



Global Plastics Flow 2018

Prepared by



Conversio Market & Strategy GmbH
Am Glockenturm 6
63814 Mainaschaff
Germany

+49 (0) 6021 1506 700
info@conversio-gmbh.com
www.conversio-gmbh.com

February 2020

With support from



(BKV GmbH) A company of the German plastics industry, which provides facts and figures about resource efficiency and circularity of plastics
www.bkv-gmbh.de



(EUROMAP) Association for plastics and rubber machinery manufacturers in Europe
www.euromap.org



(GKV) Umbrella organisation for plastics processors associations in Germany
www.gkv.de



(GPA) Collaboration among plastics industry associations and allied industry associations around the world with focus on marine litter solutions
www.marinelittersolutions.com



(IK) German association for plastics packaging and films
www.kunststoffverpackungen.de



(PED) German association representing plastics manufacturers
www.plasticseurope.org/de



(K Fair) International fair for the plastics and rubber industry in Düsseldorf, Germany
www.k-online.de



(VDMA) German association representing the mechanical engineering industry
www.vdma.org

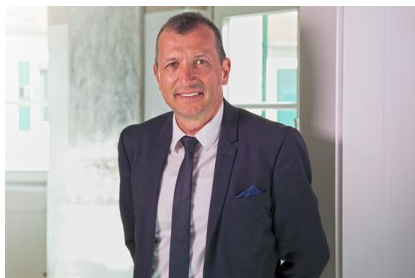


(WPC) International organization representing plastic resin producers
www.worldplasticscouncil.org

Conversio Market & Strategy GmbH

Conversio Market & Strategy GmbH is a b2b consulting, project management and market research company for technical industries with a special focus on the plastics value chain. This includes a holistic circular economy approach, from production and processing to waste management and recycling. With the technical and methodological expertise of more than 20 years of relevant projects, Conversio employees assist clients around the world to identify solutions for complex questions and challenges.

Conversio project leaders of the survey



Christoph Lindner
+49 (0) 6021 1506 701
c.lindner@conversio-gmbh.com



Hendrik Beylage
+49 (0) 6021 1506 706
h.beylage@conversio-gmbh.com



Conversio Market & Strategy GmbH

Am Glockenturm 6
63814 Mainaschaff
Germany

+49 (0) 6021 1506 700
info@conversio-gmbh.com
www.conversio-gmbh.com

Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100

Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100

Background and motivation of the survey

The global plastics industry is working towards a more circular economy for plastics, leading stakeholders to improve existing and invest in new waste management and recovery solutions, address illegal dumping, and to deploy advanced technologies to generate valuable new materials from waste.

There is currently a relative lack of publicly available information on global plastic waste generation and disposition (e.g., “waste flows”). Better information would help support stakeholder investment, and help guide decision making to focus on areas of greatest need. Because investments and other interventions are undertaken at a national and sub-national level, this pilot survey has been undertaken in consultation with national representative with knowledge concerning local waste generation, collection, recycling, energy recovery and disposal of plastics waste in individual countries.

This survey presents national level responses, and then uses that information to make general global predictions on plastic waste flows. While this information can have directional benefit, it has important limitations to this methodology. First, plastic “leakage” into the environment varies greatly from country to country, and even within different parts of each country. Furthermore, regulations, economics and priorities for waste management vary greatly. Finally, as this is thought to be a first global survey, it is expected that subsequent analysis and measured data will result in more reliable iterations. Irrespective of this, the study defines a first base line to monitor the further developments over the next few years. This pilot study was also carried out to define and develop a uniform basic data structure on national, regional and global level and to encourage other countries participating in this project, which still have gaps in their plastics statistics. In addition, this publicly available pilot study can be used by other parties as a basis for further specific studies.

The **Global Plastics Alliance (GPA)** is pleased to have contributed to this initial “Global Plastics Flow” survey, and it welcomes feedback to improve global and national understanding of plastic flows.

Survey introduction

This pilot survey with data from 44 countries provides insights in the overall plastics flow including general data coverage and data quality with focus on plastics waste management and treatment.

The survey provides a first attempt to collect data from individual countries together with national representatives and additional assessments about the regional plastics waste situation including waste generation, collection and treatment.

This survey includes and reflects...

- ...data availability in the individual countries,
- ...identification of relevant organizations able to deliver and share data, and
- ...critical data reflection including the identification of data gaps.

This survey is intended to provide a basis on which to conduct further, more detailed analyses that will ultimately better inform strategies to end plastic waste in the environment, including investments in recycling and recovery. This information should be considered a starting point which stakeholders are invited to supplement and build upon to create better informed strategies for improving waste management.

Data collection and cooperation

This survey and analysis was carried out with the Global Plastics Alliance (GPA) – a collaboration among global plastics industry associations – and this survey includes responses from associations representing plastic material suppliers and/or converters in countries all over the world. In some cases this information was further elucidated by data from value chain stakeholders and the institutions listed below. The initial results were compiled and summarized by Conversio Market & Strategy GmbH, and when possible were compared with secondary sources (as described below). Neither Conversio nor the other parties have independently validated the underlying data.

In an initial stage, the following drivers and targets were captured:

- Strong cooperation with sponsors and associations or members of the GPA
- Evaluation analysis of existing data from GPA members and country representatives
- Identification of data gaps and data inaccuracies
- Research and checking of existing reports from institutions, associations, environmental agencies, NGOs, etc. (e.g. World Bank, International Solid Waste Association ISWA, World Wide Fund for Nature WWF) on world, continental and country basis
- Additional contact with institutions, associations, environmental agencies, NGOs etc., where necessary
- First attempt of framing continental plastics waste projections

Multi-methodological approach

A multi-methodological research and information gathering process was chosen for the survey Global Post-Consumer Plastics Flow.

Preliminary information based on the results from the “Plastics Industry Survey 2016” provided by the Global Plastics Alliance with complete survey responses from Turkey, the United States, Canada, Colombia, India, Japan, the Philippines, Thailand, Malaysia, South Africa and Ghana.

For EU28+2 countries, existing plastics flow analyses were used based on Conversio’s own databases and existing reports.

Additional information about plastics flow analyses were requested from the GPA country representatives for each participating country.

Additional secondary information was researched for each participating country as well as on a continental and world level.

Secondary information including

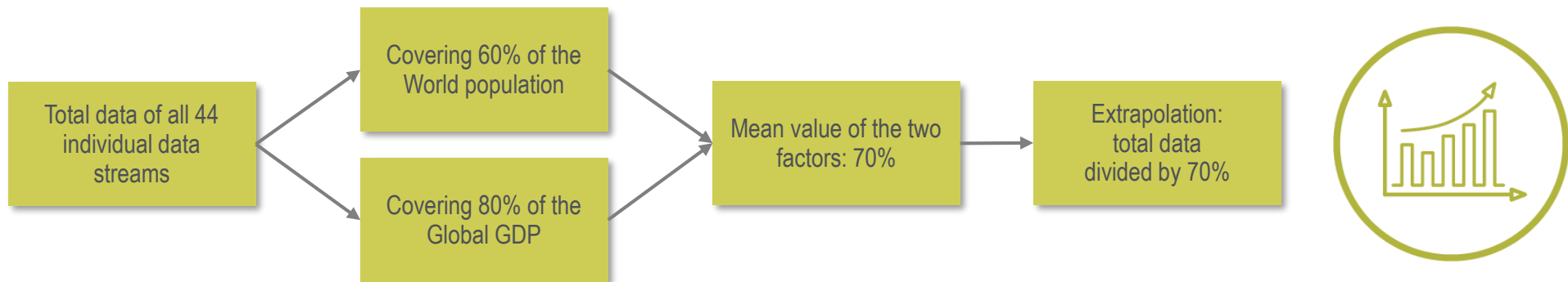
- Waste stream analyses on a country, continental and world level
- Data and statistics from stakeholders along the plastics value chain, environmental agencies and government authorities
- Reports from other consultancies and NGOs
- Analyses of peer-reviewed journals and reports
- Data and information from newspapers and information websites

Data extrapolation

The Global Post-Consumer Plastics Flow survey includes information about plastics from production to waste from 44 countries and regions, that altogether cover about **60% of the World population** and around **80% of the Global GDP**.

The accuracy for data extrapolation differs significantly among the different continents

- All extrapolations were realised on a **continental basis** using a correlation factor of population and GDP and individual adaptations.



- All continental **extrapolations** were subsequently **adjusted** on the basis of secondary sources and a review by the project team and individual country representatives.
- For example, an **extrapolation** for **Europe** and **Asia** is **more accurate**, as data availability and robustness are better with a higher number of individual country data streams. For **Latin America** and **Africa**, data extrapolation **accuracy is more limited** as only a few country data streams were available. Here, the stronger influence of individual key countries had to be taken into account, which led to necessary adjustments for the continental extrapolation.
- The overall extrapolation accuracy will improve as the number of individual data streams increases.

Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100

Definitions

(1/5)

Recycling

Plastics recycling in this study is defined as **collected or sorted waste for recycling**. Some countries defined and calculated recycling on a recycling output basis or defined energy recovery as recycling. Accordingly, adjustments were made to align the different recycling definitions and calculations of the countries. However, a 100% matching and alignment is not possible. Furthermore, this report focuses on import-adjusted plastics recycling quantities, as data availability from developed waste exporting countries is usually better.

- **Mechanical recycling** is well-established and the current most common recycling technology for plastics from post-consumer waste and production as well as scrap conversion. Mechanical recycling is a method by which waste is recycled into “new” (secondary) raw materials without changing the basic structure of the material. It is also known as material recycling or related to plastics, back-to-plastics recycling. Depending on the condition of the waste in terms of homogeneity and degree of impurities, the waste fractions pass through extensive manual or automated mechanical sorting processes at source or in specialised sorting facilities designed to separate different material streams. The proper identification of materials is essential for achieving a maximised purity of recyclates. For this purpose, various technologies such as near-infrared spectroscopy (NIR), laser or x-ray techniques are available for automated sorting processes. After the cleaning and grinding processes, the material is recovered by re-melting and re-granulating.
- **Dissolution** is a process whereby plastics are dissolved in a suitable solvent and includes a series of purification steps to separate target polymer(s) from additives and other added materials (e.g. fibres, fillers, colourants) and contaminants. The resulting output consists of recovered polymers that remain largely unaffected by the process and can be reformulated into plastics.
- **Chemical recycling, also known as feedstock recycling**, aims to convert plastic waste into chemicals. It is a process whereby the chemical structure of the polymer is changed and converted into chemical substances including monomers that are then used again as a raw material in chemical processes. Chemical recycling includes processes such as gasification, pyrolysis, solvolysis and depolymerisation, which break down plastic waste into chemical substances including monomers for the production of plastics.

Definitions

(2/5)

Energy recovery

Waste incineration processes for energy conversion in the form of electricity and/or heat.

MSWI (municipal solid waste incineration), **SRF/RDF** (solid recovered fuel/refuse-derived fuel) in power plants with energy conversion as heat (steam) and/or electricity, or heat utilisation in cement kilns.

The term “energy recovery” includes both direct incineration in waste incinerators for electricity and/or heat conversion as well as high-grade energy recovery in industrial facilities if the main purpose of the operation is to replace fossil fuels (e.g. cement kilns, pulp mills, gasification plants)

The difference between RDF and SRF can be described as follows: refuse-derived fuel (RDF) or solid recovered fuel/specified recovered fuel (SRF) is a fuel produced by shredding and dehydrating municipal solid waste (MSW) using waste converter technologies.

Disposal – managed landfill

An overall definition of a “**sanitary landfill**” is not simple since this very much depends on the level of development of the country under consideration. Nevertheless, the differences mostly lie in the degree of isolation the relevant disposal site offers for the separation of the disposed waste and the surrounding environment. Since this is also a very sensitive issue in many developed countries, not the same requirements are feasible for a developing country. In order to qualify as a sanitary landfill, a disposal site must meet the following three basic conditions [UNEP, 2005]:

- Disposed waste must be properly compacted;
- The waste has to be properly covered for good separation from the surroundings;
- High level of control over and prevention of the negative impact given by odours, contaminated waters etc. resulting from the construction and operation of the landfill

Definitions

(3/5)

Post-consumer waste

Post-consumer waste is end-consumer waste arising after the use phase (products with a shorter as well as a longer period of use) from household and end-consumer activities. Post-consumer waste also includes waste that is generated during installation and assembly processes (e.g. pipes, cables, flooring, films/tarpaulins). The waste often has a certain degree of contamination/impurities and/or mixing of different plastics types.

Formal waste collection

Formal waste collection services usually include public service providers and contracted, privately organised companies. Public waste collectors or private waste management companies typically have technological solutions for the collection of waste on a large scale including kerbside collections (sacks/bins) and/or central container or depot collections. Waste is then fed into an official treatment route including sorting/preparation for recycling, energy recovery or managed landfill (official or controlled dumps or sanitary landfills*).

Informal waste collection

The informal waste collection sector comprises unregistered, unregulated activities, individual and family enterprises, small-scale and low capital inputs, local materials and labour-intensive techniques, e.g. individuals or small unregistered companies that are active as waste pickers, waste collectors, itinerant buyers and recyclers. It is typically realised through door-to-door or on-site collection.

* Sanitary landfills are sites where waste is isolated from the environment until it is safe.

Definitions

(4/5)

Unknown waste

Waste that is not statistically covered/unknown to any data collection. Data about the weight of waste do not exist, further information about waste treatment does not exist. This category includes **improper disposal** and **leakage**.

Improper disposal

Waste that is not disposed in authorised or sanitary landfill sites. Waste is typically concentrated **and remains at one area**, e.g. local dumpsites where individuals dispose of their waste. The definition of unknown waste includes unsanitary/uncontrolled dumpsites, the burial of waste or the burning of waste under uncontrolled conditions. A clear distinction between unknown waste and formally collected waste including managed landfill is not always possible, e.g. formally collected waste by public waste collection services and managed landfill in uncontrolled dumpsites.

Waste leakage

Waste leakages into the environment can either be generated through leakage (e.g. by flooding or wind) from unmanaged/unsanitary dumpsites/burning or through conscious or active individually managed landfill of waste, e.g. when an individual dumps a bottle into the environment. Land-based waste leakages are typically **spread over an area** and account for a major share of marine litter.

Marine litter

Marine litter can be defined as “any anthropogenic, manufactured, or processed solid material (regardless of size) discarded, disposed of, or abandoned in the marine environment, including all materials discarded into the sea, on the shore, or brought indirectly to the sea by rivers, sewage, stormwater, waves, or winds” (United Nations Environmental Programme UNEP 2011). About 60 to 90% of marine litter consists of plastics (UNEP-GRID 2016). A rather small fraction of it stems from sea-based sources, e.g. waste that ships discard directly at sea. The vast majority of marine plastics litter comes from land-based sources (waste leakages), entering into the marine environment from human settlements along coastlines and river catchments. Land-based sources include tourism, sewage and illegal or poorly managed landfills. Marine litter consists of items that have been deliberately discarded, unintentionally lost, or transported by winds and rivers, into the sea and on beaches.

Definitions (5/5)

cap.	capita (per capita)
ELV	End-of-life vehicle
EPR	Extended producer responsibility
EU28+2	EU28 countries + Norway and Switzerland
GDP	Gross domestic product
kt	kilotonne
m	million
MRF	Materials recycling facility
MSW	Municipal solid waste
MSWI	Municipal solid waste incineration
mt	million tonnes
NGO	Non-governmental organisation
NIR	Near-infrared spectroscopy
RDF	Refuse-derived fuel
SRF	Solid recovered fuel
WEEE	Waste from electrical and electronic equipment

Polymer types

PE-LD/LLD	Polyethylene low-density / linear low-density
PE-HD/MD	Polyethylene high-density / medium-density
PP	Polypropylene
PS	Polystyrene
PS-E/EPS	Expanded polystyrene
PVC	Polyvinylchloride
ABS, ASA, SAN	Acrylonitrile-butadiene-styrene, acrylonitrile-styrene-acrylate, styrene-acrylonitrile
PET	Polyethylene terephthalate
Other plastics	PMMA (polymethyl methacrylate), PA (polyamide), PUR (polyurethane), POM (polyoxymethylene), PC (polycarbonate), PBT (polybutylene terephthalate), blends, thermosetting plastics

Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100

Data availability, robustness and limitations (1/4)

Data availability

- Many countries have environmental or public institutes that publish data about waste build-up and treatment (e.g. municipal solid waste MSW). Additional information about shares of plastics and build-up of plastics waste in total are available in some countries. Therefore, the analysis of secondary data (e.g. scientific articles) is especially important in those countries that lack sufficient data monitoring and reporting structures.
- Many countries have additional information from plastics industry associations. Reports published by these associations focus primarily on plastics production (i.e. production of plastics raw materials) and plastics converting figures (i.e. plastics processing and the production of plastics products) and less on plastics waste.
- Analyses of different waste streams that include plastics seldom exist. The majority of accessible reports cover MSW and its treatment.
- Information about MSW and its plastics content is often only published for urban regions or cities. Data about waste build-up and collection in more rural areas is another key barrier to gaining a comprehensive picture about plastics from production to waste in individual countries.
- The support of governmental institutions and relevant industry associations is fundamentally important in order to develop a comprehensive plastics data model for each individual country and region. Many countries provided valuable additional information improving and resulting in overall higher data accuracy. In order to be able to transfer more and better data into the model in the future, even stronger support is essential.

Data availability, robustness and limitations (2/4)

Data robustness (1/2)

- Data availability in the first place is indispensable. However, having reliable and robust data is particularly important for comparing data from different countries or continents.
- Using a pre-defined matrix is essential to allow the comparability of data from different countries and regions. The major problem is that accessible data from different countries does often not allow a simple comparison due to different definitions (e.g. recycling share based on collected waste for recycling vs. recycling output), lack of data quality or non-availability of specific data.
- Formal and informal waste collection often co-exist in many countries of the world. Yet most of the countries that have a distinct informal waste collection sector do not have sufficient data gathering and tracking systems. Some countries have integrated the informal waste sector into their formal waste management system, but the lack of data is often a key barrier.
- Our experience shows that almost every country has a fundamental interest in presenting its waste collection and management in the best possible way, and often better than it is in reality. A critical data reflection is therefore unavoidable.
- Recycling rates are often calculated based on collected waste or plastic packaging products put on the market. Countries that have sophisticated waste management systems and a collection coverage of 95% or above are not as problematic as countries that have high shares of unknown waste – waste that is typically not statistically recorded. In Asian, Latin American and African countries in particular waste figures for collected and generated waste often differ significantly, and figures for generated waste do often not exist in these countries. A projection based on secondary research together with adjustments based on GDP and generated waste per capita are often the only option for generating and harmonising data.

Data availability, robustness and limitations (3/4)

Data robustness (2/2)

- Many waste analyses of MSW focus on urban or city areas. Extrapolations on a country level often fail to properly take into account fundamentally different waste compositions in rural areas. The lack of any data from rural areas is a barrier for the overall data robustness, especially in less developed or emerging countries. This report focuses on plastics waste as a share of MSW and other waste streams with varying plastics shares.
- There is no unified classification of unknown waste across the world. The definition of unknown waste in this study is (more or less) aligned with the definition “unmanaged” used in “A Global Roadmap to achieve near-zero ocean plastic leakage by 2040: Economic analysis” by SYSTEMIQ. Furthermore, a clear distinction between “unmanaged dumpsites” and “sanitary landfills” is an additional key barrier to aligning data, no harmonised definitions exists (often mixed data).
- A global alignment of definitions and the introduction of proper data extrapolation methods (e.g. comparable to those from the “The Ocean Cleanup”) for emerging countries will contribute to more robust data in the future. The inclusion of GDP and plastics waste per capita as control mechanisms should be included to critical reflect waste data between the countries.
- Double counting of waste data, especially of recycled plastics waste quantities, is always problematic as many western countries include exports for recycling in their own recycling rates and Asian countries refer to their recycling efforts based on domestic and imported waste.

Data availability, robustness and limitations (4/4)

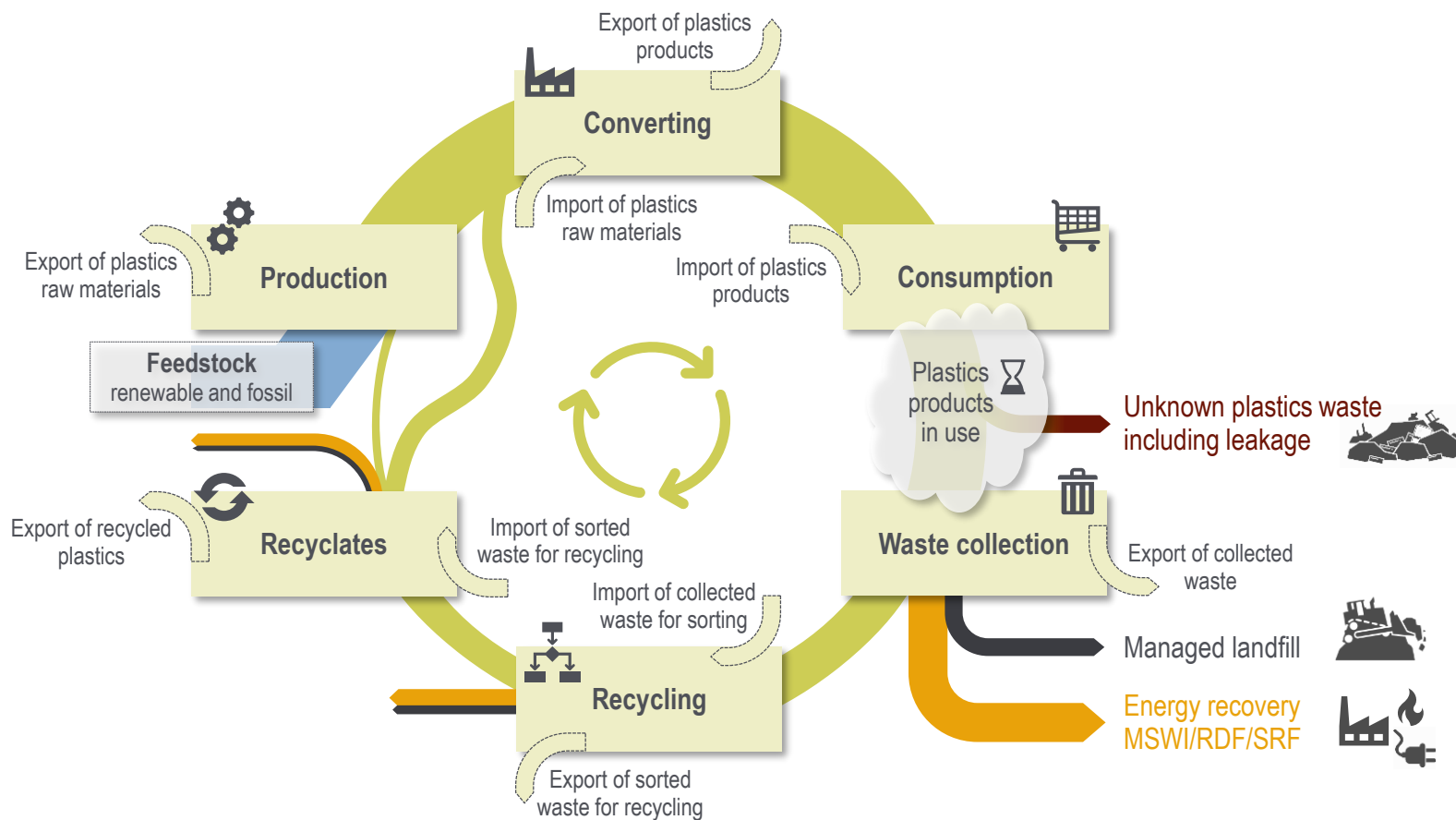
Limitations

- The data availability and data quality differ significantly from country to country. Almost every developed country has a national statistical office that collects and harmonises data on the plastics in general and on municipal solid waste (MSW) including plastics. However, not all existing waste streams are statistically covered even in these countries.
- Data modelling and information collection from different additional sources are often necessary in order to obtain a complete picture.
- Data availability and data quality in less developed or emerging countries is more limited. In many Latin American, African, Asian and Eastern European countries, plastics streams data do not often exist. Scientific articles, information brochures and analyses from plastics associations together with newspaper articles are often the only available data sources that can be used. Furthermore, information and data from countries with comparable waste management structures were compared and adopted as basic assumptions for countries with less available information.
- This study tries to keep data corrections to a minimum and focuses on harmonising data streams based on kg per capita (e.g. plastics waste generated) and GDP per capita.
- **Overall data accuracy will improve significantly with globally harmonised definitions and more countries contributing with individual data streams to an extrapolation of global plastics flow.**

Table of contents

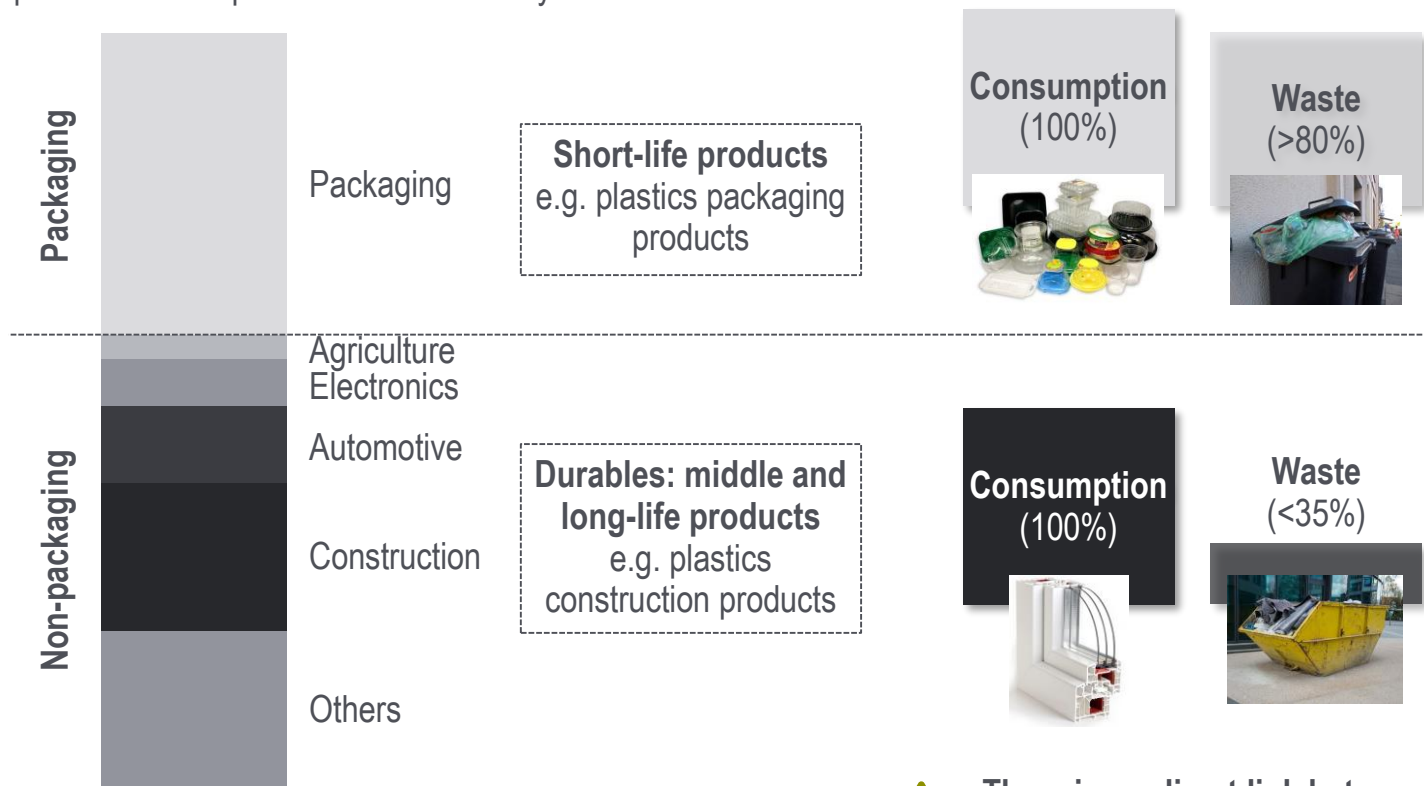
Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100

Systematic illustration for the circularity of plastics



Systematic illustration of the general dynamics of a generic plastics life cycle

General dynamics of a generic plastics life cycle from plastics production to plastics waste with regard to plastics consumption in one reference year.



Individual life cycles result in a **gap** between plastics consumption and plastics waste.

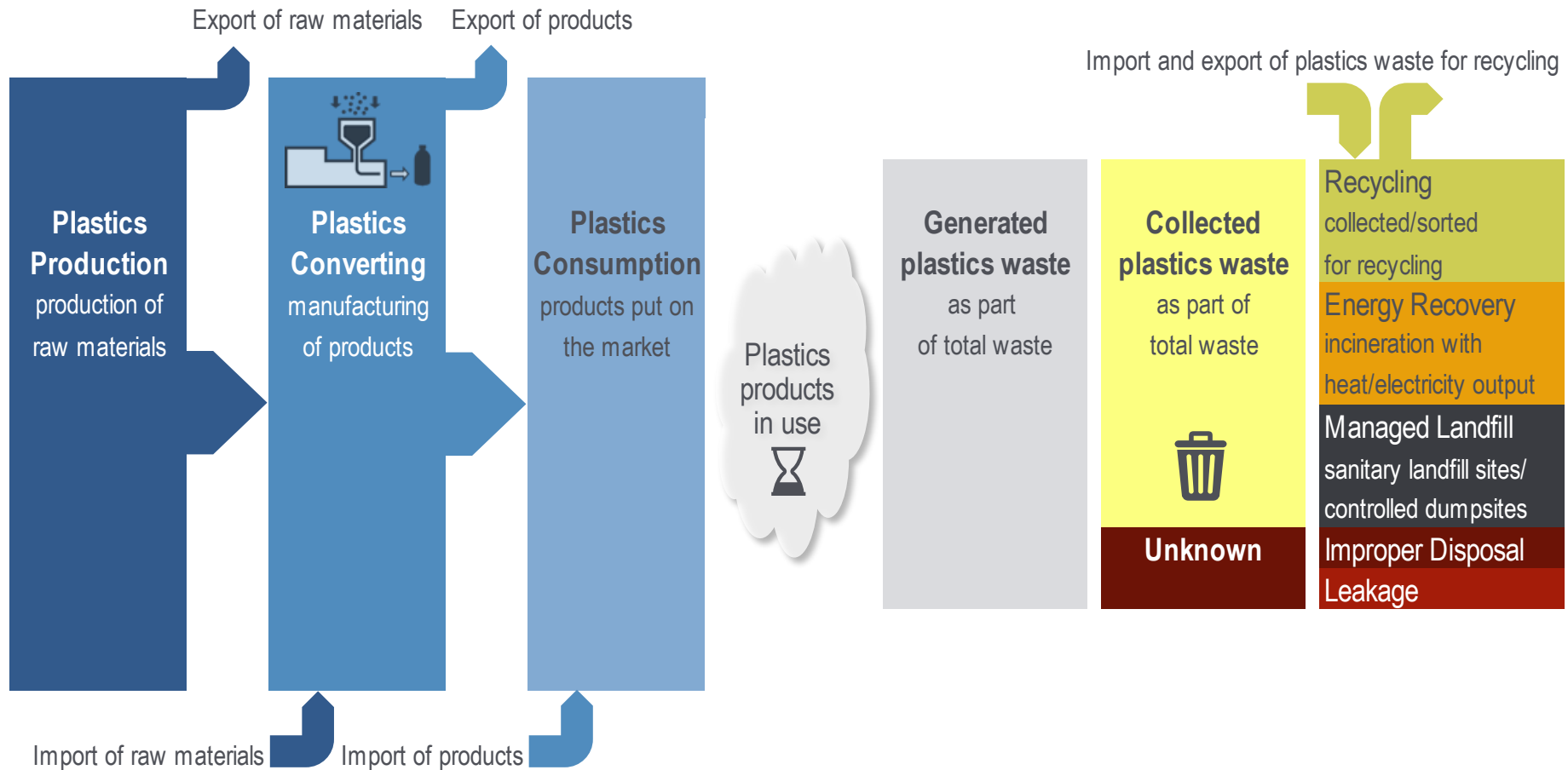
Example

Plastics profiles in window frames that were installed around 40 years ago become waste (end of life cycle through dismantling). The market volume for plastics window frames was significantly lower 40 years ago than today.



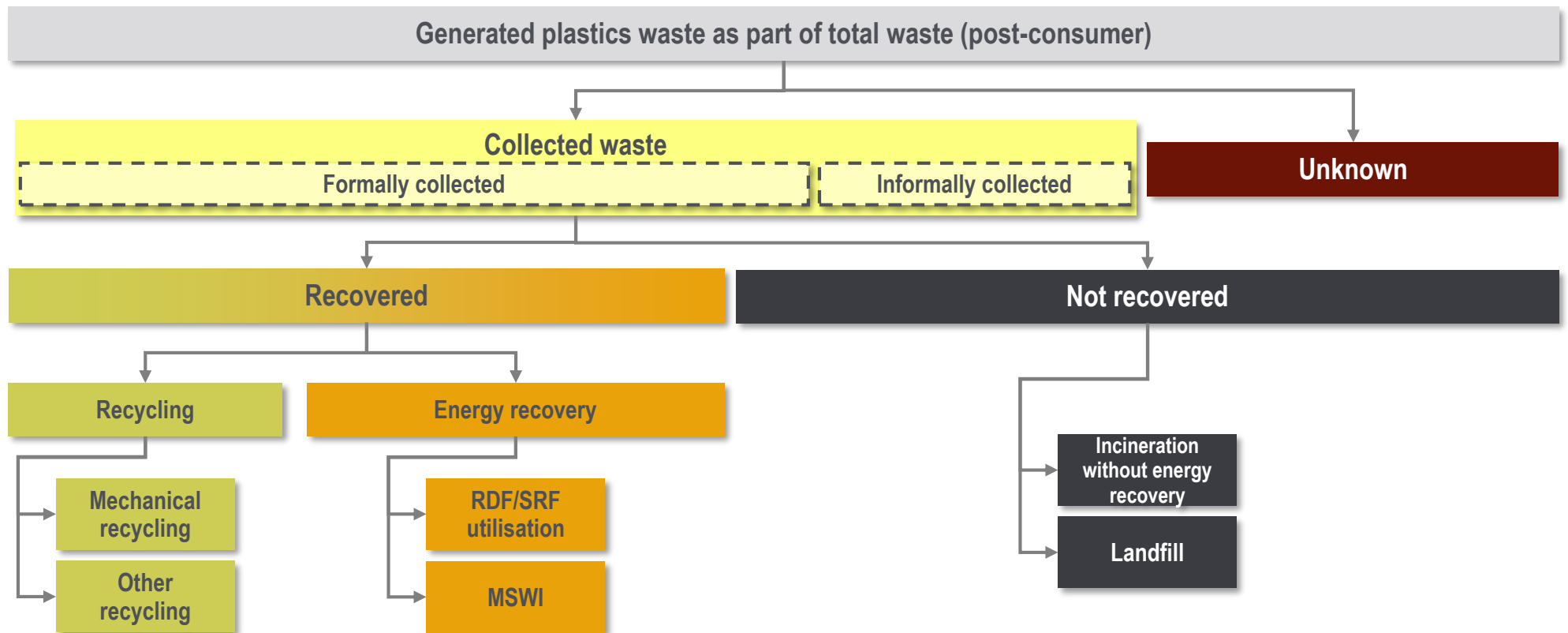
There is no direct link between plastics consumption and plastics waste generated in one reference year.

Systematic illustration for a linear plastics flow chart



Generation, collection, and treatment of post-consumer plastics waste

Systematic illustration of post-consumer plastics waste generation, collection and treatment



Plastics waste treatment and conversion of recovered waste

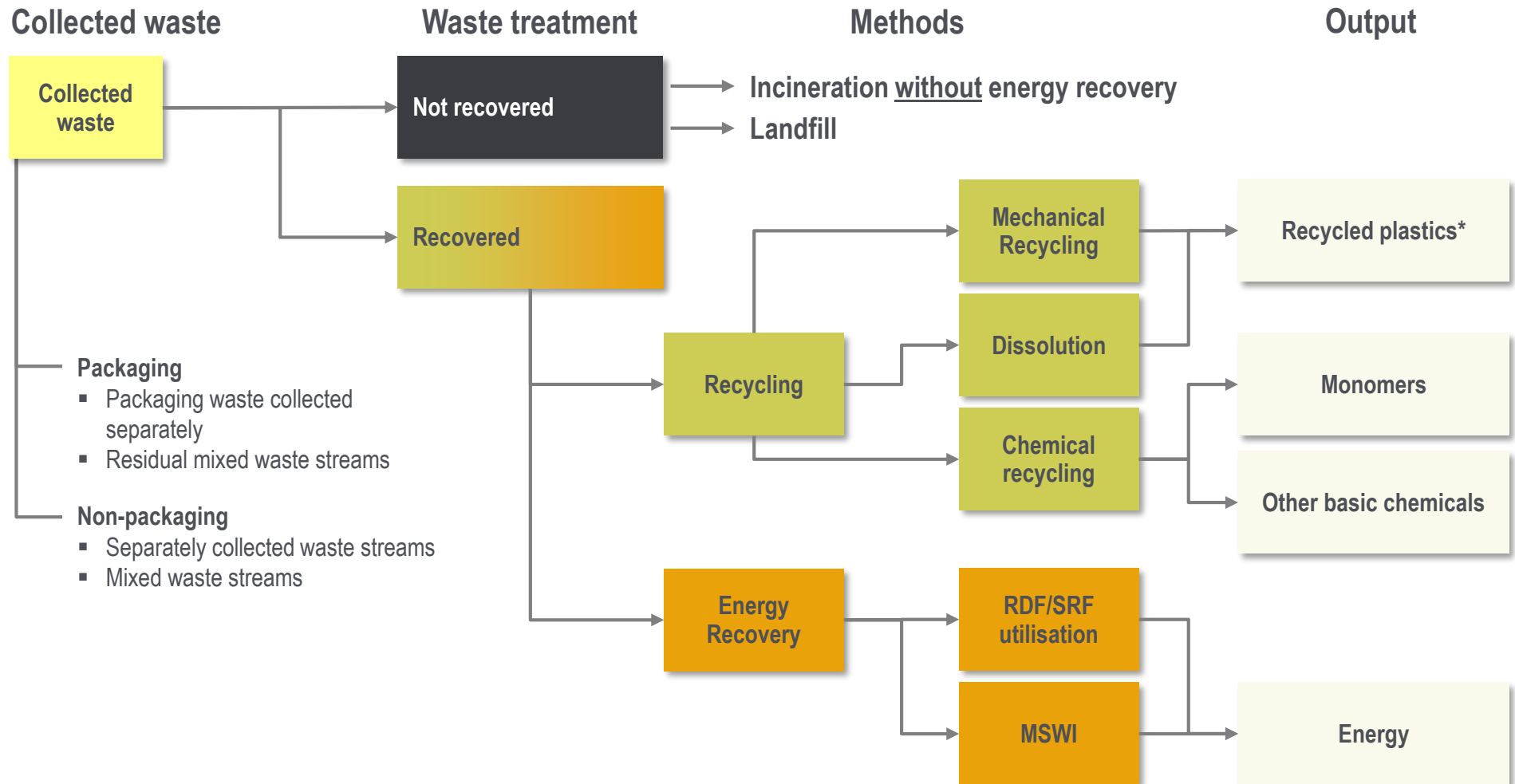


Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100

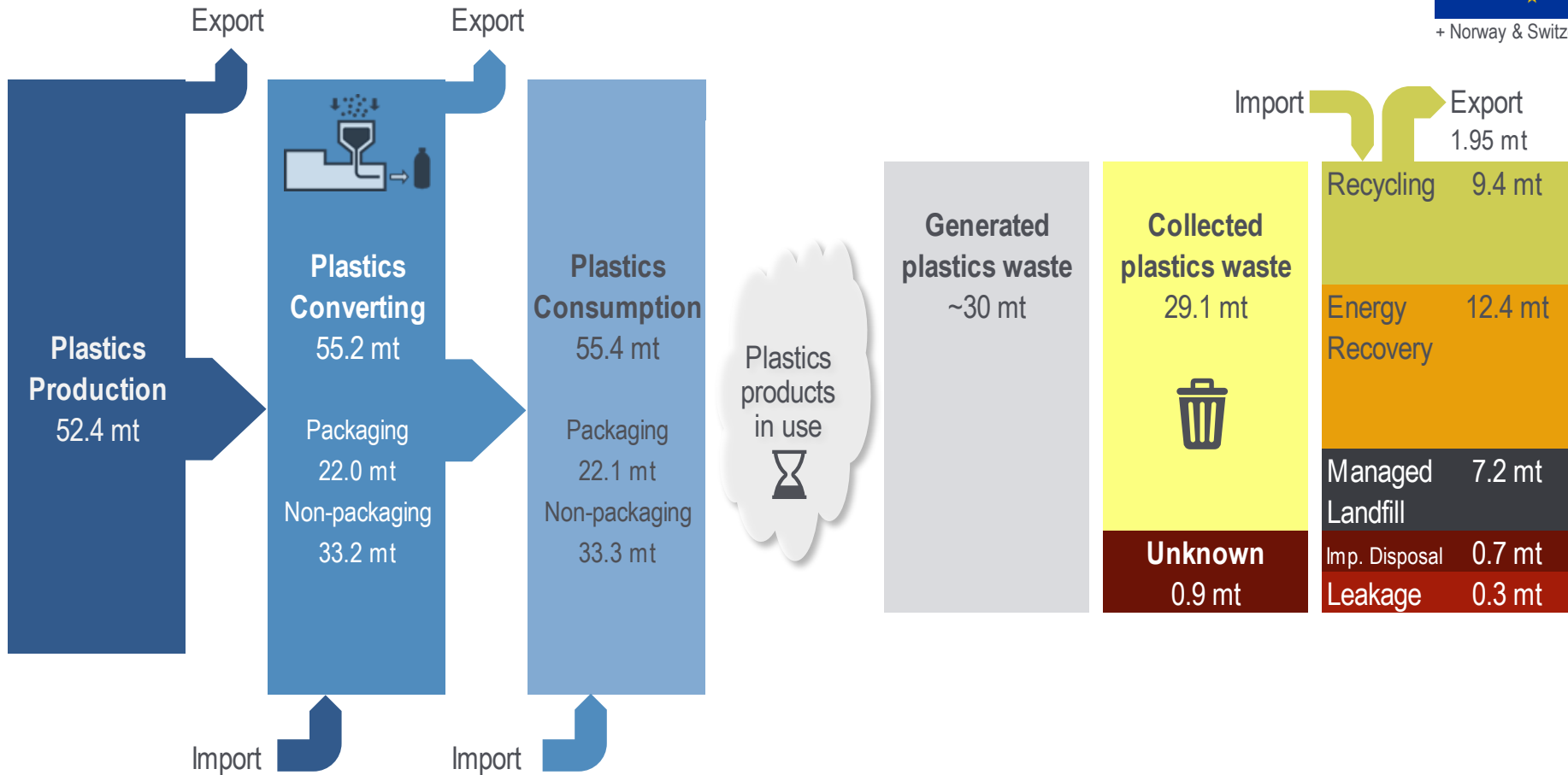


Europe
including Turkey

EU28+2
(1/3)



+ Norway & Switzerland



Plastics flow from production to recycling

EU28+2 (2/3)



+ Norway & Switzerland

Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
Applications	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	18.4	61%	17.8	97%	17.6	99%	0.2	1%	7.5	41%	7.0	38%	3.3	18%	0.4	1.9%	0.2	1.2%
Non-packaging	11.6	39%	11.3	97%	11.1	99%	0.2	1%	2.0	17%	5.4	46%	3.9	34%	0.3	2.6%	0.1	0.6%
Σ	30.0	100%	29.1	97%	28.6	99%	0.4	1%	9.4	31%	12.4	41%	7.2	24%	0.7	2.2%	0.3	1.0%

At a glance

- About 30 mt of plastics waste were generated in the EU28+2, while 29.1 mt were collected.
- The EU28 countries + Norway and Switzerland had a total **recycling rate** of **31%**. About **9.4 mt** of plastics were collected for recycling, of which around **1.95 mt** were **exported** for recycling primarily to Asian countries.
- The export and import adjusted **recyclates usage** in Europe was **around 4 mt**. The EU sets 10 mt of recyclates usage as a target for the plastics industry by 2025.
- **New recycling targets** for plastics packaging waste of **55% in 2030** (50% in 2025) will result in significantly higher quantities of domestic recycled plastics, especially with declining plastics waste exports for recycling.

EU28+2 (3/3)



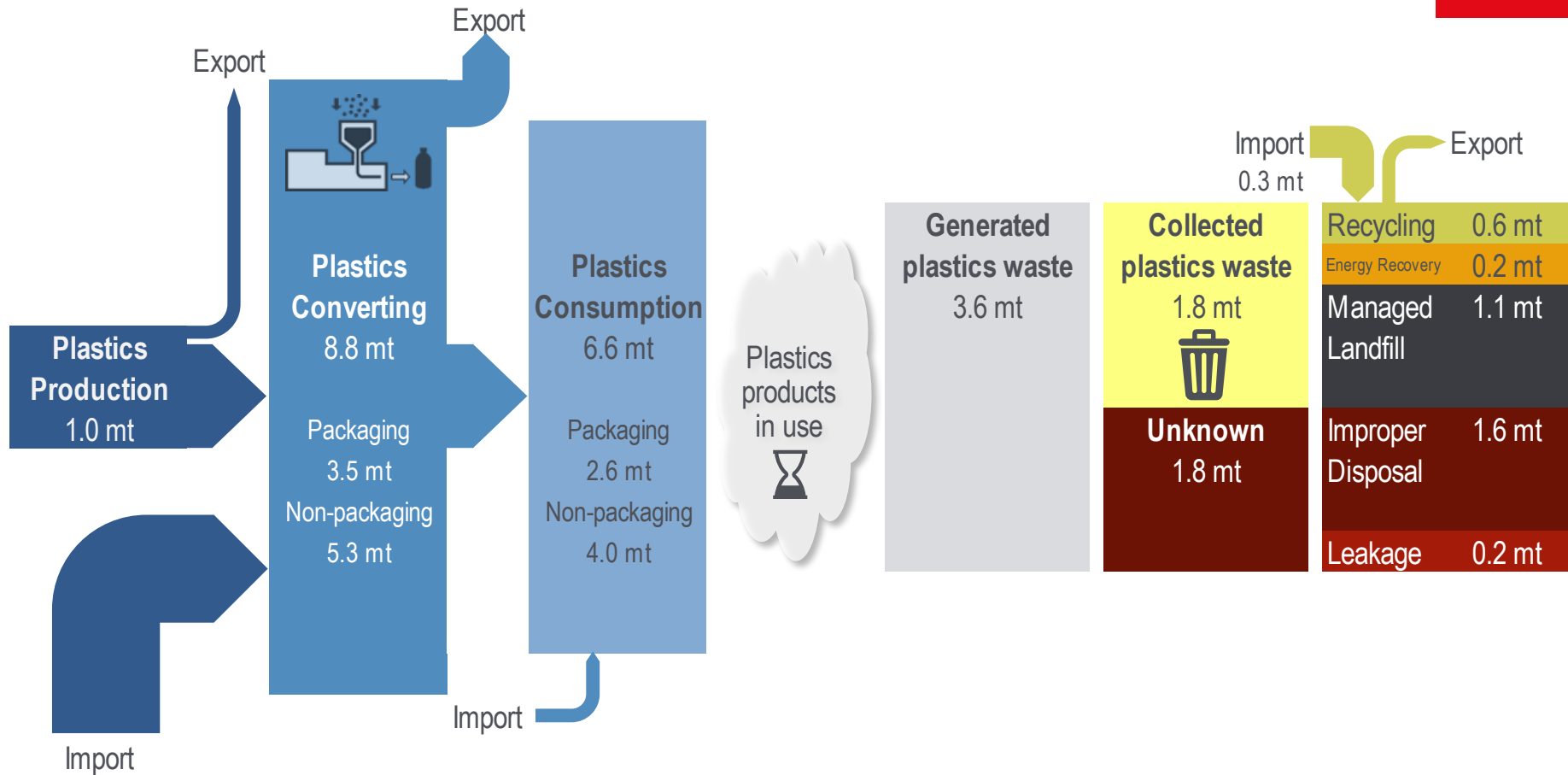
+ Norway & Switzerland

- **In 2018, ten countries** (Switzerland, Austria, Netherlands, Germany, Luxembourg, Sweden, Finland, Belgium, Denmark, Norway) **achieved a recovery rate** (recycling and energy recovery) of more than **95%** for post-consumer plastics waste. These countries have established landfill restrictions.
- Many EU countries **are expanding** their **separately collected waste management** schemes to allow a ‘cleaner’ collection of waste at source (e.g. France and Italy). Some European countries sort plastics from mixed waste streams (e.g. Spain and Norway). Few countries have implemented **deposit schemes** (e.g. for PET bottles in Sweden and Germany), while some countries are considering the implementation of deposit schemes (e.g. France).
- The current rate for **plastics packaging recycling is 41%** in total for the EU28+2 countries. The **financing** of (plastics) packaging waste **collection** and **treatment** is primarily realised through **extended producer responsibility (EPR) fees** for packaging products put on the market. The implementation of mandatory EU legislation differs in the individual EU countries.

Waste collection and treatment

- Typically, waste is collected as **mixed waste** (e.g. residual household waste) or as **separately collected waste** (e.g. light-weight packaging waste (LWP) including tinplate, plastics, drink cartons and, in some countries, paper and cardboard).
- **Separately collected waste is typically collected for sorting.** Different output fractions are then sent to recyclers for additional processing and recovery steps.
- **Energy recovery** including **MSWI** and **RDF utilisation in cement kilns and steel furnaces** accounts for the major share of plastics waste treated in total in the EU28+2 countries.
- The overall **recycling performance of flexible post-consumer packaging materials** can be **improved**, as the recycling of mixed and soiled plastics is often not economical (food residues, dirt, soil etc.).
- **Agricultural applications** incl. silage films or separately collected plastics waste from **construction applications** (e.g. window profiles and pipes) account for a major share of total of non-packaging plastics that are recycled.

Turkey (1/3)



Plastics flow from production to recycling

Turkey (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	2.16	60%	1.19	55%	0.89	75%	0.30	25%	0.43	20%	0.11	5%	0.65	30%	0.86	40%	0.11	5%
Non-packaging	1.44	40%	0.65	55%	0.55	85%	0.10	15%	0.14	10%	0.07	5%	0.43	30%	0.75	52%	0.04	3%
Σ	3.60	100%	1.84	51%	1.44	79%	0.39	21%	0.58	16%	0.18	5%	1.08	30%	1.61	45%	0.15	4%

At a glance

- In Turkey, municipalities collect around **30 million tonnes of municipal solid waste (MSW)** per year, including about 3.6 mt of plastics waste. The overall plastics share of MSW differs, with 4–6% in rural areas and up to 10% in cities (Union of Municipalities of Turkey 2015).
- The definition of unknown and formally collected waste used in this report does not mirror the plastics waste collection in Turkey adequately. **A large share of unknown plastics waste is formally collected by public waste collection services** but sent to unsanitary landfill sites, especially in smaller provinces.

Turkey (3/3)



Waste collection and treatment

- The **collection of municipal waste** including plastics is widely established by municipal **public services**.
 - There is **only a limited separate collection of (plastics) packaging waste for sorting**. Municipal waste is usually a **mixed stream** that causes cross-contamination between recyclables and reduces the quality of recyclable materials.
 - Turkey has **few materials recycling facilities (MRF)** to recover plastics. According to the Union of Recycling Workers, around half a million **informal waste collectors** in Turkey contribute to a major input stream of recyclable materials.
 - In more rural areas and **smaller provinces, unsanitary dumpsites** are widely common. In **metropolitan municipalities, sanitary landfill sites** have been established to a large extent.
- The **recycling of PET bottles** accounts for the major share of all domestic recycled plastics. The recycling of **other plastics** packaging materials is **limited**. The recycling of plastics packaging waste from mixed waste streams has not been realised due to the **lack of domestic sorting plants** on a large scale (except for recovered fractions through waste pickers).

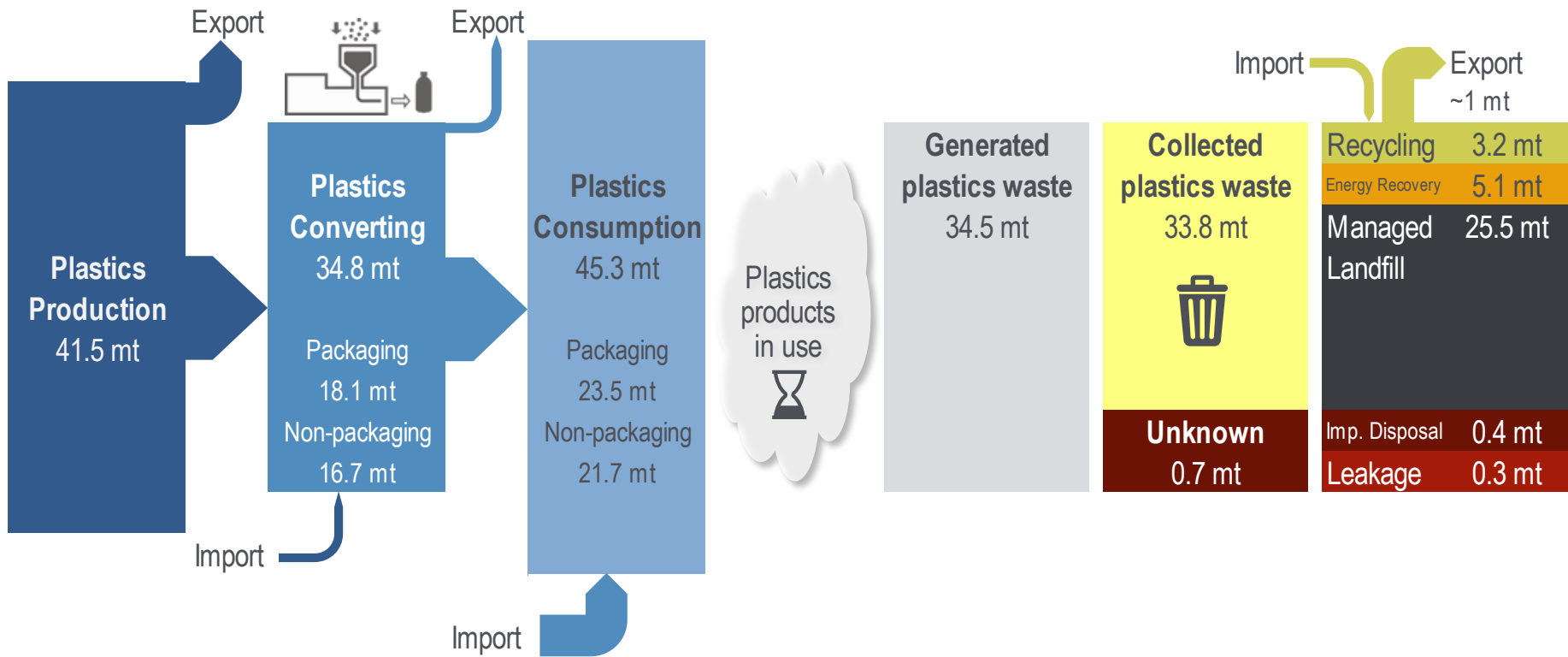
Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100



Northern America

United States (1/3)



Plastics flow from production to recycling

United States (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	19.0	55%	18.6	98%	18.3	98%	0.3	2%	2.3	12%	3.2	17%	13.1	69%	0.2	0.8%	0.2	1.2%
Non-packaging	15.5	45%	15.2	98%	14.9	98%	0.3	2%	0.9	6%	1.9	12%	12.4	80%	0.2	1.4%	0.1	0.6%
Σ	34.5	100%	33.8	98%	33.2	98%	0.6	2%	3.2	9%	5.1	15%	25.5	74%	0.4	1.1%	0.3	0.9%

At a glance

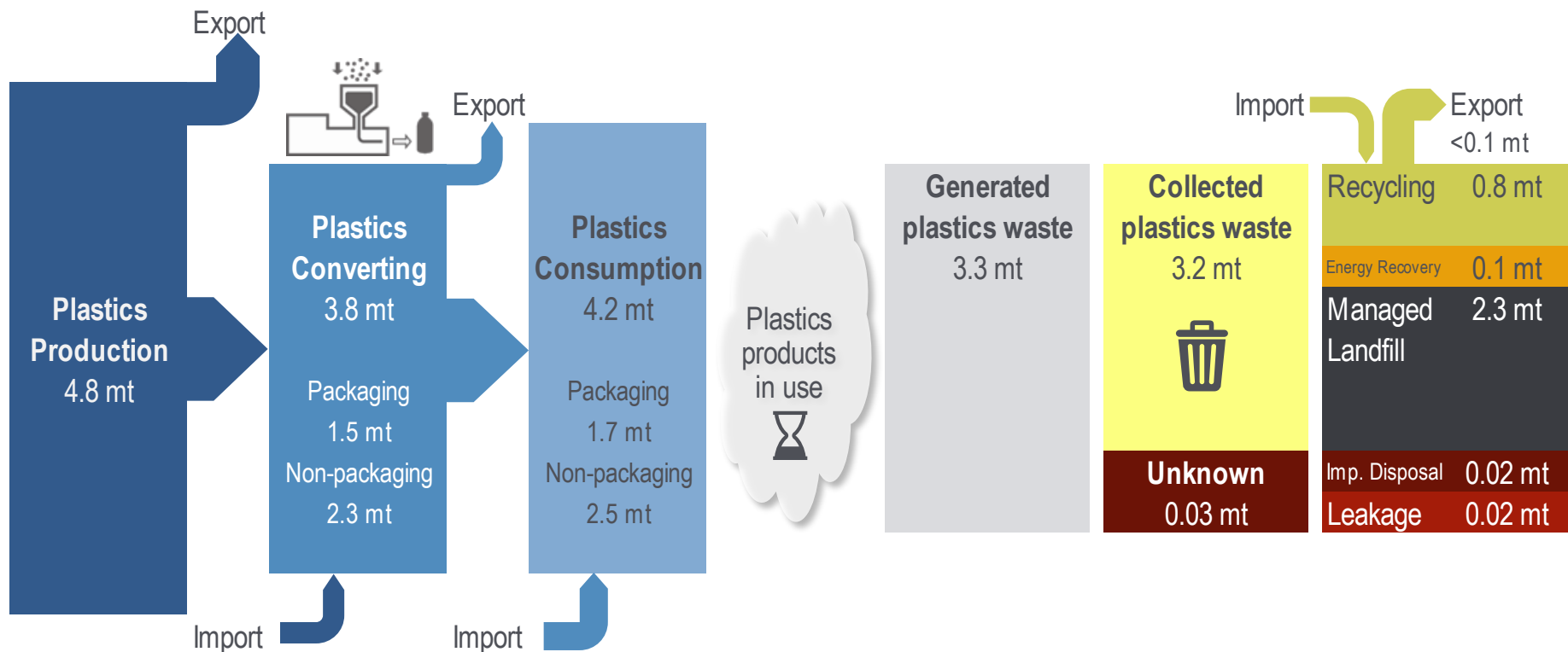
- 34.5 mt of post-consumer plastics waste were generated in the US, of which almost 34 mt were collected.
- Total volumes for **recycling, energy recovery and disposal** have remained relatively **stable** over the past few years. Input quantities for incineration plants for energy recovery processes have declined in the past two decades.
- Low landfill costs per tonne and **no landfill restriction** in any federal state lead to a high disposal share.
- The United States currently has around **650 materials recycling facilities**, which can clean, sort and bale a total of up to 100 kt of recyclables per day.

United States (3/3)



- **Managed landfill waste** and plastics waste on landfill sites are common practice in the United States. With a share of over 70% in total, disposal is the most relevant waste treatment method. Plastics recycling and energy recovery rates are relatively low, at 9% and 15% in total respectively.
 - Since the **import ban by China**, many regions and cities have been struggling to cope with higher build-ups of plastics waste. Nevertheless, around 1 mt of plastics waste was exported in 2018. Sending waste to incineration plants and landfill sites is a growing trend, as robust domestic recovery and recycling capacities do not exist yet.
- Waste collection and treatment**
- The collection of waste is primarily realised through **formal door-to-door waste collection services**. In the early 2000s many federal states and cities changed from separate kerbside waste collection to **single-stream collection for recycling** including plastics, glass and metals. Around 80% of all US communities today have a single-stream collection of recyclables. Recyclable mixed waste is than typically delivered to sorting facilities.
 - Due to increasing contamination levels (~25%) of the single-stream, recycling is less economical than it was one or two decades ago. As a result, **domestic recycling of plastics is still not seen as profitable for many companies**.
 - Some federal states have very **low landfill fees**. The cost for a tonne of mixed waste to landfill are therefore very low in some federal states (e.g. 20\$ per tonne in Alabama).
 - The **recycling of PET bottles** accounts for the major share of domestic recycled plastics. The recycling of **industrial plastics barrels** is established throughout the country.
 - The total plastics recycling performance differs on a federal state and regional level. The **recycling of non-packaging plastics** is, for example, established in some regions ('island solutions') for **construction and agricultural waste**.

Canada (1/3)



Plastics flow from production to recycling

Canada (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	1.54	47%	1.52	99%	1.50	99%	0.02	1%	0.35	23%	0.06	4%	1.11	72%	0.01	0.4%	0.01	0.6%
Non-packaging	1.73	53%	1.71	99%	1.69	99%	0.02	1%	0.46	27%	0.07	4%	1.19	69%	0.01	0.6%	0.01	0.4%
Σ	3.27	100%	3.24	99%	3.19	99%	0.05	1%	0.81	25%	0.13	4%	2.29	70%	0.02	0.5%	0.02	0.5%

At a glance

- About 3.27 mt of post consumer plastics waste were generated in Canada.
- According to the “Economic Study of the Canadian Plastics Industry, Markets & Waste” published by the Canadian government in 2019, the main generating sectors for plastic waste were **packaging (47% of total plastics waste)**, automotive (9%), textiles (7%), electrical and electronic equipment (WEEE 7%) and construction (5%).
- **Approx. 11 recycling facilities** exist across Canada. These facilities primarily recycle PET (with a total share of 37%), PE-HD (30%), PE-LD (6%), PP (14%) and other plastics (13%).

Canada (3/3)



- The plastics recycling rate based on collected/sorted for recycling was around 25% in 2018 (~0.8 mt of plastics).
- **About 1%** of all plastics waste generated was either discarded in **unmanaged** dumpsites or leaked into the environment (unknown plastics waste).
- **Increasing reliance on single-stream collection systems** in recent years.
- Since the **import ban by Asian countries, including China**, additional quantities of domestic plastics waste have been sent to domestic landfill sites. Due to the **lack of sufficient domestic recycling capacities**, Canada still has high export rates of plastics waste for recycling. In 2018, almost 0.1 mt of plastics waste were exported for recycling.

Waste collection and treatment

- The collection of waste is primarily realised through public and **formal door-to-door waste collection services**. 25% of all plastics discarded are collected for diversion¹⁾ (e.g. through kerbside collection, recycling depots, deposit-refund systems).

- In total, around **0.8 mt of plastics were collected for sorting** (diverted¹⁾) **including ~0.35 mt of packaging plastics** and around 0.3 mt of automotive plastics²⁾.
- The **recycling industry focuses** on **PET, PE-HD and PP**, and is predominantly located in large end-markets providing easier access to plastic waste feedstock, such as in Ontario, Quebec and British Columbia.
- Key barriers to the recovery of plastics are **low diversion rates**, process losses in the sorting (e.g. shredded residues containing plastics sent to landfill) and reprocessing stages and the near-absence of high volume recovery options for hard-to-recycle plastics (e.g., WEEE or ELV plastics).

1) Plastic diverted from direct disposal and sent to a sorting facility (R1)

2) Recovery/recycling of ELVs in total incl. a share plastics that accounted for ~300 kt plastics diverted

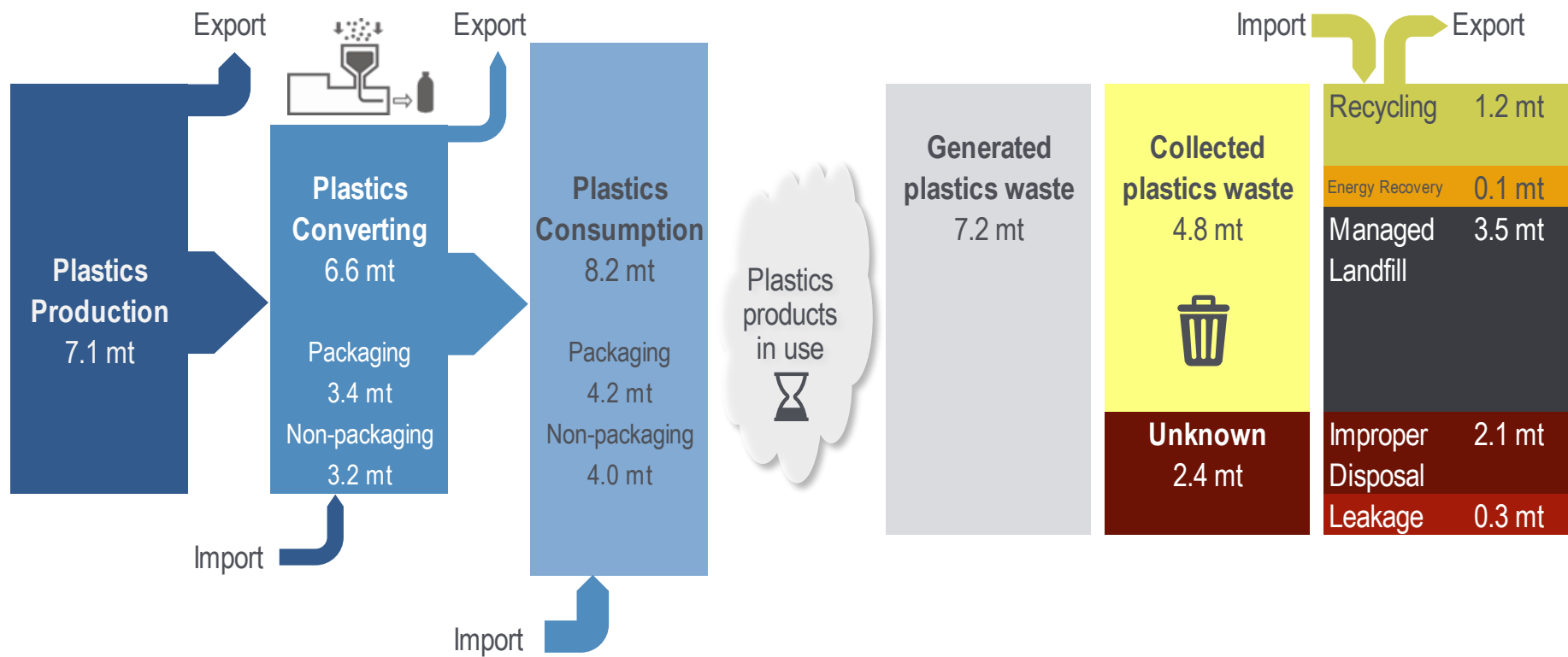
Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100



South and Central America including Mexico

Brazil (1/3)



Plastics flow from production to recycling

Brazil (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
Applications	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	4.54	63%	3.18	70%	1.91	60%	1.27	40%	0.95	21%	0.07	2%	2.15	48%	1.13	25%	0.23	5%
Non-packaging	2.66	37%	1.60	70%	1.04	65%	0.56	35%	0.21	8%	0.04	2%	1.35	51%	0.99	37%	0.08	3%
Σ	7.20	100%	4.77	66%	2.94	62%	1.83	38%	1.17	16%	0.11	2%	3.50	49%	2.12	29%	0.31	4%

At a glance

- Brazil passed a comprehensive **Solid Waste National Policy** in 2010, which recognised waste picking cooperatives as service providers and created **mechanisms to integrate informal waste workers into the country's formal system**.
The legislation's focus was on establishing safe disposal systems, decreasing waste generation and increasing reuse and recycling, all through the combined efforts of the government, private, and informal waste sectors.
- Around **80 mt of municipal solid waste** are generated in Brazil annually. The plastics share is around 9% on average.
- This means that 7.20 mt were generated, of which only 4.77 mt were collected. The unknown quantity is still at a level of 2.4 mt. About 16% was recycled.

Brazil (3/3)

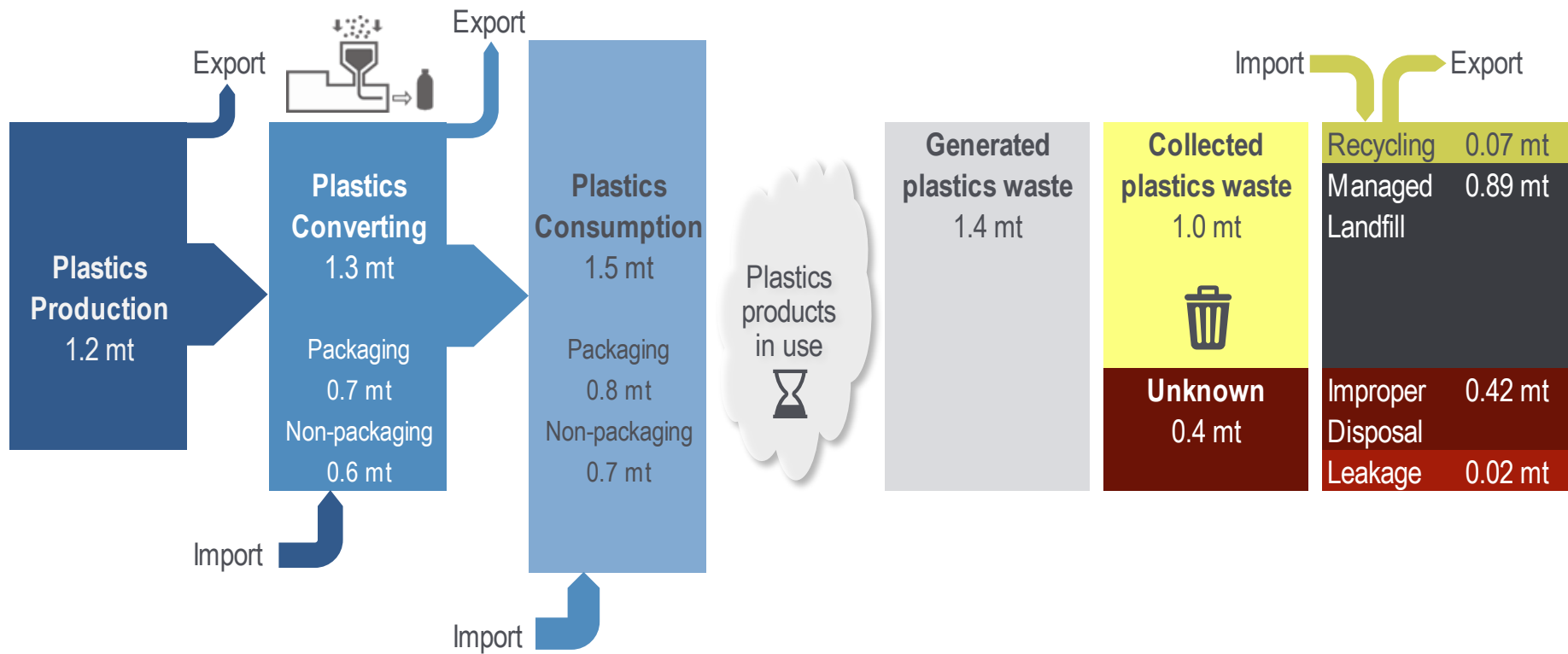


- Figures from the Brazilian plastics industry association (Abiplast) show domestic **consumption of plastics** (plastics products put on the market) of around **6.5 mt** (31 kg/cap.). These figures **contradict** some published plastics **waste figures** of over **10 mt** in total. Accordingly, figures for plastics consumption and for generated plastics waste were **adjusted** to a comparable level for countries with a similar GDP per capita.
- **Rio has prohibited** the use of **plastic drinking straws**, while cities in Sao Paulo have banned petroleum-based plastic bags.

Waste collection and treatment

- **Around 70% of all Brazilian cities have initiatives for recyclable waste.** Recyclable waste is usually collected, sorted and sold to recycling companies via 'Coleta Seletiva' (selective collection).
- According to data from the Institute of Applied Economic Research (IPEA), **around 13% of MSW is sent to recyclers.**
- **Informal waste pickers** contribute the most relevant share of all plastics collected for recycling.
- Based on a study with a focus on the production chain conducted by the Foundation Institute of Administration (FIA) and the University of São Paulo (USP), **Abiplast published that around 550 kt of plastics were recycled in Brazil in 2016** (output-based).
- According to the PET recycler ABIPET, plastics recycling is mainly related to PET bottles, which are primarily collected by informal waste pickers in cities. **Around 50% of PET bottles are recycled** every year (~300 kt in total).
- On average, around 16% of all rigid plastics and films are collected for recycling each year in Brazil. Approximately 60% of all recycled plastics result from commercial and industrial sources and 40% from urban sources.

Colombia (1/3)



Plastics flow from production to recycling

Colombia (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
Applications	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	0.90	64%	0.63	70%	0.54	86%	0.09	14%	0.06	7%	n.a.	n.a.	0.57	63%	0.25	28.0%	0.02	2.0%
Non-packaging	0.50	36%	0.33	70%	0.30	92%	0.03	8%	0.01	1%	n.a.	n.a.	0.32	64%	0.17	34.0%	0.01	1.0%
Σ	1.40	100%	0.95	68%	0.84	88%	0.11	12%	0.07	5%	n.a.	n.a.	0.89	63%	0.42	30.2%	0.02	1.6%

At a glance

- About **2/3** of generated plastics was **collected**, 1/3 was still unknown.
- **Waste pickers**, who are registered by the Colombian Superintendence of Domiciliary Public Utilities, are entitled to receive a percentage of the garbage fee citizens pay.
- Colombia has recently established an **extended producer responsibility (EPR) system** for packaging materials. Among other things, waste management including recycling initiatives are co-financed.

Colombia (3/3)



- Colombia has a **couple of recycling initiatives** for plastics packaging waste such as PE-LD, PE-HD, PP and PET.
- **Socya** is a one example of a private non-profit organisation **developing sustainable solutions** in Colombia. Together with the recycler **Apropet**, the organisation is responsible for the collection of around 1 kt of PET bottles per month from Medellín, Bogotá, Barranquilla and Cali. Apropet is making **food-grade PET resins** for Peru-based packaging manufacturer San Miguel Industries (SMI).
- A couple of **other sustainable initiatives** exist, e.g. by Ajover-Darnel, Carvajal, Biocirculo or Enka. Enka is for example producing food-grade PET resins.

Waste collection and treatment

- **Some cities have PET collection containers.** In rural areas the collection of MSW is realised by a **single mixed waste stream**. A **separate collection** of LWP, including plastics, is **limited** overall (e.g. established in Medellín).
- **The collection of plastics waste for recycling** is primarily realised through **informal waste pickers**.
- **Two large PET bottle recyclers** (Ekored and Apropet) together have a market share of about 80%.
- **Recycled PE-HD resins** are for example used to produce detergents or soaps **packaging** materials, for **construction** and **agricultural** applications and for household products (baskets, brooms, trash cans).
- The **recycling of other plastics** materials is **limited**. Recycling initiatives for other plastics are currently being developed.
- Some **cement kilns** use **plastics** waste for **incineration**/heating processes. MSWI plants for energy recovery do not yet exist in Colombia.
- **Disposal of waste** including plastics in landfill sites accounts for the **major share of treatment** of total waste generated.

Table of contents

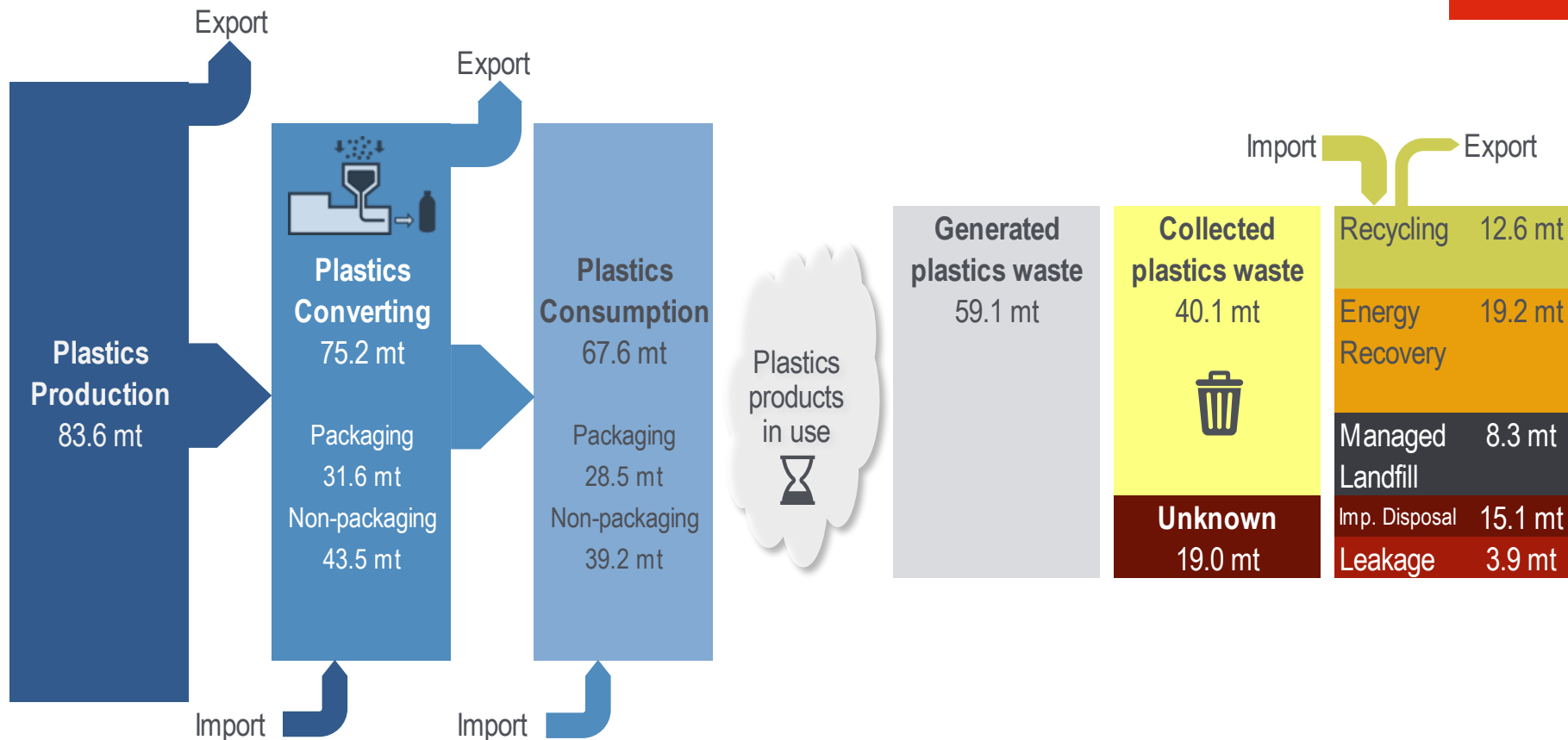
Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100



Asia and Oceania



China (1/3)



Plastics flow from production to recycling

China (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	34.3	58%	24.0	70%	14.4	60%	9.6	40%	9.6	28%	10.3	30%	4.1	12%	7.9	23%	2.4	7%
Non-packaging	24.8	42%	16.1	70%	10.5	65%	5.6	35%	3.0	12%	8.9	36%	4.2	17%	7.2	29%	1.5	6%
Σ	59.1	100%	40.1	68%	24.9	62%	15.2	38%	12.6	21%	19.2	33%	8.3	14%	15.1	26%	3.9	7%

At a glance

- 59.1 mt of post consumer plastics waste were generated in China, of which about 40 mt were collected. About 19 mt were still unknown. The total quantity of 59.1 mt contributes to 23% of global post-consumer plastics waste.
- China recently restricted recyclable waste imports drastically with the implementation of the “**National Sword**” policy. With a growing domestic stock of recyclables and authorities that no longer want China to be seen as the world’s dumpsite, the political leadership has reacted accordingly.
- China does not yet have a ‘real’ formal recycling system.** As a result, many cities turn to private waste management companies that do not yet have adequate recycling strategies for MSW.

China (3/3)

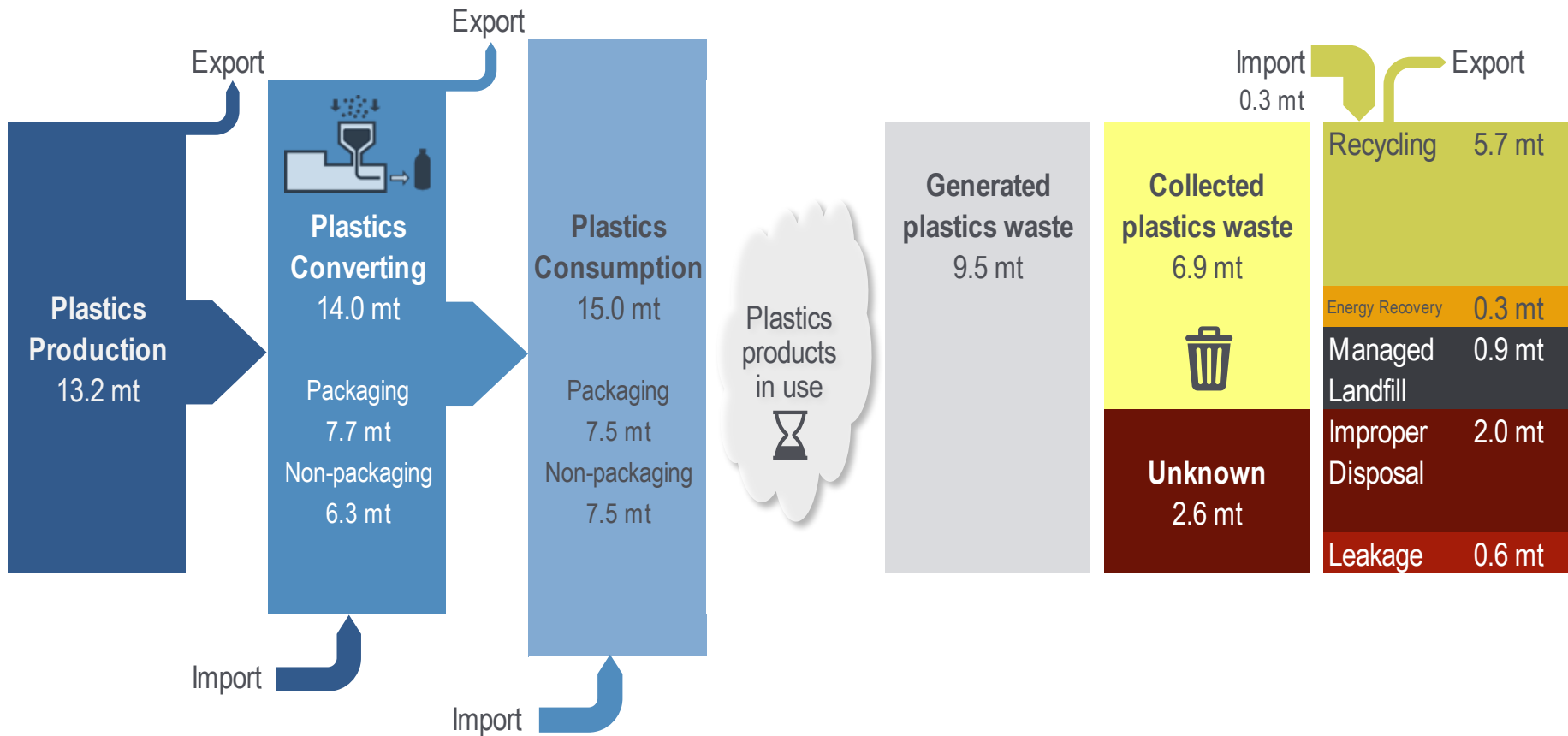


- Overall **data availability** and **accuracy** are **limited** as comprehensive waste statistics, including breakdown into plastics, either **do not exist, or existing studies focus on cities**.
- According to **recent legislation** by the State Council, 46 cities have to achieve a **recycling rate of 35%** for **commercial waste** including office buildings, hotels, institutions, schools but **not households** by 2020,
- **Shanghai** is the first city in China to introduce **mandatory waste separation at source**. In July 2019, a new ordinance came into force in the metropolis of 25 million inhabitants. Violations result in fines. In addition, the **use of single-use plastics** such as cups, tableware and packaging will be **restricted**.
- In **2018**, China acted with an **import ban on 24 types of recyclable materials, including recycled plastics**, as part of an environmental reform movement designed to deal with its own growing domestic waste.

Waste collection and treatment

- The central government announced in 2017 that it would make **waste separation compulsory** for cities by the end of 2020 – and those who did not sort their waste would be charged fees for sorting. The aim is for one-third of the waste produced by large cities to be recycled by the end of next year.
- **Individual waste pickers or small businesses collect and separate waste** from a certain area and sell recyclables to processing centres. These centres sort the waste further and deliver it to recycling plants.
- The existing **ten large waste management companies** in China **will focus strongly on waste incineration for energy recovery** in the next few years. These companies today have a combined incineration input capacity of around 200 kt MSW per day.
- **Informal waste pickers contribute to the largest share of recycled plastics packaging materials** in China. Recycled plastics include PET bottles and other rigid plastics as well as post-consumer films.

India
(1/3)



Plastics flow from production to recycling

India (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
Applications	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	5.95	63%	4.01	67%	1.00	25%	3.01	75%	3.01	51%	0.20	3%	0.80	13%	1.44	24%	0.50	8%
Non-packaging	3.55	37%	2.88	67%	0.19	7%	2.69	93%	2.69	76%	0.09	3%	0.10	3%	0.58	16%	0.09	3%
Σ	9.50	100%	6.89	73%	1.19	17%	5.70	83%	5.70	60%	0.29	3%	0.90	9%	2.02	21%	0.59	6%

At a glance

- Almost **10 mt** of post-consumer **plastics waste** were **generated** in India. The figure was estimated by the Central Pollution Control Board (CPCB) in India.
- Due to low labour costs and existing domestic markets for recycled plastics, the **informal collection and recycling industry** is relatively **large** compared to other emerging countries.
- **Various sources** assume **plastics waste generation per year** to be around **8–15 mt** of plastics waste in total. The United Nations Development Programme (UNDP) for example estimated the total volume to 15 mt of plastics waste generated in 2018.

India (3/3)



- With almost 1.4 bn people, India has the **second largest population** after China.
- **Data availability and quality** in India is generally **limited**. Official statistics from the Central Pollution Control Board (CPCB) published in its annual Report 2017–18 show a volume of **661 kt of plastics waste generated**. However, only 14 of India's 35 state pollution boards (SPBs) provided information for the report. A comprehensive national **waste collection monitoring** system does **not exist**.
- India has a large **informal recycling sector** of **PET** and **PE-HD** bottles and other rigid plastics. **Flexible plastics waste**, including discarded PE-LD bags and films, are **poorly managed**.
- **A high share of** India's waste is still **disposed of** in unmanaged **dumpsites** or in public drains.

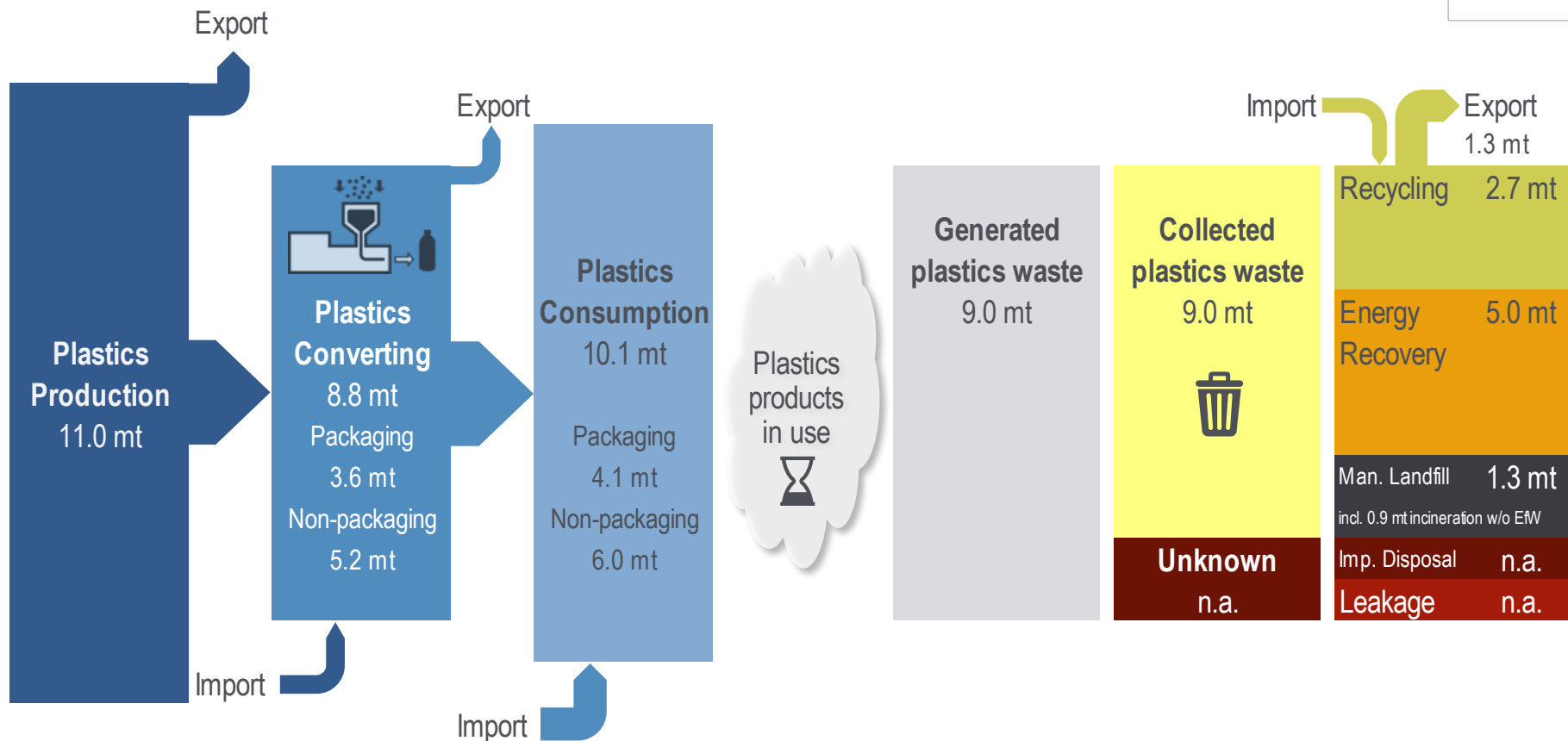
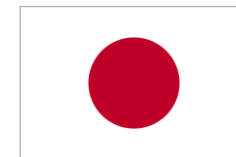
Waste collection and treatment

- Waste collection of **dry waste** in city areas is primarily realised through **informal waste pickers**, especially for **recyclable materials** such as glass, paper, plastics, metals and wood.
- The collection of **wet residual mixed** waste, including organics and non-recyclable or non-valuable materials, is generally **poorly managed**.
- The **recycling rate** for **PET bottles** is **one of the highest** of all emerging countries anywhere in the **world**.
- **Four waste-to-energy plants** exist in India. RDF/SRF utilisation in cement kilns accounts for an additional share of recovered plastics, but data availability is generally limited.
- **Managed dumpsites** are common in urban areas and **cities** but most rural areas lack proper waste management structures.

Editorial note

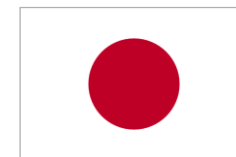
The figures in this report are based on official data from the Central Pollution Control Board (CPCB) and the Indian Centre For Plastic In The Environment with additional support from Reliance Industries. On average around 20% of all non-packaging plastics waste was collected for recycling in Asian countries, which is significantly lower compared to the 76% in India. We assume that the Indian recycling figures were calculated on the basis of the quantities of plastics waste collected rather than generated. Further studies need to address these differences.

Japan (1/3)



Plastics flow from production to recycling

Japan (2/3)

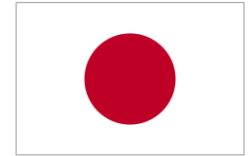


Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	4.15	46%	4.15	100%	4.15	100%	n.a.	n.a.	1.25	30%	2.32	56%	0.58	14%	n.a.	n.a.	n.a.	n.a.
Non-packaging	4.88	54%	4.88	100%	4.88	100%	n.a.	n.a.	1.47	30%	2.71	56%	0.70	14%	n.a.	n.a.	n.a.	n.a.
Σ	9.03	100%	9.03	100%	9.03	100%	n.a.	n.a.	2.72	30%	5.03	56%	1.28	14%	n.a.	n.a.	n.a.	n.a.

At a glance

- About **9 mt** of **plastics waste** were **generated**, of which almost 100% were formally collected.
- Among different **feedstock recycling** processes in Japan, **pyrolytic decomposition** of plastics (coke oven) is most common recycling process.
- 2017 data incl. pre-consumer production and processing waste.

Japan (3/3)

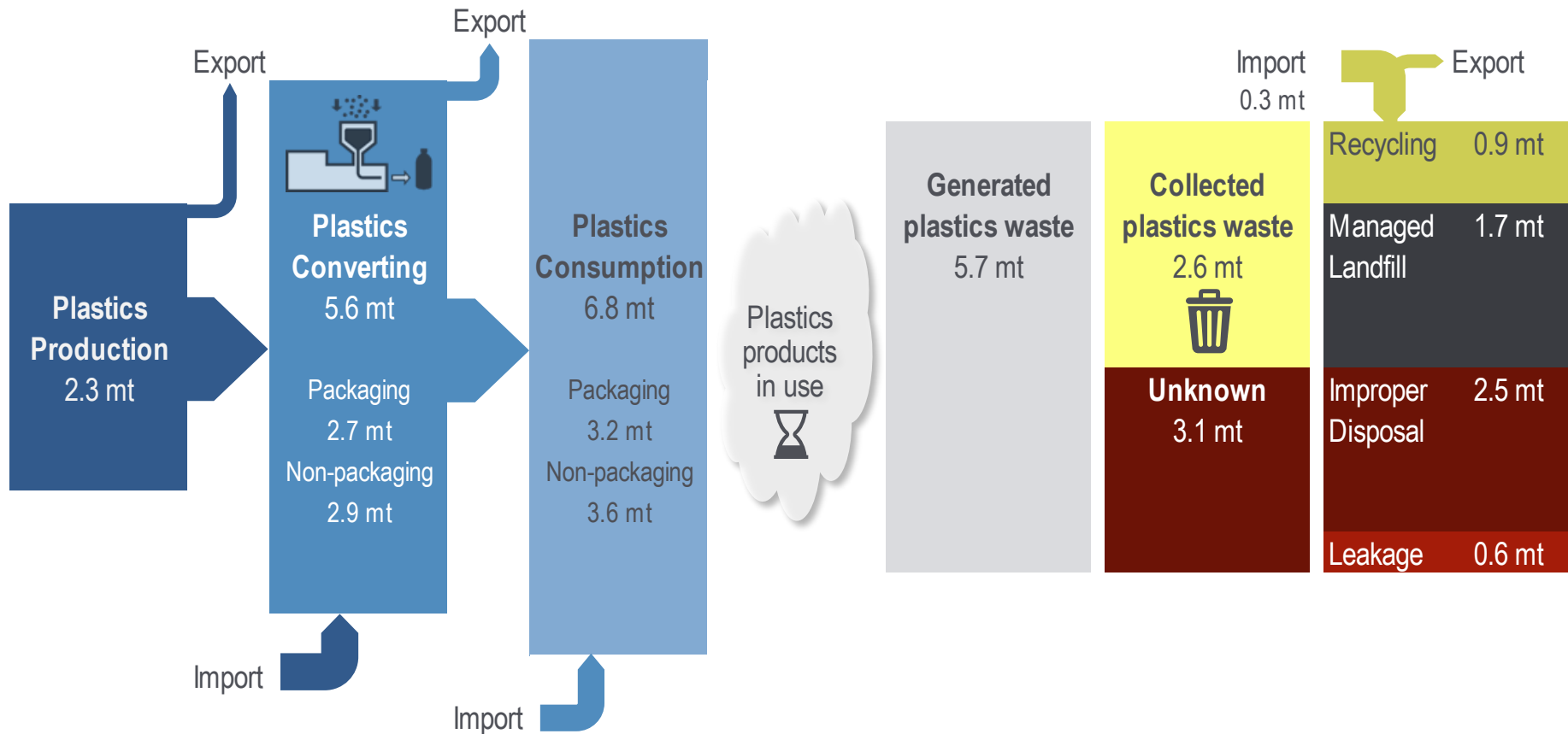


- The flow diagram of the **Plastic Waste Management Institute (PWMI)** in Japan covers the entire lifecycle of plastics including production and waste management from industrial and household sources. PWMI data from 2017 were used for this report. In recent years, Japan has **exported** a large share of its **plastics waste** to China for further treatment. In 2017, around 1.3 mt of plastics waste were exported for recycling. Domestic processing capacities struggle to cope with the higher amounts of domestic waste.
- **Different recycling laws** such as the Containers and Packaging Recycling Law and the Home Appliance Recycling Law have been **implemented**.
- In 2019, Japan's government unveiled a **proposal** with the goal of **reducing** the country's **plastics waste** by 25% by 2030. This Plastic Resource Recycling Strategy has the basic principle of promoting the 3Rs (reduce, reuse, recycle) as well as encouraging the use of recycled plastics and bioplastics.

Waste collection and treatment

- **Formal collection** of waste accounts for **almost 100%** of total collected waste in Japan.
- Japan has established **separate collection** of plastics for **almost all households**, especially for PET bottles.
- In total, **2.3 mt of plastics waste were collected for mechanical recycling**, including 1.5 mt of 'post-use' plastics products and 0.8 mt of production and processing waste. The 1.5 mt 'post-use' plastics include ~40% (0.6 mt) PET bottles.
- **0.4 mt** of plastics waste were collected for chemical recycling.
- The **disposal rate of plastics waste is approximately 14%** in total, including **6% landfill** and **8% incineration without power or heat utilisation**.

Indonesia (1/3)



Plastics flow from production to recycling

Indonesia (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
Applications	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	3.53	62%	1.77	50%	0.71	40%	1.06	60%	0.78	22%	n.a.	n.a.	0.99	28%	1.34	38%	0.42	12%
Non-packaging	2.17	38%	0.87	50%	0.39	45%	0.48	55%	0.15	7%	n.a.	n.a.	0.71	33%	1.15	53%	0.15	7%
Σ	5.70	100%	2.63	46%	1.10	42%	1.54	58%	0.93	16%	n.a.	n.a.	1.70	30%	2.49	44%	0.58	10%

At a glance

- About 5.7 mt of post-consumer plastics waste were generated in Indonesia. More than 50% were still unknown.
- The Indonesian government is currently **developing an analytical waste management data model** to evaluate solutions that can contribute to the country's ambitious national plan to reduce marine plastics debris by 70% by 2025.
- According to Indonesia's Statistics Agency, around **80% of Indonesian MSW is unsorted**, making it difficult to recycle. Many municipalities have a formal collection of mixed MSW, including plastics. **Separate collection at source has not been realised on a large scale** (e.g. waste4change initiative).

Indonesia (3/3)

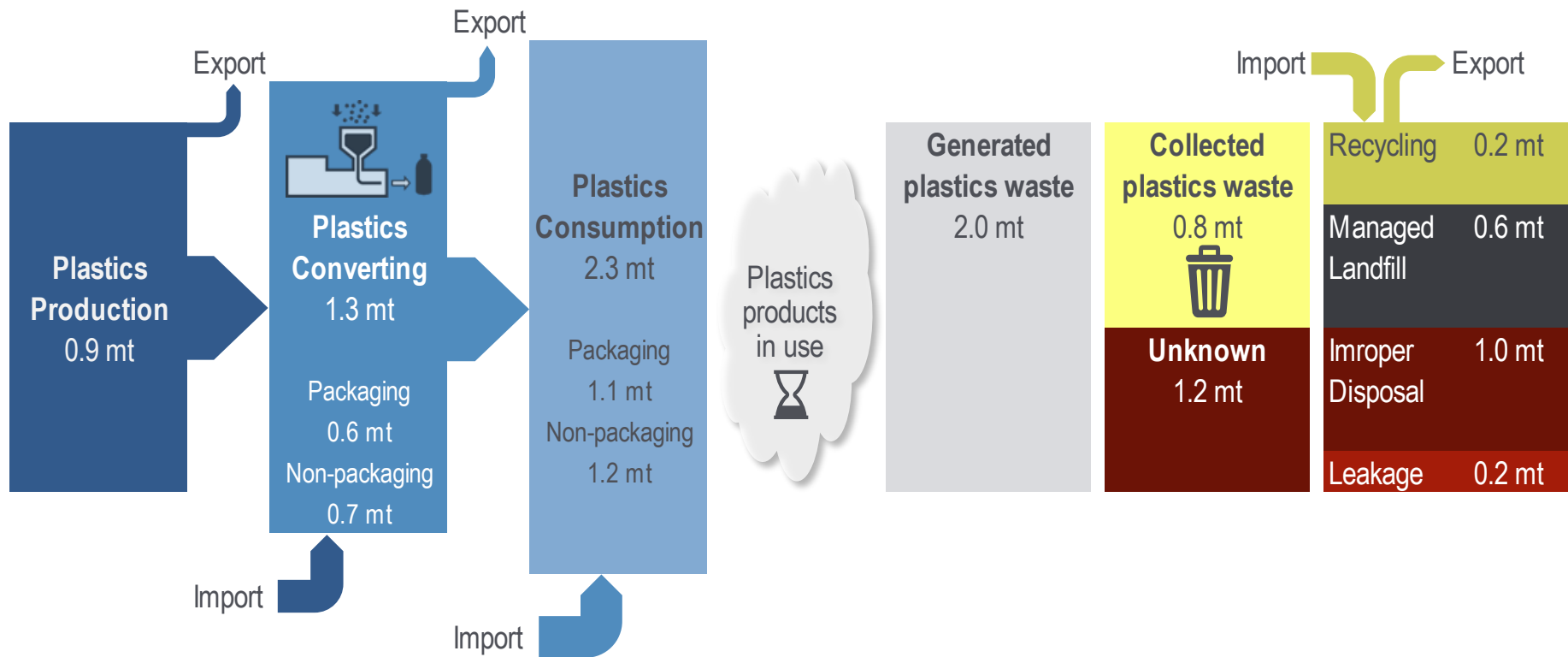


- As in many other Asian countries, there is **no EPR system** in charge of collecting licencing fees for financing plastics packaging waste management.
- The **largest landfill in Indonesia is the Bantar Gebang landfill in Jakarta**, with an estimated 5 mt of MSW and other waste fractions being disposed of every day.
- Since the Chinese ban on waste imports, Indonesia has become one of the **key countries for taking waste imports**, e.g. from Australia. In 2018, around 0.3 mt of plastics waste were imported (often illegally). Authorities have recently **returned around 450 tonnes of plastics waste** to waste exporting countries, including Australia, United States and Canada.
- According to the study “Plastic waste inputs from land into the ocean” (Jambeck et al., 2015), Indonesia contributes to significant volumes **of marine debris, including plastics**. Data from the study “River plastic emissions to the world’s oceans” revealed that four of Indonesia’s rivers – Brantas, Solo, Serayu and Progo – rank among the 20 most polluted rivers in the world (Lebreton, L. C. M. et al., 2017).

Waste collection and treatment

- There is **no adequate formal infrastructure** for recycling plastics waste collected by municipalities. Many recycling activities result from informal recycling activities.
- A **clear distinction between managed and unknown waste is challenging**, as waste from unmanaged dumpsites is often collected and sorted by waste pickers for recycling (primarily rigid plastics).
- **Sorting of domestic and imported plastics waste for recycling has become profitable** for many informal waste pickers. Non-valuable plastics and materials predominantly remain as residues in unmanaged dumpsites.
- **Plastics waste being used as alternative fuel** for different industrial applications and industrial processes is **prevalent**.
- One of the **largest dumpsites** where **plastics waste is channelled for recycling is located** near the city of **Surabaya**.

Philippines (1/3)



Plastics flow from production to recycling

Philippines (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	1.28	64%	0.58	45%	0.17	30%	0.40	70%	0.18	14%	n.a.	n.a.	0.40	31%	0.58	45%	0.13	10%
Non-packaging	0.72	36%	0.25	45%	0.09	35%	0.16	65%	0.04	5%	n.a.	n.a.	0.22	30%	0.42	59%	0.04	6%
Σ	2.00	100%	0.83	41%	0.26	32%	0.57	68%	0.22	11%	n.a.	n.a.	0.61	31%	1.00	50%	0.17	9%

At a glance

- About 2 mt of post consumer plastics waste were generated, 60% were still unknown.
- The **reduction of waste going into landfill is set by law**, but is generally practiced with **low compliance**.
- **Commerce and industry are usually responsible for their own waste treatment**. Private waste management companies (and in some cities public waste management services) are contracted to collect and treat waste.
- An **informal collection** of plastics waste by waste pickers only exists for **recyclables with established markets**.

Philippines (3/3)

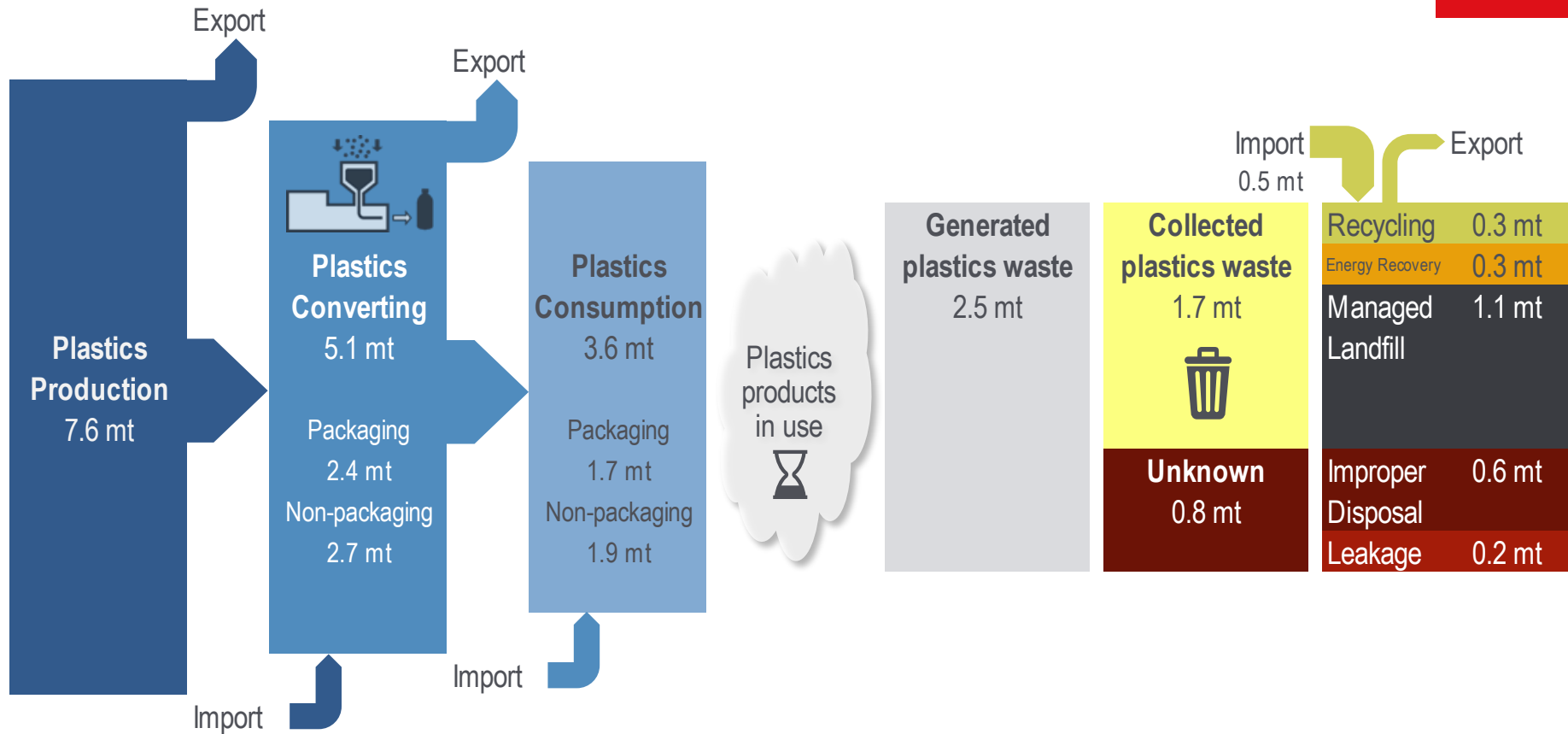


- **The establishment of materials recovery facilities (MRF) is set by law** at Barangay level (smallest administrative division/level) but **overall compliance is low**.
- Typically **established markets** exist for trading **recyclable plastics from commercial and industrial** sources.

Waste collection and treatment

- Many smaller cities and rural areas **do not have proper waste management**.
 - The **collection of industrial and commercial films** (including agricultural films) for recycling has been established **in some areas**.
 - There is **no separate collection of plastics packaging materials**, but in some areas recyclables are collected. In general, waste separation at source is usually performed with low compliance. Mixed waste streams are common.
- **Waste sorting in MRFs is typically realised by manual sorting processes** through workers for the recovery of recyclables. Automation technology for the sorting and processing of waste is only available to a limited extent or does not exist.
 - **Haulers often recover recyclables** with higher market values during waste collection.
 - Rigid packaging plastics such as **PET bottles** and **PE-HD canisters** have higher recycling shares due to established markets for these recycled materials.
 - **PET bottles** were usually **exported** to China for recycling; **PE/PP/PS** is often recycled by **local** recycling companies.
 - **Multilayer films and non-recyclable** plastics are recovered as **RDF** in cement kilns to a **small extent**.

Thailand (1/3)



Plastics flow from production to recycling

Thailand (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	1.55	62%	1.09	70%	0.71	65%	0.38	35%	0.23	15%	0.17	11%	0.68	44%	0.31	20%	0.16	10%
Non-packaging	0.95	38%	0.62	70%	0.43	70%	0.19	30%	0.10	10%	0.09	9%	0.44	46%	0.28	29%	0.06	6%
Σ	2.50	100%	1.70	68%	1.14	67%	0.57	33%	0.33	13%	0.26	10%	1.12	45%	0.59	23%	0.21	8%

At a glance

- According to the Booklet on Thailand State of Pollution 2018 from the Pollution Control Department, the **total volume of MSW generated** was around **28 mt**. Of this, around 7.4 mt were disposed of improperly. 10.9 mt were disposed of under controlled conditions and around **9.6 mt were collected for recovery**.
- The collection of **MSW** for disposal by local administrative organisations (formal collection) is **managed inappropriately** in many areas.
- The total volume of MSW includes about 2.5 mt of post-consumer plastics waste, of which about 70% was collected.

Thailand (3/3)

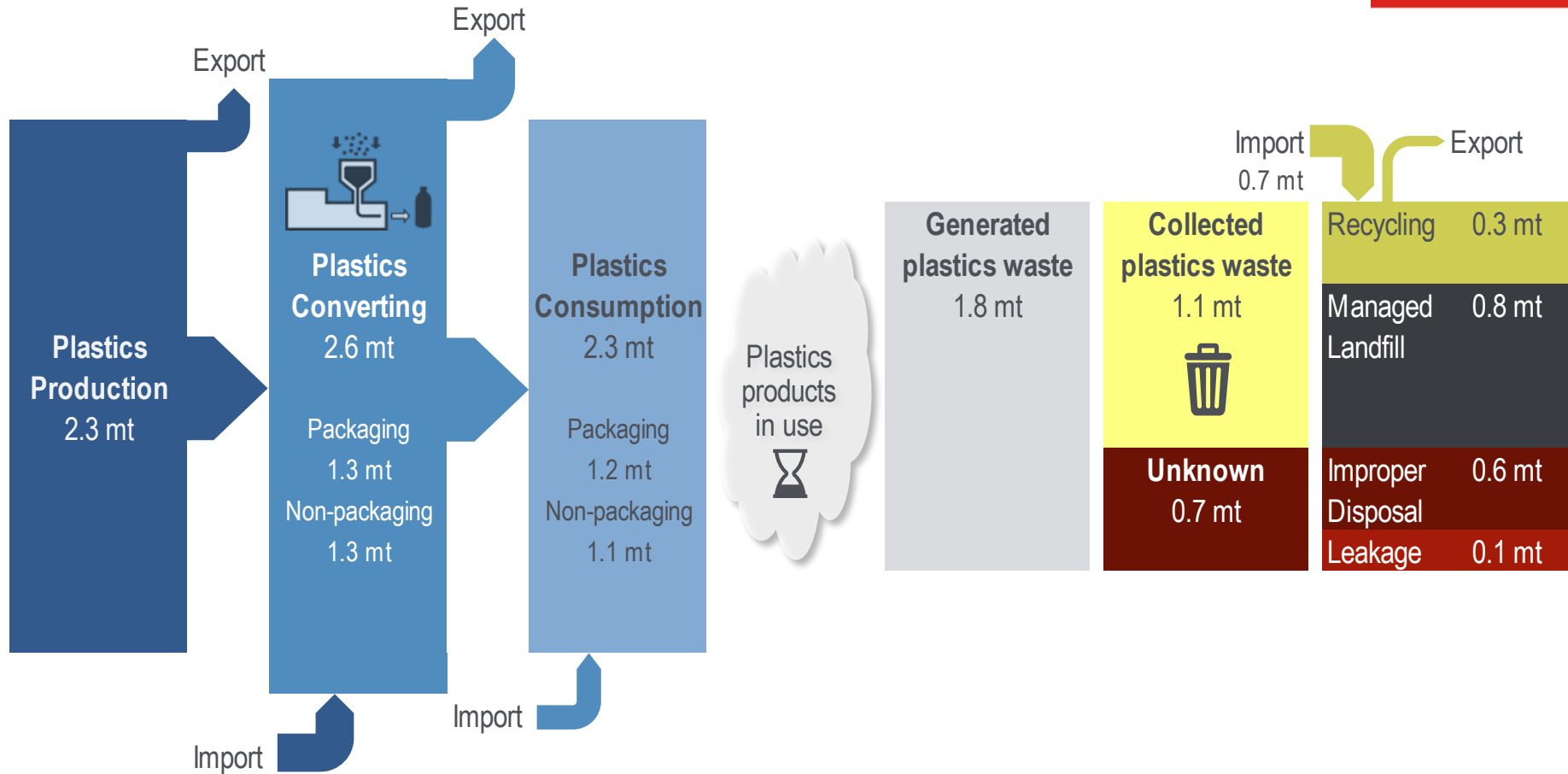


- In **Bangkok**, around **4.9 mt of MSW** were generated in 2018, of which **0.9 mt were segregated for recycling**.
- The **average generation rate** of municipal solid waste (MSW) in Thailand is around **0.7 kg per capita** and day varying from 0.4 kg in rural to 1.2 kg in urban areas.
- According to different sources, the **share of plastics waste in MSW differs** slightly. We aligned our data to the figures provided in the Booklet on Thailand State of Pollution 2018, with around **2 mt of plastics** waste as part of **MSW and** additional **0.5 mt of plastics** waste from **other** post-consumer waste streams.
- Around **500 kt** of plastics as part of MSW **could be used for recycling** (primarily bottles) according to the Pollution Control Department.
- As in many other Asian countries, there is **no EPR system** in place for financing plastics packaging waste management and recycling activities.
- Around **0.5 mt of plastics waste** were **imported** for recycling.

Waste collection and treatment

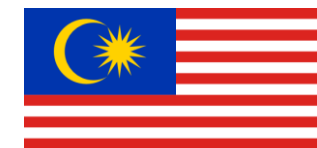
- Some **rural areas** in Thailand do **not yet have access to waste management** services.
- The **separate collection** of plastics waste is generally **limited**, with e.g. only a few cities having established a PET bottle collection.
- Around **500 kt of plastics bottles**, canisters and other rigid plastics packaging materials for food and beverage products were generated as waste in 2018. **1.2 mt tons result from plastics bags and other film materials**. Around 300 kt of plastics waste result from other packaging and non-packaging applications.
- Over **50% of total MSW** was **disposed of** in sanitary landfills and controlled dumpsites.
- Overall, Thailand has around **6 MSWI plants** for energy recovery and **23 mechanical-biological treatments plants** for RDF production.

Malaysia (1/3)



Plastics flow from production to recycling

Malaysia (2/3)

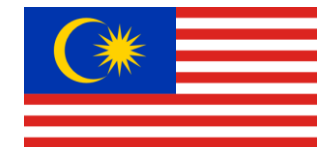


Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	1.15	64%	0.75	65%	0.45	60%	0.30	40%	0.25	22%	n.a.	n.a.	0.50	43%	0.31	27%	0.09	8%
Non-packaging	0.65	36%	0.36	65%	0.25	70%	0.11	30%	0.06	10%	n.a.	n.a.	0.29	45%	0.26	40%	0.03	5%
Σ	1.80	100%	1.11	61%	0.70	63%	0.41	37%	0.32	18%	n.a.	n.a.	0.79	44%	0.57	32%	0.12	7%

At a glance

- In total, around **40 kt of MSW are generated per day** in Malaysia (~14.4 mt per year). The recycling share is around 18% in total.
- Malaysia is one of the few Asian countries with established **waste separation at source**. Nevertheless, mixed waste collection accounts for a major share of all plastics collected.
- Malaysia **has become a large importer of plastics waste** since the implementation of the Chinese waste import ban. In 2018, around 0.7 mt of plastics waste were imported for recycling (<0.2 mt in 2017).
- Post consumer plastics waste accounts for 1.8 mt, about 60% was collected.

Malaysia (3/3)



- Malaysia follows other Asian countries in trying to reduce **uncontrolled imports** of recyclable waste. Official Malaysian authorities argue that their waste management structure cannot cope with the increasing amounts of imported waste. The implementation and enforcement of stricter regulations is challenging.
- A significant number of **illegally operated recycling** plants have been **forced to close** by the authorities. These **privately owned facilities** often recycle plastics under uncontrolled conditions, leading to high levels of plastics leakage. Non-recyclable plastics residues are often burned illegally.
- Malaysia has **dozens of legally operated plastics recycling plants** that focus on the recycling of rigid plastics packaging materials such as PET bottles or PE-HD canisters, and a few factories with focus on PE-LD films.
- Due to **unseparated waste**, more than **30% of potentially recyclable materials** such as paper, plastics, aluminium and glass are still **disposed** of in landfills directly.
- Many landfill sites are poorly managed**, leading to water contamination and waste leakage. In addition, several unmanaged dumpsites with illegally disposed of waste exist.

Waste collection and treatment

- Formal waste collection accounts for a major share** of the total plastics waste collected in Malaysia. The **informal sector** accounts for a **major share of domestically collected plastics** waste channelled **for recycling**.
- The **collection of MSW** is primarily realised through **public waste management** services. A few privately owned waste management companies collect plastics from larger commercial sources or retailers.

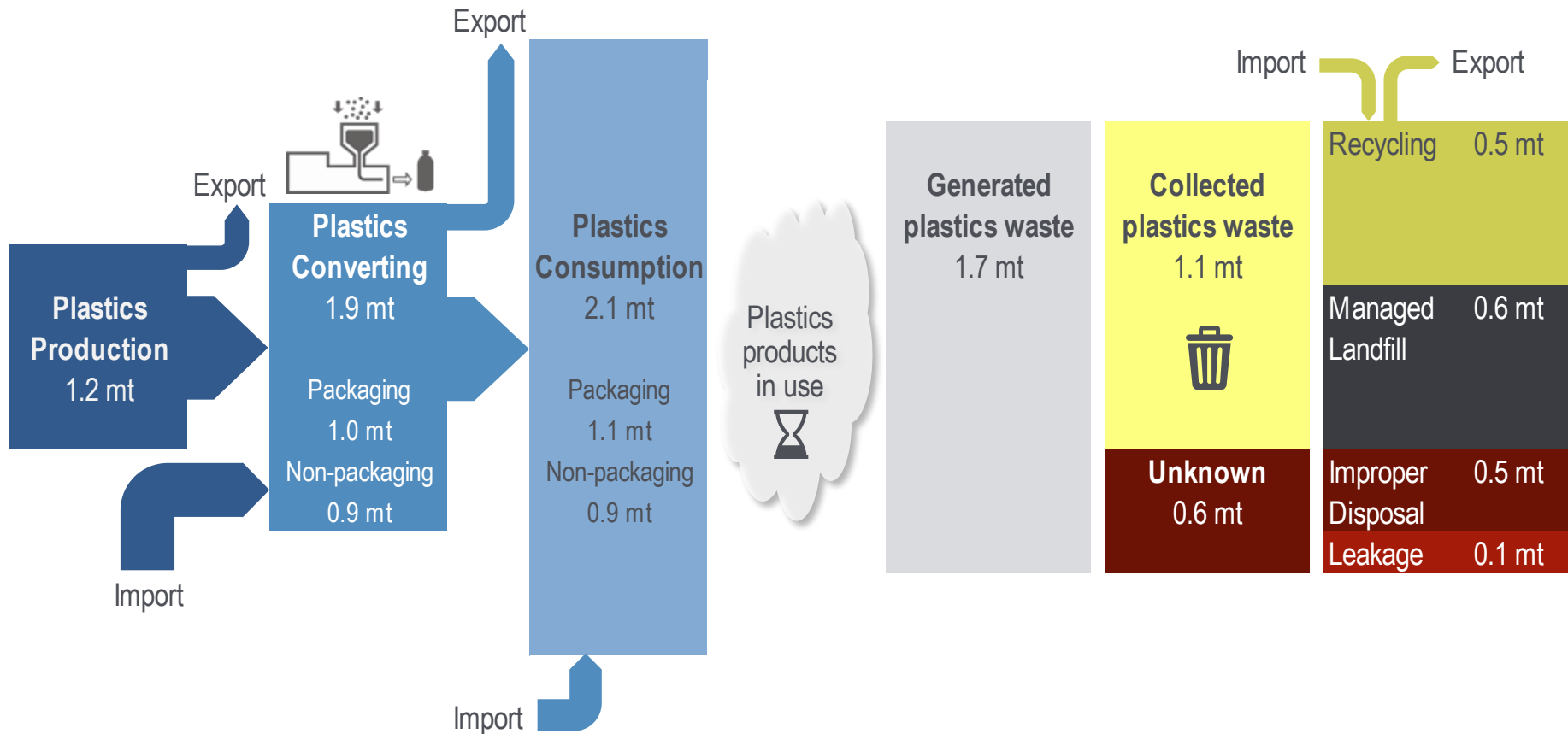
Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100



Africa

South Africa (1/3)



Plastics flow from production to recycling

South Africa (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	1.02	60%	0.69	68%	0.38	55%	0.31	45%	0.40	39%	n.a.	n.a.	0.3	29%	0.28	27%	0.05	5%
Non-packaging	0.68	40%	0.43	68%	0.30	70%	0.13	30%	0.12	18%	n.a.	n.a.	0.3	45%	0.22	33%	0.03	4%
Σ	1.70	100%	1.12	66%	0.68	61%	0.44	39%	0.52	31%	n.a.	n.a.	0.6	35%	0.50	29%	0.08	5%

At a glance

- About 1.7 mt of post-consumer plastics waste were generated, of which 66% was collected.
- South Africa has **one of the highest recycling rates** for plastics of all emerging and developing countries.
- **Plastics packaging** waste accounted for almost **60% of the total plastics waste** generated.
- **Recyclable plastics were mainly obtained directly from landfill sites** (e.g. informal waste pickers) and other post-consumer sources. Around 60% of all materials collected for recycling were sourced from the formal sector.

South Africa (3/3)

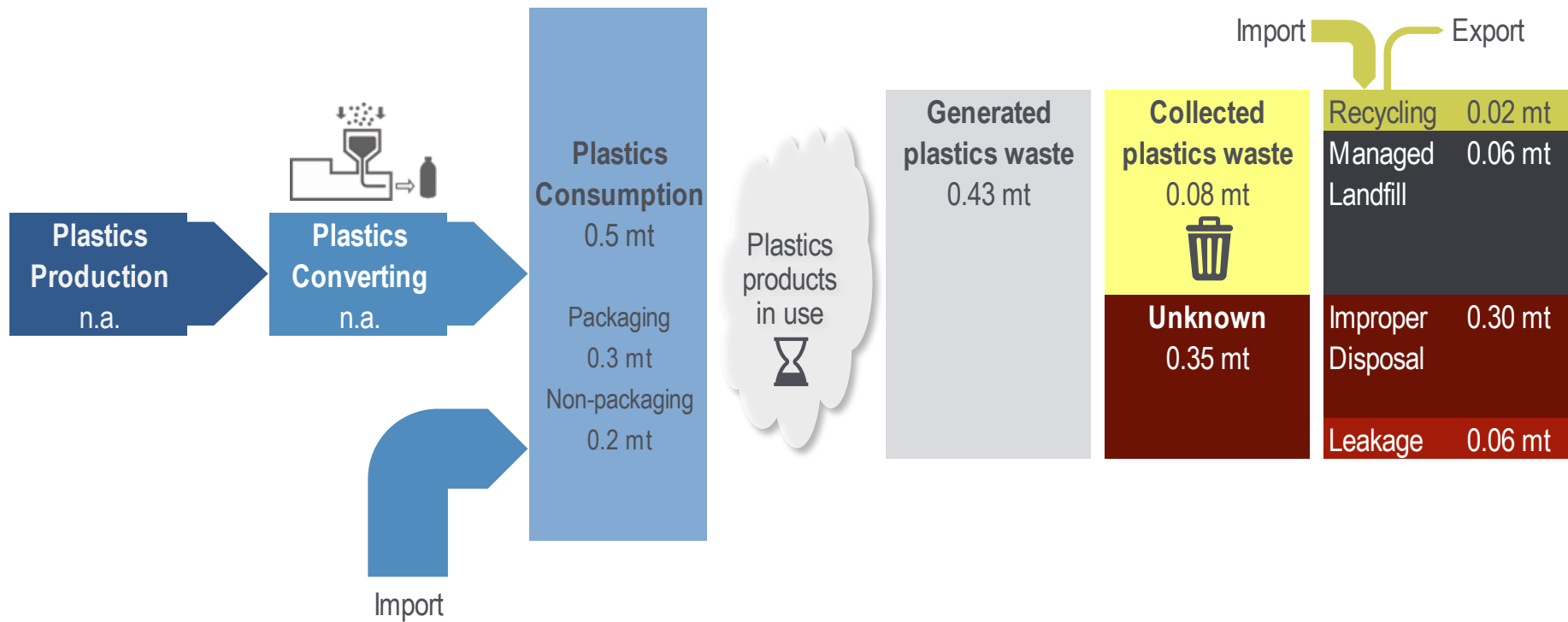


- According to Plastics SA, an association representing the plastics industry in South Africa, **around 330 kt of recycled plastics** were re-used by the plastics converting industry, together with around 1.54 mt of virgin resins.
- The **recycling rate based on collected plastics for recycling** is, at 46% (~520 kt in total), on a par with some of the leading countries in the field of plastics recycling in Europe. The recycling rate calculated based on total plastics waste generated is, at 31%, at a very high level (~1.7 mt plastics waste generated, of which about 1.1 mt are collected).
- Nevertheless, **recycling** in South Africa is primarily **based on financial principles**. Providing **access to waste management services for all inhabitants** is one of the key **challenges** that need to be addressed for diverting unknown waste into managed recovery and disposal streams.

Waste collection and treatment

- The **formal collection** of plastics waste accounts for **around 60%** of the total plastics waste collected in South Africa.
- **MSW including plastics** is primarily collected via a **mixed waste stream**. Separate collection at source has been established in some cities and areas.
- In **cities, waste management companies** offer additional waste collection and treatment services for commercial and industrial sources.
- The **recovery of plastics from landfill sites** contributes to a major share of plastics channelled into recycling streams.
- PE-LD films account for a major share of all plastics packaging materials collected for recycling (around **120 kt of recycled PE-LD/LLD films** in total). Recycled **PET bottles** account for over **70 kt** in total.
- The recycling of **PET bottles** has seen a **steady increase over the last five years** followed by PE-HD bottles, drums and crates.

Ghana (1/3)



Plastics flow from production to recycling

Ghana (2/3)



Plastics waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
Applications	mt	Share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	0.27	62%	0.05	20%	0.01	10%	0.05	90%	0.01	5%	n.a.	n.a.	0.04	15%	0.17	65%	0.04	15%
Non-packaging	0.16	38%	0.02	20%	0.00	15%	0.02	85%	0.01	4%	n.a.	n.a.	0.02	11%	0.12	75%	0.02	10%
Σ	0.43	100%	0.08	18%	0.01	12%	0.07	88%	0.02	5%	n.a.	n.a.	0.06	13%	0.30	69%	0.06	13%

At a glance

- Ghana is **one of the world's fastest growing economies**. The existing waste management infrastructure cannot currently keep up with Ghana's economic growth, leaving many cities, including the capital (Accra), to struggle with increasing volumes of plastics waste.
- The government in Ghana has now set up a **plastics levy system**. Importers of plastics will have to pay levies that will be utilised to finance plastics waste management and recycling systems in the country.
- Today, 0.43 mt are generated, but of this more than 80% is still unknown.

Ghana (3/3)



- Data availability and quality is generally limited. Gathering consistent data requires the **establishment of official and robust data management structures**.
- Ghana is one of the **destinations** in Africa for **imports of used electronics** (and WEEE) from all over the world.
- The **government** of Ghana has announced **it will not be banning any plastics packaging products**, "...The problem is that plastics are not bad, but its management is problematic..." (GhanaWeb 2019: We'll not ban plastics – Government).
- Ghana has rather **strict environmental** laws, but **cannot enforce them adequately**.
- Residents often dispose of their waste in **open dumpsites** or into drains and rivers, which **contributes to flooding** in Ghana's rainy season, as many drains become clogged.
- **Residents in urban areas regularly burn plastics** waste to cope with the waste that builds-up. Burning WEEE waste (e.g. cable waste) to obtain valuable metals is one of the negative side effects of being one of the largest importers of WEEE in Africa.

Waste collection and treatment

- The sanitation minister of Ghana announced that about 300 kt (over 500 kt according to other statistics) of plastics waste are generated per year and **2% is actually recycled** (recycling output).
- Ghana has **recyclers** that produce e.g. road application products and floor slabs from post-consumer plastics waste.

Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100

Extrapolation of plastics waste for Europe and Turkey

Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	~27	60%	~25	93%	~23	92%	~2	8%	~9	33%	~8	30%	~8	30%	~1.4	5.2%	~0.6	2.2%
Non-packaging	~18	40%	~16	89%	~13	81%	~3	19%	~3	17%	~6	33%	~7	39%	~1.8	10.0%	~0.2	1.1%
Σ	~45	100%	~41	91%	~36	88%	~5	12%	~12	27%	~14	31%	~15	33%	~3.2	7.1%	~0.8	1.8%



- The **data extrapolation** for Europe is **based** on waste analyses from **EU28 countries, Norway, Switzerland and Turkey**. Due to the long-time cooperation of all stakeholders, data availability and data quality for EU28+2 countries are highly satisfactory. However, smaller data inaccuracies cannot be excluded.
- For data extrapolation for Europe including Russia and Ukraine, **small adjustments** were made for **plastics waste treatment**. The extrapolation for plastics waste generated was satisfactory based on the correlation factor of population and GDP.
- Around **12 mt** of plastics waste were **collected for recycling** in Europe and Turkey. **3.2 mt** of plastics waste were **improperly disposed of** and **0.8 mt** of plastics ended up as waste **leakage**.

Extrapolation of plastics waste for Northern America

Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
Applications	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	~21	55%	~20	96%	~20	>98%	<0.5	<2%	~3	15%	~3	15%	~14	70%	~0.5	2.4%	~0.3	1.4%
Non-packaging	~17	45%	~16	96%	~17	>98%	<0.5	<2%	~1	6%	~2	12%	~13	82%	~0.5	2.9%	~0.2	1.2%
Σ	~38	100%	~37	96%	~37	>98%	<1	<2%	~4	11%	~5	13%	~28	72%	~1.0	2.6%	~0.5	1.3%



- **Data availability** and **data quality** from **North American** countries were generally **satisfactory** with existing data streams from the United States and Canada covering almost 100% of the Northern American population.
- The **data extrapolation accuracy** for **Northern America** was accordingly also **satisfactory**. The final data set was slightly rounded to be align with the structure of the other data extrapolations.
- **38 mt** of post consumer plastics waste were generated. About **4 mt** of plastics waste were **collected for recycling** in Northern American countries. **1 mt** of plastics waste were **improperly disposed** and **0.5 mt** of plastics ended up as waste **leakage**.

Extrapolation of plastics waste for South and Central America including Mexico

⚠ Limited data reliability

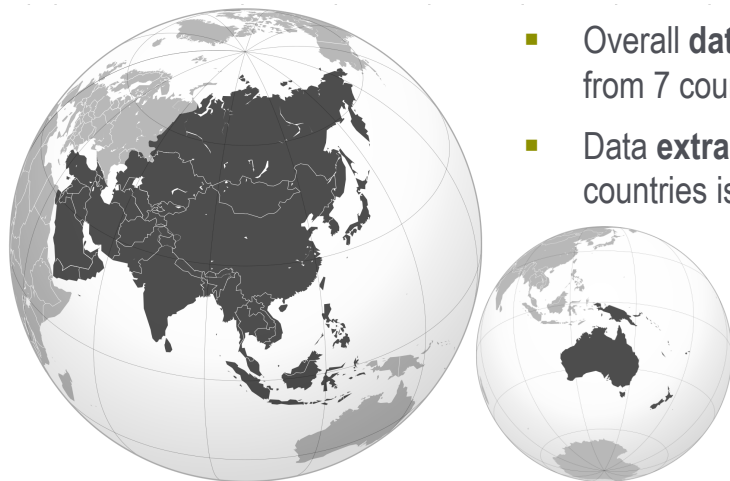
Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	~16	59%	~10	63%	~5	50%	~5	50%	~3	30%	~2	20%	~5	50%	~4.8	30%	~1.2	8%
Non-packaging	~11	41%	~5	45%	~2	40%	~3	60%	~1	20%	~1	20%	~3	60%	~5.5	50%	~0.5	5%
Σ	~27	100%	~15	56%	~7	47%	~8	53%	~4	15%	~3	11%	~8	30%	~10.3	38%	~1.7	6%



- Due to the lack of comprehensive data collection and monitoring structures, data availability and data quality in **South American** countries are generally **limited**. A larger informal sector also leads to higher level of uncertainty.
- The **data extrapolation accuracy** for South and Central America including Mexico with available data streams from Brazil and Colombia is limited, especially for plastics waste treatment. The final data set was slightly adapted to represent and scale other South American countries.
- **27 mt** of post-consumer plastics waste were generated. About **4 mt** of plastics waste were **collected for recycling** in South and Central America. **10.3 mt** of plastics waste were **improperly disposed** and **1.7 mt** of plastics ended up as waste **leakage**.

Extrapolation of plastics waste for Asia and Oceania

Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	~68	60%	~44	65%	~27	61%	~17	39%	~18	26%	~15	22%	~11	16%	~19.0	28%	~5.0	7%
Non-packaging	~46	40%	~28	61%	~21	75%	~7	25%	~9	20%	~13	28%	~6	13%	~15.5	34%	~2.5	5%
Σ	~114	100%	~72	63%	~48	67%	~24	33%	~27	24%	~28	25%	~17	15%	~34.5	30%	~7.5	7%



- Overall **data availability** and **data quality** from **Asian** countries was **satisfactory** with data streams from 7 countries.
- Data **extrapolation accuracy** for **Asia and Oceania** with available data streams from seven countries is at a **satisfactory** level. The final data set was slightly rounded afterwards.
 - 114 mt of post-consumer plastics waste were generated in Asia and Oceania, which reflects almost one half of the global plastics waste generation.
 - Around **27 mt** of plastics waste were **collected for recycling** in Asia and Oceania. **34.5 mt** of plastics waste were **improperly disposed of** and **7.5 mt** plastics ended up as waste **leakage**.

Extrapolation of plastics waste for Africa

! Limited data reliability

Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	~16	62%	~6	38%	~3	50%	~3	50%	~2	13%	<0.1	1%	~4	24%	~8.0	50%	~2.0	13%
Non-packaging	~10	38%	~4	40%	~2	50%	~2	50%	~1	10%	<0.1	1%	~3	29%	~5.0	50%	~1.0	10%
Σ	~26	100%	~10	38%	~5	50%	~5	50%	~3	12%	<0.2	1%	~7	26%	~13.0	50%	~3.0	12%

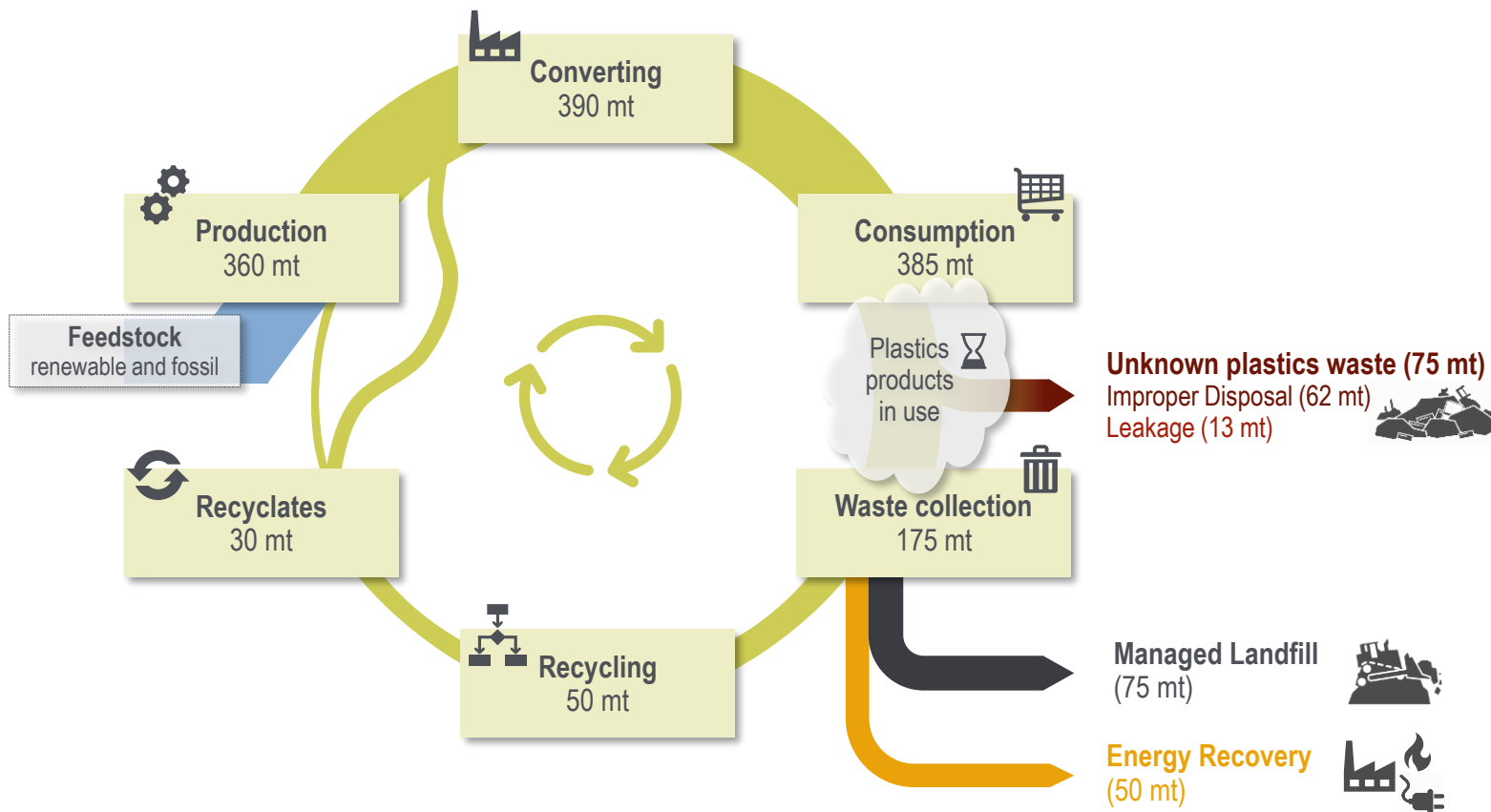


- Overall **data availability** and **data quality** from **African** countries were **limited** with data streams from South Africa and Ghana. The overall findings in South Africa were satisfactory, data quality from Ghana needs to be improved.
- Data extrapolation accuracy** for Africa with available data streams only from South Africa and Ghana —countries that are fundamentally different in their waste management strategies — is generally very **limited**. The data extrapolation for plastics waste generated as well as for plastics waste treatment needed to be adjusted to mirror other African countries adequately.
- Around **3 mt** of plastics waste were **collected for recycling** in Africa. **13 mt** of plastics waste were **improperly disposed of** and **3 mt** plastics ended up as waste **leakage**.
- About **26 mt** of the post-consumer plastics waste were generated in Africa.

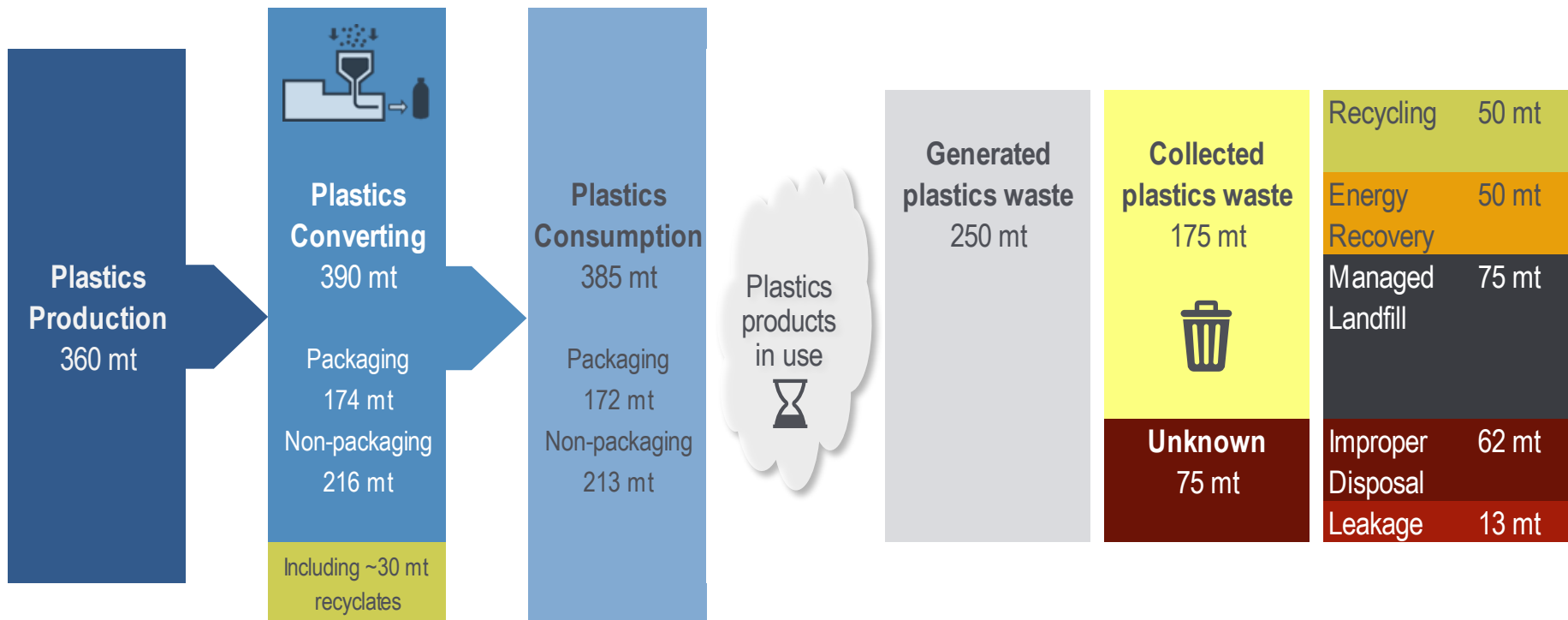
Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100

Results of the survey Global Plastics Flow 2018



World 2018 (1/3)



Plastics flow from production to recycling

World 2018 (2/3)



Plastics waste as part of total waste	Generated		Collected for treatment						Treatment				Unknown					
	Total		Total		Thereof Formal		Thereof Informal		Recycling		Energy Recovery		Managed Landfill		Improper Disposal		Leakage	
Applications	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share	mt	share
Packaging	~148	59%	~104	70%	~78	75%	~26	25%	~35	24%	~28	19%	~41	28%	~35	24%	~9	6%
Non-packaging	~102	41%	~71	70%	~55	77%	~16	23%	~15	15%	~22	22%	~34	33%	~27	26%	~4	4%
Σ	~250	100%	~175	70%	~133	76%	~42	24%	~50	20%	~50	20%	~75	30%	~62	25%	~13	5%

- Around **250 mt** of **plastics waste** were generated worldwide in 2018. **175 mt** of plastics waste were collected for waste treatment and **75 mt** of plastics waste remained **unknown**.
- **100 mt** of plastics waste were **recovered** worldwide, of which around **50 mt** of plastics waste were collected for **recycling**. Assuming a process loss of ~40%, around 30 mt of plastics were recycled. **Energy recovery** of plastics waste accounted for **50 mt** in total.
- **75 mt** of plastics waste were **disposed of** in sanitary landfills or controlled dumpsites. Another **62 mt** of plastics waste were **improperly disposed of** and plastics waste **leakage** accounted for around **13 mt** in total (30% of the material is still unknown).

World 2018 (3/3)



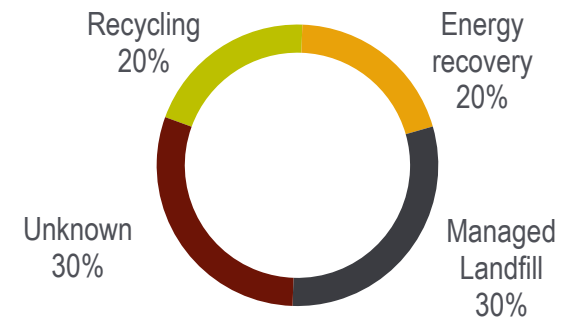
Production and consumption of plastics

- The world extrapolation based on 44 individual data streams covering 60% of the world's population and 80% of the world's GDP resulted in a plastics production volume of approx. 360 mt.
- Approx. 390 mt of plastics were used by the plastics converting industry for the production of plastics products, including the usage of ~30 mt recyclates.
- Total global plastics consumption by almost 8 bn individuals was estimated to be a volume of 385 mt in total.

Plastics waste generation and collection

- According to the extrapolation in this survey, around 250 mt of plastics waste were generated worldwide.
- Around 175 mt (70%) of plastics waste were collected by formal and informal waste collection schemes.
- Informal waste pickers account for a major share of plastics waste for recycling, especially in emerging countries. Some countries have integrated informal waste schemes into their formal waste management system, which is beneficial for the overall plastics recycling performance.






Plastics waste treatment and unknown plastics waste

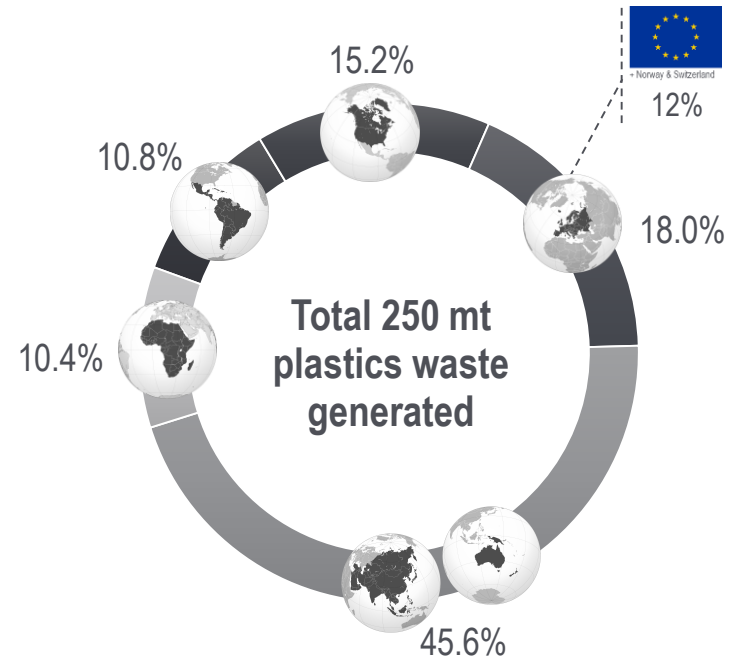


- Economically emerging countries such as India and China will play an import role when it comes to plastics waste generation and plastics waste treatment in the future. Together with accompanying measures in these countries such as investment in proper waste collection structures, new sorting and recycling technologies and consumer education, global plastics waste leakage could be reduced significantly. Today, Asia and Africa account for more than 80% of unknown plastics waste.

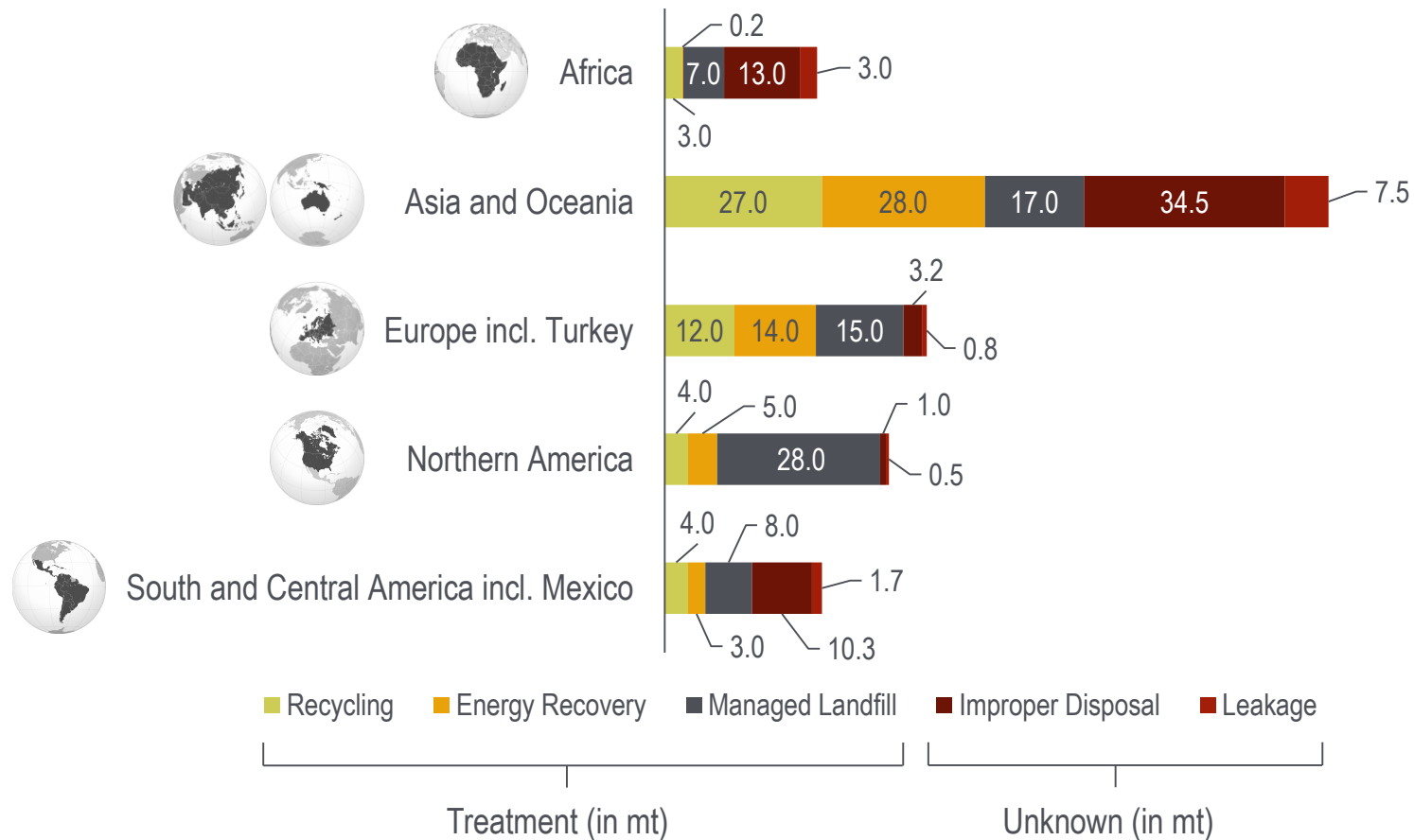
Post-consumer plastics waste generation by region



Region	Quantity in mt	Share in %
 Africa	26	10.4
 Asia and Oceania	114	45.6
 Europe and Turkey	45	18
 Northern America	38	15.2
 South and Central America incl. Mexico	27	10.8
Total	250	100



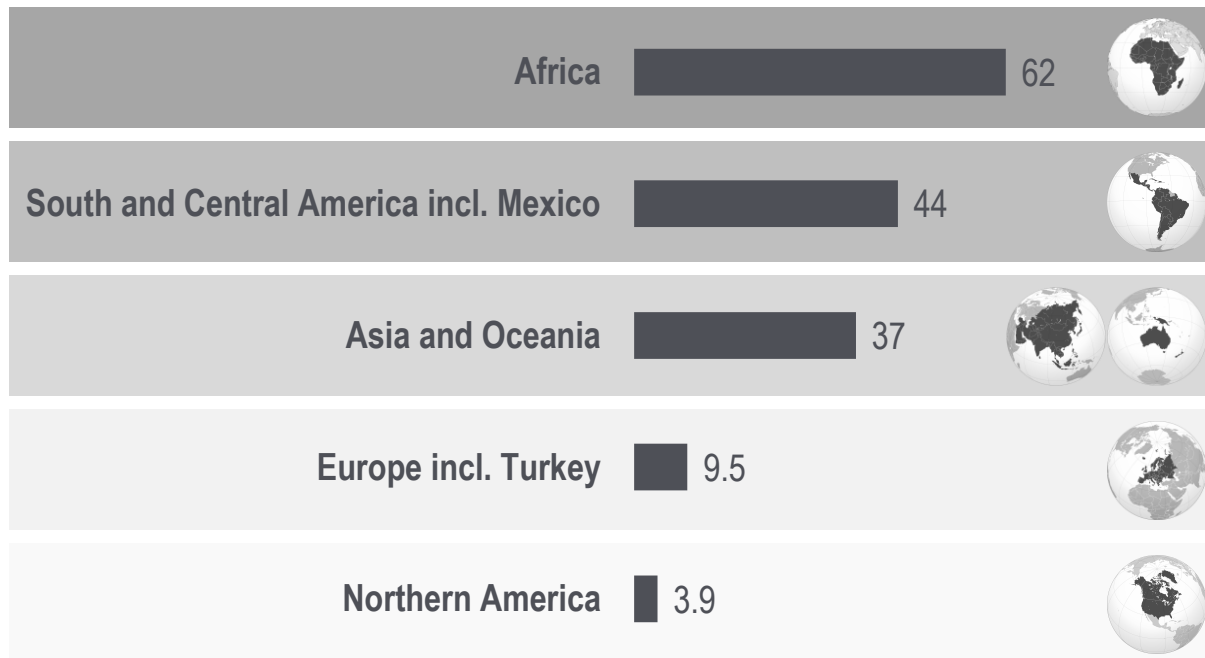
Post-consumer plastics waste generation and treatment by region



Unknown plastics waste



Unknown plastics waste within a region (in %)



Global shares and volumes of unknown plastics waste

22%	16 mt
12%	12 mt
60%	42 mt
5%	4 mt
<2%	<1.5 mt
100%	~75 mt

Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100

Management summary (1/3)

About the survey

- The results of this study using existing plastics flow analyses from 44 countries worldwide covering 60% of the world's population and 80% of the world's GDP and with additional support from country representatives of the plastics industry as well as extensive secondary research is the very first attempt made by the plastics industry to track total global post-consumer plastics flow from plastics production to plastics waste.
- This study gives a detailed overview of post-consumer plastics flow with a focus on plastics waste generation, collection and treatment. Furthermore, plastics waste leakage as part of poorly managed or unknown waste is also described.

Data availability and quality

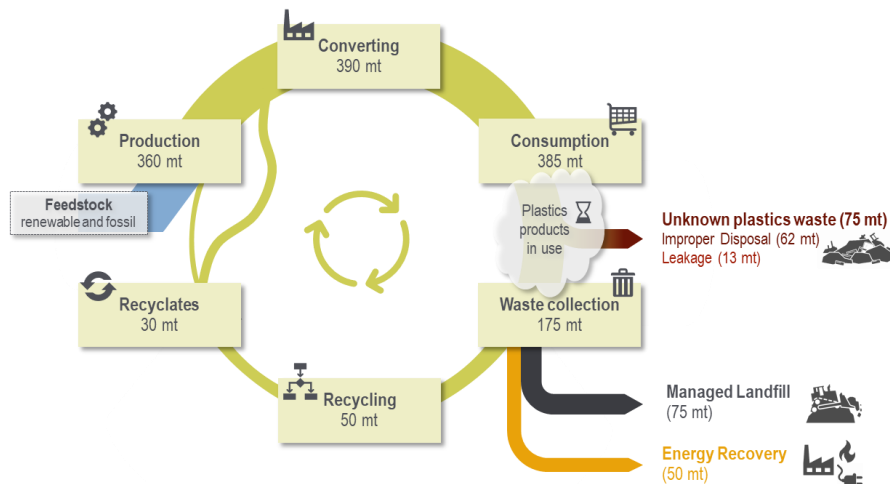
- The data availability and data quality differ significantly from country to country. Almost every developed country has a national statistical office that collects and harmonises data on the plastics in general and on municipal solid waste (MSW) including plastics. However, not all existing waste streams are statistically covered even in these countries.

- Data modelling and information collection from different additional sources are often necessary in order to obtain a complete picture.
- Data availability and data quality in less developed or emerging countries are even more difficult. In many Latin American, African, Asian and Eastern European countries, important data flows about plastics do not often exist. Scientific articles, information brochures and analyses from plastics associations together with newspaper articles are often the only available data sources that can be used.
- This study tries to keep data corrections to a minimum and focuses on harmonising data streams based on kg per capita (e.g. plastics waste generated) and GDP per capita.
- Overall data accuracy will improve significantly with globally harmonised definitions and more countries contributing with individual data streams to an extrapolation of global plastics flow.

Management summary (2/3)

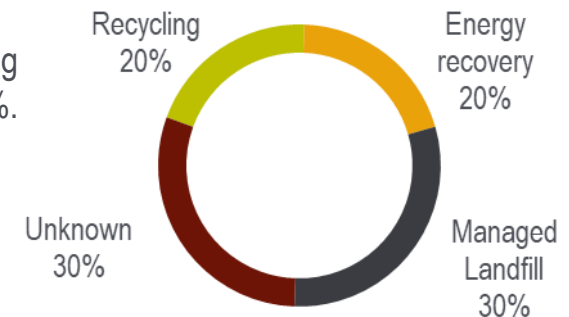
Results at a glance

- The results of this study show that, based on a global extrapolation, around 360 mt of virgin plastics were produced, 390 mt plastics (including 30 mt recyclates) were converted plastics products and around 385 mt plastics products were consumed or put on the market.



- Around 250 mt of plastics waste were generated and 62 mt of plastics waste were disposed of under improper conditions (i.e. unsanitary landfills, improper burning or burial of waste).

- Around 13 mt of plastics waste leaked into the environment (i.e. dispersion of plastics waste caused by flooding, wind or individual mismanagement).
- About 175 mt of plastics waste were collected either formally by municipal or privately organised and contracted waste collection and management services or informally by waste pickers, organised groups or smaller companies. In less developed countries, informally collected plastics waste contributes a high share to overall plastics recycling (e.g. India). Waste pickers usually collect plastics directly from the source, e.g. through door-to-door collection or recovery of marketable plastics fractions from dumpsites.
- The quantity of plastic waste sorted for recycling was 50 mt, or about 20%. 50 mt (20%) were accounted for by energy recovery and 75 mt (30%) went to landfill.¹⁾



1) Challenging is the prevention of double counting (e.g. formally collected and statistically recorded waste for disposal on dumpsites and afterwards informally collected plastics for recovery from these dumpsites).

Management summary (3/3)

- The recovery of marketable plastics fractions for recycling is a profitable business for many people in Latin America, Africa and Asia.
- Separately collected waste streams accounted for the minor share of all plastics waste collected. In addition, separately collected waste streams have been replaced with mixed waste streams in wealthy countries such as the United States or Canada. Deposit schemes, e.g. for PET bottles, are only established in a few countries.
- Overall, around 50 mt tons of plastics were collected or sorted for recycling. Assuming a process loss of 40%, global output-based plastics recycling had a volume of around 30 mt.
- Energy recovery of plastics waste accounted for around 50 mt in total. Asian countries in particular are currently investing in energy from waste solutions, including municipal solid waste incineration (MSWI) plants. China has in recent years extensively expanded its waste incineration capacities to cope with the increasing volumes of domestically generated MSW, including plastics.
- The disposal of plastics waste in sanitary landfills and in controlled dumpsites accounted for around 75 mt in total. A clear distinction between improper disposal and 'safe' disposal is not always possible due to ambiguous data or varying definitions.

Trade in waste

- Nevertheless, high volumes of waste exports for recycling from developed countries to emerging countries with improper waste management and recycling infrastructures could be identified. Developed countries need to invest in robust domestic recovery and recycling solutions to cope with their own waste.
- Destinations for waste exports for recycling from developed countries to Asian countries have changed since the implementation of the Chinese import ban on different waste types including unsorted packaging waste. Other Asian countries became new destinations for waste imports. Some of these countries are already sending waste back to the countries of origin.

Table of contents

Background, motivation and introduction of the survey	4
Definitions	10
Data availability, robustness and limitations	16
Plastics flow model	21
Europe incl. Turkey	27
Northern America	35
South and Central America incl. Mexico	43
Asia and Oceania	51
Africa	74
Extrapolation regions	82
Extrapolation World	88
Management summary	96
References and appendix	100

References [extract] (1/2)

- American Chemistry Council and Association of Plastic Recyclers (2018). 2017 United States National Postconsumer Plastic Bottle Recycling Report. <https://plastics.americanchemistry.com/Reports-and-Publications/National-Post-Consumer-Plastics-Bottle-Recycling-Report.pdf>
- Aydin, N. (2017). Review of Municipal Solid Waste Management in Turkey with a Particular Focus on Recycling of Plastics. *Energy Procedia*, 113, 111-115. <https://reader.elsevier.com/reader/sd/pii/S1876610217321549?token=D2AF2429AF56FABAFE58940EFE402C067468C8F0F8D70E6DF390C968D175935B6079681CC9EC7C0D68CFA232F1C2A837>
- Brooks, A. L.; Wang, S.; Jambeck, J. R. (2018). The Chinese import ban and its impact on global plastic waste trade. *Science advances*, 4(6), eaat0131. <https://advances.sciencemag.org/content/4/6/eaat0131.full>
- Ellen MacArthur Foundation (2017). The New Plastics Economy: Rethinking the future of plastics. https://www.ellenmacarthurfoundation.org/assets/downloads/EllenMacArthurFoundation_TheNewPlasticsEconomy_Pages.pdf
- Environmental Protection Agency (2018). Advancing Sustainable Materials Management: 2015 Fact Sheet. https://www.epa.gov/sites/production/files/2018-07/documents/2015_smm_msw_factsheet_07242018_fnl_508_002.pdf
- Federation of Indian Chambers of Commerce and Industry (2017). Sustainable Infrastructure with Plastics: Knowledge Paper on Plastic Industry for Infrastructure. <http://ficci.in/spdocument/20872/report-Plastic-infrastructure-2017-ficci.pdf>
- Geyer, R. et al. (2017). Production, use, and fate of all plastics ever made. *Science Advances*, 3, e1700782. https://www.researchgate.net/publication/318567844_Production_use_and_fate_of_all_plastics_ever_made
- Greenpeace (2019). Data from the global plastics waste trade 2016-2018 and the offshore impact of China's foreign waste import ban: An analysis of import-export data from the top 21 exporters and 21 importers. <http://www.greenpeace.org/eastasia/Global/eastasia/publications/campaigns/toxics/GPEA%20Plastic%20waste%20trade%20-%20research%20briefing-v1.pdf>
- Jambeck, J. R.; Geyer, R.; Wilcox, C.; Siegler, T. R.; Perryman M.; Andrady A.; Narayan R. & Law K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, 347(6223), 768-771. <http://science.sciencemag.org/content/347/6223/768.full>
- Lebreton, L.; Andrady, A. (2019). Future scenarios of global plastic waste generation and disposal. *Palgrave Communications*, 5(1), 6. <https://www.nature.com/articles/s41599-018-0212-7>
- Lewis, H.; Atherton, A. (2018). Addressing plastic pollution in India, Report on Mumbai July 2018 Business Forum on Addressing Plastic Pollution in India, prepared for Stewart Investors, Institute for Sustainable Futures, University of Technology Sydney, Australia. https://www.uts.edu.au/sites/default/files/article/downloads/StewartInvestors_INDIA_WEB_NoDisclaimer.pdf
- McKinsey & Company (2018). How plastics waste recycling could transform the chemical industry. <https://www.mckinsey.com/industries/chemicals/our-insights/how-plastics-waste-recycling-could-transform-the-chemical-industry>
- Meidiana, C.; Gamse, T. (2010). Development of waste management practices in Indonesia. *European journal of scientific research*, 40(2), 199-210.

References [extract] (2/2)

- More Recycling (2019). 2017 National Post-Consumer Non-Bottle Rigid Plastic Recycling Report.
<https://plastics.americanchemistry.com/2017-National-Post-Consumer-Non-Bottle-Rigid-Plastic-Recycling-Report.pdf>
- Owusu-Sekyere, E. et al. (2013). An analysis of plastic waste collection and wealth linkages in Ghana. *International Journal of Current Research*, 5, 205-209.
https://www.researchgate.net/publication/267028222_An_analysis_of_plastic_waste_collection_and_wealth_linkages_in_Ghana/link/54418e890cf2a6a049a5b103/download
- Plastic Waste Management Institute Japan (2019). *Plastic Products, Plastic Waste and Resource Recovery 2017*.
- Plastics Industry Association (2018). *Size and Impact of the Plastics Industry on the U.S. 2018*.
<https://access.plasticsindustry.org/ItemDetail?iProductCode=AB168&Category=PUBLICATION>
- PlasticsSA (2019). *National plastics recycling survey 2018*.
<http://www.plasticsinfo.co.za/where-to-recycle/>
- Resources Management for Sustainability (3R) Foundation, Thailand (2017). *Country Chapter State of the 3Rs in Asia and the Pacific*.
[http://www.uncrd.or.jp/content/documents/5695\[Nov%202017\]%20Thailand.pdf](http://www.uncrd.or.jp/content/documents/5695[Nov%202017]%20Thailand.pdf)
- Ritchie, H.; Roser, M. (2018). *Plastic Pollution. Our World in Data*.
<https://ourworldindata.org/plastic-pollution>
- Ryan, P. G.; Perold, V.; Osborne, A.; & Moloney C. L. (2018). Consistent patterns of debris on South African beaches indicate that industrial pellets and other mesoplastic items mostly derive from local sources. *Environmental Pollution*, 238, 1008-1016.
<https://www.sciencedirect.com/science/article/pii/S0269749117344767>
- Shuker, I. G.; Cadman, C. A. (2018). *Indonesia - Marine debris hotspot rapid assessment : synthesis report (English)*. *Marine Debris Hotspot Rapid Assessment (Synthesis Report)*. Washington, D.C. : World Bank Group. <http://documents.worldbank.org/curated/en/983771527663689822/Indonesia-Marine-debris-hotspot-rapid-assessment-synthesis-report>
- The Guardian (2019). *Where does your plastic go? Global investigation reveals America's dirty secret*.
<https://www.theguardian.com/us-news/2019/jun/17/recycled-plastic-america-global-crisis>
- The Pew Charitable Trusts and SYSTEMIQ (2019). *A Global Roadmap to achieve near-zero ocean plastic leakage by 2040: Economic analysis*.
- World Wildlife Fund (2019). *Stop the flood of plastic: How Mediterranean countries can save their sea*.
https://mobil.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/WWF-Report_Mediterranean_Stop_The_Flood_of_Plastic.pdf
- Yintii, B. B. et al. (2014). Household Perspective of Plastic Waste Management in Urban Ghana: A Case Study of the Bolgatanga Municipality. *Global Journal of Biology, Agriculture and Health Sciences*, 3, 18-26. <https://www.longdom.org/articles/household-perspective-of-plastic-waste-management-in-urban-ghana-a-case-study-of-the-bolgatanga-municipality.pdf>