

GLOBAL ASSESSMENT OF MUNICIPAL ORGANIC WASTE PRODUCTION AND RECYCLING

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Foreword

The aim of this report is to update ISWA's knowledge about the amounts of organic waste (excluding purposely grown energy crops and sewage sludge) that are generated annually and those quantities of organic waste that are separately collected and currently composted/anaerobically digested around the world.

Whilst there are a number of documents that provide a global, or at least continental, overview of the current situation about municipal solid waste (MSW) management, there are currently no up-to-date publications available - to the knowledge of the authors – that summarise the amounts of organic waste that arise worldwide and the quantities that are collected and recycled into compost and or biogas.

This lack of information should be of concern to decision makers and national authorities responsible for MSW management, as the inappropriate management of MSW in general, and organic solid waste specifically, is a

significant source of short-lived climate change pollutants and is the third largest man-made source of methane; hence mis-managed organic waste contributes to climate change and ozone pollution [CCAC]. Thus, it is of concern that there is a lack of current, accessible global data summarising organic waste arisings and its management, and that centralised reporting schemes are currently non-existent or “under construction” even in regions with advanced MSW management systems.

This investigation was performed between April and August 2018 and aims to plug this information gap.

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Executive summary

This report summarises global estimates of the amount of organic solid wastes produced, separately collected (source segregated) and treated through a composting and/or anaerobic digestion process.

It does not, as far as reasonably practicable, include non-segregated wastes treated in mixed waste plants, such as at mechanical biological treatment (MBT) facilities. The survey covers the main solid organic waste sources, focusing principally on waste from municipal origin. Other sources of organic waste, such as agricultural and industrial waste, have been differentiated, as far as possible. The study excluded sewage sludges and crops grown solely as energy sources and treated in anaerobic digesters.

The information summarised in this report was extracted from published secondary data sources, including: EUROSTAT, the OECD and World Bank. It also relied upon the proactive participation of members of ISWA's Working Group on the Biological Treatment of Waste to provide country-specific data. The data reported were therefore derived from different sources, with the reference baseline years spanning 2014-2016; the most up-to-date figures available were used, and depended upon the geographic area and/or countries investigated.

The outcomes and available data show that currently 2.6 million (m) tonnes per day (tpd) of organic waste is generated as MSW every day, and, due to increasing urbanisation and improving living conditions, this amount is expected to reach 4.5 m tpd by 2050.

Cities are an important “player” in the world's development and consequently in generating environmental pollution; organic waste is on average 53% of total MSW arisings, thus the main waste stream produced in urban settlements. The impact of organic waste on the management of MSW in cities can be better understood by considering that 37 of the world's megacities currently generate 115 m tonnes per annum (tpa) of organic waste, an amount comparable to the bio-waste fraction that arises across the European Union.

The number of composting and biogas facilities treating mainly separately collected organic waste from urban dwellings is estimated to be at least 11'650 plants, bearing in mind that there is a lack of organised data from many countries in Africa, Asia and South America; these numbers do not include the facilities dedicated to treat organic waste/energy crops from agricultural origin.

Our investigation concludes that where MSW management strategies aim to divert organic waste from disposal towards recycling, there is a need for a density of composting and AD facilities that range from one plant per 200'000 inhabitants up to one each per 22'000 inhabitants in areas with complex logistics.

3 Definitions and abbreviations

We have adopted the World Bank (and ISWA's) definition of wastes for the purposes of this survey. We recognise that this will better fit data collected in some countries more than others however, we hope that by adopting this approach it will provide some level of consistency.

Organic waste is defined as food scraps (and kitchen waste) from households, restaurants, caterers and retail premises, biodegradable garden and park waste (leaves, grass, brush), food waste and comparable waste from food processing plants. It does not include forestry or agricultural residues, manure, sewage sludge, or other biodegradable waste such as natural textiles, paper or processed wood. It also excludes those by-products of food production that never become waste. We deliberately chose not to use the word bio-waste, being that this definition is mainly used in the European context.

The report includes different types of **biological treatment** of separately collected organic wastes, defined as follows:

- **Composting** – the aerobic biological degradation of solid organic wastes under controlled conditions; and
- **Anaerobic digestion (AD)** – the anaerobic degradation of organic wastes under controlled conditions with the production of 'biogas'.

There can also be combined recycling facilities that apply both the anaerobic digestion of organic wastes followed by subsequent aerobic stabilisation of digestate in a composting plant.

We also use following abbreviations for quantities and wordings:

- **AD** - Anaerobic Digestion
- **MBT** - Mechanic and Biological Treatment mixed MSW
- **MSW** - Municipal Solid Waste
- **SDG** - Sustainable Development Goals
- **bn** - billion
- **m** - million
- **t** - tonnes or metric tonnes; US tons have been converted into metric tonnes
- **tpd** - tonnes per day
- **tpa** - tonnes per annum

- **€** - Euro
- **USD** - US Dollar
- **HoReCa** - An abbreviation for the commercial sector of Hotels, Restaurants and Canteens
- **EPR** - Extended Producer Responsibility
- **WWTP** - Waste-Water Treatment Plant
- **C&D** - Construction and demolition
- **PC** - per capita

Decimals are separated by points (full stops) “.” and markers for thousands with an apostrophe “’”.

Where reference has been made to selected countries, these have been denoted using their two-letter country code defined by ISO 3166-1.

4 Contributors

We would like to thank a significant number of experts that contributed with data and comments to the synthesis of this report.

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5

The amounts of organic waste produced globally in human settlements

In 2015, the earth's population was estimated to be about 7.4 billion (bn) people, with 49% of the world's population living in cities.¹

Globally the quantities of municipal solid waste (MSW) generated are not precisely known, with estimates made by the World Bank and United Nations being based mainly on the quantities collected in urban settlements. According to World Bank data [GD02], about 2.01 bn tonnes of MSW was generated worldwide in 2016 and at least 33% of the waste generated was not managed in an “environmentally safe manner”.



5.1

The role of cities and urban settlements

The rate of urbanisation is growing at unprecedented rates and it is estimated that by 2050 approximately 70% of the world's population will live in urban areas [GD0, GD1].

With changing consumption patterns and ever-expanding volumes of discarded materials, city administrators and decision makers will have to pay close attention to waste arisings in urban areas. The way MSW, especially organic waste, is sorted and treated in cities in the future will affect the development of the organics recycling sector, in particular composting and anaerobic digestion (AD); this, in turn, will affect the possible attainment of the UN Sustainable Development Goals numbers: 12.3 (food waste); 12.5 (waste generation); and, 15.3 (desertification, degraded land).²

The following analysis is based on a UN-Habitat report [GD3] focusing on MSW management in 20 cities with a total population of about 49.3 m; this is a similar number of people to those living in France, and representing 1.4% of the world's urban population. These cities were

selected by the UN as reference cases for guiding decision makers of urban settlements to help them manage their solid waste effectively.

According to data from the report, a city generates on average 0.9 kg of MSW per capita per day; organic waste is on average 53% of the MSW total, so about 0.48 kg per capita per day (Figure 1). This amount will probably increase as economic prosperity and consumption of food within cities grows. Table 1 summarises the estimated quantities of MSW and organic waste generated in 20 cities, based on UN-Habitat Data (2010). From Table 1 it is clear that, globally, organic waste is the main fraction of MSW produced in urban settlements and that any consistent MSW strategy should consider treatment and recycling options for this fraction.



Figure 1 – Estimated quantities of MSW produced per capita per day and the contribution of mega cities

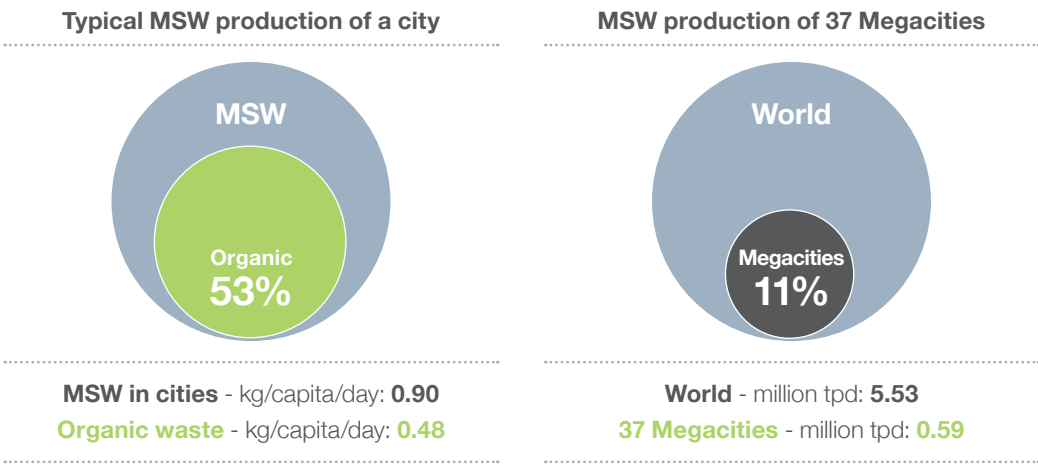


Table 1 - Amount of MSW and organic waste generated in 20 cities – based on UN-Habitat Data 2010

City	Population	MSW	Organic	Organic	MSW	Organic
		kg/capita/day	%	kg/capita/day	tpa	tpa
Adelaide, Australia	1'089'728	1.30	26	0.34	533'967	138'831
Bamako, Mali	1'809'106	0.70	21	0.15	463'131	97'258
Belo Horizonte, Brazil	2'452'617	1.40	66	0.92	1'297'434	856'307
Bengaluru, India	7'800'000	0.70	72	0.50	2'098'200	1'510'704
Canete, Peru	48'892	0.70	70	0.49	12'027	8'419
Curepipe, Republic of Mauritius	83'750	0.80	48	0.38	23'785	11'417
Delhi, India	13'850'507	0.50	81	0.41	2'548'493	2'064'280
Dhaka, Bangladesh	7'000'000	0.50	74	0.37	1'169'000	865'060
Ghorahi, Nepal	59'156	0.50	79	0.40	9'879	7'804
Kunming, China	3'500'000	0.80	58	0.46	1'001'000	580'580
Lusaka, Zambia	1'500'000	0.60	39	0.23	301'500	117'585
Managua, Nicaragua	1'002'882	1.10	74	0.81	421'210	311'696
Moshi, Tanzania	183'520	0.90	65	0.59	62'030	40'319
Nairobi, Kenya	4'000'000	0.60	65	0.39	876'000	569'400
Quezon City, Philippines	2'861'091	0.70	50	0.35	735'300	367'650
Rotterdam, Netherlands	582'949	1.40	26	0.36	307'797	80'027
San Francisco, USA	835'364	1.70	34	0.58	508'737	172'970
Sousse, Tunisia	173'047	1.10	65	0.72	68'181	44'317
Tompkins County, USA	101'136	1.60	29	0.46	58'355	16'923
Varna, Bulgaria	313'983	1.20	24	0.29	136'583	32'780
Sum	49'247'728				12'632'610	7'894'328
Average	2'462'386	0.90	53	0.48	631'630	394'716
Median	1'046'305	0.80	61	0.49	442'171	128'208

One eighth of the global population currently live in megacities around the world and this number is set to rise to half by 2050. The world's megacities include: Tokyo, with 37 million inhabitants; followed by New Delhi, India, with 29 million; Shanghai, China, with 26 million; Mexico City and São Paulo, each with approximately 22 million inhabitants. These are followed by the cities of Cairo, Mumbai, Beijing and Dhaka with close to 20 million inhabitants. Megacities will have a significant

role to play in achieving the goals and targets of the 2030 Agenda for Sustainable Development developed by the United Nations, including the sound management of MSW giving priority to recycling.

According to recent data about world population and cities [GD4], 632 m people live in 37 megacities (i.e. urban areas with over 500'000 population), with an estimated production of 217 m tonnes per annum (tpa) of MSW (assuming 0.90 kg per capita per

day) and about 115 m tpa of organic waste (assuming 53% is organic), an amount comparable to the 90 m tpa of organic waste fraction of municipal waste that arise across the European Union (see Chapter Europe and the EU). By 2030, the world is projected to have 43 megacities, with most of them in developing regions. However, some of the fastest-growing urban agglomerations are cities with fewer than one million inhabitants, with many of them located in Asia and Africa.³

¹ 2018 Revision of World Urbanization Prospects, Population Division of the UN Department of Economic and Social Affairs (UN DESA), <https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html>

² The sustainable development goals (SDGs) are a new, universal set of goals, targets and indicators that UN member states are expected to use to frame their agendas and political policies over the next 15 years: 2016-2030.

³ Taken as the average in 20 cities, based on UN-Habitat Bank Data 2010 (Table 1 of this report).

A tentative assessment of organic waste produced globally

Organic waste comprises somewhere between 44 to 46% (by mass) of the total global production of MSW according to the recently updated World Bank report published in 2018 [GD2].

Other fractions in MSW include paper, metal, other waste, plastic and glass. At 53% of MSW generated, East Asia and the Pacific region (EAP) have the highest proportion of organic waste globally, while OECD countries have the least at between 27 to 30%. The approximate amount of organic waste inside MSW is comparable to the data quoted for cities in the UN-Habitat report [GD3].

Based on the World Bank data for MSW production and on the income level of each country, global production of **MSW from urban settlements can be coarsely quantified to be in the region of 2.02 bn tpa and the amount of organic waste accounts for approximately 2.6 m tonnes per day** (including food waste, green waste, wood and others); thus totalling an annual global estimate of 0.94 bn tpa. This amount is projected to increase by 75% by 2050, according to the forecast included in the World Bank report, reaching an estimated 1.64 bn tpa by 2050; this is due to increased urbanisation and assumes that the composition of MSW remains the same (see Tables 2 a and b and Figure 2). These numbers should be considered to be a tentative assessment and are likely to be underestimated, due to a lack of data reported from MSW produced and collected in rural areas world-wide.

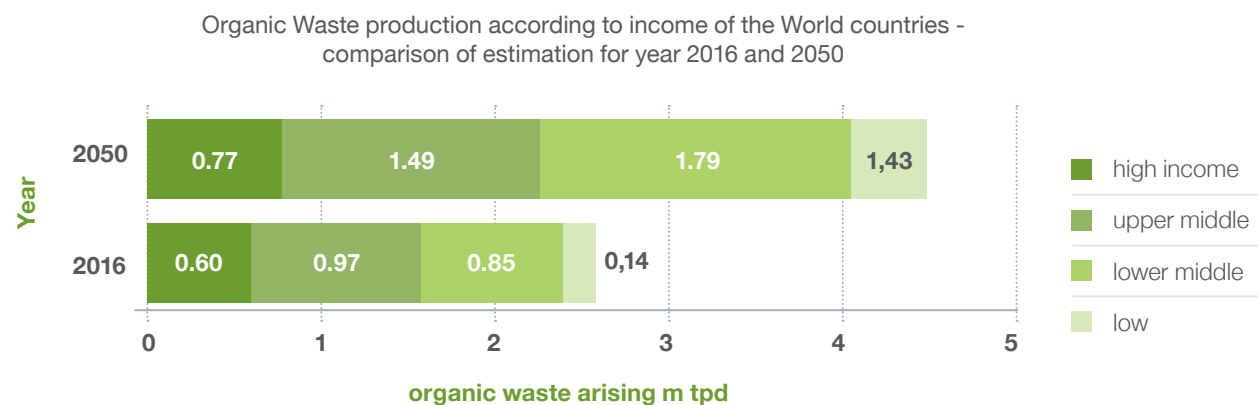
Table 2a - Organic fraction of MSW generated globally – based on World Bank Data 2016

Population data [GD1] MSW data [GD2]	Total Population 2015 (x1000)	Urban MSW Generation - 2016			
		Per Capita (kg/capita/day)	Total (m tonnes/year)	Organic waste	Total organic waste (m tonnes/year)
Income Level					
Lower Income	641'859	0.40	93	56%	52
Lower Middle Income	2'969'901	0.53	586	53%	311
Upper Middle Income	2'588'363	0.69	655	54%	354
High Income	1'180'061	1.58	683	32%	219
Total	7'380'184	0.75	2'017	46%	935

Table 2b - Predicted organic fraction of MSW generated globally – based on World Bank Data for 2050

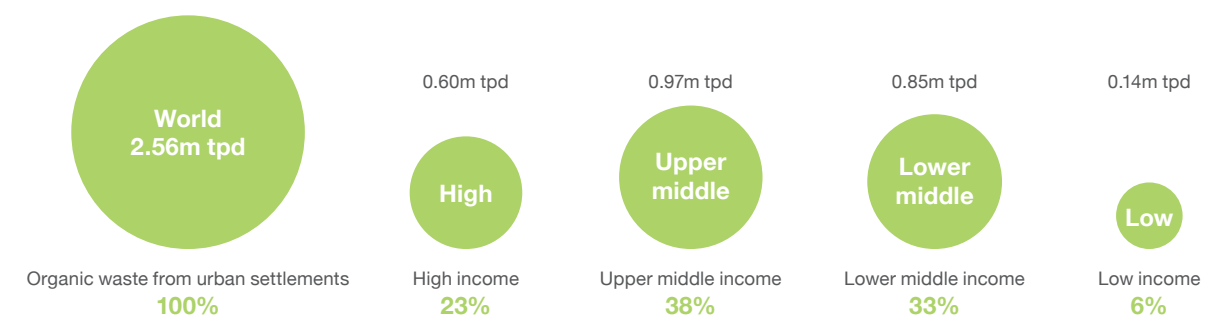
Population data [GD1] MSW data [GD2]	Total Population 2050 (x1000)	Predicted urban MSW Generation - 2050			
		Per Capita (kg/capita/day)	Total (m tonnes/year)	Organic waste	Total organic waste (m tonnes/year)
Income Level					
Lower Income	1'413'034	0.56	283	56%	158
Lower Middle Income	4'276'584	0.79	1'233	53%	653
Upper Middle Income	2'790'496	0.99	1'004	54%	542
High Income	1'287'798	1.87	879	32%	281
Total	9'767'912	0.95	3'399	48%	1'635

Figure 2 – Organic waste production according to income of world countries



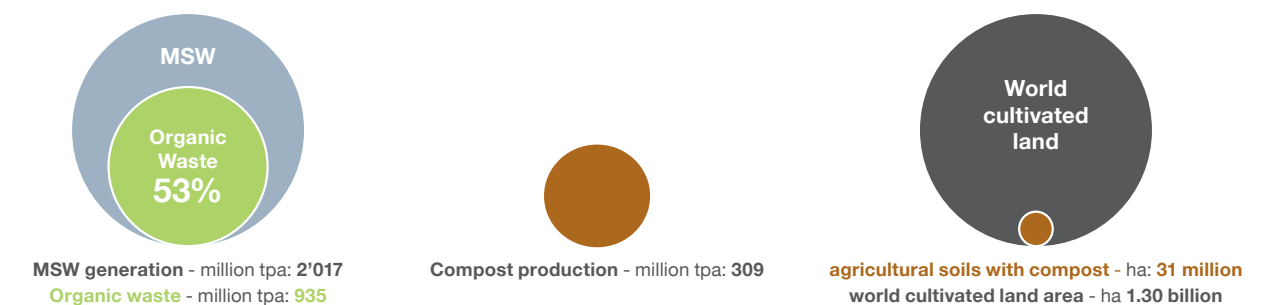
The quantities of organic waste produced worldwide in the year 2016, according to the available global sources and our estimations, are shown in the infographics below in (Figure 3)

Figure 3 – Organic waste production according to income of countries (estimation 2016)



If we assume that, theoretically, the total quantity of organic waste produced in 2016 was recycled solely into compost (with a conservative conversion yield of 33% compost of the incoming feedstock), annual production would result in about 309 m tpa of compost. This amount of compost - assuming an application rate of 10 t/ha – could be used to restore fertility to about 31 m ha of arable agricultural soil, representing 2.4% of the current world suitable land area being cultivated according to FAO [GD5]. This is shown schematically in Figure 4.⁴

Figure 4 – Key data about organic waste arisings and potential compost use (2016)



References

- | | | |
|--|---|--|
| GD0 https://esa.un.org/unpd/wup/ data for 2015 | GD2 WHAT A WASTE 2.0. World Bank. 2018 | GD5 Fast facts: The State of the World's Land and Water. FAO. http://www.fao.org/fileadmin/user_upload/newsroom/docs/en-solaw-facts_1.pdf |
| GD1 2018 Revision of World Urbanization Prospects. Population Division of the UN Department of Economic and Social Affairs (UN DESA). https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html | GD3 SOLID WASTE MANAGEMENT IN THE WORLD'S CITIES. UN-Habitat. 2010 | GD6 WHAT A WASTE. World Bank. 2012 |
| GD4 http://www.demographia.com/db-worldua.pdf | | |

⁴ 1'600 m ha is the total land area currently being cultivated according to FAO; of which of which 80% is defined as suitable lands.

6 Regional Assessments

The following chapters summarise data on the amounts of organic waste generated as part of the municipal solid waste (MSW) stream across different continents and in selected countries of the world.

The data have been derived from publicly available documents and the responses and inputs received by waste experts of the ISWA Working Group on the Biological Treatment of Waste (WGBTW). The documents and sources of data are quoted at the end of each section.

For each country or area, the following information was assessed:

- Current legislation, strategy and policy for MSW management
- The organic waste fraction produced as part of MSW

- Estimates of the amount of organic waste recycled at composting and AD or other facilities
- Estimates of the number of treatment facilities in comparison to the population

The areas where data were obtained, are shown in Figure 5.

Figure 5 – Data for selected countries and continental assessment



The assessment is neither complete nor exhaustive, but it provides a concise insight into the different organic waste management strategies identified in selected countries. However, it must be remembered that the majority of organic waste is generated in cities and urban settlements.

7 North America

The focus of this section is limited to the USA and Canada.

7.1 FOCUS ON CANADA

7.1.1

Key data

All data refer to year 2014 according to the literature quoted; the population of Canada was about 36 m.

Canada produces annually about 14.6 m t of MSW (residential waste according to the sources quoted) and about 4.80 m t of this is diverted from disposal [CAN3; CAN4]. According to [CAN6] typical residential waste composition, food and yard waste represent 40% of MSW. This is summarised in Table 3.

Canada produces annually about 14.6 m t of MSW and of these about 5.8 are organic waste.

7.1.2

Current strategies and regulations governing organic waste

Between 2000 and 2010, the composting of food and yard waste has seen a massive increase of 125% in diversion from disposal.

This increase can mainly be attributed to kerbside or backyard organics collection programmes [CAN 6]. In most cases, this has been a result of significant efforts by municipalities who have been spurred to action due decreasing landfill space.

The provinces of Nova Scotia and Prince Edward Island have statutory organics diversion programmes for household and industrial sectors as well as for commercial and institutional sectors. They also have a ban in place for landfilling of organic waste [CAN6]. Recent estimates suggest that the province of Quebec has a diversion rate of 2% of all organic wastes from landfills, with a goal of improving this and reaching a diversion rate of 60%. In 2015 the province enacted a ban on landfilling compostable materials and plans a complete landfill ban by 2020 [CAN8].



Table 3 – Key data: Canada

Key data	N or %	t per year	kg/capita/day	Sources
Population	35.59 m			CAN2
MSW production		14.6 m	1.12	CAN3. CAN4
Organic waste fraction of MSW	40% of MSW	5.84 m	0.45	CAN6
Organic waste recycled (of municipal origin only)		1.42 m	0.11	CAN4 and estimation by the authors
Composting and AD facilities	~ 212			



Separate collection and recycling of organic waste

In 2014, the Canadian statistical agency, Statistics Canada, reported that the amount of organic waste diverted in Canada, both from residential and non-residential sources, was 2.69 m tonnes [CAN3 & CAN4].

Estimates of the quantities from solely residential areas were not available; however, by assuming that 53% of urban MSW comprises organic waste, it is estimated that in the region of 1.42 m tonnes of organic waste was produced by urban sources.

In 2011, 61% of households in Canada participated in some form of home composting and the separate collection of organics, 63% of Canadian households composted their yard waste using a kerbside collection system while 32% had made use of a compost bin or pile for their garden/yard waste. Another 12% reported using a depot or other means to compost their yard waste. Approximately 60% of households that composted their kitchen waste did so

using a kerbside collection program while the rest did so by using a compost bin or pile. A small percentage (5%) had disposed of their kitchen waste by taking it to a depot or by using an alternative composting practice [CAN7].

In almost all of the selected Metropolitan Areas households were most likely to have used kerbside collection services for their kitchen and/or garden waste [CAN7]. In Ontario, Canada's most populous province, about 40% of municipalities — including Toronto and its surrounding suburbs — have kerbside organics collections with other municipalities in the process of implementing programmes, and more are implementing programmes [CAN8]. The largest participation rate can be seen in

the Quebec region of the Ottawa-Gatineau census metropolitan area, with the proportion of households using kerbside collections rising to 61% in 2011 [CAN7].

According to CAN1, there were 204 composting facilities operating in Canada in 2016, which treat about 2.64 m tpa of organic waste, of these 127 are municipal facilities. In addition, 8 AD facilities were mentioned, without further indication about the quantities treated. The quantity of organic waste treated at composting facilities, including residential and non-residential sources is estimated to be about 2.64 m tpa; Table 4.

Table 4 - Types and quantities of organic waste recycled in Canada – year 2016

Facility	Number of plants	Quantities treated (tpa)	Comments
Composting	204	2'640'000	CAN1
AD for food, co-digestion, other organics	8		CAN1
AD for manure and biosolids			
TOTAL	212	2'640'000	

Based on these numbers there is statistically one recycling facility for organic waste from municipal origin for every 168,000 inhabitants.



Current strategies and regulations governing organic waste

Key data

USA produces annually about 238 m t of MSW, almost 2.02 kg per capita daily. About 28% is organic waste.

All data refer to year 2015 according to the literature quoted; the population of the US was about 322 m.

In 2015 the US-EPA [US5] reported that approximately 238 million tonnes of solid waste was generated from residential, commercial and institutional sources; about 15.1% of that was food waste, 13.3% was green waste (yard trimming in the US EPA definition) and 6.2% was wood. Thus, food - and green-waste account for an estimated 67.5 m tonnes or 210 kg/capita annually. This is summarised in Table 5.

Table 5 – Key data: USA

Key data	N or %	t per year	kg/capita/day	Sources
Population	321.77 m			US6
MSW production		237.63 m	2.02	US5
Organic waste fraction of MSW	28% of MSW	66.54 m	0.57	US5
Organic waste recycled		21.13 m		US5
Composting and AD facilities	~ 5100			

Current strategies and regulations governing organic waste

In the last decades, the United States has had no federal or nationwide organic waste diversion, processing laws, or policies; instead, states, counties and/or municipalities have been leading the way by implementing organic waste diversion or disposal bans on yard and/or food waste, or by enacting requirements (policies/ incentives) to encourage organic waste diversion and processing [US3].

In September 2015 the Department of Agriculture (USDA) announced the nation's first-ever food waste reduction goal of 50% by 2030. About half of all states have enacted yard and/or food waste disposal bans and a few states—California, Connecticut, Delaware, Florida, Massachusetts, Michigan and New York—have also set landfill diversion targets, and organics exclusion will likely help achieve those goals. Currently [US2] a ban/mandate including food scraps is applied in the States of California, Vermont, Massachusetts, Connecticut and Rhode Island.

Many federal incentive programmes support organic waste diversion and processing [US3] including:

- Biomass-related regulatory policies and/ or financial incentives specifically to AD technologies (NC Clean Energy Technology Center 2016).
- The federal Renewable Fuel Standard

includes biogas as a cellulosic and advanced fuel to meet renewable volume obligations (US EPA 2017).

- The US Department of Energy's Qualified Energy Conservation Bonds offer AD funding (US DOE 2017).
- The USDA's Advanced Biofuel Payment Program offers AD funding (USDA 2017a).
- The USDA's Rural Energy for America Program can help agricultural producers and rural small businesses install renewable energy systems, including AD (USDA 2017b).

California is one of the few US States that has dedicated legal provisions for recycling organic waste; the Californian Department of Resources Recycling and Recovery (CalRecycle), is the State agency that promotes waste reduction and oversees the state's recycling and waste management

programmes. The current target [US1] set by Strategic Directive N° 6-1 aims to increase the amount of organics diverted from landfills by 50% by the year 2020. CalRecycle provides funding for public and private solid waste management projects, such as composting and AD, through its organics grants programme (CalRecycle 2017). The goal of this competitive grant programme is to lower overall GHG emissions by expanding existing capacity or establishing new organics processing facilities around the state to reduce the amount of organic materials or alternative daily cover sent to landfills.

Separate collection and recycling of organic waste

Kerbside food collection programs continue to grow in the US with the expansion of programs in Denver, New York City, and Austin and new programmes in Cambridge, Ipswich, Salem and Manchester-by-the-Sea in Massachusetts [US7]. In addition, many cities encourage households to compost organic waste in their gardens and some others have drop-off sites for organic waste.

A survey conducted by BioCycle in autumn 2016 [US8] identified 326 communities with kerbside collection of food waste serving 5.1 m and drop-off programmes serving 318 communities, serving 6.7 million households. Only government-supported programmes were covered by the survey. With the growth in private subscription services around the country the total number of households with access in the US is thought to exceed 5.1 m. Using this data, collection programmes are estimated to have been available to approximately 4% of all US households in 2014.

California leads the US with the most households having access to a kerbside collection (1.74 million), followed by Washington

State (980'000), New York (790'000) and Texas (400'000); California also leads the nation with the number of communities (97) that offer kerbside collection of food waste.

According to EPA [US5] and other sources [US8] approximately 21 m tpa of food and green waste was recycled in 2015 at composting and AD facilities. A recent survey by BioCycle [US8] assessed the number of facilities in the US in 2015/2016 (Table 6). In total there were 4'713 composting facilities and on average each facility treated about 3150 tpa. This suggests that the majority of composting plants are small-scale, since 57% of the facilities (2698) treated only green waste.

The majority of the AD facilities (400) were farm-based systems used to manage livestock and poultry manure; only 1/3 of these were estimated to accept/co-digest food waste. However, the source does not indicate whether this was pre- or post-consumer food waste [US8]. According to a national survey published in 2017 [US8] there were also 11 MBT facilities treating the organic fraction of mixed MSW; these facilities are not shown in the Table 6.

Table 6 – Types and quantities of organic waste recycled in the US – year 2015-2017

Facility	Number of plants	Quantities treated (tpa)	Comments
Composting	4'713	14'041'000	Most accept only green waste
AD for food, co-digestion, other organics	119	7'092'050	No clear distinction for the origin of different feedstocks
AD for manure and biosolids	279		
Others			
TOTAL	5'111	21'133'050	

Based on these numbers there is statistically one recycling facility for organic waste from municipal origin every 163'000 inhabitants.

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Key data

As of 2015, the Latin America and Caribbean (LAC) region had over 600 million people [LA8] with 81% of the population living in urban areas [GD1].

According to GD2, in 2016 the average production of MSW was 1 kg per capita per day, varying between 0.44-4.50 kg per capita per day according to each specific country in Latin America and Caribbean and generating a total of 0.63 m tpd of solid waste; this figure is expected to increase to about 0.73 m tpd by 2025 [GD6]. It is estimated that between 2.2% and 4.5% of municipal waste is officially recovered and recycled in LAC [LA1; GD2].

According to the MSW composition for LAC countries [quoted in GD2] organic waste

represents around 52% of all MSW and food waste is estimated to be about 52%, thus it is the vast majority of the waste arising in urban and local settlements in the region. This is summarised in Table 7.

According to LA1 the recycling of organic waste had been practiced in the region for several decades, mostly relying on composting. There are plants that were installed over 60 years ago in Mexico, El Salvador and Ecuador. Later, starting in the 1970s, more modern plants were installed in some cities of Mexico,

Venezuela and Brazil. Most facilities separated out recyclable products from mixed MSW and incorporated a mechanised system of aerobic biodegradation through piling up and tumbling the waste or through rotary drum anaerobic digesters. Due to operational and financial problems (in general, operational costs had not been evaluated and were substantially higher than what the municipalities could afford), only a few of the plants survived. Today cities like Mexico City and Rosario in Argentina compost about 10% of their waste [GD2].

Table 7 – Key data: Latin America and Caribbean

Key data	N or %	t per year	kg/capita/day	Sources
Population	632.38 m			GD1
MSW production		231 m	1.0	GD2
Organic waste fraction of MSW	52% of MSW	120 m	0.5	GD2 and ISWA survey
Organic waste recycled				
Composting and AD facilities				



Key data

As the largest LAC country in terms of total population and urban population, Brazil generated about 49% of all the MSW of the LAC countries.

Table 8 – Key data: Brazil

Key data	N or %	t per year	kg/capita/day	Sources
Population	206.81m			
MSW production		78.26m	1.04	LA7
Organic waste fraction of MSW	51% of MSW	39.91m	0.53	LA3; Infosheet
Organic waste recycled		0.32 m	>0.01	Infosheet
Composting and AD facilities	~ 70			Infosheet

Current strategies and regulations governing organic waste



Current assessments [LA3] quantify the organic fraction of MSW at 51%, thus generating almost 40 m tonnes per year or about 193 kg per capita annually. The current diversion and recycling rate of the organic fraction is rather poor and estimated to be below 1% (or 316’000 tpa).⁵

According to the National Policy on Solid Waste [LA5], Brazil is committed to reducing MSW arisings and boost recycling rates; this requires municipalities to introduce separate collection and composting schemes, and requires the industrial/private sector to implement an extended producer responsibility (EPR)

scheme for packaging. Thus, composting and anaerobic digestion of the separately collected organic fraction of MSW will become pivotal, considering that this fraction exceeds 50% of the MSW generated, including large cities such as São Paulo with a population of about 12 m.

Separate collection and recycling of organic waste

Over the last decade, recycling initiatives of sorted organic waste have developed rapidly, usually relying on local initiatives by means of home- and community-composting (as in the state of Santa Catarina) and dedicated collection services at large commercial producers.

The City of São Paulo is probably the most interesting case considering that home composting has been actively promoted both at household and school-level and that currently three, small-scale composting facilities (in the range of 5000 tpa) have been realised by the municipality and the MSW Management services. The City’s MSW Management Master Plan of 2014 [LA6] establishes that

recycling of organic waste cannot be based on commingled collection of MSW and aims to extend separate collection to 37% of all households by the year 2023/24. The plan anticipates that 30% of organic waste will remain inside the mixed MSW stream, while 45% will be treated in composting or AD plants and 25% will be reduced at source due to home- and community-composting initiatives.

In Brazil, the number of composting facilities [LA7] for recycling organic waste from municipal and commercial origin was estimated to be 67 plants in 2016. Currently, the existing AD plants treat manure, mainly from pork and chicken production, and their numbers are not assessed by national statistics and are not shown in Table 9.

Table 9 – Types and quantities of organic waste recycled in the Brazil – year 2015

Facility	Number of plants	Quantities treated (tpa)	Comments
Composting	67	315’983	
AD for food, co-digestion, other organics			
AD for manure and biosolids			
Others			
TOTAL	67	315’983	

Statistically there is one recycling facility for organic waste from municipal origin for every 3 m inhabitants, clearly indicating that the recycling sector for organic waste still needs to be developed across the different states of Brazil.

⁵ According to personal communication by the MoE there are 220,000,000 of organic industrial/agricultural waste that are currently recycled in Brazil.



Key data

Argentina had a population of 40 m people in 2010 and an estimated 43 m people in 2016. The LAC country generated 13.7 m tonnes of MSW in 2010, including waste produced by households, commercial activities and green areas. About 45% of the total amount is generated in the Province of Buenos Aires, thus in a heavily urbanised area.

The amount of organic waste represents on average 49% of MSW and the vast majority (39%) is food waste; the amount of food waste rises up to 42.6% in smaller municipalities [ARG2].

According to [ARG3] about 91% of the population is connected to regular MSW collection services but 39% are not connected to appropriate disposal sites for MSW. This is summarised in Table 10.

Table 10 – Key data: Argentina

Key data	N or %	t per year	kg/capita/day	Sources
Population	40.1 m			ARG1
MSW production		13.69	1.022	ARG2
Organic waste fraction of MSW	49%	6.68	0.499	ARG2
Organic waste recycled				
Composting and AD facilities	~ 7			

Current strategies and regulations governing organic waste

The National Legislation on MSW management is transposed and adapted by each of the 24 Federal States of Argentina, each having its own specific targets and objectives.

Currently there is no specific legislation promoting the separate collection of organic waste or composting of organic waste collected separately in municipalities [ARG4]. Technical norms [ARG5] do consider composting mainly as an option for treating sludge from wastewater treatment plants (WWTPs); the existing fertiliser norms [ARG4; ARG6] do not allow the licensing of fertilisers/ compost obtained from the organic fraction

from MSW, thus preventing the development of a market for compost from source segregated organic waste.

Thus, the MSW management sector currently does not consider organic waste from separate collection will become a valuable resource through its transformation into new products; this is reflected in the lack of national legislation in this regard.

Separate collection and recycling of organic waste

Currently there are a few local initiatives in Argentina for testing separate collection and recycling of organic waste. Pilot schemes have been initiated in the City of Las Flores (Buenos Aires) using compostable bags to sort food waste at households, in the City of Rosario and a pilot scheme in Buenos Aires collecting organic waste from markets [ARG7].

Currently most composting facilities are used to treat sludge from WWTPs with capacities around 10'000 tpa and some smaller composting facilities recycle green waste only; (Table 11). In addition, there are three MBT facilities treating mixed MSW, including the LAC area's largest facility (treating 2'000 tpd) located in Buenos Aires [ARG4; ARG7].

Table 11 – Types and quantities of organic waste recycled in the Argentina – year 2015

Facility	Number of plants	Quantities treated (tpa)	Comments
Composting	6		3 for sludge from WWTP. others for green waste
AD	1		For sludge from WWTP of Buenos Aires
MBT	3		
Others			
TOTAL	10		

Statistically there is one recycling facility for organic waste from municipal origin for every 10 m inhabitants, clearly indicating that Argentina's recycling sector for organic waste still needs to be developed.

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ARG6

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ARG7

M. Ricci - personal communication



Of the countries located in the European continent, currently 28 are members of the European Union. Those Member States rely on common EU legislation with regards to environmental protection and specifically towards MSW management and recycling, although legislation is adopted and/or implemented at the single member state level.

In this chapter we survey the situation in the members states in the European Union and also quote data for three non-EU countries (Iceland, Norway and Switzerland), as they have developed organic waste recycling sectors.

Key data

All data refer to the year 2016. The population of the European Union with 28 members was about 510 m.

Municipal waste accounts for about 10% of the total waste generated in the 28 EU countries; in 2016 municipal waste generation per capita varied considerably ranging from 777 kg per capita in Denmark to 261 kg per capita in Romania [EU1] and there are differences between countries regarding the degree to which industrial, commercial and institutional waste is collected and managed together with waste from households.

According to the European Commission, official data across the European Union between 118 m – 138 m tonnes of organic waste arise annually, of which about 88-103 m tonnes is of municipal origin [EU1; EU2]; this is so-called

'bio-waste' according to the definition in the EU Waste Framework Directive. This amount is projected to increase on average by 10% by 2020 [EU2]. According to EU5 the amount of food waste produced from households, food services, wholesale/retail and primary production and processing accounts for 87.6 ± 13.7 m tpa and the amount of municipal origin (households) is estimated to be 46.5 ± 4.4 m tpa.

The key data for the EU-28 countries are summarised below in Table 12. The organic waste fraction accounts for about 40% of all MSW produced.

Table 12 – Key data: Europe

Key data – EU 28	N or %	t per year	kg/capita/day	Sources
Population	510.28m			EU7
MSW production		246.38m	1.32	EU1
Organic waste fraction - municipal origin	39% of MSW	95.5m	0.48	EU1; EU2
Food waste municipal origin		46.5m	0.25	EU5
Green waste municipal origin		49.0m	0.23	Derived from previous data
Organic waste recycled		39.80m	0.21	EU3
Other organic waste (food waste)		41.1m	0.22	EU5
Composting and AD facilities *	~ 4700	52.5m		Based on ECN and ISWA survey for 20 countries

Note: * data refer to only 18 of the 28 EU member states plus 2 non-EU member countries

Current strategies and regulations governing organic waste

Since coming into force in 1999, the EU-Landfill Directive (1999/31/EC) has mandated that EU Member States reduce the amount of biodegradable municipal waste that they landfill to 35% of 1995 levels by 2016 (for some countries by 2020).

The Landfill Directive does not prescribe specific separate collection and recycling for the diverted waste. On 2 July 2014, the European Commission adopted a legislative proposal and annex to review waste related targets in the Landfill Directive 1999/31/EC as well as recycling and other waste-related targets in the EU Waste Framework Directive 2008/98/EC and the Packaging and Packaging Waste Directive 94/62/EC. This proposal resulted into the reshaping of these four fundamental directives, entering into force on 4 July 2018.

The Circular Economy Package approved in 2018 introduces a general obligation for

member states to collect bio-waste separately by 31 December 2023. By the end of 2024 the Commission shall consider the setting of recycling targets for commercial bio-waste and non-hazardous industrial bio-waste.

According to the Circular Economy Package, the amount of organic waste from MSW that enters aerobic or anaerobic treatment facilities may be counted as recycled where that particular treatment generates compost, digestate, or other outputs with similar quantity of recycled content in relation to input which is to be used as a recycled product, material or substance. When the output from that treatment is used on land, it may only be

considered recycled if resulting in improving agriculture or ecology. An EU-wide food waste reduction target of 50% by 2030 has also been set. In addition to EU Regulations and Directives, individual member states also have dedicated legislation focusing on organic waste collection and recycling; national legislation include bans on the disposal of certain types of organic waste into landfills, obligations for separate collection and targets for recycling. These need to be analysed on a country-by-country basis.

Separate collection and recycling of organic waste

Large differences exist in the provision of separate collection and treatment capacity for organic waste across Europe.

Countries such as Austria, Switzerland, Germany, Italy, the Netherlands, Flanders (Belgium), Sweden and Norway (the latter not belonging to the EU-28), have relied upon separate organic waste collection and treatment systems for over 15 years; whilst countries such as the UK, Finland, Ireland, Slovenia, Estonia and France have made significant advances during this period. On the other hand, considerable potential for expansion remains in a number of countries such as Bulgaria, Greece, Croatia, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Spain, Czech Republic, Hungary and Cyprus. In some instances, countries with established organic waste collections rely predominantly upon composting green waste,

leaving further potential for separate household food waste collections. Similarly, studies in regions where established separate bio-waste collections have been in place for many years indicate that a high proportion of organic waste (60-70 kg per capita, per year) remains within the residual waste stream [EU6]. Both therefore suggest further potential for expansion.

For over a decade the separate collection of organic waste has been rolled out in large, densely populated cities (such as Munich, Berlin, London, Vienna and others) and in the last 5-7 years intensive schemes for collecting food waste from households have also been applied in large European cities such as Milan, Barcelona, Copenhagen, Ljubljana, Parma, Paris and others [EU10].

Due to different collection schemes applied in the 28 EU countries it is not easy to assess the amounts of food and green waste collected separately, nor is there any specific information from EUROSTAT. Across the EU, according to previous estimations, about 118 m to 138 m tpa tonnes of bio-waste (i.e. organic waste from municipal origin and from other sources) arise annually [EU1; EU2]; in 2016 according to EUROSTAT data the amounts that are recycled at composting and AD facilities account for about 39.8 m tpa or 78 kg per capita [EU3] (Table 13). Hence the amounts recycled into compost and/or biogas are about 34% to 29% of the quantities currently produced in Europe.⁶

Table 13 – Types and quantities of organic waste produced and recycled in the EU-28 – year 2016

Production and recycling of organic waste – data in million tonnes	Generated (municipal)	Generated (production. HoReCa. retail)	Total generation	Composting and AD
Food waste	46.5	41.1	87.6	
Green waste	49.0		49.0	
Total organic waste from municipalities	95.5			39.8
Commercial, Production & HoReCa		41.1		
TOTAL	136.6		136.6	

Statistically there is one recycling facility (i.e. composting or AD) for organic waste from municipal origin (considering a total of about 4700 plants) for every 96'000 inhabitants of the 20 countries assessed, clearly indicating that the recycling sector for organic waste from municipal origin is significantly developed in Europe.

The average amounts of organic waste from municipal origin recycled through composting and AD in single EU countries (including Switzerland, Norway, the Netherlands and Iceland that are not part of the EU-28) are quoted by the EU [EU3] at almost 80 kg per capita; it has to be stressed that some countries divert mostly green waste and that large portions of food waste are still collected with the mixed MSW (or residual waste) stream. This is summarised in Table 14.

The number of composting and biogas (AD) facilities in the EU-28 is not available from EU level statistics or the Environmental Directorate; a conservative assessment (see Table 15 on the next page) based on ECN's country reports and the ISWA-survey launched for **this report consolidates the data for 20 European**

countries, including Norway and Switzerland, with a collective population of approximately 451 m people.⁷ The assessment leads to about 4700 composting and AD facilities (about 4300 without Norway and Switzerland) recycling organic waste from municipal origin and 79% of these are composting facilities. The assessment in terms of number of facilities is likely to be under-estimated, while the amounts treated partially include other feedstocks from commercial and food services and amounts assessed are higher compared to those based on EUROSTAT statistics for the year 2016 (40 m tonnes).

In addition, there are a significant number of AD facilities in the EU managed by, and relying on, organic feedstock produced from agriculture and farming. According to the European Biogas

Association EBA [EU8] there are in 2015 about 17'358 biogas plants in Europe; considering the 992 AD facilities that accept organic waste from municipal origin, we can estimate that currently there are about 17 biogas facilities (Table 15) for agricultural waste for each biogas facility treating organics from municipal origin.

Table 14 – Amounts of bio-waste recycled through composting or digestion in Europe – year 2016

Country	kg/capita/year	Country	kg/capita/year
European Union (current composition)	78	Latvia	42
Austria (composition in 2016)	181	Lithuania	104
Belgium	84	Luxembourg	121
Bulgaria	37	Malta	0
Croatia	7	Netherlands	144
Cyprus	25	Poland	21
Czech Republic	23	Portugal	79
Denmark	149	Romania	18
Estonia	10	Slovakia	26
Finland	65	Slovenia	69
France	93	Spain	51
Germany	113	Sweden	72
Greece	17	United Kingdom	82
Hungary	30	Iceland	50
Ireland	-	Norway	77
Italy	94	Switzerland	155

Source: <http://appsso.eurostat.ec.europa.eu/nui/show.do>

⁶ And in Norway or Switzerland, two countries that do not belong to the EU-28 but which have a developed sector for recycling organic waste.

⁷ Estimate based on the data shown in Tables 13 and 14.

Table 15 – Types of recycling facilities for organic waste in 18 countries of the EU-28, Norway and Switzerland – year 2016

Recycling facilities – for organic waste	18 EU-28 countries Number of plants	CH & NO Number of plants	Quantities treated (m tpa)
Composting	3407	300	31.8
AD and combined AD & Composting	886	106	20.7
Total Composting and AD facilities treating mainly organic waste from municipal origin	4293	406	52.5
Total AD facilities in the EU (+CH) including agricultural facilities	17358		

The facilities that currently are operating in 18 EU-member countries and in two non-EU member countries (Norway and Switzerland) - treating mainly organic waste from municipal origin - are listed in the following two tables, according to the sources quoted; most data refer to the year 2016/17 so the numbers of existing facilities are likely to have increased since the data were published.

The sources have been aligned with the most recently published data by the European Compost Network (ECN), which used the ISWA survey as baseline data. Where more than one data source was available, preference was given to data that quote both the number of facilities and the amounts treated.

The total amounts of organic waste recycled according to ECN/ISWA's investigation for 20 countries are higher than official EUROSTAT data for the EU-28 (Table 12) and suggest that almost 52.5 m tpa of organic waste was recycled by means of composting and anaerobic digestion; these numbers do not include facilities for agricultural residues and feedstock.



Estimates for the different European countries are summarised in Tables 16 and 17. A more detailed insight about the single EU-28 member states can be accessed under the European Compost Network's Country Report section of the ECN website (www.compostnetwork.info).

Table 16 – Number of composting and biogas facilities in 20 European countries – year 2016

Country	Austria	Flanders-BE	Denmark	Estonia	Finland	France
Composting	406	45	33	8	135	780
AD	156	39	90	0	24	9
Combined AD & C	3	3	1	0	0	0

Country	Germany	Hungary	Ireland	Italy	Lithuania	Netherlands
Composting	849	81	20	276	60	90
AD	246		4	0	5	
Combined AD & C	49	0	1	50	1	11

Country	Norway	Poland	Portugal	Slovenia	Spain	Sweden
Composting	40	160	10	23	44	25
AD	8	8	0	16	23	36
Combined AD & C	0	1	12	1	0	0

Country	Switzerland	UK	TOTAL
Composting	260	362	3707
AD	98	97	859
Combined AD & C	0	0	133

Table 17 – Amounts (in tpa) treated at the facilities in 20 European countries - year 2016

Country	Austria	Flanders-BE	Denmark	Estonia	Finland	France
Composting	1185800	831000	540000	29000	270000	4567300
AD	127000	1356840	277000		170000	52700
Combined AD & C		82500	0			0

Country	Germany	Hungary	Ireland	Italy	Lithuania	Netherlands
Composting	7505900	240000	278870	4163319	307971	3246919
AD	5144600	0	74130		20000	
Combined AD & C	1453600		0	2346448	0	543058

Country	Norway	Poland	Portugal	Slovenia	Spain	Sweden
Composting	228000	802.840	51614	82660	660273	297000
AD	105000	40.142		477811	3056503	1606000
Combined AD & C	0	5.018	61937	100000	0	0

Country	Switzerland	UK	TOTAL
Composting	626323	5920000	31834789
AD	626045	2940000	16073771
Combined AD & C	0	0	4592561

Data for UK refer to year 2014

9.2 FOCUS ON SWEDEN

9.2.1

Key data

All data refer to year 2011 according to the literature quoted; the population of Sweden is about 9.5 m. MSW data refer also to the year 2011 and we have assumed that they are still representative of the current situation. Key data are summarised in Table 21.

Table 18 – Key data: Sweden

Key data	N or %	t per year	kg/capita/day	Sources
Population	9.45m			S5
MSW production		4.33m	1.26	S2
Organic waste fraction of MSW	35% of MSW			S4 (for the %) other data derived
Organic waste recycled		1.25m	0.36	S1
Composting and AD facilities	~ 60			See next table

9.2.2

Current strategies and regulations governing organic waste

MSW is managed by municipalities, which can decide how to organise their own waste management activities; some also co-operate on specific issues such as joint procurement. In around 70% of Swedish municipalities, household waste collection is outsourced to private companies.

The Swedish government implemented a set of new objectives concerning waste management in 2012 [S1]. One specific objective requires the implementation of measures to ensure that resource economisation in the food chain manifests itself by boosting separate collection of food waste from households and large generators. Furthermore, it requires that at least 50% of this amount needs to be treated biologically to recover plant nutrients and that at least 40% needs to be treated to recover energy.

Avfall Sverige, the national association of MSW professionals has adopted a long-term vision of “zero waste” which impacts on the strategy for recycling organic waste, aiming to increase the number of municipalities [S1] that collect food waste separately, extending the scheme progressively to all municipalities.



9.2.3

Separate collection and recycling of organic waste

According to a survey by Avfall Sverige [S1] close to 60% of all municipalities in Sweden collect food waste at source.

About 20% of them only collect from the HoReCa sector (in this case restaurants and large-scale kitchens), while the remaining municipalities have adopted schemes for households as well. Avfall Sverige expects that an additional 70 municipalities plan to introduce systems for the source-separation of food waste and is supporting this trend by developing guidelines [S3] for local authorities.

The most common collection system for source-separated food waste from single-family households is in two separate bins, one for food waste and one for residual waste. Another collection system sometimes used is optical separation of differently coloured bags that are put into the same container and co-collected.

The separate collection and treatment of food waste more than doubled in the last ten years (2000/2011) from about 300'000 tpa to 650'000 tpa with an increase of 10% in 2010/2011. The amounts of organic waste collected or composted at home accounts for about 132 kg/capita, corresponding to about 15% of all MSW collected in Sweden. The amounts of organic waste recycled at composting and biogas facilities are shown in Table 22. The national statistics also include waste streams not considered as household waste (such as from the food industry, slaughterhouses and other producers). Waste from municipal origin accounts for about 57% of all organic waste recycled at composting and AD facilities in Sweden.

The average amount of organic waste inside MSW in Sweden has been estimated [S4] at between 35% and 48%, thus in a range of 160-220 kg/capita; a conservative assessment of 160 kg/capita leads to a current rate of separate collection of about 43% of the potential organic waste.

The number of composting and biogas (AD) facilities in Sweden are shown in Table 23. The average size of AD facilities is about 15'100 tpa, almost double of the average amount recycled at composting facilities.

The amounts of compost produced can be estimated to be about 241'000 tpa while the amount of digestate produced in 2011 is quantified [S1] at about 549'000 tpa.

Table 19 – Types and quantities of organic waste collected and recycled in Sweden – year 2011

Recycling of organic waste	Composting (tpa)	AD (tpa)	AD+C (tpa)	Other recycling (tpa)	Total (tpa)
Food waste	77'520	132'380		65'000	274'900
Green waste	323'900				323'900
Total organic waste					598'800
Home composting					51'500
Total from municipalities					650'300
Other organic waste	288'680	422'670			711'350
Total	690'100	555'050			1'245'150

Note: Other recycling = anaerobic digestion at WWTP

Table 20 – Composting and AD facilities in Sweden – year 2011

Recycling facilities – for organic waste	Number of plants	Treatment capacity (tpa)	Quantities treated (tpa)
Composting	42		690'100
AD	16		550'050
AD and combined AD & Composting			
Total	58	-	1'245'150

Statistically there is one recycling facility for every 126'000 inhabitants.

We stress that the data reported from ECN and considered in the assessment at the EU level are lower than the ones shown in this section and refer to the year 2016, focusing specifically on bio-waste.



9.3 FOCUS ON UK

9.3.1

Key data

Data refer to year 2016 (municipal waste arisings) and 2014 (composting and AD estimates).

The population of the UK in 2016 was about 65.6 m and households produce about 27.3 m tpa of MSW [UK1; UK2]. Biodegradable waste (including paper and card) accounts for 51% of MSW [UK2], while 17% is the quota of food waste and the same quota accounts for green waste. Key data are summarised in Table 27.

Table 21 – Key data: UK

Key data	N or %	t per year	kg/capita/day	Sources
Population	65.64 m			UK1
MSW production		27.31 m	1.14	UK1 and UK2
Organic waste fraction of MSW	34% of MSW	9.28 m	0.39	UK2 and UK3
Organic waste recycled				
Composting and AD facilities	~			



9.3.2

Current strategies and regulations governing organic waste

Waste management across the UK is devolved to each of its four nations: England, Northern Ireland, Scotland and Wales. Each has its own separate legislation and waste strategy.

England relies solely on landfill tax as a fiscal mechanism to reduce landfilling of Biodegradable Municipal Waste (BMW). The tax is currently set at £ (GBP) 91.35 per tonne (for the financial year 2019/20). Scotland also relies on a landfill tax and permitting of landfills. A landfill allowances scheme (LAS) is in place in Northern Ireland and Wales, which requires waste disposal authorities to limit the amount of biodegradable municipal waste that they send to landfill.

England currently does not have any specific recycling targets, although a Waste and Resource Strategy, published in late 2018, seeks to introduce weekly separate food waste collections for households and some businesses. However, England does have: a Food Waste Recycling Action Plan, which is a voluntary initiative led by the Waste and Resources Action Programme (WRAP); a Clean Growth Strategy (2017), which aims to divert food waste from landfill; and, a 25 Year Environment Plan (2018), which aims to work towards an ambition of zero avoidable waste by 2050.

Northern Ireland has in place the Food Waste Regulations (Northern Ireland) (2015), which requires the separate collection and subsequent treatment of food waste and prohibits its disposal to sewer.

Scotland has in place a Zero Waste Plan (2010), which sets a 70% recycling target, with a minimum of 5% sent to landfill by 2025. The Waste (Scotland) Regulations (2012) also require local authorities to offer a food waste recycling service in non-rural areas and places a ban on municipal biodegradable waste going to landfill by 1 January 2021.

Wales has a strategy called Towards Zero Waste (2010), which sets target to recycle at least 70% of waste by 2025 (businesses, households and the public sector) and promotes food waste collected separately to be managed in anaerobic digestion facilities. The Waste (Wales) Measure (2010) sets in law a requirement that every Welsh local authority must meet an annual recycling target. This rises to 70% by 2025.

Across the UK as a whole, there are two voluntary agreements in place, both led by WRAP (the Waste & Resources Action Programme):

- Courtauld Commitment – this is aimed at improving resource efficiency and reducing waste within the UK grocery sector
- Hospitality and Food Service Agreement – this is aimed at reducing and recycling food waste in the hospitality and food service sector.

In addition, WRAP has also developed the ‘Love Food Hate Waste’ campaign. It provides information and resources for local authorities (municipalities) across the UK to help them communicate with residents about ways in which they can reduce the amount of food they throw away.

Separate collection and recycling of organic waste

According to WRAP, in 2016/2017 almost 96% of all households were connected to a separate collection scheme for green waste; about 38% of all households were connected to a separate kerbside collection for food waste and another 19% to commingled collection of both food - and green waste [UK5].

Separate collection of organic waste is developed in the UK, leading to at least 5.53 m tpa collected in 2014 from local authorities and sent to composting and 5.24 m tonnes to anaerobic digestion [UK2; UK4]. In addition, there were 5.64 m tpa of commercial and industrial, and agricultural waste produced and treated separately [UK2] (Table 28).

There were 362 composting facilities operating in 2012 and 259 AD facilities; out of the 259

operating AD plants in the UK, 162 are defined as farm-fed (Table 29). Data for composting in 2014 were estimated from 2012 data and scaled up to 5.92 M tpa; the largest volume of feedstock recycled at composting plants is green waste (63%) followed by food and green waste (about 26%) [UK2]. Focusing on AD plants (both urban and agricultural) the largest volume of feedstock recycled was post-consumer food waste (35%) followed by crops (26%) [UK4].

Table 22 – Types and quantities of organic waste collected and recycled in UK – year 2014

Recycling of organic waste	Composting (tpa)	AD (tpa)	Total (tpa)
Food waste	0.23	0.32	0.55
Green waste	3.39	0.00	3.39
Co-collected food and green waste and others	1.59	0.00	1.59
Total organic waste from municipalities			5.53
Other organic waste	0.71	4.92	5.63
Total	5.92	5.24	11.16

Table 23 – Composting and AD facilities in UK – year 2014

Recycling facilities	Number of plants	Treatment capacity (tpa)	Quantities treated (tpa)
Composting	362		5.92m
AD and combined AD & Composting	97		2.94m
AD facilities recycling waste from agric. origin	162		2.31m
Total	621		11.17m

Statistically there is one organic waste recycling facility for every 105 thousand inhabitants.



A short focus is shown also for Switzerland, which is not an EU member state, but whose environmental legislation and extended organic waste recycling reflects the approach followed in an Alpine Region.

Key data

All data refer to year 2013 according to the literature quoted; the population of Switzerland's about 8.1 m. Key data are summarised in Table 24.

Table 24 – Key data: Switzerland

Key data	N or %	t per year	kg/capita/day	Sources
Population	8.14 m			CH4
MSW production		5.82 m	1.96	CH2
Organic waste fraction of MSW	32% of MSW	1.86 m	0.63	CH3 (percentage)
Organic waste recycled *		0.66 m	0.22	WG-infosheet
Composting and AD facilities	~ 370			

Note: see also data in next table

Current strategies and regulations governing organic waste

In Switzerland there is a general ban to landfill untreated MSW since the 1980s.

The Waste Ordinance (4.12.2015) [CH5] aims to prevent the generation of waste in general and promotes the recycling of glass, paper, cardboard, metals, organics and textiles in particular (as long as this is less harmful to the environment than their “disposal”). Current waste management regulation in Switzerland does not include any obligation to sort and recycling organic waste, but expectations are to introduce an obligation in the near future [CH1].

There are no MBT facilities treating the organic fraction of mixed MSW.



Separate collection and recycling of organic waste

The separate collection and treatment of organic waste (including food waste and green waste) from municipal origin accounts [CH1] to 660’000 tpa in year 2013 (Table 25).

This is about 81 kg/capita being about 11% of all MSW collected in Switzerland. If we include the amounts of organic waste from commercial, industrial and agricultural origin, it amounts to an increase to 130 kg/capita.

The amounts of organic waste recycled at composting and biogas facilities are shown in Table 26. The national statistics also include waste streams not considered to be household

waste (such as food industry, slaughterhouses and other producers). The waste from municipal origin accounts for about 26% of all organic waste recycled at composting and AD facilities quoted in the table.

The average amount of organic waste inside MSW in Switzerland is estimated [CH3] to be 32%, which equates to 229 kg/capita/year; thus considering the data quoted below, the

current rate of separate collection (i.e. 81 kg/capita/year) is about 35% of the potential amount that could be recycled.

The number of composting and biogas (AD) facilities in Switzerland are shown in Table 26. The average size of AD facilities is about 3500 tpa, almost double the average composting facility; the latter including a lot of decentralised, small-scale plants.

Table 25 – Types and quantities of organic waste collected and recycled in Switzerland– year 2013

Recycling of organic waste	Composting (tpa)	AD (tpa)	AD+C (tpa)	Other recycling (tpa)	Total (tpa)
Food waste					-
Green waste					-
Total organic waste			660’000		660’000
Home composting					-
Total organic waste from municipalities			660’000		660’000
Commercial. industrial. agricultural			394’000		394’000
Other organic waste				860’000	860’000
Total			1’714’000	860’000	2’574’000

Note: Other organic waste = manures

Table 26 – Composting and AD facilities in Switzerland – year 2013

Recycling facilities	Number of plants	Treatment capacity (tpa)	Quantities treated (tpa)	Comments
Composting	260	626’323	626’323	
AD	98	626’045	626’045	71 agricultural co-digestion plant
Combined AD & Composting			-	
Other recycling facilities	10	3’517	3’517	
Total	368	1’255’885	1’255’885	

Note: data do not include manure

Statistically there is one recycling facility for every 22’000 inhabitants, reflecting the national strategy to have a set of small facilities near settlements, so as to avoid long-distance travel for waste.

The amounts recycled at composting and AD facilities in 2013 can be quantified [CH1] in 336’000 tpa of compost, 816’000 tpa of digestate and about 50 m Nm³ of biogas.



Key data

All data refer to year 2016 according to the literature quoted; the population of Italy is about 61 m. Italy produces about 30.1 m tpa of MSW. This is summarised in Table 18.

Table 27 – Key data: Italy

Key data	N or %	t per year	kg/capita/day	Sources
Population	60.67			IT1
MSW production		30.12m	1.36	IT2
Organic waste fraction of MSW	28% to 35% of MSW	8.00m	0.63	IT3
Organic waste recycled *		5.72m	0.26	IT3
Composting and AD facilities	~ 330			

Source: <http://appsso.eurostat.ec.europa.eu/nui/show.do>

Current strategies and regulations governing organic waste

MSW management is the responsibility of municipalities, and they generally organise waste collection and transport at a district level.

Since 2006 the Italian Waste Framework Law (DL 152/2006) requires single municipalities to collect separately and recycle a minimum of 65% of all MSW, thus driving municipalities towards intensive schemes for collecting organic waste (and specifically food waste) separately.

In addition, MSW with a high content of organic waste cannot be landfilled without pre-treatment. Compost obtained from separately

collected feedstock has the status of a product for about 20 years, whilst digestate - obtained at AD facilities accepting organic waste – is still considered to be a waste and therefore needs to be further composted to be used as a soil conditioner or organic fertiliser.

Separate collection and recycling of organic waste

According to CIC – the Italian Composting and Biogas Association [IT2] – the separate collection of organic waste in Italian cities is rising annually at about 10% over the last decade, while kerbside collection schemes are generally preferred. Organic waste must be collected by means of compostable bioplastic or paper liners.

In 2016 about 5.72 m tpa of organic waste (including 4.1 m tpa of food waste) were collected separately in Italian municipalities, involving about 40 m people; intensive collection schemes have been successfully applied both in small-medium sized settlements and in large cities [IT4] such as Bolzano, Parma, Milan and Rome, collecting between 70-100 kg capita/year of food waste in addition to variable amounts of green waste. Data are summarised in Table 19.

Italy's 326 composting and AD-facilities represent the backbone of the country's recycling sector for the waste streams collected

separately at Italian urban settlements; these numbers do not include about 600 AD facilities treating only agricultural residues. Most biogas facilities accepting organic waste as a feedstock consist of an anaerobic digestion stage followed by post-composting of the digestate. The amounts recycled at about 330 industrial composting and biogas facilities accepting mainly organic waste from separate collection in municipalities and other organic waste from commercial and agro-industrial origin is shown in Table 20; the output of this sector is about 1.91 m tpa of compost and 207.3 m Nm³ of biogas.

Table 28 – Types and quantities of organic waste collected and recycled in Italy – year 2016

Recycling of organic waste	Composting (tpa)	AD (tpa)	AD+C (tpa)	Total (tpa)
Food waste	1.954.491	249.082	1.854.348	4.057.921
Green waste	1.443.004	-	220.259	1.663.263
Total organic waste from municipalities				5.772.684
Other organic waste	729.109	437.041	212.053	1.378.203
Total	4.126.604	686.123	2.286.660	7.099.387

Table 29 – Composting and AD facilities in Italy – year 2016

Recycling facilities	Number of plants	Treatment capacity (tpa)	Quantities treated (tpa)
Composting	274		5'408'309
AD and combined AD & Composting	52		3'397'897
Other recycling facilities			
Total	326	-	8'806'206



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EU8

<http://european-biogas.eu/wp-content/uploads/2017/01/Graph-1-Number-of-biogas-plants.png>

EU9

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EU10

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IT1

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IT2

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IT3

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IT4

ogy.de/et2x

S1

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S2

avfall web/avfall Sverige 2012

S3

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S4

“comparative analysis of household waste composition in the different districts of Stockholm. S. Miafodzyeva. N. Brandt. 2011”

S5

https://en.wikipedia.org/wiki/Demographics_of_Sweden

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CH2

Waste Statistics Switzerland and Liechtenstein. 2016

CH3

Erhebung der Kehrrichtzusammensetzung. Bundesamt für Umwelt. Bern. 28.01.2014

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CH5

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UK1

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UK2

ISWA survey – by Jane Gilbert

UK3

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UK4

Organics recycling industry status report 2015. WRAP

UK5

<http://laportal.wrap.org.uk/Statistics.aspx>

Key data

The total African population in 2017 was estimated to exceed 1.25 billion, with a growth rate of more than 2.5% p.a. The most populous African country is Nigeria with 191 million inhabitants [AF1]. According to other sources, the population of Nigeria, Egypt and South Africa represent about 23% of the continent’s population.

According to [AF2] the total amount of MSW generated in Africa (in 2012) was estimated to be 125 million tonnes per year, of which 81 million tonnes (65 per cent) was produced in sub-Saharan Africa⁸. **Waste generation in Africa is projected to grow to 244 million tonnes per year by 2025, thus doubling the 2012 arising** [AF2]. Total waste collected in Africa (in 2012) was only 55% of total waste generated (68 million tonnes). Therefore the average production of MSW is estimated to be about 0.31 kg/capita/day, significantly lower than in higher-income countries.

According to more updated information for the year 2016 [GD2] MSW produced in sub-Saharan Africa was 174 m tpa and in North African⁹ countries, 129 m tpa; as a whole Africa produces about 150 m tpa of organic waste, thus leading to an average content of 49% organic waste inside MSW [ISWA estimations based on GD2]; the average composition of MSW in sub-Saharan Africa is about 57% organic [AF], and it can reach about 63% of MSW in African cities [AF2]. Key data are summarised in Table 30.

Similar to other low to middle income economies, waste generation in Africa is

increasing rapidly fuelled by population growth, changing consumption patterns, urbanisation and other factors. In 2015 the urban population on Africa was around 472 m and it is increasing at a rate faster than any other continent at 3.55% per annum. Some projections also suggest that between 2010 and 2025 some African cities will account for up to 85% of the population in Africa. In this context it is important to keep in mind that inappropriate waste management has serious health and environmental consequences and if not taken care of in a sound and sustainable manner, could hinder Africa’s efforts to achieve the Sustainable Development Goals [AF2].



Table 30 – Key data: Africa

Key data	N or %	t per year	kg/capita/day	Sources
Population	1'467m			AF1
MSW production		303m	0.56	AF2; GD2
Organic waste fraction of MSW	49% of MSW	150m	0.28	GD2 (for %)
Organic waste recycled				
Composting and AD facilities				

⁸Sub-Saharan Africa consists of all African countries that are fully or partially located south of the Sahara. The UN Development Program lists 46 of Africa's 54 countries as "sub-Saharan," excluding Algeria, Djibouti, Egypt, Libya, Morocco, Somalia, Sudan and Tunisia.

⁹ These include: Algeria, Djibouti, Egypt, Libya, Morocco, Somalia, Sudan and Tunisia.

Current strategies and regulations governing organic waste

The Agenda 2063 – a 50-year strategic socio-economic transformation framework for the African continent established by the 55 Member States of the African Union¹⁰ establishes significant policy for the continent for recycling and requests African cities to recycle at least 50% of the waste that they generate by 2023 [AF2]. Hence, this target is likely to be achieved only if the collection and recycling of organic waste is adequately addressed and promoted.



Separate collection and recycling of organic waste

In Africa, traditionally waste collection services are provided by the public and private sectors, such as municipalities or private contractors. However, the role of community based organisations and the informal sector in waste collection play an equally important role in several African Countries.

Typically, well extended and performing waste collection and transportation services are often only found in city centres while services in suburbs are usually lacking or poor. Door-to-door waste collection services are most common in urban centres [AF2].

The average MSW recycling rate in Africa is estimated at only 4%. In sub-Saharan Africa, roughly 37% of all the food produced is lost or wasted; per capita food losses are at 120–170 kg per year. In South Africa, an estimated 50 per cent of food losses and waste occur at the agricultural/post-harvest stage, 25 per cent during processing and packaging, 20 per cent during distribution and retail and only 5 per cent at the consumer level. Food losses and waste in South Africa have been estimated at 10.2 million tonnes per annum [AF2].

Selected organic waste recycling initiatives through composting or AD are reported in Africa; with the most relevant ones listed below [AF2]:

- **Kafr El Sheik and Gharbia (Egypt):** in the two densely populated regions with some eight million inhabitants a large waste management project was started with an aim to process about 5000 tpd of MSW; the project included the development of 3-6 composting plants [AF2]; organic waste accounts for 56% of all MSW in Egypt [AF6].

- **Bamako (Mali):** Bamako, the capital city of Mali, achieves an 85% recycling rate due to the fact that raw or partially decomposed organic waste is fed to pigs and used as a soil conditioner; it is questionable if these amounts can be considered as “treated” in terms of modern MSW management techniques that rely on facilities designed and licenced to accept specific waste streams.

- **Lokossa (Benin):** the capital city of Mono Department, with a population of 77’065, organised a pilot project in 2011. The door-to-door collection of organic waste from households was contracted to local non-governmental organisations (NGOs) while the municipality was responsible for collecting market waste and managing secondary collection. Organic waste is composted, and the composted product is sold to finance the initiative. The pilot project demonstrated that novel approaches are available for the concurrent management of human waste and the organic fraction of municipal solid waste and, for achieving resource efficiency through the re-use of organic matter in farming.

- **Lagos (Nigeria):** An MSW composting project developed by Earthcare Nigeria Ltd processes in the region of 1500 tonnes of solid waste per day to produce a composted material (CompostPLUS). It currently is the largest commercial producer of organic fertiliser in West Africa using a mix of municipal solid waste as the raw materials. As an endorsement of the quality of CompostPLUS. In 2009 the Federal Ministry of Agriculture purchased 2500 metric tonnes of CompostPLUS for distribution to all the Agricultural Development Programs (ADPs) in the 36 States of the Federation and the Abuja Federal Capital Territory. In addition, during the 2009 farming season, the Enugu State Government bought 1000 metric tonnes for its farmers. Testimonies by farmers who have used the compost are quoted in [AF4].

- **Cape Town (South Africa):** the municipality has treated mixed wastes in municipal compost plants since 1969. In 2004 the city sorted about 36’000 tonnes of green waste and 31’200 tonnes of mixed household waste, representing about 2% of all MSW of the town.

- **Bronkhorstpruit (South Africa):** An AD plant treating industrial organic wastes was commissioned, treating 120.000 tonnes of organic waste (cattle manure and mixed organic waste) per year.

¹⁰ <https://au.int/en/memberstates>

10.2 FOCUS ON EGYPT

10.2.1

Key data

The estimated population of Egypt in 2012 was about 81.4 m [AF8].

The specific production of MSW is estimated at 253 kg per capita per year in 2012 and waste collection coverage varied between 40% to 80% of the population depending upon the Governorate¹¹ [AF8]. Waste generation is projected to exceed 30 million tonnes annually by 2025 [AF6]. Key data are summarised in Table 31.

The main portion of the Egyptian MSW is organic waste which forms about 56% of the total amount of MSW generated (21 m tonnes) [AF6; AF9]. while agricultural waste accounts for about 30 m tonnes annually [AF8].

Table 31 – Key data: Egypt

Key data	N or %	t per year	kg/capita/day	Sources
Population	81.4 m			AF8
MSW production		21 m		
Organic waste fraction of MSW	56%		0.67	AF6; AF9
Food waste from restaurants				
Organic waste recycled				
Composting, AD facilities and others				

10.2.2

Current strategies and regulations governing organic waste

Part of the organic fraction of MSW is generally used to feed householder’s livestock in rural areas. Recycled organic waste does not exceed 20%, so there is an urgent need to manage the rest of organic waste [AF6].

In villages and in some municipalities, trucks and tractors are used to collect municipal solid waste which is then dumped in open dumpsites. The mixed MSW is often deposited on an empty piece of land, alongside roads, irrigation and water courses. A majority of the Egypt’s solid waste is currently disposed of in non-sanitary open dumpsites [AF6].

The Egyptian solid waste management sector is currently characterised by critical ailments

which hinder its effectiveness and capacity to safeguard public health [AF7]. In 2012, the Central Department of Waste Management in the Egyptian Environmental Affairs Agency, proposed an executive programme to improve MSW management services in Egypt, including the establishment of recycling centres and upgrading of existing composting facilities [AF9]. However. no budget was allocated by April 2013 by the authorities for these programmes. The Annual Report on Waste

in Egypt [AF9] recommended developing a National Expert Knowledge Centre for the implementation and consolidation of biological treatment of biodegradable waste. A strategic directive was launched in 2014 [AF7] aiming to introduce fundamental reform with a medium and long-term vision and targets. The topic of organic waste diversion, recycling or collection is not mentioned among the 10 directives included in the Strategic Document.

10.2.3

Separate collection and recycling of organic waste

There are no official statistics summarising separate collection and recycling of organic waste.

However, there are about 60 MBT facilities and final disposal sites across the 27 Egyptian Governorates; since 1998 the Egyptian Government adapted open aerobic treatment as an approach to recycle the ‘wet’ organic fraction of MSW [AF9]. The poor performance of those composting facilities might be ascribed to technical, financial, and operational management factors; in addition, the use of mixed waste produces low quality compost and raises operational costs.

10.3 FOCUS ON NIGERIA

10.3.1

Key data

The population of Nigeria in 2011 was estimated at about 162.5 m [AF10].

Nigeria produces about 25 m tonnes of MSW each year [AF14]. Lagos State, the commercial hub of Nigeria, is the second fastest growing city in Africa and seventh in the world. The latest reports estimate its population to be more than 21 million making it the largest city in Africa. With per capita waste generation of 0.5 kg per day, the city generates more than 10’000 tonnes of urban waste every day [AF13]. Key data are summarised in Table 32.

MSW in Nigeria contains over 50% organic waste [AF10] and average values of 60% are reported in cities [AF12]. Thus, we can estimate that the country generates about 11.5 m t of organic waste from municipal origin. The role of organic waste from the farming sector can be highlighted by quoting Nigeria to be the second largest tomato producer in Africa (after Egypt) and sixteenth in global tomato production, accounting for 10.8 per cent of Africa’s tomato production and 1.2 per cent of global tomato production. a staggering 45% of tomatoes harvested in Nigeria are lost [AF2].

Table 32 – Key data: Nigeria

Key data	N or %	t per year	kg/capita/day	Sources
Population	162.5 m			AF10
MSW production		25 m	0.5	AF13
Organic waste fraction of MSW	50-60%	11.5 m		AF12
Food waste from restaurants				
Organic waste recycled				
Composting, AD facilities and others				

10.3.2

Current strategies and regulations governing organic waste

Current critical factors affecting MSW management in Nigeria include: an inadequate regulatory framework that has manifested itself in a lack of private sector investment, uncoordinated institutional functions, low political will, poor data for planning and a complacent attitude by waste generators [AF10].

However, the commitment of the Lagos State Government towards sustainable waste management has made this state a model for the others in the country.

Waste collection services are offered mainly by the public sector though some State Governments operating some level of formal public-private participation (PPP). The collection service is mostly organised in cities, resulting in efficiencies of generally less than 50%, but with Lagos and Calabar (a city in Cross River State in Southern Nigeria) as exceptions. In Lagos, the collection frequency is either once or twice a week and usually on a door-to-door basis [AF10].

10.3.3

Separate collection and recycling of organic waste

Recycling activities can be found in Lagos State, including a compost plant at Ikorodu for the treatment of market waste.

The MSW composting project developed by Earthcare Nigeria Ltd is currently the largest commercial producer of organic fertiliser in West Africa. It is the first of its kind in Nigeria and currently, EarthCare has two truck heads, nine containers, three dump trucks and about six hired trucks and provides employment for approximately 60 workers and an additional 40 ‘area boys’ who collect organic waste. Area boys are local unemployed youths often engaged in gang activity and the compost project has provided them with employment with a social purpose [AF5].

¹¹ The highest tier of public administration in Egypt, broadly equivalent to a state or province.

10.4.1

Key data

The population of South Africa in 2011 (baseline year for the waste data quoted) was about 52 m [AF16] and rose in 2016 to 55.9 m [AF15]. Key data are summarised in Table 33.

The National Waste Information Baseline Report (2012) (NWIBR) estimates the total organic waste (garden and food waste) generated in South Africa to be about 3 m tonnes for the year 2011, of which approximately 35% was recycled and the remaining amounts (about 2 million tonnes) landfilled. Although the NWIBR establishes a baseline for organic waste generation, it is unable to quantify each waste type (i.e. garden, food or wood) within the category for organic waste. due to a lack of waste characterisation studies [AF18]. The fraction of organic waste in the MSW stream is likely to be significantly underestimated (estimated to be about 13-15% of MSW) since MSW in South Africa also includes construction and demolition (C&D) and commercial and industrial waste. These largely ‘inert’ fractions account for 10-15% (for

C&D) and 25-40% (for commercial waste) of MSW [AF17]. In addition, by comparison MSW composition in other similar African cities have on average around 63% organics. Thus, it is estimated that a more realistic amount should be in the region of 9-10 m tpa, leading to an average production of about 150 kg per capita per year.

Almost 45% of all quantified organic waste produced in South Africa is generated in only two Provinces; Gauteng (24%) and KwaZulu-Natal (20%) [AF18].

At the national level, there is very limited data on food waste arisings [AF21] and any available data and assumptions surrounding food waste in South Africa are at a preliminary level and should be used with caution [AF22].

Food waste rates across the supply chain in South Africa vary considerably from other African countries as the distribution networks and infrastructure in the country are more sophisticated and thereby reduce food waste [AF23]. Given the inconsistencies and lack of data the average estimate of food waste generation in South Africa is approximately 9.04 m tonnes per annum which accounts for 31% of the total agricultural production which is 28.8 m tonnes per annum [AF22]. The majority of the food waste generated in South Africa is pre-consumer food waste at 8.7 m tonnes per annum [AF22]. Food waste generated at the consumption stage (post-consumer) makes up 1.3% of the total agricultural production and amounts to 4% or 0.4 m tonnes of the total food waste generated in South Africa.

Table 33 – Key data: South Africa

Key data	N or %	t per year	kg/capita/day	Sources
Population	55.6 m			
MSW production		9-10 m	150	Derived from AF17
Organic waste fraction of MSW		3 m		
Food waste from restaurants				
Organic waste recycled		~1 m		
Composting. AD facilities and others				

10.4.2

Current strategies and regulations governing organic waste

In 2011 the Department of Environmental Affairs (DEA) issued the National Waste Management Strategy which sets targets to promote waste minimisation, reuse, recycling and recovery of waste [AF16].

The National Waste Management Strategy promotes composting as one of the approaches towards achieving the objectives of the waste management hierarchy amongst other measures. The DEA also initiated the National Organic Waste Composting Strategy

(NOWCS) with the aim to develop and promote the diversion of organic waste from landfill sites for soils and other uses through composting [AF17]. This strategy led to the development of Draft National Norms and Standard for Organic Waste Composting (Notice 68 from 7 February

2014) which mentions composting facilities. Digestate can be used as an organic fertiliser and should be considered as part of the NOWCS currently underway be DEA [AF20].

10.4.3

Separate collection and recycling of organic waste

South Africa is in the process of implementing its waste management climate change flagship programme [AF21], which includes identifying areas for strategic interventions that advance the objectives of both the National Climate Change Response Policy and the National Waste Management Strategy.

The first leg identified six municipalities and the project will be rolled out to the 24 other municipalities. The current six are shown in the Table 34 and clearly show that organic waste, either in the form of food waste or garden waste, is presenting a problem and is thus a priority in South Africa.

There are several composting initiatives reported in the country [AF19]:

- In Cape Town about 30% of the 120'000 tpa of green waste is collected and composted together with about 31'000 tpa of mixed MSW-derived organics.

- In the cities of Radnor and Cape Town suburb of Bellville South composting facilities were established in the 1970s and each plant accepts about 62'400 tpa of organic waste producing between 9500-19'000 tpa of compost, whilst almost 50% of the input waste is disposed of as rejects. The compost is marketed as a soil improver, despite the impurities (i.e. small plastic fractions, stones, glass, etc.)

- In Cape Town, Reliance Compost started to collect separately about 500'000 m3 pa of green waste, producing about 60'000 m3 pa of compost and mulch; and

- Earth to Earth is part of the national waste company Interwaste which is well established in the waste business. The company transports and handles different kinds of commercial waste.

Table 34 – Selected pilot organics recycling projects in South Africa

Name	Province	Targeted Waste Streams
Emfuleni Local Municipality	Gauteng	Food waste from residential and commercial sources
Manguang Metro Municipality	Free State	Garden waste
Mbombela Local Municipality	Mpumalanga	Garden waste
Msunduzi Local Municipality	KwaZulu-Natal	Food waste
uMhlathuze Local Municipality	KwaZulu-Natal	Food waste
Rustenburg Local Municipality	North West	Food waste



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11.1 FOCUS ON CHINA

Current population in Asia was estimated to be about 4.42 bn in year 2015 [GD0]. Three countries (China. India and Japan) were included in this survey. representing about 61% of the total Asian population.

11.1.1

Key data

China's population in 2015 reached about 1.375 m people [CN1] with about 775 m living in urban settlements [GD0].

MSW production in China was estimated at about 355 m tpa in 2014 and about 50% of this was collected in cities. 19% in counties and the remaining in rural areas [CN3]. In addition, about 30 m tpa of food waste were produced and this amount is quantified in about 0.1 kg per capita per day in cities [CN7]. Key data are summarised in Table 35.

Table 35 – Key data: China

Key data	N or %	t per year	kg/capita/day	Sources
Population	1375 m			Year 2015 CN1
MSW production		355 m	0.71	CN2
Organic waste fraction of MSW*	50% of MSW	178 m	0.35	Based on CN6 data for cities
Food waste from restaurants		30 m	0.10	CN7
Organic waste recycled				
Composting. AD facilities and others**	~ 33	4.66 m	0.01	Estimation based on CN8

Note: * data not including 30m food waste; ** estimation. see text

According to [CN6] organic waste in cities is mainly kitchen waste representing between 60-70% of all MSW.

Current strategies and regulations governing organic waste

Traditionally in China the informal waste system collected food waste and used it to feed animals; this was well established.

It is a system that is able to separate food from oil and includes a measure of processing that protects the pigs from eating harmful objects (metal etc), but is closely linked to the challenges that the State is facing with food safety [CN5]. Since the SARS¹² epidemic broke out in in 2003, about 20 Chinese cities banned the direct use of catering waste as pig and other livestock feed [CN7], and this prohibition was further enforced by the State.

During the 12th Five-Year Plan (2011-2015) significant investment was made to improve waste treatment infrastructure at county level, among these an investment of 10.9 bn Chinese Yuan (1 CNY ~0.15 USD) for food

waste projects [CN2]. During this period China has gradually implemented separate disposal of food waste, aiming at turning waste into resources. China experimented with this strategy in around 100 cities by mapping out formal food waste collection and disposal systems before expanding it nationally. Due to the large quantities of food waste and their characteristics thus far, Chinese food waste treatment still focuses on non-household food waste generated by restaurants and catering industry. Final products include fertiliser, soil amendments and biodiesel [CN5; CN7].

According to the current five-year plan for 2016-2020 [Chapter 10, Article 43], China

is focusing on the “*use of waste resources, promoting the circular economy... and accelerating the construction of... Urban kitchen waste treatment system*”, thus focusing also on the treatment and recycling of organic waste. By 2020 most important cities are required to achieve a “separation rate” of 90%, including separately collected biodegradable waste. By 2020 the plan expects the realisation of a 40’000 tpd treatment capacity for organic waste with an investment of about 13.6 bn CNY (~2 bn USD) [CN3]. A proposal for a new strategy by German RETech Partnership [CN4] suggests the segregation of 25% bio-waste for anaerobic digestion and/or composting, mostly ending in compost products.

Separate collection and recycling of organic waste

According to [CN4; CN7], in 2015 there were about 33 biological treatment plants for catering (food) waste adopting a range of technologies from hydrothermal processing to AD.

[CN6] underlines that the current techniques for kitchen/food waste treatment are immature, and some existing kitchen waste composting projects do not achieve expectations. A key solution to these problems is to sort kitchen waste at source.

According to [CN8], in 2010 about 1.55 m tpa of organic waste was treated in 11 composting facilities in China; considering that the same source [CN4. CN7] estimated that 33 biological treatment plants were active for catering waste in 2015, we may estimate by assuming that

each plant treats a similar quantity of waste, that currently at least 4.65 m tpa of organic waste (mainly food waste) was treated in China in 2015. These data are summarised in Table 36.

Table 36 – Composting. AD and other treatment facilities for organic waste in China – year 2015

Recycling facilities	Number of plants	Treatment capacity (tpa)	Quantities treated (tpa)
Composting	11		
AD			
Other recycling facilities	22		
Total	33		4’650’000

Key data

India is the world’s second-most populous country [IN1] with about 1.21 billion inhabitants according to the 2011 census.

India generates approximately [IN2] 62 m tonnes of MSW annually; this amount is likely to be underestimated and refers to 377 m people residing in urban areas; it is projected that by 2030 these urban centres will generate 165 m tonnes of waste annually and by 2050 it could reach 436 m tonnes. The amount of biodegradable MSW, including food waste

and green waste, ranges from 40-60% and accounts for 42.5% on average [IN2]. Official data by the Central Pollution Control Board of the Ministry of Environment report that in the year 2011, about 127’486 tpd of MSW was generated from across the country, out of which 70% was collected and 13% processed or treated, while the rest was dumped. If we

consider an average production if 0.45 kg/capita/day the total generation of MSW in India would be around 199 m tpa and the organic fraction 85 m tpa, representing significant potential for recycling or treatment. Key data are summarised in Table 37.

Table 37 – Key data: India

Key data	N or %	t per year	kg/capita/day	Sources
Population	1211m			IN1
MSW production*		62m	0.45	IN2. IN3
Organic waste fraction of MSW*	42.5%	26.4m	0.19	IN2 (average %)
Organic waste recycled				
Composting and AD facilities*	~ 1350			

11.2.2 Current strategies and regulations governing organic waste

There is no dedicated strategy on organic waste or food waste, specifically. The National Action Plan [IN5] requires each State to adopt a policy to prevent the generation of unnecessary waste within the cities and minimise the generation of waste at source.

It further requires specific attention to the generation/ management of the “*bio-degradable fraction of waste as it has potential to cause health effect and need immediate stabilization*”. The measures to be taken to prevent organic waste arising, suggested by the Action Plan are: home-composting initiatives; community biogas production and using the residues for cattle feed. As a secondary option the pre-treatment of MSW before landfilling is envisaged so as to reduce the organic fraction; to achieve this strategy regional or decentralised composting and AD plants are suggested by the policy document.

In 2016 the Ministry of Environment, Forest and Climate Change released a comprehensive

set of Solid Waste Management Rules (SWMR 2016) which are applicable beyond municipal areas and extend to urban agglomerations, railways, airports, State and Central government organizations, places of pilgrimage, religious and historical importance, among others. The SWMR 2016 require generators to segregate waste into three categories – Wet, Dry and Hazardous Waste – with a requirement for the generator to pay a ‘User Fee’ to the waste collector and a ‘Spot Fine’ for littering and non-segregation.

Furthermore, the SWMR 2016 requires hotels and restaurants to segregate biodegradable waste and set up a system of collection or follow the system of collection set up by the local body to ensure that such food waste is

utilized for composting/ or anaerobic digestion. The SWMR 2016 states that the bio-degradable waste should be processed, treated and disposed of through composting or AD within the premises as far as possible. New townships and Group Housing Societies have been made responsible to develop in-house waste handling, including processing arrangements for bio-degradable waste. Every street vendor is mandated to keep suitable containers for the storage of waste generated during the course of his activity such as food waste, disposable plates, cups, cans, wrappers, coconut shells, leftover food, vegetables, fruit etc. and deposit such waste at a waste storage depot or container or vehicle as notified by the local authority.

Note: * food waste only

¹²SARS stands for Severe Acute Respiratory Syndrome, and is a contagious viral disease spread by animals to humans.

Separate collection and recycling of organic waste

The following methods for the biological treatment of organic waste are commonly adopted in India [IN2, IN3]. In smaller towns, labour-intensive composting is carried out.

However, in big Indian cities, power-driven composting units have been installed, whilst in Bengaluru, Vadodara, Mumbai, Delhi, and Kanpur, mechanical composting units of between 150 to 300 tonnes/day capacities have also been installed.

The Indian Government encourages AD technologies by utilising industrial, agricultural

and municipal wastes [IN2] and a number of AD schemes are in the planning and inception stages for some cities, such as Delhi, Bengaluru and Lucknow to utilise waste generated from vegetable markets and yard wastes.

The number of biological treatment facilities are quoted in reference [IN4], including composting,

AD and vermicomposting (as “other recycling facilities”); there are 199 processing facilities which were under construction or in the planning phase, which are not reported in Table 38. It cannot be excluded that some composting facilities do treat the organic fraction sorted from mixed MSW; data about the amounts treated are currently not available.



Table 38 – Composting and AD facilities in India – year 2016

Recycling facilities	Number of plants	Treatment capacity (tpa)	Quantities treated (tpa)
Composting	983		
AD	98		
Other recycling facilities	266		
Total	1347		

Considering that the quota of the Indian population living in urban areas (i.e. 377 m people) there is an estimated one facility for approximately 280'000 people.

Key data

In 2015, Japan was the world's tenth-most populous country [JP1] with about 127 m inhabitants. The country generated about 44 m tpa of MSW in 2014.

According to Ministry of Environment data [quoted in JP5 and JP7] almost 17-18m tpa of food waste was generated including 9 -12 million tpa of food waste and similar from

households and commercial activities and 5 - 8 million tonnes of food loss, thus quoting data beyond the boundaries of MSW management. Therefore, estimating that 10.5 m tpa were

organic waste from municipal origin (not including green waste), the organic waste fraction of MSW can be estimated at 24%. Key data are summarised in Table 39.



Table 39 – Key data: Japan

Key data - 2015	N or %	t per year	kg/capita/day	Sources
Population	127.1m			JP1
MSW production		43.32m	0.95	JP4
Organic waste fraction of MSW	28%	12.13m	0.27	JP7 (for %)
Organic waste recycled				
Composting and AD facilities	~	159'000		JP2

Note: * food waste only



11.3.2

Current strategies and regulations governing organic waste

The Food Recycling Act, enacted in 2000 and revised in 2007, aimed to reduce the generation of food waste and to recycle it, primarily as raw materials for animal feed and fertiliser.

The Act established a system for recycling, defined the responsibilities of the different entities involved and set waste reduction and recycling rates and targets [JP3]. The Food Recycling Act created a system for registering business operators that manufacture fertilisers and stock feed by using recyclable food resources as raw material. It also introduced a system for authorising plans to implement recycling programmes by food-related

business operators, recycling operators and farmers to use fertilisers and stock feed obtained from recycling programs.

With an aim to further reduce the amount of food waste produced and enhance recycling into animal feed, fertiliser and methane, the Food Recycling Act was revised in 2015. According to the new amendments, new industries are required to reduce the amount of

food waste generated and reach new recycling targets by 2019 with an aim to recycle up to 95% by food manufacturers and processors and 50% from restaurants. Currently there does not seem to be a policy addressing householder obligations.

11.3.3

Separate collection and recycling of organic waste

According to the Ministry of Environment [JP3] the recycling rate for recyclable food waste has increased since 2000, when the Food Recycling Act was enacted, reaching 82% in 2010.

Although the recycling rate in the food manufacturing industry is generally high, the recycling rate for recyclable food waste for other sectors becomes lower; for wholesale and retail food waste it does not exceed 37% and the amounts from the restaurant industry are recycled at about 17%.

Food waste is part of the Biomass Industrialization Strategy that includes

measures to promote ethanol production and bio-gasification technologies [JP5]. The plan includes the creation of a collection system by type, the enforcement of recycling through methane gasification, solid fuel conversion and combined utilisation with sewage sludge and animal waste, as well as the application of a Feed-in-Tariff scheme. The average utilisation ratio is aimed to increase from 27% in 2009 to 40% in 2020.

Authors could not find any online data about the number or types of facilities for composting or AD; according to OECD online data for the year 2015, about 159'000 tpa of organic waste from municipal origin was composted in Japan.



11.4

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12.1 FOCUS ON AUSTRALIA

12.1.1

Key data

All data refer to the year 2014/2015 according to the literature quoted; the population of Australia was about 23 m people [AU1]. In the same year Australia generated about 13.3 m tonnes of MSW from urban dwellings, settlement and municipalities [AU2]. Key data are summarised in Table 40.

Table 40 – Key data: Australia

Key data	N or %	t per year	kg/capita/day	Sources
Population	23.41m			
MSW production		13.3m	1.5	AU2
Organic waste fraction of MSW *	23.3%	3.1m	0.36	AU2
Organic waste recycled **		2.2m	0.26	AU9 see table 22
Composting and AD facilities	~ 150			AU4

Note: * data referring to organic waste and other commercial waste not collected as MSW

12.1.2

Current strategies and regulations governing organic waste

The National Waste Policy [AU6] was agreed upon by all Australian environment ministers in November 2009 and espouses a coherent, efficient and environmentally responsible approach to waste management in Australia.

The NWP was endorsed by the Council of Australian Governments, sets Australia’s waste management and resource recovery direction to 2020. The policy sets directions in six key areas and identifies 16 priority strategies that would benefit from a national or coordinated approach.

In November 2017, the National Food Strategy was launched by the Minister for the Environment and Energy at the National Food Waste Summit. The Strategy establishes a framework to support actions that can help work towards halving Australia’s food waste by 2030. Implementation of the strategy

is supported by a \$1.37 m AUD (1 AUD = ~0.75 USD) investment over 24 months. It is estimated that Australian consumers throw away around 3.1 m tonnes of edible food a year and another 2.2 m tonnes is disposed by the commercial and industrial sector. The Australian strategy is concentrating its efforts along the whole supply chain for food production and not setting any specific targets or obligation on separate collection and recycling of organics at the municipal level.

In 2018 Australia developed a Fight Food Waste Cooperative Research Centre (CRC). The AUD 133 m program is a partnership

between 57 industry and research participants from Australia and internationally. The Fight Food Waste CRC directly supports the Federal Government’s National Food Waste Strategy as well as its science and research priorities in food, advanced manufacturing and health. It also directly aligns with the Food and Agribusiness Sector Competitiveness Plan prepared by Food Innovation Australia Ltd (FIAL).

In Australia, waste management is dealt with at the state level and hence data are collected and collated on a state-wide basis making analysis at the national level difficult.

12.1.3

Separate collection and recycling of organic waste

Before commenting on MSW data, it is important to stress that total organic waste (non-hazardous) generation in Australia, including food, garden organics and timber, was estimated in 2016 at 13 m tonnes and only 24% of this amounts were of municipal origin, while 17% were from the commercial and industrial sector and the vast majority from other sectors [AU2].

Concentrating on food waste, more recent country data [AU2] estimates that food waste generated in municipalities accounts for almost 23% of all MSW. i.e. 3.1 m tonnes or 133 kg per capita; about 6% (0.2 m tonnes) of collected MSW food waste was recycled, mainly through composting. A further 23% (0.7 m tonnes) was used for energy recovery, almost entirely via landfill gas utilised for generating electricity. This resulted in an estimated recovery rate for municipal food waste of 29%. This is summarised in Table 41.

In Australia, many councils do not offer food recycling services. Those who do, generally co-collect food with garden waste (so called FOGO = Food Organics and Green Organics). Because it is collected as a mixed stream, it is hard to obtain estimated quantities of food waste collected.

The amounts of organic waste collected and recycled in Australia, both from municipalities and commercial companies and food-

processors, are estimated at about 3 m tpa according to the available data from the single states. Most of the food waste is collected from commercial activities and the HoReCa sector and many municipalities serve households with a commingled collection of FOGO (Food and Green Waste). Other organic waste includes residues from food processing and mixed organics not collected at municipalities. We can thus coarsely estimate that about 2.25 m tpa were collected separately in municipalities in year 2015/2016, with organics originating from households and commercial activities.

There are in Australia [AU4] around 150 industrial composting and organics recycling facilities. Some councils provide composting facilities through their kerbside waste collections, either through green organics and garden waste bin, or through a dedicated organics recycling service. Matching the data about organic waste recycling (about 3 m tpa) with those of the number of facilities, the average size of the facility is about 20’000 tpa.

The “other recycling facilities” included in Table 42 are landfill sites with landfill gas recovery, but should not be considered as recycling for the purposes of this document.

There is a growing interest in Australia in co-digestion of food waste and sewage sludge to boost biogas production [AU8], particularly at small wastewater facilities that accept food and drink manufacturer process waste, residential food and green waste, food waste from supermarkets and commercial activities; however the number of facilities is not available in the reports of the single states in Australia.

Statistically there is one recycling facility for organic waste from municipal origin each 156’000 inhabitants.

Table 41 – Types and quantities of organic waste collected and recycled in Australia – year 2015-2016

State	Data year	Food waste (t)	FOGO (t)	Green Waste (t)	Other organic waste (t)	Total organic waste (t)
South Australia	2016-17	8.100		293.000	543.000	844.100
Victoria	2015-16	74.000	31.200	429.000	151.000	685.200
Western Australia	2015-16	37.200		208.300	8.100	253.600
Queensland	2016-17	68.635		570.216	40.107	678.958
New South Wales	2014-15		98.178	436.844		535.022
Total		187.935	129.378	1.937.360	742.207	2.996.880

Note: not all States have reported data and information

Table 42 – Composting and AD facilities in Australia – year 2014

Recycling facilities - year 2014/15	Number of plants	Treatment capacity (tpa)	Quantities treated (tpa)
Composting	150		2’996’880
AD			
Other recycling facilities			700’000
Total	150	-	3’696’880

Key data

All data refer to year 2016 according to the literature quoted; the population of New Zealand is about 4.8 million people [NZ1].

New Zealand currently has no national waste data framework for collecting waste statistics on either MSW or organic materials and as such there are no national figures available. Individual councils (67) report on their waste composition, however, there is not a consistent framework for reporting. Quoting OECD data [NZ2] in 2016 the country generated about 3.4 m tonnes of MSW from urban dwellings, settlement and municipalities. Key data are summarised in Table 43.

WasteMINZ¹³ currently has a project underway to implement a national waste data framework to enable national reporting of waste

statistics. It is also undertaking a stocktake of composting facilities in New Zealand to determine the number of sites.

Whilst there are no national waste statistics some individual studies have been completed. In 2009 a survey of four major New Zealand landfills [NZ4] estimated the organic waste (i.e. including garden trimmings, food scraps and food processing waste) at 28% of all MSW disposed in landfills. Currently total waste to landfill is estimated at 3.41 m tonnes [NZ2] making organic waste equivalent to 950'000 tonnes annually. An older assessment from 2008 [NZ7] quantified MSW disposal to landfill

at 1 million tonnes of which 44% was organic waste, 24% was food waste (258'000 tonnes) with garden waste 19.6% (205'000 tonnes).

According to the results of a national audit [NZ3] conducted in 2015, in New Zealand 30% of the MSW residual waste produced by households was food waste. This amounted to about 148 kg per household or 229.022 tonnes nationally per annum; of this food waste, 54% or 79 kilos per household was avoidable, 12% potentially avoidable and 35% non-avoidable. These amounts do not include generation at schools or the commercial sector, nor quantities of green waste.

Table 43 – Key data: New Zealand

Key data	N or %	t per year	kg/capita/day	Sources
Population	4.82			NZ1
MSW production		3.41m	1.94	NZ2
Organic waste fraction of MSW	28%	0.95m	0.54	NZ4. NZ7
Organic waste recycled *				
Composting and AD facilities	~ 100			

Note: * data not available

Current strategies and regulations governing organic waste

WasteMINZ launched the National Food Waste Prevention Project initiative in 2013.

This quantified the volume and nature of household food waste in New Zealand and led to a national campaign to reduce household food waste. Sixty-one councils from around the country took part in the three-year Love Food Hate Waste New Zealand campaign which has also received central government funding.

An Environment Select Committee Briefing on food waste was also held by the government in October 2018.

Separate collection and recycling of organic waste

Organic waste collection schemes are only partially implemented in New Zealand, in selected cities and settlements; according to WasteMinz [NZ5] 193'000 households are served by a separate food waste and green waste collection scheme, thus involving at least 12.4% of the households [NZ6] of the country.

There are about 98 processing facilities for organic waste in NZ which includes commercial composting, sites where green waste is mulched and community gardens [NZ8], which is summarised in Table 44. For New Zealand it is not possible to distinguish between urban

and agricultural origin as that information is not available, so all sites have been listed as urban. If we consider only commercial composting facilities, thus excluding other processing facilities, there are 40 facilities [NZ5], equating to about one facility per 120'000 inhabitants.

There are currently no national statistics available about the amounts recycled at composting or AD facilities.

Table 44 – Composting and AD facilities in New Zealand – year 2014

Recycling facilities - year 2014/15	Number of plants	Treatment capacity (tpa)	Quantities treated (tpa)
Composting	40		
AD			
Other recycling facilities	58		
Total	98	-	

Statistically there is one recycling facility for organic waste from municipal origin for every 49'000 inhabitants.

References

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AU2

Australian National Waste Report 2016. Dep. For Energy and Environment. 2016

AU3

EOCD Data - 2014

AU4

<https://www.bioplastics.org.au/composting/industry-composting/>

AU5

<http://www.foodwise.com.au/foodwaste/food-waste-fast-facts/>

AU6

<http://www.environment.gov.au/protection/waste-resource-recovery/national-waste-policy/about>

NZ1

<https://www.stats.govt.nz/topics/population>

NZ2

<https://data.oecd.org/waste/municipal-waste.htm>

NZ3

New Zealand Food Waste Audits. WasteNot Consulting 2015

NZ4

Solid Waste Composition. MoE. 2009

NZ5

Questionnaire

NZ6

<http://archive.stats.govt.nz/Census/2013-census/profile-and-summary-reports/qstats-families-households/households.aspx>

NZ7

"Summary of existing information on domestic food waste in New Zealand. 2013"

NZ8

Assessing the availability of composting facilities for events in New Zealand. The Packaging Forum. 2015

Summary of the assessment in different regions and continents

The previous chapters summarised data on the amounts of organic waste generated as part of the municipal solid waste (MSW) stream generated across different continents and in selected countries of the world.

The data have been derived from publicly available documents, which are quoted at the end of each section. Where available, data about composting and anaerobic digestion (biogas) treatment facilities processing solid organic waste, mainly from municipal origin, are quoted.

Table 45 summarises the estimated quantities of organic waste produced in the regions surveyed, the amounts recycled in 2012/2016 (where data are available) and the number of composting and AD facilities treating mainly organic waste from municipal origin. The investigation performed with the support of experts from ISWA's Working Group on Biological Treatment of Waste comes to an

estimation of about 0.67 bn tpa of organic waste produced by urban settlements considering that the survey covers a population of about 5.5 bn people;¹⁴ this amount is of same order of magnitude as the 0.94 bn tpa based on OECD and World Bank data (see Table 2), that refer to the global amount of organic waste currently produced by the world population.

Table 45 – Amounts of MSW and organic waste generated according to the ISWA assessment – year of reference 2012/2016

Key data	Population (m)	Organic waste as part of MSW (m tpa)	Organic waste recycled (m tpa)	Composting and AD facilities (N)	Current collection schemes for organic waste
North America and Canada	357	72	24	5'323	Implemented at single state/ province level
South America	632	120	na	na	Implemented only occasionally at single city or settlement level
Europe: EU-28, CH & NO	524	102	53	4'699	Implemented in significant number of EU member states
Africa	1'250	150	na	na	Implemented only occasionally at single settlement level
Asia (IN, CHN & JP)	2'713	216	5	1'380	Implemented only occasionally at single settlement level
Australia & New Zealand	28	4	2	248	No data about organic waste recycling available
TOTAL	5'504	665	83	11'650	



Notes:

North America: Data about recycling and number of facilities include partial agricultural data and plants

Europe: data for composting and AD facilities for 20 EU countries only. estimated by the European Compost Network and ISWA survey data

Africa: data about MSW are estimated based on data for 2011 applied to 2016/17 population

Asia: data about composting and AD refer to China and India; amounts of organic waste recycled refer to China only

Australia & New Zealand: data not available for amounts of organic waste treated in composting and AD facilities

N = number

Based on this research less than 13% (i.e. 83 m tpa) of organic waste is collected separately and treated, mainly at aerobic treatment facilities (i.e. composting plants). This estimate does not solely relate to the organic fraction of MSW (due to the difficulty in disaggregating the data) and includes organic waste, such as hospitality, restaurants and catering establishments, and (in some cases) from the production sector.

The key parameters assessed for the different countries/continents analysed in this report are summarised below with the help of two basic infographics (Figures 6 and 7). It is clear from the first figure that there is a "global" trend in aligning organic waste produced in human settlements and that lower-income areas in the world (such as Africa) or fast developing "regions" (such as India and China) are going to increase their food consumption and thus

organic waste production in the near future. In terms of potential for treating and recycling organic waste, the largest amounts are located in China, followed by Europe, Latin-America, Africa and India.

Figure 6 – Global estimated municipal organic waste arisings per person per day

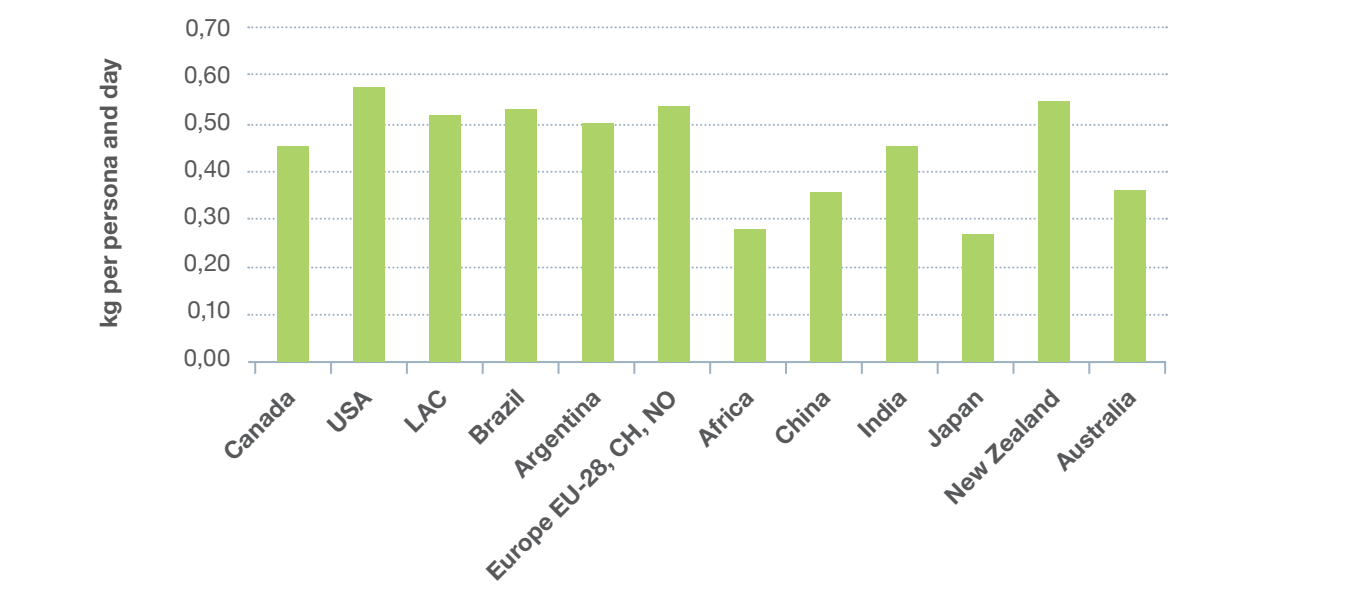
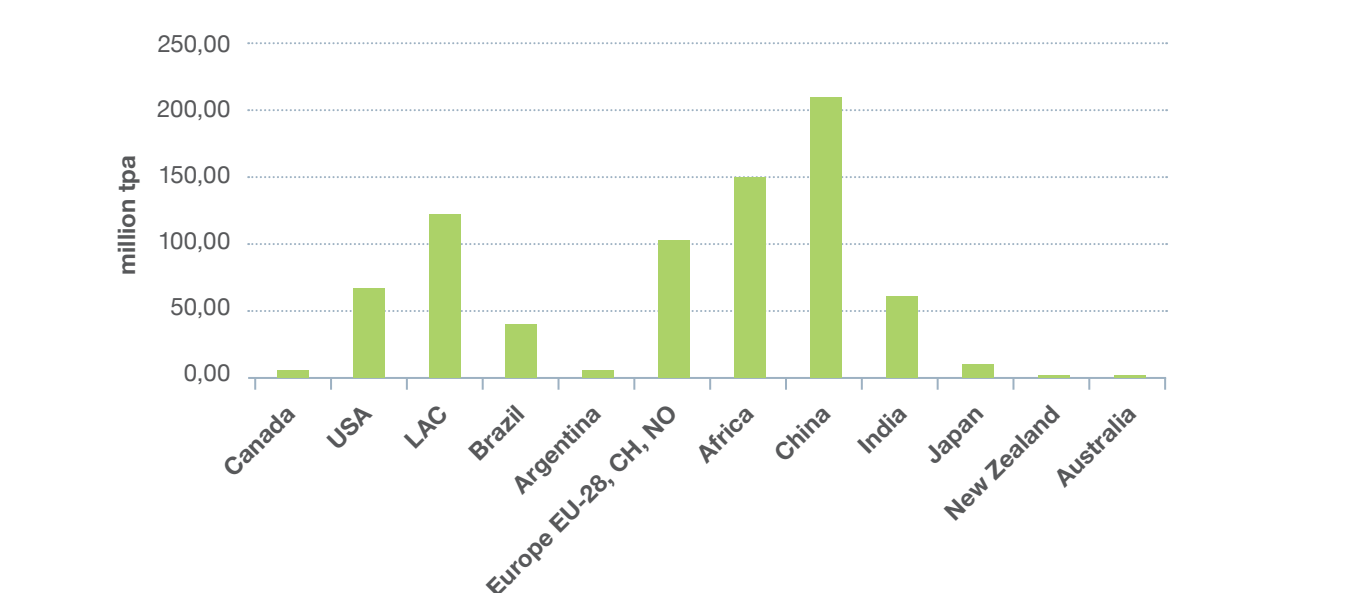


Figure 7 – Global estimated municipal organic waste arisings per year



¹⁴ This number results by summing the population listed in the previous chapters, referring to areas of the world that are included in the assessment.

The number of biological treatment facilities is estimated to be about 11'650 plants worldwide and is likely to be underestimated. The majority of these facilities will treat separately collected organic wastes; however, it is recognised that in parts of Asia, some of these facilities would be treating organic waste delivered as mixed MSW to the facility, this is summarised in Table 46.

Table 46 – Key data about organic waste produced and recycled in selected countries or geographical areas

Country/area		Canada	USA	LAC	Brazil	Argentina
Population		35'587'793	321'773'631	632'380'831	206'814'000	40'117'096
Year	for waste data	2016	2015	2016	2016	2010
Organic waste as part of MSW	kg/capita/day	0.45	0.57	0.51	0.53	0.50
	million tpa	5.84	66.54	120.12	39.91	6.68
Composting	million tpa	1.42	14.04		0.32	
AD	million tpa		7.09			
Others	million tpa	1.22				
All facilities	million tpa	2.64	21.13	-	0.32	-
	kg/capita/day	0.20	0.18		0.00	

Country		Europe EU-28, CH & NO	Africa	China	India	Japan
Population		523'713'950	1'101'369'617	1'374'620'000	1'210'854'977	127'094'745
Year	for waste data	2014/2016	2016	2014	2011	2015
Organic waste as part of MSW	kg/capita/day	0.53	0.28	0.35	0.45	0.27
	million tpa	102.10	149.64	207.50	62.00	12.31
Composting	million tpa	31.83		4.66		
AD	million tpa	20.67				
Others	million tpa					
All facilities	million tpa	52.50		4.66	-	-
	kg/capita/day	0.27		0.01		
		Facilities under estimated	Data very uncertain	production includes food waste from HoReCa		

Country		New Zealand	Australia
Population		4'817'800	23'413'000
Year	for waste data	2016	2014
Organic waste as part of MSW	kg/capita/day	0.54	0.36
	million tpa	0.95	3.08
Composting	million tpa		2.25
AD	million tpa		0.74
Others	million tpa		
All facilities	million tpa	-	3.00
	kg/capita/day		0.35
		No national reporting system in place for MSW	other facilities include amounts C&I

Please refer to the individual sections of this report for an explanation and contextualisation of these data.



Conclusion

In conclusion, while there are existing reports that give a global, or at least continental, overview on the current situation about MSW, there are currently no updated information or publications available - to the knowledge of the authors - about the amounts of organic waste that arise worldwide and that are collected and recycled into compost and or biogas.

As a consequence, there is an evident lack of updated and accessible global data about organic waste arisings and its management and centralised reporting schemes are currently missing or “under construction” even in more developed regions of the world.

Therefore, ISWA calls on local decision makers to regularly publish basic data about organic waste production (if not recycling) and to include this fundamental waste stream into local and national statistics.



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