling rate, on the condition that they are convenient to use (close-by and suitable opening hours) and that the number of sorted fractions is significant.
- The trend in recyclate markets is likely to be towards requiring higher quality materials.

5.4 Distance to collection points

As noted in the previous section, the distance to collection points and convenience for the waste generator in general are important factors to consider when implementing source separation.

There tends to be an inverse relationship between convenience for the citizen and collection cost per tonne for the collecting organisation. Collection via large bring banks in civic amenity sites is significantly cheaper per tonne than door-to-door collection. On the other hand, bring banks in street-side areas have been reported to have a higher contamination than door-to-door collection or manned collection points.

Street-side bring banks have a relatively low cost per tonne of collection and will be used by motivated citizens, but less-motivated segments of the population may only deliver to collection points that are close by; outside their door, in the waste collection areas of multi-apartment housing or in supermarkets and workplaces that are party of daily routines.

Clear branding of collection sites reduces confusion of citizens in relation to where they should put their used textiles. In Rotterdam for example, it was found that by giving all bring banks for textiles the same single colour and placing them away from containers for waste, contamination by non-textile waste was reduced.

A study in Sweden[7] measured the participation of households in a source separation scheme and came to the conclusion that two interventions: (a) shorter distance to the drop-off point and (b) easy access to correct information, significantly improved source sorting of household waste. Decreasing the distance to drop-off point from 2 km to 50 m (intervention (a)) reduced the amount of missorted packaging and newsprint from 2.23 to 1.61 kg per household per week (30% decrease). Information stickers about food waste sorting (intervention (b)) reduced the miss-sorted fraction, such as diapers, by more than 70%.

Ultimately, collection points must:

- Be easily accessible for waste collection vehicles; and
- Encourage waste separation at source.

The receptacles for separation at source must be:

- Covered so as to prevent windblown litter; and
- User friendly to allow even children and disabled persons to safely deposit waste into the receptacles.

5.5 Communication, awareness and willingness to comply

The key determinants of waste separation intention among generators include:

- Their attitude towards environment and climate change,
- Their awareness of consequences and perceived cost and benefits,

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[7] https://www.researchgate.net/publication/274066642_Quantitative_assessment_of_distance_to_collection_point_and_improved_sorting_information_on_source_separation_of_household_waste

- Past recycling (source separation) behaviour,
- Perceived convenience,
- Trust in waste management,
- Knowledge on waste separation, and
- Socio-demographic variables (gender, age, education, income, household type and size)

People needing to comply with source separation at their workplace are more likely to continue the behaviour with source separation in their private homes.

Clear communication and transparency on what types of wastes are being collected, what happens to these subsequently and what the profits are used for can be critical. It can increase motivation amongst citizens for delivering separated waste since a significant share are concerned the waste materials they take effort to separate ends up in the landfill or creating profits for certain people at their expense.

Clear communication of what happens to source separated waste increases the public's willingness to comply to new measures set in place.

In designing and deploying awareness campaigns, the essential steps include[8]:

- Defining the key message
- Establishing the target audience
- Designing activities, delivery mechanisms and timing

Regarding the timing of the communication and awareness campaign timing, it is important to start activities in synchronicity with the implemented source separation infrastructure and acknowledging there will be a buffer period in which compliance will gradually increase, or start a short time before the implementation of the infrastructure, clearly communicating a 'cut-off date' for current practices.

Allowing for too much time to pass between the information campaign and the setting up of infrastructure in place, will risk the target audience forgetting the message or retaining the instructions just partially.

Setting up the infrastructure in place without properly informing the key audience, will lead to disparate use of infrastructure by hear-say and allowing the creation of habits which will be difficult to change with the information campaign.

[8] More information and practical examples for setting up awareness campaigns can be found in the 'UPOPs Prevention and Chemical Awareness: Elements of a General Awareness Campaign', available online at https://www.sprep.org/attachments/Reports/GEFPAS_Pollutant_Awareness_Camapign.pdf, last accessed Feb 2020

Clear communication of consequences of non-compliance and subsequent enforcement of communicated consequences will increase the degree of compliance.

Example: Key elements of an awareness campaign to promote composting

Key message
Environmental and health benefits of composting; How to easily set up a compost pile; Harmful effects of toxic smoke caused by open burning; Health benefits of gardening

Target audience
Schools, households/communities, restaurants, local councils, gardeners and farmers

Example of awareness campaign activities

- Demonstration compost piles at schools which can be monitored, and different materials tested for their 'compostability'
- Set up communal compost piles in communities
- Local Councils can lead by example by using composting principles when maintaining public land and parks
- Organic gardening competitions
- Community information and Q&A sessions
- Public events to promote awareness, such as church events or markets
- Radio interviews, newspaper articles and television news stories
- Public demonstration on the construction of compost piles
- Integration into other waste management programs.

Local champions, who are generally well respected and have established relationships with key audiences can be used to help deliver key messages to the audience and spearhead initiatives. Local champions can include leaders in the environmental and non-governmental sectors; community leaders/elders; youth leaders; as well as TV, sports and music personalities.

Results from a study of Thailand residents' reasons for not participating in source separation of recyclable is depicted in Figure 9.[9]

[9] Excerpt from research article 'Factors influencing source separation intention and willingness to pay for improving waste management in Bangkok, Thailand', S. Vassanadumrongdee, S. Kittipongvises / Sustainable Environment Research 28 (2018) 90-99, available online at https://doi.org/10.1016/j.serj.2017.11.003, last accessed Feb 2020.

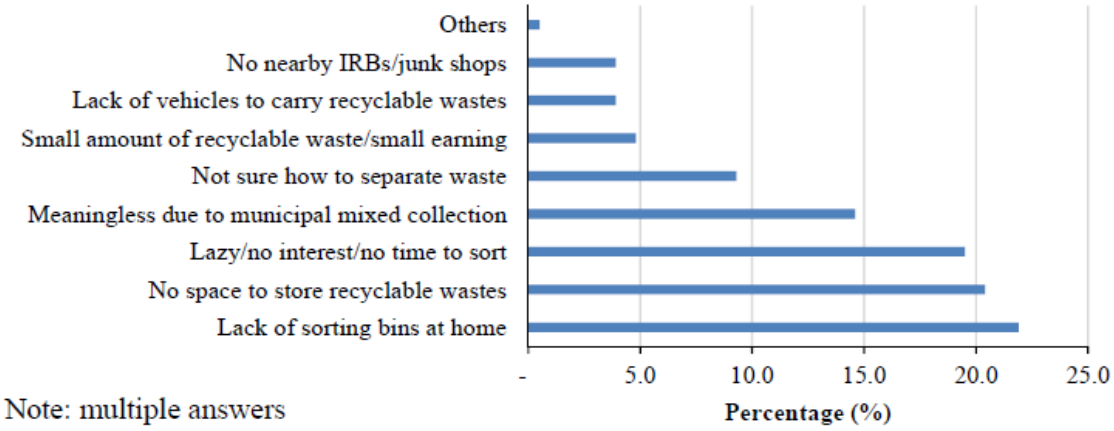

Figure 9: Reasons for not doing source separation for recycling among Bangkok residents

Figure 10 depicts an unintendedly amusing design of waste related communication, which fails to convey the key message.

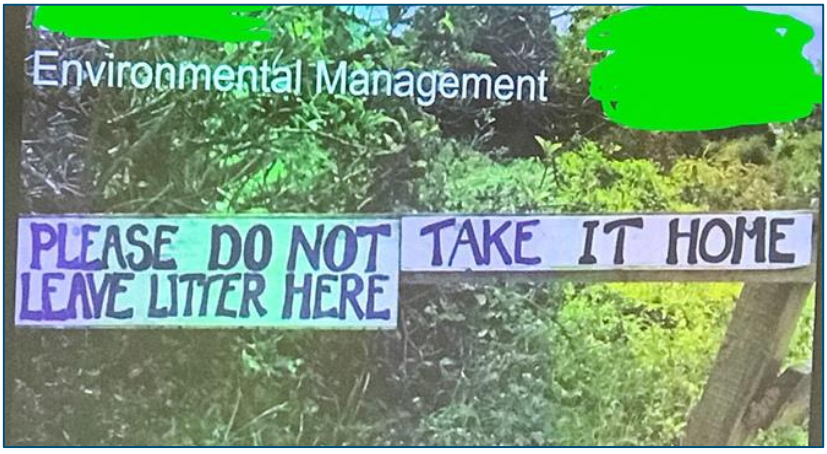

Figure 10: Confusing litter prevention campaign message. (Image source: https://i.redd.it/9u66pjnljxp11.jpg)

5.6 Willingness to pay

Implementing source separation will invariably incur higher costs for the collection of waste. As such, it is useful to know the waste generators' level of willingness to pay when designing source separation programmes and ancillary activities (legal framework, awareness campaigns, etc.).

Studies show a series of factors influencing the willingness to pay for improved waste management services (source separation versus mixed collection). Some of these factors are the same as in the case of willingness to comply listed above. Other factors include the period of stay and expected economic benefits, with a negative effect on the willingness to pay, according to the previously cited study in Thailand[9].

The study[9] concluded that people who had high satisfaction with the current waste collection service performed by the operator were more willing to pay for improving municipal solid waste service and recycling facilities. The income and education level of residents was not found to have much influence on the willingness to pay. Improving people's knowledge on waste problems that could have adverse impact on the economy and well-

being of residents and improve its collection service were factors with a positive influence on residents' willingness to pay.

It is important to note, however, that the amount that residents were willing to pay for the improved services was still much lower than the average municipal solid waste management cost.

Surveys on the willingness to pay for collection and management of source separated waste streams should be carried out prior to scoping such programmes. Results should be taken into consideration when designing awareness campaigns and setting up new tariffs.

5.7 Duty of Care

Duty of Care is a tool that can facilitate implementation of the producer responsibility principle. In England and Wales, the Environment Agency enforce a Duty of Care on waste producers.[10] Under the Environmental Protection Act 1990, anyone who produces, imports, keeps, stores, transports, treats or disposes of waste must take all reasonable steps to ensure that waste is managed safely and responsibly in accordance with local laws. This includes commercial and industrial businesses, institutions, householders, and anyone who acts as a broker and has control of waste. There is a distinction between the duty of care required for household waste and other general waste streams. A breach of the duty of care could lead to an unlimited fine if convicted in the Magistrates Court or in the Crown Court. The duties required of waste producers and service providers to fulfil the duty of care requirements include:

General Duty of Care (excluding households)

Those entities that have waste:

- Must ensure that the person who takes control of their waste is licensed to do so.
- Must take steps to prevent it from escaping from their control.
- Store it safely and securely.
- Prevent it from causing environmental pollution or harming anyone.
- Describe the waste in writing and prepare a transfer note if they intend to pass the waste on to someone else.

The entities that collect waste from others:

- Must be authorised under the law to collect and receive waste (e.g. have a waste carrier licence).
- Obtain a description of the collected waste in writing.
- Complete and retain a transfer note.

Household Duty of Care

Householders are required to take reasonable steps to check that people removing waste from your premises are authorised to do so, which might be to:

- Require the waste carrier to provide their full address and telephone number.
- Physically see their waste carrier licence issued by the Environment Agency.
- Contact the Environment Agency hotline and ask for a free instant Waste Carrier Validation Check, or check online on the Environment Agency website.

[10] https://www.gov.uk/government/publications/waste-duty-of-care-code-of-practice/waste-duty-of-care-code-of-practice

Part of the Duty of Care includes ensuring the waste transportation vehicles are appropriate for the waste being transported and are operated properly. For example, for hazardous wastes, this would include as a minimum:

- Transport vehicles meet basic requirements
    - For example, well maintained, bulkhead to separate driver from vehicle load, system to secure load, proper placards and markings including hazard symbol and emergency contacts, spill kit, easy to decontaminate, etc.
- Driver trained on laws, risks, safe handling methods, labelling, documentation and emergency procedures
- An appropriate consignment or manifest system included and completed for each material collected and transported.

Each stakeholder in the waste sector has a responsibility and role to play in exercising Duty of Care. Table 11 provides several examples of stakeholder responsibilities as presented by the Department of Environmental Affairs in South Africa. By taking on these responsibilities, and understanding the importance of their role, source separation systems can make a large and lasting impact to improving resource and environmental management in the Eastern Caribbean.

Table 11: Example responsibilities of waste sector stakeholders towards source separation schemes

Stakeholder	Responsibility
Business / Commercial	• Develop and commit to a sustainable Integrated Waste Management Policy and Plan for the company • Set a measurable target for waste reduction within the organisation over a specified period • Develop and implement waste minimisation, recycling and composting initiatives as appropriate • Ensure that there are suitable storage and collection facilities in place for general waste, recyclable and special wastes. • Put formal contracts in place for the removal of general waste. • Implement a waste management education programme for all staff.
Schools	• Form an eco-club to monitor the types and quantities of waste produced by the school. • Implement waste minimisation activities and school recycling projects where appropriate. • Find out where recovered materials can be taken to / sold. • Have facilities in place for the storage and collection of general waste and recyclables. • Educate learners and educators on sustainable waste management
Households	• Monitor the types and quantities of waste produced in the household. • Make a place to store general waste and recyclables until it is collected. • Meet requirements of the waste authority for waste storage and put waste out for collection on time for collection.
Individuals	• Accept responsibility for handling waste consciously so that it has a minimal negative impact on the environment and other people.

6 Case studies and good practice examples

This section presents a series of case studies from the European Union considered examples of good practice for source separation of waste[11]. It is important to note that the regulatory framework of the European Union and opportunities for European Commission co-funding for projects in the field of environmental protection and circular economy is a strong enabling factor in the success of these examples. Lessons, however, can be applied in SIDS and specifically the Caribbean context.

6.1 BEST bag kerbside collection for textiles, Netherlands[12]

Challenge: Kerbside collection of textiles can be expensive but can potentially reach citizens who otherwise are not motivated enough to use bring-to collection points. Combining textile collection with collection of other waste streams can reduce these costs.

Description: Two municipal-owned waste and service companies Rd4 and Circulus Berkel operating in two different regions of the Netherlands work with a collection system for books, small electronics, toys and textiles called BEST bag. Householders receive the BEST bags from the waste company and are asked to place filled bags on the kerbside on the day of collection. The bags are single use plastic bags with a QR code specific to the household.

Collection is carried out by the waste companies according to a schedule provided by the relevant municipality. Collection frequency varied from once every 2 weeks in the larger towns to once every eight weeks elsewhere in the first period, but from 2018 onwards collection frequencies were reduced in most municipalities to three times a year to reduce costs. The collected bags are scanned by their QR tag in local collection centres to identify which households have delivered them. These later receive a bag for the next collection. Textiles make up roughly half of the collected items (by weight). About 10% are suitable for resale in local Kringloop shops and the remainder are sold to a charity (ReShare) for resale on global reuse and recycling markets.

Results: In the municipalities served by Circulus Berkel, 336 tonnes of books, electronics, textiles and toys were collected with the BEST bags in 2016, of which 144 tonnes were textiles. In total nearly 46 000 BEST bags were collected between February and October 2016. 16% of all households in the municipality made use of the BEST-bag. On average, 2.5kg of textiles are delivered per bag. In the municipalities served by Rd4, 1500 tonnes of used textiles are collected of which 400 tons are from BEST bags and 1100 tons are delivered to bring banks.

Costs of collection (200 Euro/tonne) are higher than for collection in bring banks (165 Euro/tonne) but the quality of textiles collected, and therefore their value, is higher, in part due to lack of contamination by other waste. Sales of the contents of BEST bags currently don't cover collection and sorting costs and the operations is part subsidised by the municipalities.

Conditions for success: Theft of the filled bags has been an issue. The waste service companies have responded to this by communicating to citizens that they should deliver the bags in the morning of collection and not the evening before. Losses of the BEST bags by households has also been an issue since it inhibits households from delivering. Long periods between collection dates exacerbates the risk of loss. Finding suitable markets for the non-reusable textiles can also present a challenge. There has been some negative reaction to the BEST bags from charities who would otherwise have received the re-sellable goods.

[11] Indicative exchange rate: 1 EUR = 1.1 USD

[12] Source: Watson, D., Aare, A.K., Trzepacz S. & and Dahl Petersen, C. (2018a) Used Textile Collection in European Cities. Study commissioned by Rijkswaterstaat under the European Clothing Action Plan (ECAP)

6.2 Separate collection of organics in Styria, Austria[13]

Initial challenge: Due to limited landfill capacity in the 1980s, new alternatives for organics had to be found.

Description: Styria legally implemented the separate collection of biogenic (e.g. food and yard) waste by integrating it into the Styrian Waste Management Act 1990. In 1993 the home and community composting of organics was introduced. Especially in rural areas and households with gardens, home or community composting was promoted. The Styrian region includes many rural areas. Around 51% of household biogenic waste is collected in organic waste containers. The rest, mainly biogenic waste originating from gardens and green spaces, is collected via municipal structures or socio-economic organizations.

Results: The landfill volume was reduced and the volume of the biogenic municipal waste collection increased considerably. 95,136.2 tonnes of biogenic waste were collected and recovered in 2008. In 2017 113,000 tons were collected or 91kg/capita.

Conditions for success: An accompanying information campaign informed the public about the separate waste collection: events, action days, excursions to composting plants, information via internet, leaflets and newspaper articles.

Especially during the summer months odour nuisance is a problem. In order to overcome this problem, the collection intervals are shortened and the collection bins get washed regularly.

6.3 Rural Area: Home composting programmes in Spain[14]

Initial challenge: The ambition to reduce organic waste collected by the municipal services.

Description: In rural areas a high percentage of households has been equipped with a home composting bin including a small manual that recommends composting of all organics, including the remains of fish and meat. In these areas the organic content of waste going into municipal bins was expected to decline sharply which would allow the efficient use of a single waste container for collecting the resulting dry fraction. This would lead to a sharp reduction in costs for collection, transportation and waste treatment in rural areas.

Results: An efficiency of 77%, on average, was obtained by home composting of bio-waste. This corresponds to a composting rate of 126 kg/person year of organics (or 380 kg/composter year).

Conditions for success: All composting programs covered by this study were implemented via an educational project of ADEGA that delivered the composting bins and trained the users. Practical information was provided on the composting process and the management of waste in general, including the related ecological and environmental aspects.

6.4 Packaging waste: EPR system with comingled collection and high capture rate – Fost Plus, Belgium[15]

Challenge: Fost Plus wants to explore opportunities to collect and recycle more packaging. Fost Plus is the Belgian producer responsibility organization accredited for the collection and recycling of household packaging waste. It has financial and partial organizational responsibility.

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[13] *http://www.regions4recycling.eu/upload/public/Good-Practices/GP_Styria_biowaste-collection.pdf*
http://www.abfallwirtschaft.steiermark.at/cms/beitrag/12700390/135033730/

[14] https://www.sciencedirect.com/science/article/pii/S0956053X17301691

[15] Watkins et al. (2017): EPR in the EU Plastics Strategy and the Circular Economy: A focus on plastic packaging

Description: Companies that place packaging material on the Belgian market can join Fost Plus and pay an annual contribution, the Green Dot Tariff, which is based on the quantity and type of their packaging. In return, Fost Plus fulfils their information and take-back obligations, finances the collection and recycling of a number of packaging materials and coordinates the activities of municipalities, inter-municipal waste companies, collection companies and sorting centres.

Results: Fost Plus is seen as a model example due to its exceptional collection and recycling results. Belgium's recycling rate in 2015 for all packaging waste (81.5%) and for plastic packaging waste (42.6%) individually were above the EU average (65.5% and 39.8% respectively).

Conditions for success: EPR scheme and continuous awareness campaigns are needed to remind citizens of the correct sorting rules, particularly for plastic bottles and flasks. Moreover, Belgium has some of the highest PAYT contributions in Europe (up to 3 EUR for a 60 litre bag) for residual waste.

6.5 Deposit refund for plastic beverage packaging: Vending machine in Estonia accepts plastic bottles only[16]

Challenge: Packaging waste ends up in the environment

Description: The deposit system for packaging is organized at the level of the state. All retailers of soft drinks and low-alcohol beverages (beer bottles, soft drink bottles, bottles for beverages with low concentration of ethanol) whose point of sale has an area of >200 m^2 are obliged to accept deposit packaging at their point of sale or on its service land. In Estonia, the producer responsibility organization, Eesti Pandipakend, is organizing the recycling of packaging marketed by producers, importers and traders. Eesti Pandipakend's task is the administration and organization of collection, transport, sorting, counting and recycling of deposit-subjected packaging in all of Estonia, i.e. they deal with the plastic, glass and metal packaging of water, carbonized drinks, beer and low-alcohol beverages.

Results: Deposit-refund systems for packaging have especially good results in lower environmental awareness countries or in sparse population areas, where it is not possible to develop an adequate density of public packaging collection container network. Deposit-refund effectively reduces littering of packaging. Moreover, it reaches high collection rates up to 90 % owing to the financial incentives for citizens.

Conditions for success: The more packaging types and applications are subject to deposit-refund, the more packaging is collected, reused and recycled.

6.6 Ireland National Hazardous Waste Management Plan and its collection days[17]

Challenge: Hazardous waste fraction contaminating household waste

Description: Since 2015, the Department of Communications, Climate Action & Environment (DCCAE) has administered a grant scheme enabling Local Authorities to provide one-day collections for small-scale quantities of hazardous waste. The scheme is facilitated through the three Regional Waste Management Offices and is

[16] Eesti Pandipakend 2005: Good Practice in Selective Collection of Waste in Heritage City Centres: https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1522060341.pdf

[17] http://www.epa.ie/pubs/reports/waste/haz/EPA_NationalHazardousWasteManagementPlan_web.pdf

http://www.epa.ie/pubs/reports/waste/haz/Proposed%20Revised%20NHWMP%20for%20consultation.pdf

linked to the 2015-2021 objective to maximize the collection of hazardous waste in order to reduce the environmental and health impacts of various waste streams. The free household hazardous waste collection days were organized for 11 collection points in 10 counties by Ireland's three regional waste management offices (Eastern/Midlands, Southern, Connacht/Ulster) and their respective local authorities. Many civic amenity sites accept household hazardous waste all year round and during 2018 some local authorities ran and funded their own free collections in addition to the ones carried out under the DCCAE funded programmed. A nominal fee is usually charged at civic amenity sites for the disposal of household hazardous waste to help cover costs, while the service is free during collection days.

The treatment of hazardous waste has been relatively stable over time. For some waste streams export will still be needed since no or limited capacity exists in Ireland: treatment of hazardous waste batteries and accumulators, asbestos, mercury wastes and thermal treatment residues. Approximately half of the total waste managed is exported for treatment.

Authorized hazardous waste treatment in Ireland is carried out either on-site at the industrial facility where the waste was generated (under the relevant conditions of an EPA license) or offsite at authorized waste treatment facilities.

Results:

In total 170 tons of household hazardous waste (HHW) were collected during the 11 collection days. This included more than 130 tons of paint, 12 tons of oil containers, over eight tons of waste oil, almost five tons of adhesives and 2.25 tons of detergent. Householders removed more than two tons of leftover and unused medicines from their homes and disposed of them at the hazardous waste collection points. More than two tons of pesticides, close to two tons of oil filters and more than 1.7 tons of aerosols also contributed to the total weight. The remainder of the waste included cooking oil, mixed fuels, herbicides, batteries, antifreeze and solid oily waste.

Funding for the 2016 scheme totalled EUR 68,943. Analysis of the data returned shows that the largest volume of waste arising at the collections in 2016 and 2017 was paint.

Funding of EUR100,000 was provided for the continuation of the grant scheme in 2017 and the DCCAE continues to liaise with the three regional waste management offices to further develop the scheme. In 2017 the collections were held in civic amenity sites. In conclusion, this system of collection days requires an investment but huge amounts of HHW are collected.

Conditions for success: Communication and awareness campaigns were key success factors to receive support and participations from citizens.

Why it is a best practice: The set-up of free collection days in the context of the National Hazardous Waste Management Plan (2014 – 2020) allowed Ireland to collect important amounts of HHW. These one-day free collection events encouraged correct disposal of HHW but also provided ideas on the prevention of waste in everyday activities such as cleaning, gardening and Do-It-Yourself projects.

6.7 Green waste collection and chipping in Lautoka, Fiji[18]

Challenge: Excessive green waste production, open burning of green waste, decreasing landfill space, and difficulty finding a suitable site for a replacement landfill.

[18] Secretariat of the Pacific Regional Environment Programme 2018, Practical guide to solid waste management in Pacific Island Countries and Territories, https://www.sprep.org/attachments/j-prism-2/SWM_GUIDEBOOK_.pdf.

Description: Lautoka City, with a population of 45,000, is the second largest city of the Republic of Fiji. As a tropical South Pacific country, with high annual rainfall, green waste generation is often significant, particularly in the aftermath of cyclones, and with regular pruning of parks, roadsides, and residential lots.

With the support of the Japan International Cooperation Agency (JICA), the Waste Minimisation and Recycling Promotion Project in the Republic of Fiji Islands (3R Project) was implemented from October 2008 to March 2012 in Lautoka City. Prior to the 3R Project, green waste generated by households was mostly used for firewood, however, dumping in public places and waterways, and open burning were common. One of the components of the 3R Project was the implementation of a green waste collection and chipping service to reduce the amount of green waste going to landfill and illegal dumps. This included:

- a situational analysis to better understand the existing situation
- a preliminary evaluation to determine the capacity of the Lautoka City Council to implement a green waste collection and recycling service
- design of a green waste collection and chipping service, including procurement of
- delivery of an awareness programme to stakeholders
- implementation of the green waste recycling (chipping) service, with review and improvement
- development of a solid waste management plan for the council.

Results: The green waste collection and chipping service has been successful in diverting green waste from landfill, including 650 tonnes of disaster-generated green waste, and approximately 30 tonnes of green waste from households participating in the service. Approximately 330 tonnes of wood chips were also sold as boiler fuel to the Fiji Sugar Corporation.

Conditions for success: The keys to success included provision of training on equipment operation and maintenance, delivered by the equipment supplier to council staff; participation of residents (as a result of the awareness programme) in putting out green waste for chipping instead of burning or dumping it illegally; finding markets for the wood chips including as a fuel resource for the Fiji Sugar Corporation, as mulch on council gardens, and as a feedstock mixed with vegetable market waste to produce compost.

6.8 Kaoki Maange! (Return Rubbish) recycling system in Kiribati[19,20]

Challenge: Rising waste quantities, lack of suitable landfill space, and lack of on-shore recycling/reprocessing facilities.

Description: The Republic of Kiribati is a small island developing state located in the Central Pacific Ocean. More than half of the country's population of 120,000 (2018) live on Tarawa Atoll, one of 32 low-lying atolls and reef islands dispersed over 3.5 million square kilometres of ocean. By the late 1990s, Kiribati was in a waste crisis. The increasing reliance on imported products, goods and materials coupled with the lack of engineered landfills and contemporary waste management services, meant that litter was prevalent, and piles of waste often remained uncollected.

In 2003, in response to calls by grassroot communities to improve solid waste management, the United Nations Development Programme partnered with the non-governmental organisation— the Foundation for the Peoples

[19] https://www.sprep.org/news/kiribati-kaoki-maange-system-over-decade-operation

[20] Niemi, M, Carva, A, and Williams, S 2019, *Mid-term evaluation of the Kiribati Solid Waste Management Programme,* https://www.mfat.govt.nz/assets/Aid-Prog-docs/Evaluations/2019/MidTerm-Evaluation-of-the-Kiribati-Waste-Mngmnt/Mid-Term-Evaluation-of-the-Kirbiti-Waste-Mngmnt.pdf.

of the South Pacific Kiribati (FSPK)—and the Kiribati Government to implement the *Kaoki Maange!* system, which translates into Return Rubbish! The system is based on a container deposit/refund scheme.

The Special Fund (Waste material Recovery) Act 2004 allows for a deposit of AUD0.05 to be levied on each eligible container (PET bottles, aluminium cans) imported into Kiribati, with consumers able to claim a refund of AUD0.04 for each container returned for recycling. The system operator receives the remaining AUD0.01 as a handling fee, as well as the value of the materials collected.

The scheme also includes used lead acid batteries, which attract a deposit and refund of AU$5.00. Batteries were increasingly being deployed to outer islands in photovoltaic systems, and inclusion in the scheme with a full refund, provided a financial incentive for returning the batteries for recycling at end of life. To facilitate collection, processing, and export of the collected containers, a central material recovery facility appropriate to the local conditions was also constructed with all equipment included. The system is run by a private waste operator contracted by the Kiribati Government through a tender process.

Results: Since its introduction, the Kaoki Maange programme has collected and exported over 550 tonnes of waste, including over 200 tonnes of aluminium cans, over 90 tonnes of PET bottles, and over 200 tonnes of used lead acid batteries. Because of the monetary value placed on the containers, they are removed from the waste stream by residents, who transport them directly to the collection depot. While this does not eliminate the need for household collection services, it reduces the volume of waste collected. End of life vehicles are also being considered for the scheme to combat the ever-rising stockpiles.

Whilst the scheme has generally been successful, the export of baled PET containers to China has ceased due to China's National Sword Policy, which effectively banned the importation into China of contaminated recyclable wastes, including PET. Because of this immediate lack of markets for the baled PET, and lack of storage space on Tarawa, bales of PET are accumulating. This highlights the importance of considering additional measures, such as selective tariffs, and import bans to reduce single-use and low-value plastics and maximise collection, recycling and export of high value plastics.

Conditions for success: There are several reasons for the success of the Kaoki Maange recycling system, including the following:

- Implementation of a pilot project prior to introduction of the full system: This provided opportunities to test the level of the deposit/refund, the materials to target, and to collect data and information to inform design of the full system. For example, lessons learnt during the initial pilot included not issuing refunds to school-age children during school hours so as not to encourage truancy.
- Technical support at start up: During the first six months of operation, the local system operator, selected through a tender process, was provided with technical support to help resolve any problems and ensure the program has the best chance of success.
- Establishment of a special fund: This separated the deposit revenues from the general consolidated fund and helped to ensure ongoing availability of funds to support continuous operation of the scheme.

6.9 Green bag collection system in Kiribati[21,22]

Challenge: Inefficient, and inconsistent waste collection practices, leading to unsightly and unhealthy accumulation of wastes in communities.

Description: The Green Bag Collection System was first introduced into 2 communities in Kiribati (South Tarawa and Teinainano) in 2003 by a coalition of stakeholders comprising the Foundation for Peoples of the South Pacific Kiribati (FSPK), and the Community Development and Sustainable Participation project (CDSP).[23]

The Green Bag Collection System introduced pre-printed, biodegradable, green plastic bags to improve containment of waste for collection and encourage source segregation of green waste. Over the next two years, approximately 87,000 Green Bags were imported, and most distributed freely to residents, via FSPK and CDSP offices.

However, over time, usage of the Green Bags declined partly due to the end of the CDSP and shifting focus of FSPK to implement other waste management projects. The next phase of the system was thus supported by the International Waters Project (IWP)[24], which aimed to strengthen the management and conservation of marine, coastal and freshwater resources in the Pacific Islands Region.

IWP supported a range of awareness-raising activities and competitions to counteract declining usage of the bags; and introduced a user pay system by selling each bag for AUD0.20 to help finance the waste collection service. Prior to this, waste was only collected from households that had paid an annual household service charge to the council. The service charge system was fraught with difficulties as people would refuse to pay the charge because the council did not pick up the waste, and council would not collect the waste because people did not pay the service charge. By replacing this system with the pre-paid Green Bags, there could be no doubt about whether the bags put out for collection had been paid for.

IWP staff attempted to enhance uptake of the Green Bags by visiting individual stores to encourage purchase of the bags for resale. This was later abandoned in favour of distribution through the island's largest grocery importer and wholesaler at a markup of AUD0.05 per bag.

Additional support for the Green Bag Collection System has also been provided under Phase 1 (2011-2015) and Phase 2 (2016-2020) of the Kiribati Solid Waste Management Programme (KSWMP), funded by the New Zealand Aid Programme. The system (including collection of the Green Bags) is operated by Moel Trading Co. Ltd (a wholesale and retail company) selected through an open tender process.

Results: This case study illustrates the persistence that can sometimes be required to sustain good waste management practices. Ultimately, the Green Bags are widely used, and the system has improved overall waste collection practices in South Tarawa and Teinainano. In July 2018, over 178,000 bags were sold. An FSPK survey of over 2,600 households in September 2014 showed that 87% of households used Green Bags, and 71% had good understanding of what materials should go into bags. A second survey was conducted in 2018,

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[21] Leney, A 2006, *The Impact of the Greenbag on waste generation in South Tarawa, Kiribati*, https://www.sprep.org/att/publication/000518_IWP_PTR22.pdf.

[22] Niemi, M, Carva, A, and Williams, S 2019, *Mid-term evaluation of the Kiribati Solid Waste Management Programme,* https://www.mfat.govt.nz/assets/Aid-Prog-docs/Evaluations/2019/MidTerm-Evaluation-of-the-Kiribati-Waste-Mngmnt/Mid-Term-Evaluation-of-the-Kirbiti-Waste-Mngmnt.pdf.

[23] CDSP was a technical assistance programme supported by the Asian Development Bank to promote mobilise community support and contribute to an enabling environment for a broader participation in Sanitation, Public Health, and Environment Improvement project.

[24] The International Waters Project (2000-2006) was financed by the Global Environment Facility, implemented by UNDP, and executed by the Secretariat of the Regional Environment Programme.

albeit with fewer respondents and using a different methodology. The survey results indicated a possible decline in use of the Green Bag system (57%), and less understanding of the system (43%).

The Green Bag costs the same as a regular plastic shopping bag (AUD0.20), but is larger and more durable/reusable, which has led to the bags being used for more than just rubbish. As the revenue from sale of the Green Bags supports the programme, the versatility of the bags has generated additional revenue to support the financial sustainability of the system, while displacing the use of single-use shopping bags.

Both the 2014 and 2018 surveys also showed that approximately half of respondents felt that the Green Bag collection was unreliable, which is believed to be due to poor equipment management and maintenance. It has also been reported that the Green Bags are presenting as litter, which is likely related to the fact that the bags are used more generally in everyday life.

Conditions for success: Implementation of a user pay principle by selling the Green Bags helps to generate revenue to support the waste collection system. Ongoing programme monitoring, evaluation and correction as well as sustaining public education and awareness are also critical to ensure the programme stays on track and that the communities continue to engage with the scheme.

6.10 Collection of WEEE in The Cook Islands[25,26]

Challenge:

Description: The Cook Islands is a small country in the South Pacific Ocean consisting of 15 islands with a combined land area of approximately 240 square kilometres dispersed over a marine area of approximately 1.9 million square kilometres.

On 8 December 2010, the Cook Islands held its first day for the collection of WEEE ('eDay'), which is also believed to be the first such documented event in the Pacific Islands region. The aims of the event were to reduce WEEE in the environment; increase public awareness of the risks from WEE; and promote proper disposal of WEEE by schools and the community. The eDay focused on computer equipment, but also included phones and digital cameras.

Delivering the eDay costed just under NZ$80,000, approximately 90% of which was provided by the New Zealand Government through the eDay New Zealand Trust NZ. The latter was established to advance the collection and recycling of WEEE in New Zealand and Pacific Island communities.[27] WEEE collected during the 2010 eDay were packed and exported to New Zealand for recycling.

Another WEEE collection focusing on whiteware commenced in 2015 for six months with financial support from the Cook Islands Government. This round involved paying a contractor (Recycling Cook Islands Ltd) a handling fee per item to collect the WEEE (e.g. NZ$20 for a washing machine). The 1,243 items of whiteware collected were partially dismantled and exported to New Zealand for recycling.

Financial support for two further collection rounds (2016 and 2017) was provided by the Pacific Hazardous Waste Management Programme (PacWaste), a 4-year, €7.85 million hazardous waste management project funded by the European Union and implemented by the Secretariat of the pacific Regional Environment Programme across 15 countries. PacWaste also delivered training in WEEE dismantling to contractor staff.

[25] Leney, A 2018, *Review of e-waste Releated Activities in the Pacific Islands,* https://www.sprep.org/attachments/report4-ewaste-baseline-2018.pdf.

[26] SREP 2017, *PacWaste in Action: Postcard from Cook Islands,* https://www.sprep.org/news/pacwaste-action-postcard-cook-islands.

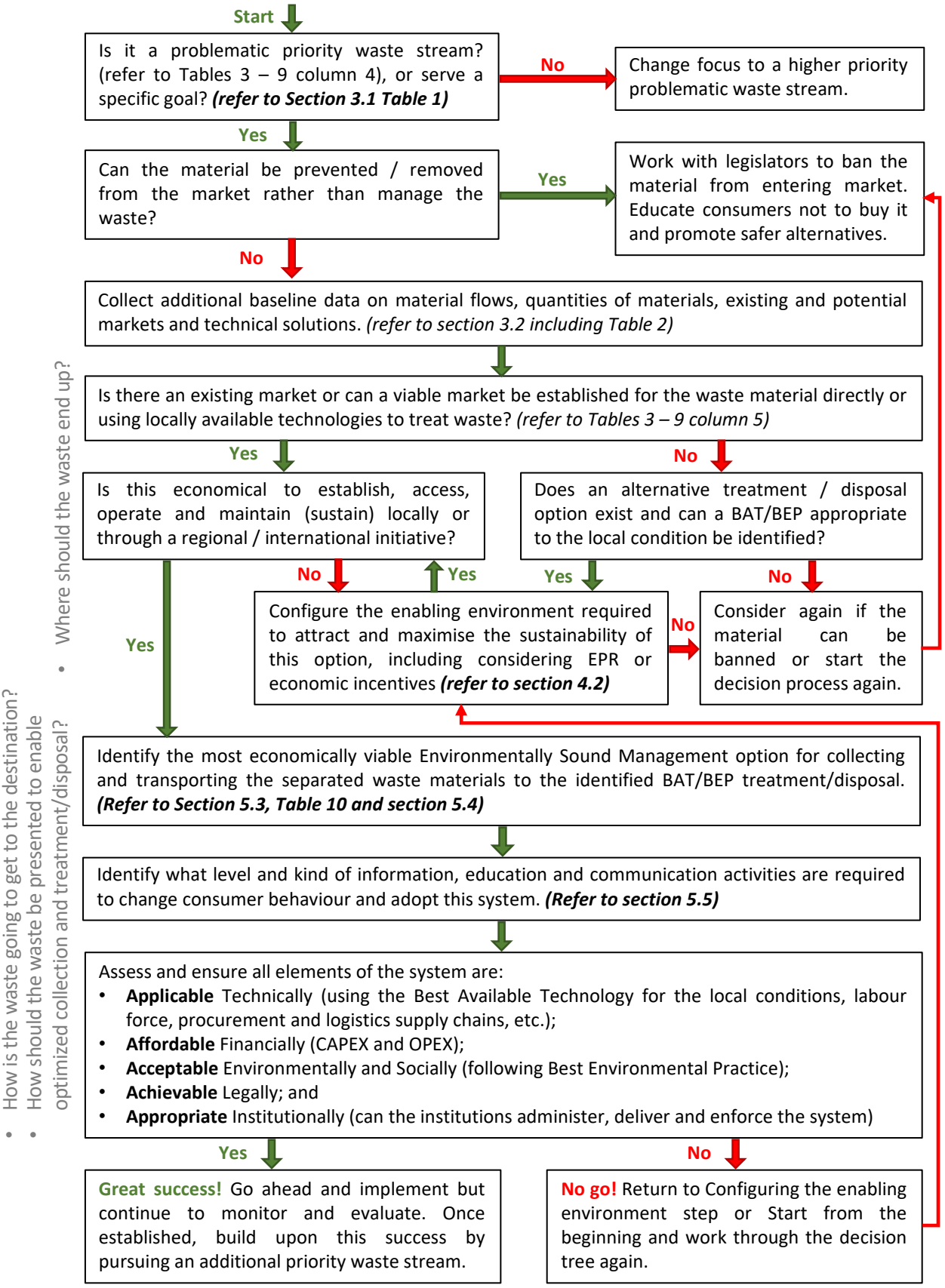
[27] https://www.eday.org.nz/about-eday/about-the-eday-new-zealand-trust.html.

These later rounds were also based on the payment of a handling fee to a contractor, although not all of the collected and dismantled WEEE could be exported prior to the closure of PacWaste.

Results: A total of 5,154 items were collected during the initial 2010 eDay, packed into seven 20-foot shipping containers within 2 days of collection, and exported to New Zealand for recycling. Seventy volunteers also participated in the eDay. Whilst the eDay was considered a success and served as the catalyst for subsequent WEEE collection rounds in 2015, 2016, and 2017, reliance on external funding support is not a sustainable strategy for WEEE management. These donor-financed events have provided invaluable pricing and operational data and recommendations that can be used to develop sustainable EPR mechanisms, such as an Advance Recycling Fee built into the purchase price of electrical and electronic goods.

Conditions for success: Collaboration with private sector entities that have access to recyclable markets and expertise in international logistics; provision of appropriate training to relevant staff to ensure safe and correct extraction of high-value materials through dismantling; dismantling and packing of WEEE and appropriate storage quickly after collection to avoid material contamination (e.g. by pests which could lead to rejection of the shipment by the importing country).

Annex 1. Methodology Decision Tree



Annex 2. Example WACS record sheet

Example data record form for conducting a typical Waste Analysis and Characterisation Study with the primary and secondary waste fractions of interest.

Data to be recorded	Date:	Time:	Vehicle ID:	Waste compacted: Yes / No
	Origin of waste: Community of ……. (list the name of the community from where the trucks come from)			

No.	Primary Category	Secondary Category	Gross (kg)	Tare (kg)	Net (kg)	Weight ratio (%)
1	Organics - food	Food waste			0	0%
2	Organics - Parks & Gardens	Parks & Garden Waste			0	0%
		Other biodegradable waste			0	0%
3	Wood	Untreated Wood			0	0%
		Treated Wood			0	0%
		Other Miscellaneous Wood			0	0%
4	Paper and Cardboard	Newspaper			0	0%
		Cardboard			0	0%
		Magazines and Catalogues			0	0%
		Office Paper			0	0%
		Other Miscellaneous Paper			0	0%
5	Textiles	Clothing			0	0%
		Non-clothing textiles			0	0%
6	Plastics (bottles)	Clear PET Bottles			0	0%
		Green PET Bottles			0	0%
		Amber PET Bottles			0	0%
		HDPE Bottles			0	0%
7	Plastics (other)	Dense plastic packaging			0	0%
		Film Plastic			0	0%
		Other plastic			0	0%
8	Glass	Glass Bottles			0	0%
		Remainder/Composite Glass			0	0%
9	Metal	Tin/Steel Containers			0	0%
		Aluminium Containers			0	0%
		Other Ferrous Metal			0	0%
		Other Non-Ferrous Metal			0	0%
		Major Appliances			0	0%
10	Special care wastes - Nappies	Nappies (diapers)			0	0%
11	Special care wastes - other	Batteries & Accumulators			0	0%
		Medical (health care/biological wastes)			0	0%
		Miscellaneous Hazardous Materials			0	0%
12	Complex Products	Composite/Complex Packaging			0	0%
		Composite/Complex non-Packaging			0	0%
		Waste Electrical and Electronic Equipment			0	0%
13	Construction & Demolition Materials	Inert materials (e.g. soils, stone, concrete)			0	0%
		Miscellaneous/composite C & D wastes			0	0%
14	Fines	Fines Fraction < 10mm			0	0%
15	Other	Tyres			0	0%
		Rubber and Leather			0	0%
		Furniture			0	0%
		Ceramics			0	0%
		Other miscellaneous materials			0	0%

Annex 3. Additional separation examples

Example hazardous waste, white good and tyre collection containers at Civic Amenity Sites / Community drop off facilities:

Figure 11: Hazardous waste public drop-off at civic amenity site. Timaru District Council, New Zealand. https://www.timaru.govt.nz/services/environment/waste-minimisation/hazardous-waste-and-asbestos

Figure 12: Lilla Nyby återvinningscentral (recycling centre) - Eskilstuna, Sweden. www.eem.se

Example green waste collection container at a Civic Amenity Sites / Community drop off facility:

Figure 13: Civic amenity green waste public drop off - Kormendi Ut Hulladékudvar, Szombathely, Hungary. (RWA, 2019)

Example door-to-door green waste integrated on-site shredding and collection vehicle:

Figure 14: Integrated green waste chipper and collection truck - Adelaide, Australia (RWA)

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