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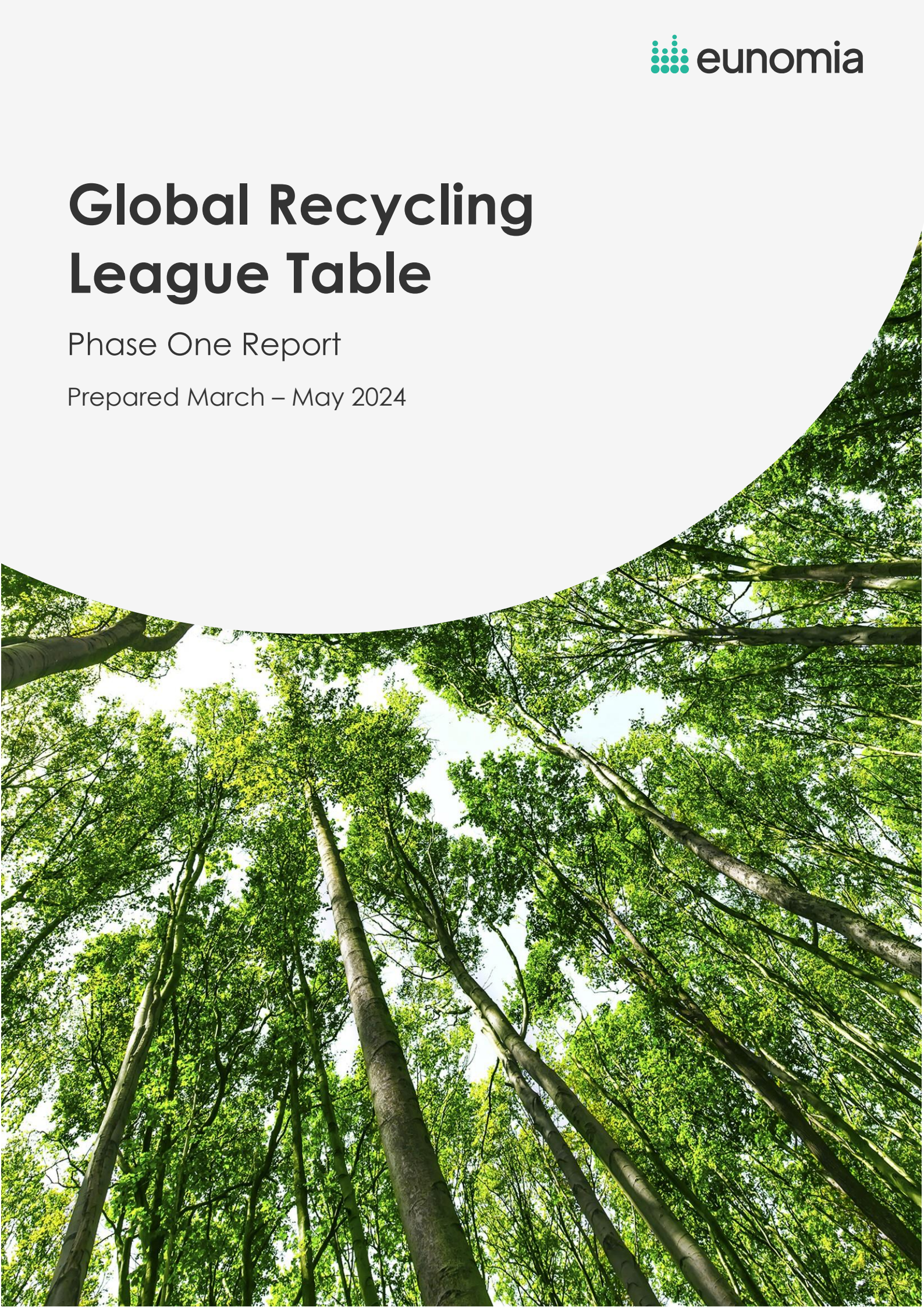
Global Recycling League Table

Phase One Report

Prepared March – May 2024



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Contents

1.0 Introduction

Which countries are the world's best recyclers? This deceptively simple question conceals a great deal of complexity, which this report tries to unpick.

A logical starting point is to examine published recycling statistics. Several databases exist which do this, including those published by Eurostat[1] and the OECD,[2] and by presenting different countries' statistics alongside one another, they invite comparisons. However, while these statistics may be indicative, comparisons must be undertaken with caution as countries have generally developed somewhat different approaches to calculating recycling performance. Individual countries' approaches to measurement are often based on the data that it was convenient for them to collect, with the goal of tracking changes in performance at a national level. It is rare that recycling statistics have been developed with the goal of facilitating international comparisons of recycling performance on a like-for-like basis.

The European Union (EU) has made the most substantial efforts to enable international comparisons, which has become important because its Member States are required to meet common recycling targets for municipal waste and packaging waste, among several other waste streams. The European Commission has therefore sought to standardise how recycling rates are calculated.[3] While this approach has begun to change the way the EU Member States report their waste statistics, it has not yet had its full effect, and some differences in calculation methods appear to remain even in the most recently published data.

This project seeks to compare a wide range of countries' recycling rates on a like-for-like basis. The main focus is on 'municipal waste' recycling rates in line with the definition used by the EU. 'Municipal waste' is waste from households and waste from other sources that is similar in nature and composition to household waste (e.g. businesses, education establishments, public administration offices).

Countries' reported recycling rate calculations differ in a wide range of ways, but the most common are:

- The scope of material included in the calculation (e.g. the extent to which waste from businesses is included);
- The types of material included within the scope of the calculation (e.g. whether waste building materials or septic tank waste from households are counted towards it);
- Whether material recovered from residual waste treatment, such as incinerators or composting of residual waste, can be counted towards recycling rate calculations;
- The extent to which losses after collection for recycling are accounted for;

[1] Eurostat (no date) Waste Database. Available at: https://ec.europa.eu/eurostat/web/waste/data/database
[2] OECD (no date) *Waste - Municipal waste: generation and treatment*. Available at: https://www.oecd-ilibrary.org/environment/data/oecd-environment-statistics/municipal-waste_data-00601-en
[3] European Commission (2019) *Commission Implementing Decision (EU) 2019/1004 of 7 June 2019 laying down rules for the calculation, verification and reporting of data on waste in accordance with Directive 2008/98/EC of the European Parliament and of the Council and repealing Commission Implementing Decision C(2012) 2384.* Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019D1004&from=EN

- Whether material that is composted at source (e.g. home composting), without needing to be collected and transferred to a composting facility, can be counted towards the recycling rate calculation; and

- The extent to which recycling activities undertaken in the informal economy is accounted for.

Section 2.1 of this report examines the recycling performance of 48 countries around the world. It begins from their officially reported recycling rate (if they have one – wherever possible using a figure that approximates a "municipal" recycling rate) and endeavours to use underlying waste data and other published sources to adjust the results to present them on a consistent basis. Our findings regarding the quality of municipal waste data in each country are reported in section 2.2.

Once waste has been created, the best outcome for it is that it is recycled. However, it is preferable that waste is avoided in the first place. It is therefore important that policymakers do not focus solely on recycling rates, as a country that generates large amounts of waste which it recycles relatively successfully may have worse environmental outcomes than one that generates less waste but has a worse recycling rate. Section 2.3 of this study therefore also explores the statistics on the total generation of municipal waste per capita in the countries it examines.

While municipal waste recycling performance is an important measure, the attention of policymakers and the public often focus on particular types of waste – either material types (such as plastics) or packaging formats. Section 2.4 of this study therefore also presents comparisons, where data allows, of differences between the featured countries' performance on plastic packaging waste generation and recycling; while section 2.5 examines generation and recycling of different beverage container formats, comparing plastic, metal and glass beverage containers.

1.1 Objectives

This project aims to:

- Create a clearer understanding of the scale of the waste issue on a global and regional scale, and contribute to national and supranational policy;

- Identify low and high performers on municipal waste generation and recycling, as well as any countries where their method of reporting may overstate performance;

- Highlight differences in plastic packaging waste generation and recycling across different countries;

- Highlight differences in beverage container generation and recycling across different countries and formats;

- Drive debate about wastefulness and the importance of consistent, high-quality data to enable better policy and practice to be implemented.

1.2 Scope and Approach

This Phase 1 report examines an initial tranche of 48 countries, including the countries that report the highest recycling rates in the world, and many of the world's largest economies. The study also includes lower income countries in Latin America, Asia and Africa, to highlight the quite different situations we see globally.

A Phase 2 publication covering a larger number of countries will be published later in 2024, as well as a database that will be published on the Reloop Global Data Observatory. Countries or other stakeholders wishing to provide additional information to improve our estimates or to fill data gaps are welcome to submit this to Eunomia for review.

The work was carried out in the following stages:

- Agreeing definitions of what should be included in municipal waste recycling rates (see section 1.2.1)
- Selecting 48 countries that appeared likely to have sufficient data to be usable and would provide some representation from every populated continent.
- Collecting official, academic and other data on municipal, packaging and beverage container waste and recycling for the selected countries.
- Analysing and standardising, as far as possible, the municipal waste recycling performance for the selected countries to produce figures that approximate their recycling rate under the agreed definitions.
- Analysing other data collected, including recycling rates by material.

Further details on the method are included as an appendix in A.1.0.

1.2.1 Definitions and their Application

A key underpinning of this work is formed by the clear definitions of:

- What is, or is not, municipal waste; and
- What is, or is not, recycling.

The definitions used are intended to correspond as closely as possible with the definitions used in EU law. This isn't with the purpose of making this a Eurocentric analysis but is rather due to the EU having the most well developed and rational framework for standardisation of these definitions and associated metrics that we are aware of. The definition of municipal waste we use are based on the 2018 amended EU Waste Framework Directive:

> *"'municipal waste' means:*
>
> *(a) mixed waste and separately collected waste from households, including paper and cardboard, glass, metals, plastics, bio-waste, wood, textiles, packaging, waste electrical and electronic equipment, waste batteries and accumulators, and bulky waste, including mattresses and furniture;*
>
> *(b) mixed waste and separately collected waste from other sources, where such waste is similar in nature and composition to waste from households;*
>
> *Municipal waste does not include waste from production, agriculture, forestry, fishing, septic tanks and sewage network and treatment, including sewage sludge, end-of-life vehicles or construction and demolition waste.*

This definition is without prejudice to the allocation of responsibilities for waste management between public and private actors." [4]

This definition is helpful, but leaves open some room for interpretation and inconsistency e.g. regarding how materials such as wood, rubble, soil, scrap metal or non-packaging glass or plastics should be treated when they arise from households, or arise in large quantities from non-household sources. Some more specific examples of what is included in municipal waste and how adjustments have been applied are provided in A.1.4. Throughout the report, we also use the term municipal solid waste, abbreviated as MSW, interchangeably with the term municipal wate.

For the definition of recycling, this study follows the EU's Waste Framework Directive and classifying recycling as:

> *any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes.*[5]

In particular, the study endeavours to apply the principles of the EU's new measurement method.[6] The analysis:

- Applies a calculation point for recycling at the entry of material into a final recycling process, and seeks to ensure that countries have, in their data, accounted for losses between collection and the final recycling process (e.g. due to the removal of contamination from separately collected recycling). Where there is no indication that this is the case, assumptions have been applied to make an allowance for losses. However, the limited information that is available makes it difficult to do this with an ideal level of consistency.

- Includes only metals separated from incinerator bottom ash (IBA) as recycling, but not other IBA. This is the only element of Energy from Waste (EfW) incineration which is counted as recycling.

- Includes the (generally very small amount of) material that undergoes preparation for reuse, insofar as this is accounted for in national statistics.

- Includes municipal bio-waste that is separated and recycled at source (e.g. material that is home composted) where a country includes this in its recycling figures, but does not attempt to apply adjustments to account for this where a country does not seek to measure it.

Where anomalies in composition or recycling accounting are identified, various efforts have been made to establish whether they reflect the character of municipal waste in the country, the nature of its recycling system or are indicative of an issue with the way the country records its data. The process of applying this definition inevitably required the application of some judgement. The general adjustments made are summarised in A.1.3 and individual country by country details in A.2.0.

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[4] From Article 3 of *Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste*. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32018L0851

[5] European Commission (2018) Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Consolidated 2018 text). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20180705

[6] European Commission (2019) Commission Implementing Decision (EU) 2019/1004 of 7 June 2019 laying down rules for the calculation, verification and reporting of data on waste. Available at: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32019D1004

2.0 Results and Commentary

2.1 Municipal Waste Recycling Rates

For the 48 selected countries, the reported and adjusted recycling rates (applying the methodology described in A.1.0) are presented graphically in Figure 2-1 and on a world map in Figure 2-2. Table 2-1 summarises how each country ranks before and after adjustment and provides insight regarding data quality for each country.

The adjustments most commonly applied across the countries that led to a reduction of the reported recycling rate were:

- Removal of construction and demolition waste from both the total reported MSW and from dry recycling reported tonnages; and

- Application of sorting losses to the tonnages reported for dry recycling and for organics recycling where it appears that these have not been fully accounted for in the published recycling rate.

The countries with the biggest drops from their reported recycling rate to their adjusted recycling rate were:

- **Singapore** (-30%): The country's reported headline national recycling rate was 57% in 2021; however, this includes all waste rather than municipal waste only. In addition, in the same year, Singapore reported a household waste recycling rate of 13% and a non-household waste recycling rate of 72% – the latter including significant amounts of non-municipal materials. We used the reported recycling rate of 13% for household waste and estimated a non-household municipal recycling rate of 33%, using the generated and recycled waste composition and removing industrial-type waste such as construction and demolition and scrap metals. The adjusted municipal recycling rate for Singapore is therefore 27%.

- **South Korea** (-19%): The country's reported municipal recycling rate was 64% in 2019; however, the municipal recycled waste includes significant quantities of bulky waste, recycling residue and waste marked as "unknown". Those categories were excluded from the dry recycling figures, which led to an adjusted recycling rate of 45%.

- **Spain** (-18%): The country reported a municipal recycling rate of 42% in 2021, but Mechanical Biological Treatment (MBT) is widely used in the country and all of the waste entering MBT plants is counted towards the recycling rate. Based on our understanding of the output composition of MBT and the fates of the output streams, we excluded all but 6% of the waste going to MBT from the recycled tonnages and calculated an adjusted recycling rate of 24%.

- **Germany** (-17%): The country reported a municipal recycling rate of 69% in 2021, but this is based on waste *collected for recycling* rather than actually recycled. In addition, the figures treat most of the waste entering MBT as recycled. We applied contamination and sorting losses (to reflect material lost between collection and the EU calculation point) as well as removing all but 6% of the waste going to MBT from the recycled tonnages, leading to a corrected recycling rate of 52%.

Conversely, a few countries saw their reported recycling rates increase following the adjustments:

- **China** (+15%): Whilst China does not officially report any of their municipal waste generated as recycled, several sources indicate that recycling is happening in the country for certain material types, including plastics, glass, paper and metals. There are also reports of anaerobic digestion which suggest that a part of the generated organic waste is recycled. We applied the recycling rates reported for individual material types, which led to an overall adjusted municipal recycling rate of 15%.

- **South Africa** (+12%): The country reported a municipal recycling rate of 11% in 2018; however, their reported municipal waste generation includes significant quantities of industrial waste which is not recycled, and impairs the overall recycling performance. Removing this non-municipal waste from the generated tonnages increased the recycling rate to 24%.

Following the amendments, the top 10 performing countries (starting with the best 'adjusted' municipal recycling rate) are:

1. Austria
2. Wales
3. Taiwan
4. Germany
5. Belgium
6. Netherlands
7. Denmark
8. Slovenia
9. Northern Ireland
10. South Korea.

This list features a preponderance of Western and Central European countries, reflecting the longstanding use of separate recycling collection systems in this part of the world and the impact of European waste policy, which has stimulated the development of infrastructure for logistics, sorting and treatment.

Austria, the leading recycler, has had widespread separate collections of organic waste across the country since 1995, and this long-established practice is likely to have contributed to their high level of recycling. Austria also introduced Extended Producer Responsibility (EPR) as long ago as the 1990s, which applies to WEEE, batteries and packaging. Wales's recycling rate has increased dramatically since the introduction of a new waste strategy, *Towards Zero Waste*[7], in 2010. The strategy set long term, escalating statutory recycling targets for municipalities in Wales, backed by provision for financial penalties if the targets were missed. Both Taiwan and South Korea introduced a deposit return scheme for beverage containers in 1997 and adopted waste management policies, such as the zero waste policy for Taiwan and the zero organic waste to landfill policy for South Korea. Backed by strong social

[7] Welsh Government (2010), *Towards Zero Waste. One Wales: One Planet*. Available at: https://www.gov.wales/sites/default/files/publications/2019-05/towards-zero-waste-our-waste-strategy.pdf.

expectations of complying with waste sorting rules,[8] these measures have contributed to their recycling rate increasing significantly in the past twenty years.

Some of the lower-income countries do not report an official recycling rate. Many of these countries do not have wide coverage of formal waste collections. Much of the recycling that takes place is conducted in the informal sector, with waste pickers carrying out collection and sorting and with aggregation and even recycling processes often taking place outside a fully formal, regulated setting. The circumstances for waste works in these situations can be hazardous in terms of health and safety and can also be exploitative from a social and economic perspective. However, the situation regarding waste pickers and waste management outside the fully formal economy is highly complex and varies considerably between regions, between countries and even within countries, so is very hard to general about meaningfully. As an example, in Colombia the line between informal and formal is blurred. Waste pickers are paid and a decree in 2016 made 'informal' recycling an official part of the solid waste management system. With increasing focus on a just transition for waste pickers as waste management systems improve in lower income counties, this situation is likely to change considerably in the coming years.

From the perspective of this study though, one common factor in countries with a significant part of waste management occurring outside the fully formal economy is that of poor data quality, in terms of both completeness and accuracy. This is unsurprising, as most high-quality waste data relied on waste being weighed and data reported at different stages of the waste management process. Having said that, even in countries where there is no formally reported recycling rate, our research found widespread evidence of recycling activity and so a focus only on reported recycling rates leads to achievements in these countries not being properly recognised. So where possible, we have drawn on other data sources to create as complete a picture as possible. Nevertheless, many of the countries showing low recycling performance have little reliable data available; that which can be found is often outdated or based on limited surveys, making it difficult to estimate their performance with confidence.

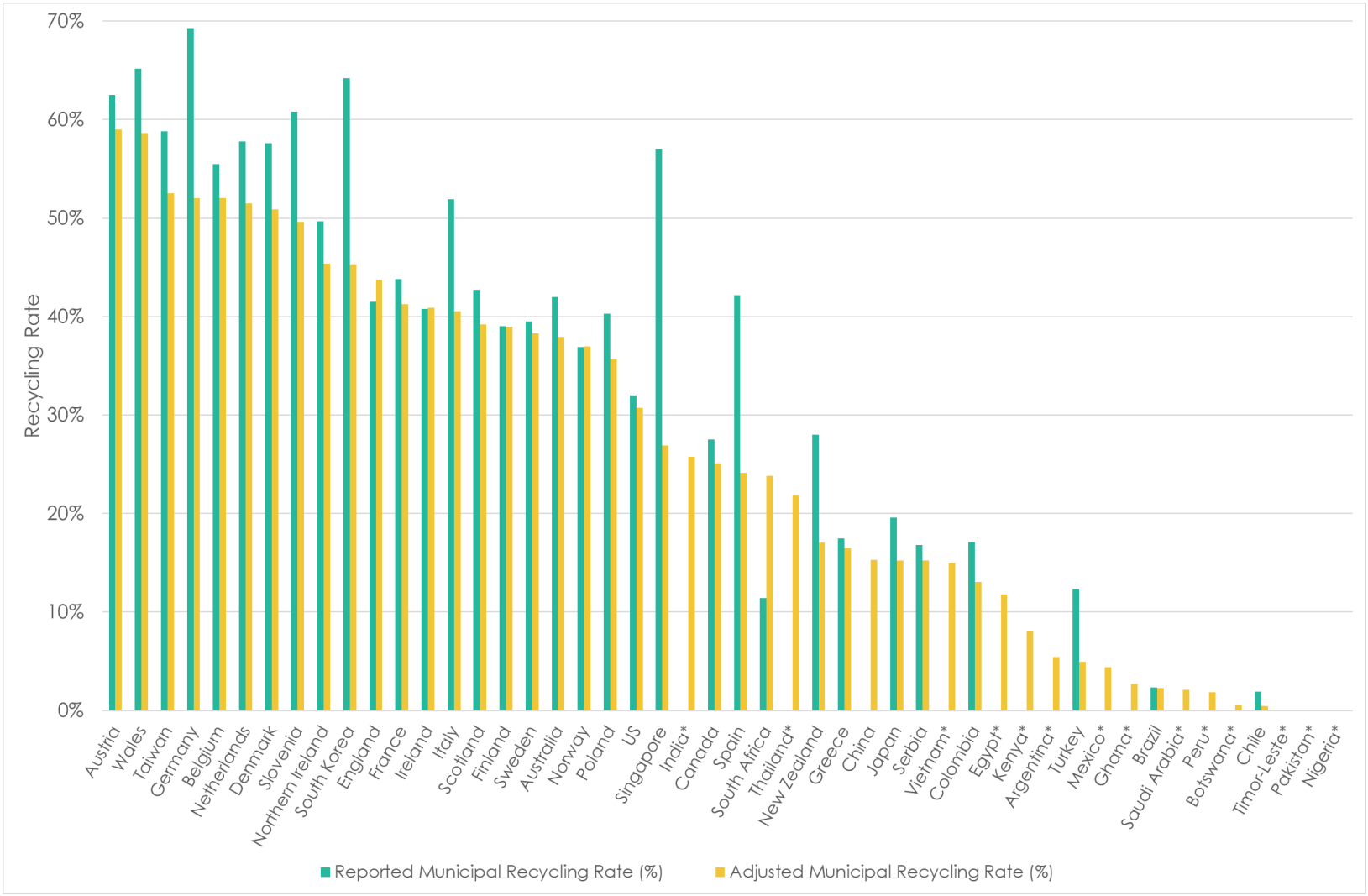
2.2 Data Quality

For the purposes of this study, Singapore, Ghana, Egypt, Nigeria, Pakistan, Timor-Leste and Colombia were the countries with the poorest data quality, while Denmark, Finland, Sweden, South Korea and Norway had the best. As a high income country, the poor quality of Singapore's data may be surprising, but our assessment reflects the country's practice of only publishing total waste statistics rather than municipal waste statistics – an issue that could be rectified relatively easily without any major change to the underlying data collection systems.

The UK nations stood out as having excellent data for waste collected by municipalities, which is reported quarterly and validated by the Government or a government agency. However, most of those nations lack robust data on their municipal commercial waste collected by the private sector. This is especially the case for England and Northern Ireland, whose latest non-household data is a survey from 2009, supplemented by more recent data regarding wastes received at waste sites. As a consequence, both countries fell slightly below the standard necessary to receive a "good" score for waste data. By contrast, Wales had a relatively recent commercial data from a 2018 survey, which, despite the limitations inherent in this methodology, was a notably more useable source than those available for England or Northern Ireland.

[8] Lee, E (2020) *South Korea: The Future of Trash*. Atmos. Available at: https://atmos.earth/south-korea-recycling-technology/

Figure 2-1: Reported and Adjusted Municipal Recycling Rate by Country



*No reported municipal recycling rate

Figure 2-2: Map of Adjusted Municipal Recycling Rate by Country

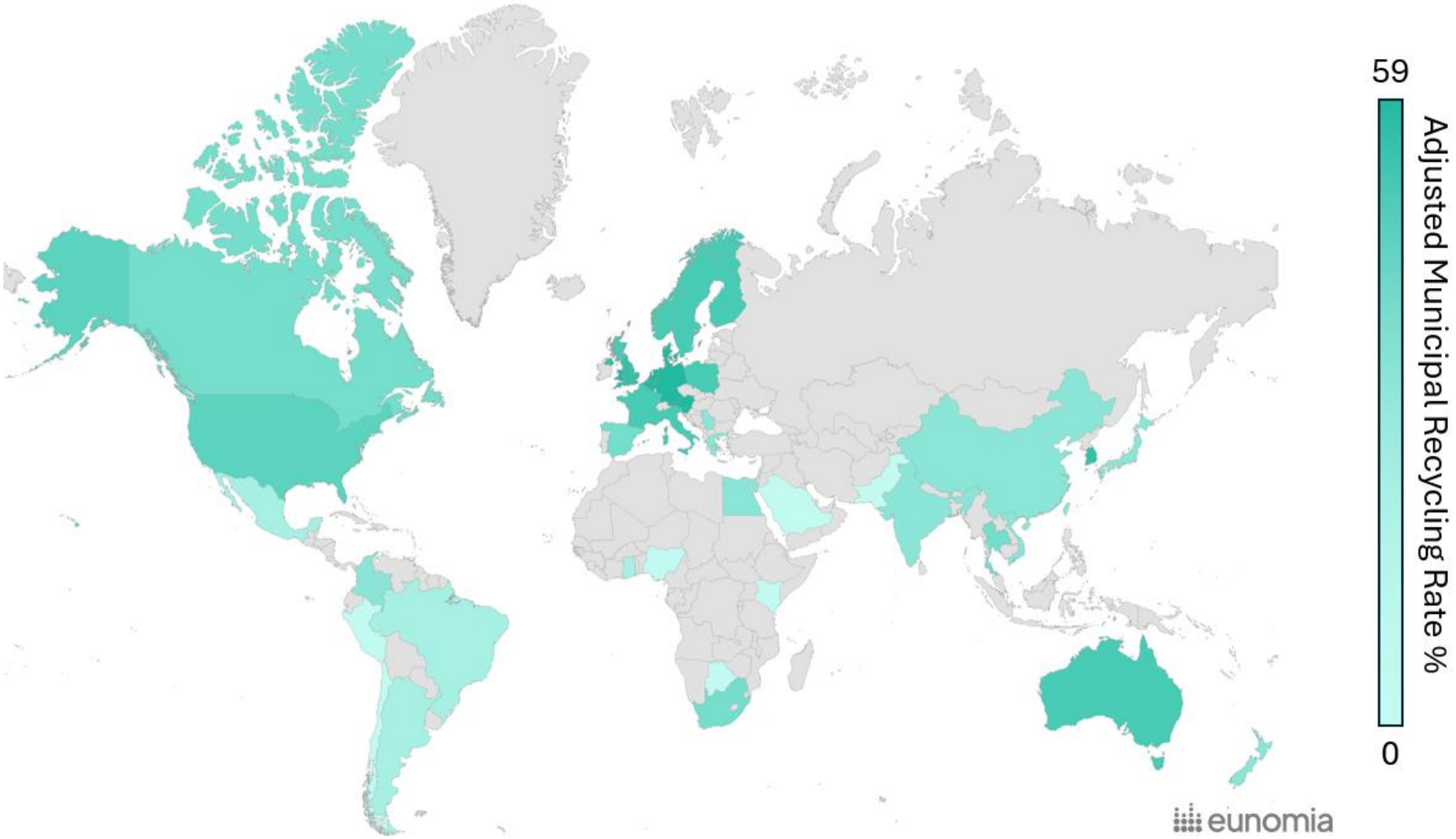


Table 2-1: Reported and Calculated Municipal Recycling Rates by Country[9]

	Reported Recycling Rate		Adjusted Recycling Rate		Change Between Reported and Adjusted		Data Quality
	Rank	Recycling Rate	Rank	Recycling Rate	Rank	Recycling Rate	
Austria	4	62.5%	1	59.0%	3	-3.5% ↓	Good
Wales	2	65.2%	2	58.6%	0	-6.6% ↓	Good
Taiwan	6	58.8%	3	52.5%	3	-6.3% ↓	Poor
Germany	1	69.3%	4	52.04%	-3	-17.3% ↓	Good
Belgium	10	55.5%	5	52.02%	5	-3.5% ↓	Good
Netherlands	7	57.8%	6	51.5%	1	-6.3% ↓	Good
Denmark	8	57.6%	7	50.9%	1	-6.7% ↓	Good
Slovenia	5	60.8%	8	49.6%	-3	-11.2% ↓	Good
Northern Ireland	12	49.7%	9	45.4%	3	-4.3% ↓	Poor
South Korea	3	64.2%	10	45.3%	-7	-18.9% ↓	Good
England	17	41.5%	11	43.7%	6	↑ 2.2%	Poor
France	13	43.8%	12	41.2%	1	-2.6% ↓	Good
Ireland	18	40.8%	13	40.9%	5	↑ 0.1 %	Good
Italy	11	51.9%	14	40.6%	-3	-11.3% ↓	Poor
Scotland	14	42.7%	15	39.2%	-1	-3.5% ↓	Good
Finland	21	39.0%	16	39.0%	5	→ 0.0%	Good
Sweden	20	39.5%	17	38.3%	3	-1.2% ↓	Good
Australia	16	42.0%	18	37.9%	-2	-4.1% ↓	Poor
Norway	22	36.9%	19	36.9%	3	→ 0.0%	Good
Poland	19	40.3%	20	35.7%	-1	-4.6% ↓	Good
US	23	32.0%	21	30.8%	2	-1.2% ↓	Poor
Singapore	9	57.0%	22	26.9%	-13	-30.1% ↓	Very Poor
India	N/A	None	23	25.7%	N/A	N/A	Very Poor
Canada	25	27.5%	24	25.1%	1	-2.4% ↓	Good
Spain	15	42.2 %	25	24.1%	-10	-18.1% ↓	Good
South Africa	31	11.4%	26	23.8%	5	↑ 12.4%	Poor
Thailand	N/A	None	27	21.8%	N/A	N/A	Poor
New Zealand	24	28.0%	28	17.0%	-4	-11.0% ↓	Very Poor
Greece	27	17.5%	29	16.5%	-2	-1.0% ↓	Poor
China	34	0.0%	30	15.3%	4	↑ 15.3%	Very Poor
Japan	26	19.6%	31	15.3%	-5	-4.3% ↓	Good
Sebia	29	16.8%	32	15.2%	-3	-1.6% ↓	Poor
Vietnam	N/A	None	33	15.0%	N/A	N/A	Poor
Colombia	28	17.1%	34	13.0%	-6	-4.1% ↓	Very Poor
Egypt	N/A	None	35	11.8%	N/A	N/A	Very Poor
Kenya	N/A	None	36	8.0%	N/A	N/A	Very Poor
Argentina	N/A	None	37	5.4%	N/A	N/A	Very Poor
Turkey	30	12.3%	38	5.0%	-8	-7.3% ↓	Poor
Mexico	N/A	None	39	4.4%	N/A	N/A	Poor
Ghana	N/A	None	40	2.7%	N/A	N/A	Very Poor
Brazil	32	2.3%	41	2.3%	-9	→ 0.0%	Poor
Saudi Arabia	N/A	None	42	2.1%	N/A	N/A	Very Poor
Peru	N/A	None	43	1.9%	N/A	N/A	Very Poor
Botswana	N/A	None	44	0.5%	N/A	N/A	Very Poor
Chile	33	1.9%	45	0.5%	-12	-1.4% ↓	Very Poor
Timor-Leste	N/A	None	46	0.0%	N/A	N/A	Very Poor
Pakistan	N/A	None	46	0.0%	N/A	N/A	Very Poor
Nigeria	N/A	None	46	0.0%	N/A	N/A	Very Poor

2.3 Waste Generation Per Capita

The adjusted MSW generation per capita per country is shown graphically in Figure 2-3 and on the world map in Figure 2-3.

The most impactful adjustment made to the reported MSW generation was to amend arisings of municipal non-household waste. This component appears to be under-reported by many countries, perhaps reflecting the greater difficulty of obtaining data from private sector waste producers and collectors, with the latter often having a critical role in providing this service. The few countries that appear to record all of their municipal commercial waste include Austria, Belgium, Ireland, Kenya, Mexico, Norway and Slovenia. In these countries, the proportion of municipal waste that is non-household waste varies between 35% and 45% of total MSW. The countries with the lowest reported proportion of non-household municipal waste were Vietnam (6%), Germany and the Netherlands (10%), Greece (16%) and France (17%), and there was nothing in these countries' approaches to waste management or prevention that would provide an explanation for the very low arisings. The under-reporting countries were all scaled up according to the adjustment methodology detailed in Appendix A.1.3.

Conversely, a few countries report a very high quantity of non-household municipal waste which makes their MSW generated per capita remarkably high, such as Canada reporting 56% of MSW as commercial waste and 942 kg/capita of MSW per year. This generally appears to indicate that the country is including some industrial and/or construction and demolition waste within their municipal waste. After the removal of non-municipal waste from Canada reported figures, their MSW generation per capita decreased to 669 kg/capita which is much more in line with the MSW generation in other developed countries.

Most African, South Asian and Pacific countries do not report the breakdown of household and non-household waste within their municipal waste generation, so we were unable to make any adjustments to reflect missing non-household waste.

As an overall observation on the municipal waste generation statistics, it is clear that there is (in general) a strong correlation between waste generation per capita and per capita income. This is unsurprising, as waste generation is to a large extent a function of consumption. However, the differential between the highest and lowest waste generating countries is stark. Even if the extremes are flattened by taking the averages of the upper and lower quartile countries, the upper quartile countries are seen to generate over four times as much waste per capita as the lower quartile countries. Many lower income countries are experiencing rapid economic growth, sometime combined with rapid population growth. It is clearly important that economic development occurs hand in hand with increased material resource efficiency if greater equality in economic prosperity is to be achieved without simply replicating the unsustainable consumption patterns of the world's biggest waste producers.

As highlighted in Figure 2-3, after adjustments, Saudi Arabia stands out as the country having the highest MSW generation per capita. Indeed, Saudi Arabia is often reported as having one of the highest waste generation per capita in the world, with a particularly high food waste generation rate.[10] This appears to be consistent with reports regarding the country's consumer culture. The US is also recognised as a "high consumption" country, which is

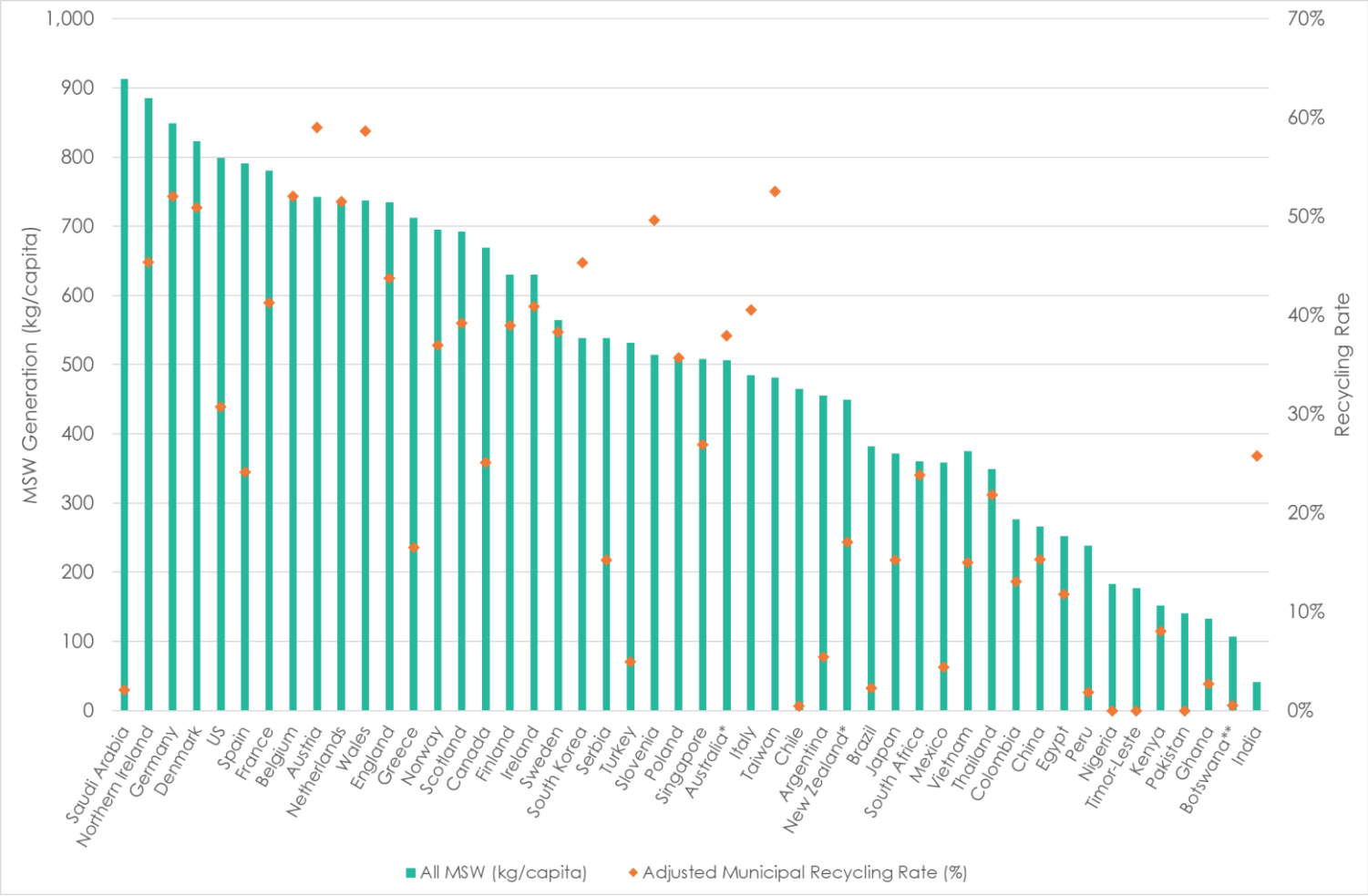
[10] UNDP (2022) *Food For Thought: Why Is Food Waste a Challenge In Saudi Arabia?* Available at: https://www.undp.org/saudi-arabia/blog/food-thought-why-food-waste-challenge-saudi-arabia.

reflected in MSW generation per capita which ranks in the top 5 of the countries included in this study.

India reports very low MSW generation, with a total reported figure of approximately 60 million tonnes per year, which translates to 42 kg/capita. This compares with Pakistan's 140kg/capita, suggesting that India's figure may not capture real waste arisings in their entirety. However, the statistic is corroborated by several sources and we did not find any reliable source suggesting that a greater volume of waste is being generated. The underlying issue may be a lack of reporting in rural areas, where 64% of the population live. However, since this explanation is speculative rather than being supported by any source, no adjustment has been made.

Italy's MSW generation per capita also appears low in comparison with similar countries. Its 485 kg/capita is almost a third less than the average of 666 kg/capita for the European countries included in the present study. The Italian Institute for Environmental Protection and Research ('ISPRA') recognises this pattern and finds it credible that Italy's current low waste generation figures are linked to a successful National Waste Prevention Program. The strong waste policy measures now active across large parts of the country (mandatory source segregation, fines for non-compliance, and pay-as-you-throw (PAYT) charging for residual and organic waste) are likely to contribute to the low waste production rates. A regional assessment also reveals an apparent link between regional MSW generation and regional GDP, which lends credibility to a link between Italy's relatively low GDP per capita and its low national average MSW generation figure. Overall, while there may be some undercounting of non-household waste, the evidence suggests that Italy's MSW generation rate is relatively low, and that may be more related to effective policy measures than to unreported waste.

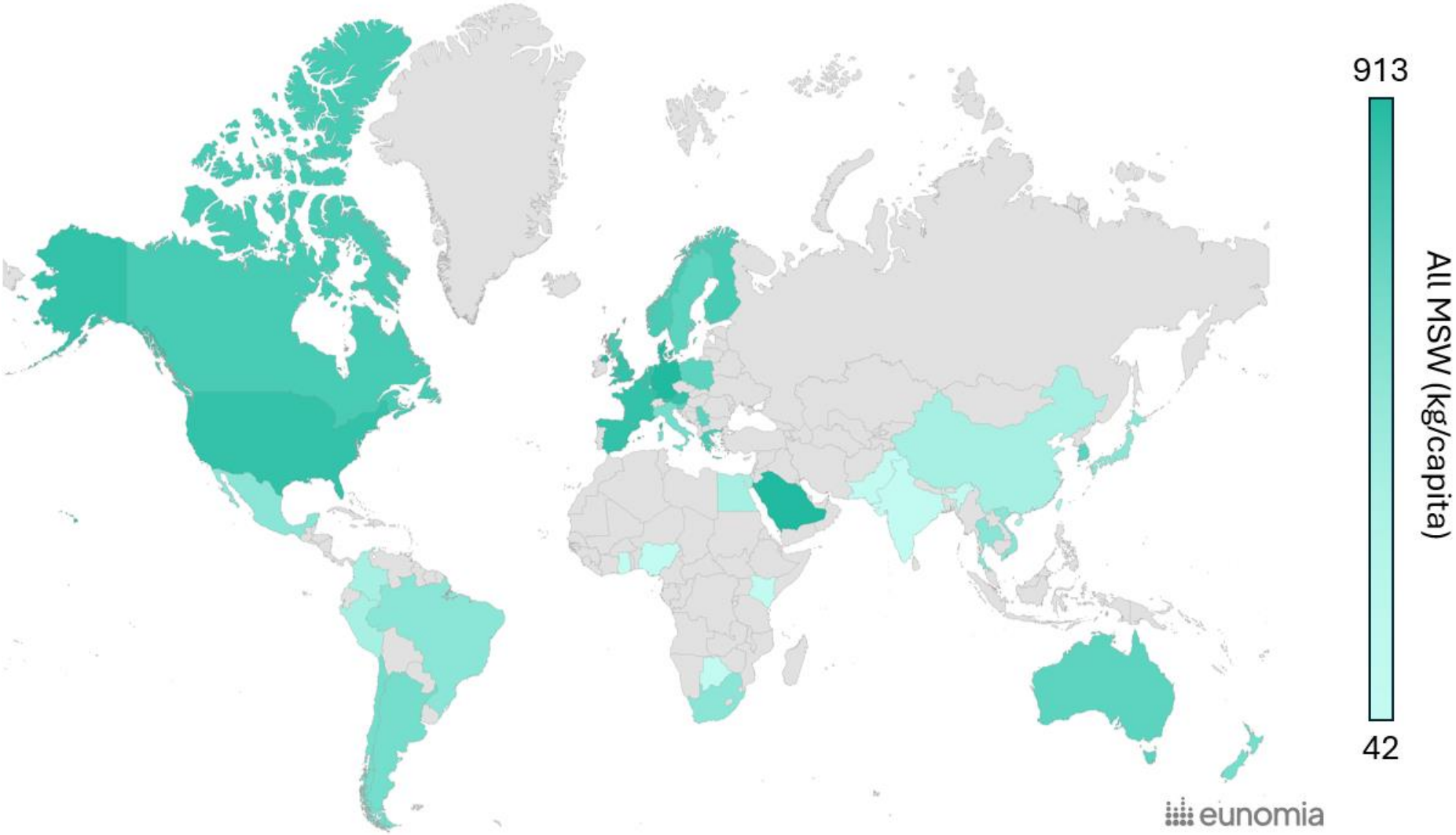
Figure 2-3: Adjusted Municipal Solid Waste Generation per Capita and Recycling Rate per Country



*Tonnages of municipal solid waste *generated* data not available, so municipal solid waste *collected* data used

**Municipal solid waste generated calculated from collected tonnages and collection rates

Figure 2-4: Map of Adjusted Municipal Solid Waste per Capita by Country



2.4 Plastic Packaging Waste

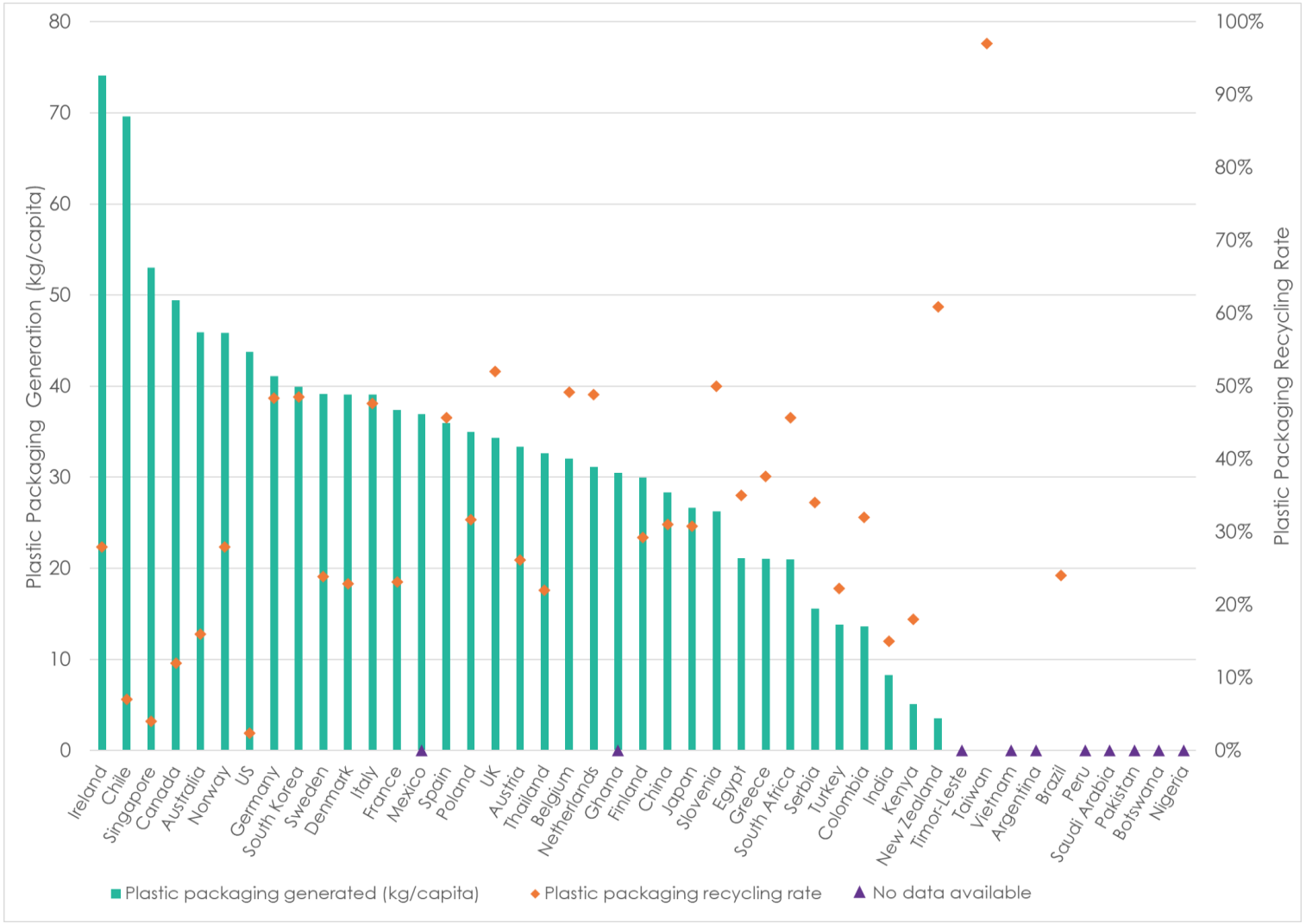
Figure 2-5 shows the reported weight of plastic packaging generated per capita and the reported plastic packaging recycling rate for each country. England, Northern Ireland, Scotland and Wales are replaced by the UK in this graph as packaging data is currently only reported at the UK level rather than for each nation separately.

Ireland is the biggest producer of plastic packaging waste per capita at 74 kg/capita/year, whilst the average generation is 33 kg/capita/year across the countries included in this study that reported plastic packaging data. Ireland also has a relatively low reported recycling rate for plastic packaging waste at 28%. This disparity was highlighted in an Irish EPA research report on packaging waste statistics in 2022,[11] in response to Ireland reporting the largest amount of plastic packaging waste in the EU in 2019. The EPA report examines several potential explanations for the high figure, including differences between Ireland's way of measuring how much plastic waste is generated and those of other countries, and differences in usage patterns – for example, Ireland's use of HDPE milk bottles is high, because Ireland is among the world's biggest consumers of milk. The report does not conclude that there is a statistical anomaly behind Ireland's reported plastic consumption, and we have therefore not sought to normalise down the figure.

Taiwan is the leading country in terms of reported plastic packaging recycling with a 97% recycling rate,[12] while Timor-Leste and the US have the lowest reported recycling rates at 0.06% and 2.41% respectively. The average plastic packaging recycling rate for the countries included in the study is 33%; this is not negligible, but for comparison it is well under the EU-wide target of 55% by 2025. None of the EU countries included in this study seem to have reached this target level yet.

[11] Environmental Protection Agency, *Packaging Waste Statistics, Producer Motivations and Consumer Behaviour*, 2022. Available at: https://www.epa.ie/publications/research/circular-economy/Research_Report_426.pdf.
[12] Ying-Ying Lai and Yuh-Ming Lee (2022) *Management strategy of plastic wastes in Taiwan*. Available at: https://sustainenvironres.biomedcentral.com/articles/10.1186/s42834-022-00123-0.

Figure 2-5: Plastic Packaging Generation per Capita and Recycling Rate per Country



2.5 Beverage Containers

As part of this research, we set out to collect data on generation and recycling of the four main beverage container types: metal; glass and plastic beverage containers; and paper-based cartons. Unfortunately, there was insufficient data on cartons to meaningfully include them in the study.

With the help of Reloop, we were able to obtain data on generation and recycling of plastic, metal and glass beverage containers. The beverages within scope were:

- Soft drinks (incl. fruit juices)
- Beer and cider
- Wine and spirits
- Milk
- Flavoured alcohol

For plastics, all resins are included. PET made up the majority, except in the milk category where HDPE is the majority. For metal, both aluminium and steel beverage containers were included. This data is not able to be separated out, but aluminium would be likely to make up a substantial majority.

Due to the limitations in availability of recycling data, for the purposes of the beverage packaging analysis we have presented our results in terms of material 'separated for recycling'. For some countries this is a reported recycling rate, but for others it can include a combination of material separately collected for recycling, material separated for recycling from mixed residual waste and in the case of metals, may also include material separated from incinerator bottom ash (the heavy residue from waste incineration). This approach has been necessary as for many countries, data for these different fractions cannot be disaggregated. No adjustments were made to the calculated 'separated for recycling' rates as the information to convert them into a like-for-like recycling rate was generally not available. It should be noted through that this does mean that data for beverage packaging waste arisings and recycling are not as comparable as for the other waste streams we have considered.

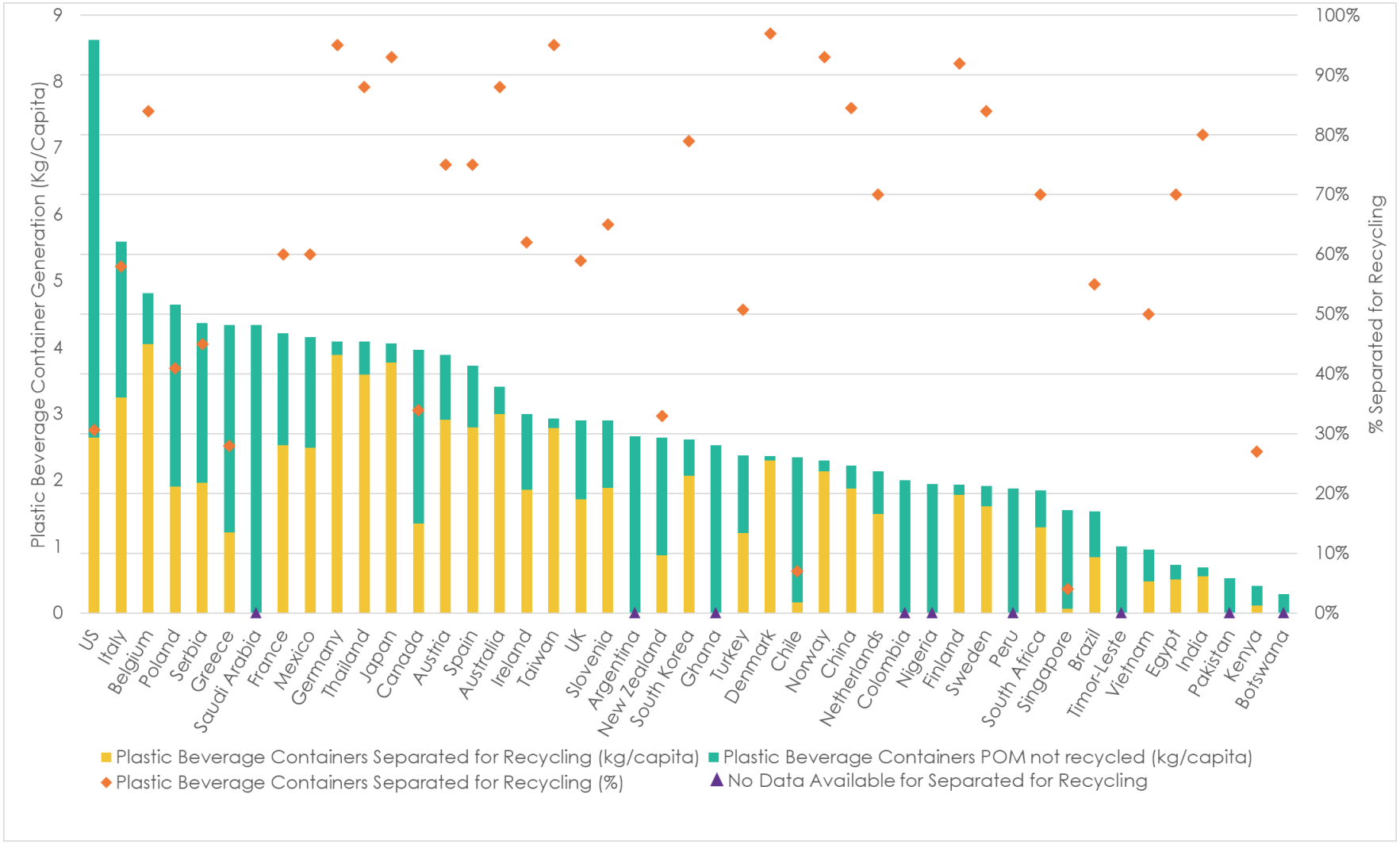
It should be noted that the 'separated for recycling' rate metric we have used is also different from the 'separate collection rate' metric used in the EU for single-use plastic beverage bottles published in 2021(2021/1752 article 2, section 4[13]). Under this metric, any bottles collected via residual waste sorting (mixed waste sorting) are excluded because, while they will be recycled, they were not collected as part of a separate collection for recycling programme.

2.5.1 Plastic Beverage Containers

The amount of plastic beverage containers generated along with 'separated for recycling' rates per country are presented in Figure 2-6. The data is presented so as to place the country that generates the greatest tonnage of plastic beverage containers on the left and that with the lowest arisings on the right.

[13] OJEU (2021) Commission Implementing Decision (EU) 2021/1752. Available at:https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021D1752

Figure 2-6: Plastic Beverage Containers Generated and Separation Rate per Country



Total material placed on the market (POM) figures presented as 'not recycled' for countries with no comparable data on containers separated for recycling

Values for generated plastic beverage containers per capita range between 0.2 and 8.6 kg/capita/year, with Botswana generating the lowest quantity per capita and the US the highest. The US does not report a collection rate but reports a recycling rate of 29%.

Seven countries achieving a 'separated for recycling' rate of 90% or more: Finland, Japan, Norway, Germany, Taiwan and Denmark, with the European countries all reporting separate collection for recycling figures. 90% is the 2029 target for the separate collection for recycling of waste single-use plastic beverage bottles in the EU, up from the 2025 target of 77%. Based on the 'separated for recycling' metric used here, many Member States of the EU are still below the 77% target, such as Greece (28%), Poland (41%), Italy (58%), France (60%), Ireland (62%), Slovenia (65%), Netherlands (70%), Austria (75%) and Spain (75%).

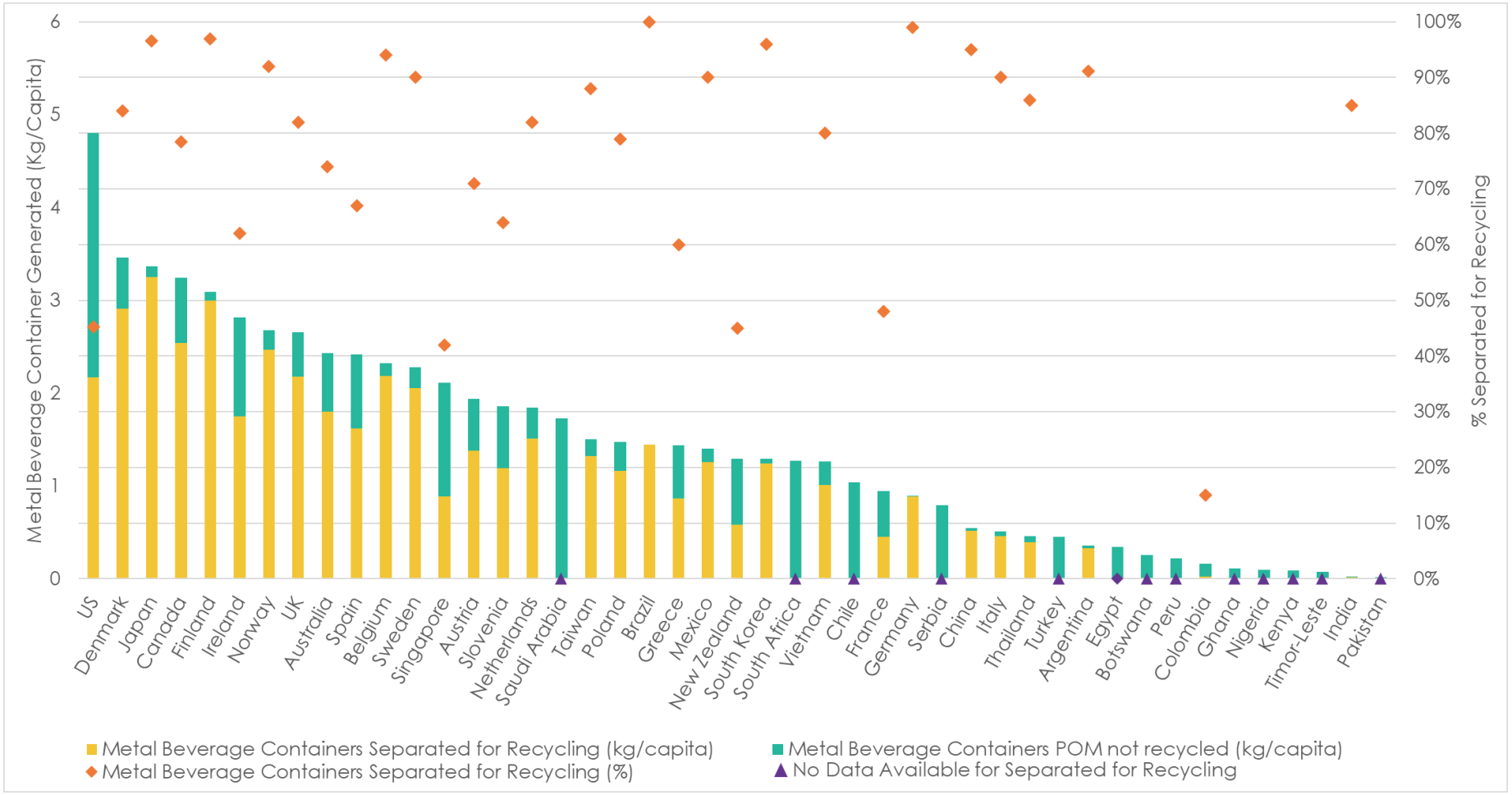
South American countries that report data include Brazil and Mexico, at 55% and 60% respectively. Egypt, Kenya and South Africa are the only African countries included in the study that have a reported rate: Kenya at 27% and Egypt and South Africa at 70%. The separated for recycling rates for several Asian countries that report this data are high, such as 88% for Thailand and 93% for Japan.

Nine of the in-scope nations do not report recycling statistics of any kind for plastic beverage containers. These are mostly middle income countries with limited formal waste collection and/or generally limited reporting of waste statistics. Six of the identified nations report recycling rate figures and so these were used (Canada, Singapore, South Korea, Turkey, US, Vietnam). Recycling rates are typically lower than separate collection rates, as in theory they should account for losses between the collection and recycling steps (e.g. in sorting). For example, in the EU recycling rates for PET bottles are on average about 17% lower than collection rates (see 2.5.4 for further information). However, differences in data reporting and verification between different countries and regions makes true like-for-like comparison impossible.

2.5.2 Metal Beverage Containers

The amount of metal beverage containers generated and separated for recycling are reported in Figure 2-7 below. The data is presented so as to place the country that generates the greatest tonnage of metal beverage containers on the left and that with the lowest arisings on the right.

Figure 2-7: Metal Beverage Containers Generated and Collection Rate per Country



Total material placed on the market (POM) figures presented as 'not recycled' for countries with no comparable data on containers separated for recycling

Values of placed on the market metal beverage containers per capita range between 0.02 (Pakistan) and 4.8kg/capita/year. The US has by far the highest placed on the market value for metal beverage containers per capita, and a relatively low 'separated for recycling' rate at 45%. The aluminium beverage container recycling rate in the US varies significantly between the different states, as reported in Eunomia's *50 States of Recycling 2.0* report.[14] The lowest ranked state (West Virginia) recycles only 6% of aluminium beverage containers, while the highest ranked (Maine) achieves 83%. High performing states tend to have measures in place such as a deposit return scheme to encourage people to recycle their beverage containers.

The countries with the highest 'separated for recycling' rates are Japan, Germany, Brazil and Chile, while in total 12 countries achieve rates at 90% higher. It is interesting to note that amongst these high performers are Brazil (100%), Chile(98%) and Argentina (91%), none of which are countries that perform particularly well on municipal waste recycling. It is possible that Brazil's figures may be affected by the ways in which the number of metal beverage containers sold and amount recycled are calculated, but the high intrinsic value of used beverage can material is clearly likely to be a strong driver of the high recycling performance we see across many countries.

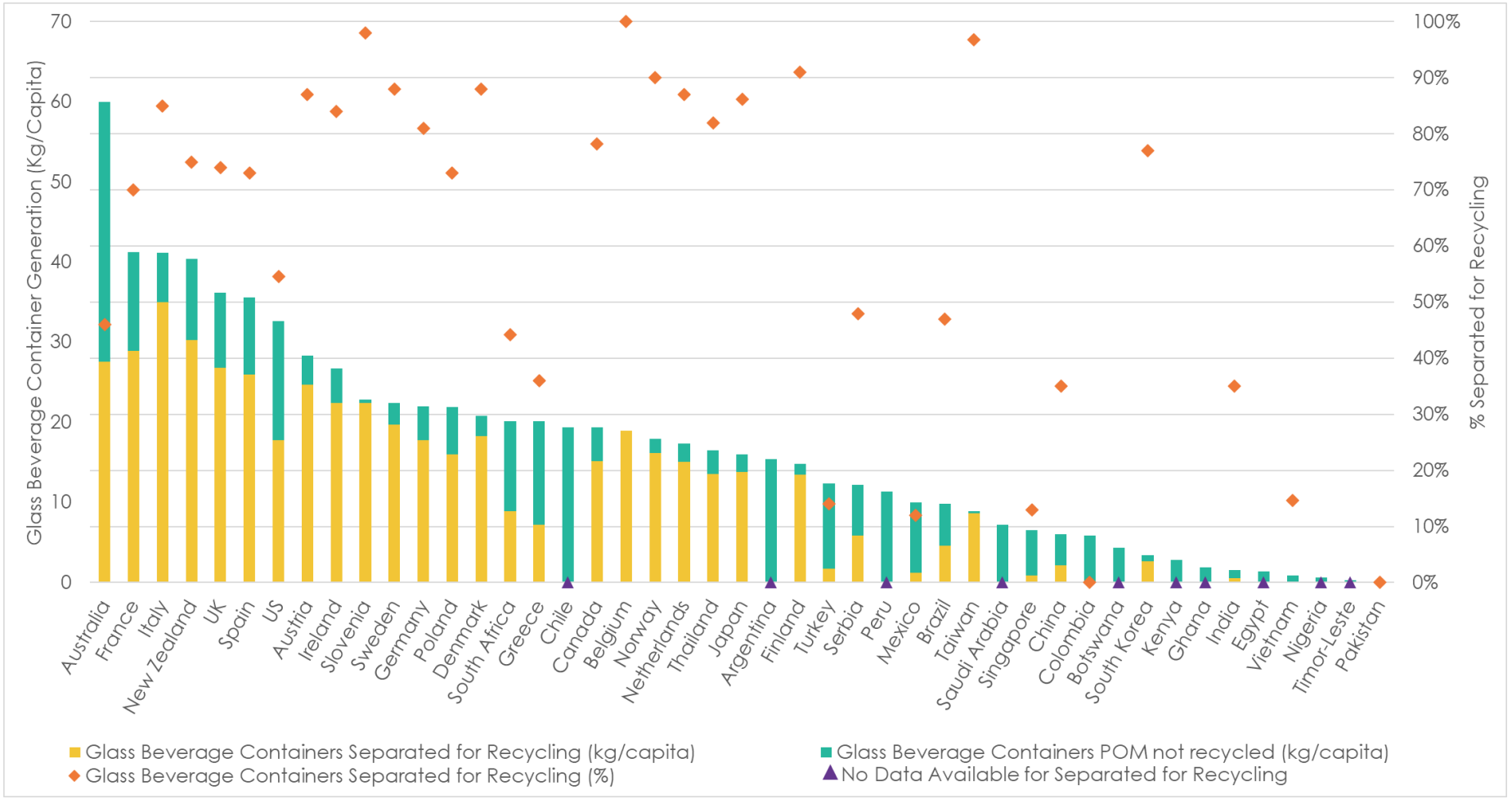
Thirteen of the in-scope nations do not report recycling statistics of any kind for metal beverage containers. These are mostly middle income countries with limited formal waste collection and/or generally limited reporting of waste statistics. Six of the identified nations report recycling rate figures and so these were used (China, Canada, Singapore, Argentina, New Zealand and Colombia). Recycling rates are typically lower than separate collection rates, as in theory they should account for losses between the collection and recycling steps (e.g. in sorting). For example, in the EU recycling rates for metal beverage containers are on average 8% lower than 'collected for recycling' rates (see section 2.5.4).

2.5.3 Glass Beverage Containers

The amount of glass beverage containers generated and separated for recycling are reported in Figure 2-8 below. The data is presented so as to place the country that generates the greatest tonnage of glass beverage containers on the left and that with the lowest arisings on the right.

[14] Eunomia (2023) *The 50 States of Recycling*. Available at: https://www.ball.com/sustainability/real-circularity/50-states-of-recycling.

Figure 2-8: Glass Beverage Containers Generated and Collection Rate per Country



Total material placed on the market (POM) figures presented as 'not recycled' for countries with no comparable data on containers separated for recycling

Based on this data, values of glass beverage containers placed on the market per capita range from 0.1kg in Pakistan to 60kg in Australia. Australia, France Italy and New Zealand were among the top generators of glass beverage containers on a per capita basis. Because glass bottles are substantially heavier than other beverage packaging formats per unit, the per capita placed on the market weights are substantially higher than for plastic and metal beverage containers.

Australia has a high placed on market volume for glass, alongside a relatively low 'separated for recycling' rate of 46%. Conversely, countries such as Belgium, Finland, Norway, Slovenia, and Taiwan exhibit collection rates at or exceeding 90% (which is the 2025 EU glass packaging recycling target). These countries have implemented robust policy frameworks that enhance separate collection of glass. For example, Finland and Norway have adopted deposit return schemes (DRS) for glass packaging, which incentivize consumers to return containers for recycling. Similarly, Taiwan's success can be attributed to its EPR scheme, which has been effective in encouraging the segregation of recyclable waste at the household level.

Ten of the in-scope nations do not report recycling statistics of any kind for glass beverage containers. These are mostly middle income countries with limited formal waste collection and/or generally limited reporting of waste statistics. In addition, five of the countries report recycling rate figures and so these were used (Singapore, Serbia, Mexico, India and Canada). Recycling rates are typically lower than separate collection rates, as in theory they should account for losses between the collection and recycling steps (e.g. in sorting). For example, in the EU recycling rates for glass beverage containers are on average 17% lower than 'collected for recycling' rates (see section 2.5.4).

2.5.4 Beverage Container Summary

This section brings together the results for each of the three beverage container formats for which we were able to obtain data to give an overall assessment of beverage container recycling performance. This summary data seeks to recognise that the performance of a country in recycling one type of beverage container does not necessarily correlate closely with its performance on other formats. A summary of the 'separated for recycling' rates for each of the three materials, where available, is shown in Table 2-2. This ranks each country for which data was available based on an average of their separated for recycling performance for each of the three formats. We have not sought to apply a weighted average, as this would result in a disproportionate focus on glass. Countries for which only partial data is available are included towards the bottom of the table.

Table 2-2: Overall Ranking of Countries on Separated for recycling Rates for Plastic, Metal and Glass Beverage Containers

Beverage Container Material	Plastic		Metal		Glass		Average	
	Rank	% Separated for recycling	Rank	% Separated for recycling	Rank	% Separated for recycling	Rank	% Separated for recycling
Finland	6	92%	3	97%	4	91%	1	93%
Taiwan	2	95%	13	88%	3	97%	2	93%
Belgium	10	84%	7	94%	1	100%	3	93%

Beverage Container Material	Plastic		Metal		Glass		Average	
	Rank	% Separated for recycling	Rank	% Separated for recycling	Rank	% Separated for recycling	Rank	% Separated for recycling
Japan	4	93%	4	97%	11	86%	4	93%
Germany	2	95%	2	99%	15	81%	5	92%
Norway	4	93%	8	92%	5	90%	5	92%
Denmark	1	97%	16	84%	6	88%	7	90%
Sweden	10	84%	10	90%	6	88%	8	87%
Thailand	7	88%	14	86%	14	82%	9	85%
South Korea	13	79%	5	96%	17	77%	10	84%
Netherlands	16	70%	17	82%	9	87%	11	80%
Austria	14	75%	26	71%	9	87%	12	78%
Italy	27	58%	10	90%	12	85%	12	78%
Wales	23	59%	17	82%	8	87%	14	76%
Slovenia	19	65%	28	64%	2	98%	15	76%
England	23	59%	17	82%	19	74%	16	72%
Northern Ireland	23	59%	17	82%	19	74%	16	72%
Spain	14	75%	27	67%	21	73%	16	72%
China	9	85%	6	95%	31	35%	19	72%
Australia	7	88%	25	74%	28	46%	20	69%
Ireland	20	62%	29	62%	13	84%	20	69%
Scotland	23	59%	17	82%	24	64%	22	68%
Brazil	28	55%	1	100%	27	47%	23	67%
India	12	80%	15	85%	31	35%	24	67%
Poland	32	41%	23	79%	21	73%	25	64%
Canada	33	34%	24	78%	16	78%	26	64%
France	21	60%	31	48%	23	70%	27	59%

Beverage Container Material	Plastic		Metal		Glass		Average	
	Rank	% Separated for recycling	Rank	% Separated for recycling	Rank	% Separated for recycling	Rank	% Separated for recycling
Mexico	21	60%	10	90%	36	12%	28	54%
New Zealand	34	33%	33	45%	18	75%	29	51%
Vietnam	30	50%	22	80%	33	15%	30	48%
US	35	31%	32	45%	25	55%	31	46%
Greece	36	28%	30	60%	30	36%	32	41%
Singapore	39	4%	34	42%	35	13%	33	20%
Turkey	29	51%		No data	34	14%		No data
Argentina		No data	9	91%		No data		No data
Egypt	16	70%		No data		No data		No data
Chile	38	7%		No data		No data		No data
Serbia	31	45%		No data	26	48%		No data
South Africa	16	70%		No data	29	44%		No data
Kenya	37	27%		No data		No data		No data
Colombia		No data	35	15%		No data		No data
Nigeria		No data		No data		No data		No data
Botswana		No data		No data		No data		No data
Ghana		No data		No data		No data		No data
Pakistan		No data		No data		No data		No data
Peru		No data		No data		No data		No data
Saudi Arabia		No data		No data		No data		No data
Timor-Leste		No data		No data		No data		No data

Unsurprisingly, many of the countries with 'Very Poor' municipal waste data quality did not have the necessary data available to calculate recycling performance for any of the beverage container materials of interest (Botswana, Ghana, Pakistan, Peru, Saudi Arabia and Timor-Leste). A key recommendation of our work is for countries to look to improve reporting of recycling rates, including for individual materials and beverage containers.

All of the top nine performers on adjusted municipal recycling rate appear in the top ten for beverage container 'separated for recycling' rate for at least one of the three materials. However, Finland and Norway have a top 10 'separated for recycling' rate for all three beverage container materials, but do not rank particularly highly for overall adjusted municipal recycling rate (16th and 19th respectively). This is likely to reflect both countries

having long-established DRSs in place for beverage containers.[15] Other countries which do not perform particularly well on municipal recycling rates but that do have a 'top 10' separated for recycling rate for at least one format of beverage containers are Chile (43), Brazil (41) and Argentina (36), all of which have top 10 'separated for recycling' rates for metal beverage containers.

The 'separated for recycling rates' that are used in the beverage container reporting do not necessarily reflect the ultimate level of recycling that is achieved (e.g. if there is contamination or process losses that lead to material that is collected and separated not being recycled). Unlike for municipal recycling rates, we have not sought to adjust performance to reflect factors such as contamination or losses. In part, this is due to data limitations, but also reflects the fact that there is less variation between what will be counted as "beverage containers" compared with what is counted as "municipal waste".

In practice, loss rates between 'separated for recycling' and being recycled vary by material and between countries. Some observations can be made regarding 'typical' loss rates between 'collection rate' and 'recycling rate' based on previous Eunomia work for International Aluminium Institute using five regions (Brazil, China, Europe, Japan and the USA). For losses across the five regions were reported to be 21% for plastic beverage bottles, 17% for glass beverage bottles and 8% for aluminium beverage containers, loss rates are lower at around 8%.[16]

Having said that, significant variation in loss rates between countries is illustrated in a recent Eunomia and Zero Waste Europe report[17] that looked at glass recycling in four case study countries. Additionally, the way in which beverage containers are collected will affect both the losses between collection and recycling and the method of data collection. For example, most DRS calculate collection for recycling by object count of in scope containers and therefore exclude dust, dirt, moisture etc. Provided that a reasonable estimate of the weight of an empty container, there would be greatly reduced post-collection losses to account for.

Due to these complicating factors, we have not attempted to apply average loss rates to reported 'separated for recycling' figures. Nevertheless it is worth considering how they could affect rankings. In Austria, for example, a slightly greater share of plastic beverage containers (75%) are collected for recycling than metal beverage containers (71%). However, the higher level of losses in plastic recycling compared with metal could mean that the proportion of metal beverage containers that will ultimately be recycled may exceed the level achieved for plastic. There are also further losses between reported 'recycling rate' and final amounts recycled, as explored more in the previous research.

It is notable that the countries with the greatest amounts of beverage containers placed on the market (US for plastics, Australia for glass and the US for metal) were also amongst those with the lowest 'separated for recycling' rates.

2.5.4.1 Beverage Container Data Limitations

The following limitations to the beverage container data are noted:

[15] Norway's Deposit Return Scheme covers plastic and aluminium only. Finland's covers plastic, metals and glass.
[16] International Aluminium Institute (2022) *A Circularity Case for Aluminium Compared with Glass and Plastic* Available at: https://international-aluminium.org/wp-content/uploads/2022/02/Aluminium-vs-glass-and-plastic-FINAL-Information-Sheet-1.pdf
[17] Eunomia/Zero Waste Europe (2022) *How Circular is Glass?* Available at: https://zerowasteeurope.eu/wp-content/uploads/2022/08/EXECUTIVE-SUMMARY_HCIG.pdf

- Not all countries had the data available to calculate 'separated for recycling' rates for all (or, in some cases, any) of the materials.

- Some countries only had recycling rates available and here this was the case, the recycling rate was used. We have clearly indicated where this is the case. Where there were conflicts within the data (e.g. where a 'recycled' figure exceeded that for 'collected for recycling', Eunomia made an assessment of how to correct the data.

- Where no 'separated for recycling' figure could be calculated for plastic bottles in general, the PET bottle rate was used if that was available. Similarly aluminium rates have been used as they were more widely available, but steel is also in scope.

- Some countries[18] did not have 'placed on the market' (POM) data for milk and flavoured alcohol. While this creates an inconsistency in the data, the scale of this is small. Across the countries for which data was available, these products made up an average of <1% of plastic POM volume, ≈5% for metal and <3% for glass. However, there was some degree of variation between countries, and so no adjustment has been made to scale up POM data to correct for this absence. Where milk and flavoured alcohol data was not available, and POM data is therefore understated, this has been indicated in the results.

- The UK only reports POM data at a UK-wide level, with no figures available for its four individual component nations. It was possible, however, to source nation-specific separated for recycling rates. Therefore, arisings per capita are presented for the UK as a whole, whereas collected for recycling rates are presented for each nation.

[18] Countries affected are: Botswana, Timor Leste, Egypt, Ghana, Kenya, Nigeria, Serbia, Slovenia and Taiwan

3.0 Conclusions

Across the countries selected, there are vast differences both in real municipal recycling performance and in how data is collected. There are also examples of countries that are relatively poor performers on municipal waste in general that nonetheless achieve very good results for particular material streams, showing the impact that effective policies can have regardless of where they are implemented.

In order to correct for differences in accounting for municipal recycling rates, the most impactful adjustments made were:

- Removal of construction and demolition waste from both the total reported MSW and from dry recycling reported tonnages; and

- Application of sorting losses to the tonnages reported for dry recycling and for organics recycling.

The countries with the biggest drops in their reported recycling rates were: Singapore, South Korea, Spain and Germany. Conversely, a few countries saw adjustments increase their performance, or compensate for the fact that they were not reporting recycling rates - China and South Africa being the biggest beneficiaries.

Following adjustments to municipal recycling rates, the top performing countries are:

1. Austria
2. Wales
3. Taiwan
4. Germany
5. Belgium
6. Netherlands
7. Denmark
8. Slovenia
9. Northern Ireland
10. South Korea.

However, even the world's top recyclers are not exceeding a 60% recycling rate for municipal waste, once differences in reporting practice are accounted for. Eight of the top 10 are to be found within Europe, with seven being in Western Europe, reflecting the longstanding strategies and policies that have driven investments in collection, logistics, sorting and reprocessing across the continent. The exceptions are two East Asian nations, Taiwan and South Korea, which also have long-established collection and treatment systems. These results highlight the importance of long-term investment in making recycling convenient and efficient, as well as the role that establishing behavioural norms over many years plays in creating a recycling culture.

Many lower-income countries do not report official recycling rates, and where a rate is reported it is often low. In such countries, waste workers in the informal or semi-formal economy are often the primary supplier of recycling services, with much of this activity very

difficult to quantify. The lack of a formally reported municipal recycling rate does not necessarily mean that there is no formal recycling being carried out in a country. For example, this study found sufficiently reliable evidence to demonstrate that China, India, and Thailand are achieving a quantifiable level of recycling, which would be missed if reported recycling rates were taken as the only data source. The data quality available was variable, with the poorest quality data for Singapore, Ghana, Egypt, Nigeria, Pakistan, Timor-Leste and Colombia – though there are very few countries where the quality and transparency of data could not be improved.

Looking at waste generation per capita, the most striking observation that can be made is the disparity in waste arisings between higher and lower income counties, which although understandable given the strong link between consumption and waste generation should give send a strong signal to high waste generating countries that their policy focus should be on waste prevention and reuse as well as on recycling.

In terms of the data, the most impactful adjustment made was to account for additional municipal non-household waste, as this component of MSW is widely under-reported – indeed, it is often measured less well than household waste recycling, or not measured at all. In some countries where non-household MSW figures are quoted, the quantity is very high, which can make their MSW generated per capita figure appear as an outlier.

In order to correct for such anomalies, adjustments were made where the data allowed. However, most African, South Asian and Pacific countries within the study did not report any breakdown of household and non-household waste within their municipal waste generation, and there was limited information available to drive a reasonable inference regarding non-household waste, so we were unable to make any adjustments in these cases.

After adjustments, Saudi Arabia stands out as the country having the highest MSW generation per capita (913kg), which appears to reflect the country's high per capita GDP and known patterns of consumption. At the other end of the scale, India reports a very low MSW generation per capita (42kg), which is a finding replicated in several studies, but appears so low as to suggest that under-reporting of waste (especially in rural areas) may be a contributing factor. Italy's MSW generation per capita is also lower than many comparable European nations; while there may be some MSW that Italy does not account for, it appears that this may be connected with relatively low GDP per capita and a successful National Waste Prevention Program.

The data regarding beverage containers was more limited, but showed big differences in the amounts of beverage containers being placed on the market in different countries, and little correlation between consumption and recycling performance. While the countries with highest municipal waste recycling rates also generally had good beverage container collection rates, the countries with the greatest amounts of beverage containers placed on the market (US for plastics and metal, and Australia for glass) had quite low 'separated for recycling' rates. There were also examples of countries that did not have particularly high municipal recycling rates that had good separated for recycling rates of beverage containers in general (e.g. Finland, Norway) or metal containers in particular (Argentina, Brazil, Chile).

Based upon the trends observed in this work, the general recommendations for countries looking to improve their waste and recycling reporting and performance would be:

- To report municipal waste and recycling rates regularly (annually where possible), with a consistent clear definition and to separate out household and non-household municipal waste so far as possible. At present, non-household municipal reporting is generally much poorer quality and frequency than household, which can lead to countries neglecting the potential role that the non-household sector can play in boosting MSW recycling;

- To report breakdowns of recycling rates for key materials, such as:
    - Different types of beverage containers; and
    - Plastic packaging, including non-beverage containers, rigids and flexibles.

  This level of breakdown is important to allow policymakers and industry to identify material streams on which a country's performance is poor and to focus action on improvements relating to these materials and/or formats;

- To distinguish as far as possible between estimates of waste generated, collected and ultimately recycled. This granularity of data is important in enabling governments to understand important issues such as:
    - How much waste is being lost through uncontrolled burning and burial; and
    - The extent of any losses that occur between collection and final recycling.

  This will enable efforts to be targeted on the stage of the waste management process that has the most room for improvement – and for researchers, it makes it easier to understand how far countries have taken account of recycling losses in their figures.

- To take care in accounting for intermediate treatments (especially MBT plants and mixed waste sorting, but also incineration if there is recovery of metals or other materials from their ash) and to be clear about the extent to which material entering these facilities is ultimately being recycled;

- To carefully consider the definition of municipal waste and ensure that materials such as wood and scrap metal that are not household-like in nature are not included in waste data;

- Where the informal recycling sector operates, examine how improved data from this activity can be achieved as part of a just transition for waste workers;

- Where home composting is happening, to make a formal estimate of this so this can be transparently reflected in recycling rates and given appropriate credit.

The features of countries whose systems yield high recycling rates can usefully be examined by those looking to improve. Typical elements of good systems include:

- A clear waste and recycling strategy, including clear goals regarding targets to be achieved and steps to be taken to improve;

- Widespread separate collection of common recyclables, including organics, to provide households and businesses with a convenient way to recycle;

- The deployment of measures to ensure that additional recyclable material can be extracted from the residual waste stream, supplementing the efforts that are made to source separate recyclables and reducing emissions and pollution from waste disposal;

- Methods to ensure that recycling is funded on a "polluter pays" basis, such as EPR, to incentivise eco-design by producers (e.g. to avoid selling unnecessary packaging) and to prevent performance from being restricted by the funds available to public bodies;

- The use of financial and other behavioural incentives to encourage households and businesses to use the recycling system (e.g. to avoid costs through PAYT or redeem deposits through DRS).

While quality of recycled materials was not in the scope of this report, it is important that recycling should be collected in a way that enables it to be used in high value, circular applications so far as possible.

While this study has noted some of the policies and schemes in use in the countries examined, it has not attempted a comprehensive survey or an analysis of which are associated with the highest levels of performance. Further analysis of policy impacts will be included within Phase 2 of the project.

We recognise that the resources available for countries to dedicate to gathering, verifying and publishing waste data are variable and limited; equally, while we have taken all steps available to us to uncover the relevant data to answer our research questions, we acknowledge that we may not have found every data set or document that could cast light on real waste generation and recycling performance. We would be happy to discuss with representatives of any of the countries featured in this report the steps we have taken to adjust their data through this desk-based exercise, and to receive any additional data that could enable us to refine our approach. Additional information that is made available to us will be used to improve our estimates in Phase 2 of this research, which we also expect to see the study extended to cover a larger pool of countries.

Appendix

A.1.0 Method

A.1.1 Selection of Countries

In this first phase of the project, we investigated a longer list of countries on the basis of:

- Countries which we knew had reasonable data available;
- Countries which were of particular interest (e.g. taking into account size of population or economy, not just selecting all European countries on basis of data availability); and
- Countries which give some representation from every inhabited continent, whilst acknowledging the data availability and timescale of the project necessitated that European and developed countries dominate due to data availability.

Further scoping of the long-list of countries was then undertaken to ensure the minimum necessary amount of data was available. The final countries selected are shown in Table 3-1

Table 3-1: Countries Selected

No.	Country	Region	No.	Country	Region	No.	Country	Region
1	Austria	Europe	**17**	Slovenia	Europe	**33**	Botswana	Africa
2	Belgium	Europe	**18**	Spain	Europe	**34**	Egypt	Africa
3	Denmark	Europe	**19**	Sweden	Europe	**35**	Ghana	Africa
4	England	Europe	**20**	Turkey	Europe	**36**	Keyna	Africa
5	Finland	Europe	**21**	Wales	Europe	**37**	Nigeria	Africa
6	France	Europe	**22**	Argentina	Latin America	**38**	South Africa	Africa
7	Germany	Europe	**23**	Brazil	Latin America	**39**	Australia	East Asia & Pacific
8	Greece	Europe	**24**	Chile	Latin America	**40**	China	East Asia & Pacific
9	Ireland	Europe	**25**	Colombia	Latin America	**41**	Japan	East Asia & Pacific
10	Italy	Europe	**26**	Mexico	Latin America	**42**	New Zealand	East Asia & Pacific
11	Netherlands	Europe	**27**	Peru	Latin America	**43**	Singapore	East Asia & Pacific

No.	Country	Region	No.	Country	Region	No.	Country	Region
12	Northern Ireland	Europe	28	Saudi Arabia	Middle East	44	South Korea	East Asia & Pacific
13	Norway	Europe	29	Canada	North America	45	Taiwan	East Asia & Pacific
14	Poland	Europe	30	US	North America	46	Thailand	East Asia & Pacific
15	Scotland	Europe	31	India	South Asia	47	Timor-Leste	East Asia & Pacific
16	Serbia	Europe	32	Pakistan	South Asia	48	Vietnam	East Asia & Pacific

A.1.2 Collection of Data

We first defined the year of focus, selecting 2021. This year was chosen because it was in many cases the most recent year for which full data was available. For EU countries, it was also a year subject to the new calculation rules, which became mandatory from 2020, but which countries are still adapting to. However, for some of the countries where data collection is not annual, particularly developing countries, the latest year of data was older than 2021 and some adjustments have been made.

The main disadvantage in using the year 2021 is that many countries were significantly impacted by COVID-19 for at least part of the year, with restrictions affecting people's movement, their access to the workplace and the wider economy.

While 2021 was deemed to be the most appropriate year to select, COVID restrictions may have affected:

- The relative volume of household and commercial waste, due to some workplaces being closed and more people working at home;
- The ability of providers of waste services to maintain normal operation, resulting in some material that might normally have been recycled instead being sent for disposal; and
- The ability of national waste data managers to identify inconsistencies or issues with the statistics, leading to lower reliability of data.

However, 2021 was generally less badly affected by such issues than 2020. The decision to choose 2021 reflected our view that undertaking this study based on the last pre-COVID year would mean analysing data that was already nearly 5 years old, while selecting 2022 would have meant many countries had no data available. On balance, the advantage of selected the latest year of data we felt most countries would have consistently available outweighed the disadvantage of any COVID-19 effects.

A standard data collection template was developed and data collected for each country by researchers. The data collection template included detailed breakdowns by material that we were aware would not be available for many countries, to include a geographic spread

of countries the focus was on getting the minimum data for each country of overall municipal recycling rate with other data optional.

A.1.3 Adjustment of Data

The key adjustments made to recycling rate to meet the definition outlined in 1.2.1 were:

- Applying a calculation point for dry recycling losses based on the principles behind the EU's new measurement method using assumptions regarding post-collection loss rates. Information regarding loss rates for material after it has been sorted is very limited, and it is difficult to determine the extent to which different countries have accounted for this in their reporting, especially where material is being exported for reprocessing. We sought, as far as possible, to make allowance for contamination in material that is destined to be input into the final recycling process, but have not sought to correct for additional losses that may occur. It is therefore likely that, if some countries are not fully accounting for subsequent losses, the performance figures reported in this study will somewhat overstate their recycling rate compared with strict adherence to the latest EU reporting rules, and such countries may be advantaged against those that are fully accounting for losses. The possible extent of such losses are summarised in the "sorting loss" rows of Figure 3-1. Where no compositional breakdown was available, we used a standard composition to arrive at a loss rate of 5% which is applied (6% for household waste and 3% for non-household municipal waste). Whilst these losses are European-specific, similar losses were applied in other countries, including those with less mechanised sorting, as these provided the best available estimate. It could be argued that manual sorting may be more accurate or less destructive of material, but in the absence of full rationale for such assumptions, these standard assumptions were used. Wherever possible, we sought to verify whether losses had already been accounted for to avoid double counting losses.

Figure 3-1: Losses Incurred in Sorting and Recycling Processes within the European Union[19]

	Plastics	Glass	Paper/board	Metals	Wood
Sorting loss					
- Household	25%	8%	4%	5%	5%
- Commercial/industrial	5%	1%	2%	2%	10%
Recycling loss					
- Household	29%	5%	10%	14%	-
- Commercial/industrial	5%	5%	10%	14%	11%

- Excluding any waste which is not municipal in character, such as construction and demolition waste and industrial waste.
    - This includes looking at the composition of waste and making a judgement as to whether it is likely to include non-municipal waste and adjusting as appropriate, for example where there is a high amount of wood, scrap metal or bulky waste.
- Excluding any outputs from residual waste processes from being counted as recycled, including incineration and Mechanical Biological Treatment (MBT), except for metals from incinerator bottom ash (IBA) (but not other IBA). Where all inputs going to MBT are counted as recycled, we adjusted this quantity to 6% of inputs actually being recycled.
- Including non-household municipal waste where the data suggests that this waste stream is missing from the reported municipal waste quantities. For developed

[19] EXPRA [Extended Producer Responsibility Alliance] (2014), *The effects of the proposed EU packaging waste policy on waste management practice - A feasibility study*, available here.

countries and urban areas of developing countries, we have used a 60%/40% ratio for household/non-household municipal waste. For rural areas of developing countries, we have used a 95%/5% ratio for household/non-household municipal waste.

Whilst the aim has been to, as far as possible, align the results for each country with the latest EU reporting requirements, there are two respects where it has not been possible to be fully consistent:

- Whilst it is assumed some home composting occurs in all countries, not all countries report it. Since it is consistent with EU reporting rules to count home composting towards recycling performance, we have not removed this material when amending recycling rates. However, we cannot know the extent of home composting in the countries that do not currently report it, and so have not sought to add in an estimate of home composting for countries where this is absent. This therefore remains a point of inconsistency between countries in the study.
- As discussed in the first bullet above, it is challenging to be completely consistent and accurate in how we apply post-collection loss rates.
- Most recycling rates will be inclusive of any preparation for reuse that is taking place within the country, but where this does not appear to have been included, we have not sought to estimate it.

A.1.4 Examples of Municipal Waste within Definition

This section provides further detail of the definition of municipal and examples of what is included in the definition of municipal waste in practical terms.

Municipal waste includes household waste and similar waste. It includes for example:

- paper and cardboard, glass, metals, plastics, wood, textiles;
- packaging;
- bio-waste (e.g. garden waste, leaves, grass clippings, street sweepings, the content of litter containers, and market cleansing waste); and
- mixed and/or undifferentiated wastes, and market cleansing waste.

It also includes materials that are likely to appear in household waste in relatively small quantities, but which in large quantities may be non-municipal in character:

- hazardous household waste (e.g. spent solvents, acids, alkalines, photochemicals, pesticides, used oils, paints, inks, adhesives and resins (partly haz.), detergents (partly haz.), hazardous medicines);
- bulky waste (e.g. white goods, furniture, mattresses etc);
- other waste: Edible oil and fat, rubber waste, ceramics, etc; and
- waste electrical and electronic equipment, waste batteries and accumulators;

Municipal waste includes waste originating from the following (whether collected by municipal or by private collectors):

- households (including recycling of biowaste at source, e.g. home composting, but excluding sewage sludge and construction and demolition [renovation] waste);
- commerce and trade, small businesses, office buildings and institutions (e.g. schools, hospitals, government buildings);

- other enterprises if the waste is similar in kind and composition to household waste and does not come from production;
- all small businesses should be included (including, for instance, waste from repair shops, handicraft, household scale businesses etc.); and
- waste from selected municipal services, i.e. waste from park and garden maintenance, waste from street cleaning services (e.g. street sweepings, the content of litter containers, market cleansing waste).

It includes waste from these collection methods:

- door-to-door through traditional collection (mixed household waste);
- fractions collected separately for recovery operations (through door-to-door collection and/or through voluntary deposits / drop off locations e.g. container parks, civic amenity sites);
- wastes collected directly by the private sector (business or private non-profit institutions); not on behalf of municipalities (mainly separate collection for recovery purposes); and
- wastes originating from rural areas not served by a regular waste service, even if they are disposed of by the one generating the waste.

As mentioned in the main text, the definition is without prejudice to the allocation of responsibilities for waste management between public and private actors.

A.2.0 Adjustments and Data Recommendations by Country

This appendix summarises the adjustments made by individual country and any specific data recommendations recognised during the adjustment process.

Country	Data adjustments
Austria	• Figures for municipal wood and metal arisings and recycled are unusually high and were adjusted down **Recommendations:** Clearly distinguish municipal and non-municipal materials in national level reporting. Review how wood and metal are categorised to exclude non-municipal material. Account for home composting.
Belgium	• Figures for municipal wood arisings and recycled are unusually high and were adjusted down • Post-collection losses from dry or organic recycling appear to have been accounted for by Flanders but do not appear to have been

Country	Data adjustments
	accounted for by Brussels Capital Region and Wallonia, and recycling was adjusted down accordingly **Recommendations:** Clearly distinguish municipal and non-municipal materials in national level reporting. Review how wood is categorised to exclude non-municipal material. Ensure that a national methodology is implemented to account for post-collection losses and show its impact in published statistics.
Denmark	• Non-municipal materials (tires, sludge) were removed from the arisings and recycling. • Figures for municipal wood arisings and recycled are unusually high and were adjusted down. • Post-collection losses from dry or organic recycling do not appear to have entirely been accounted for by Denmark, and recycling was adjusted down accordingly **Recommendations:** Clearly distinguish municipal and non-municipal materials in national level reporting. Review how wood, tires and sludge are categorised to exclude non-municipal material. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics.
England	• The published recycling rate relates to waste from all sources collected by municipalities. No published figure brings together waste collected by municipalities and non-household municipal waste collected by the private sector. Non-household data was sourced from 2018 government estimates based on data from waste sites, which required analysis to remove non-municipal waste, and non-household waste had to be removed from the material collected by municipalities to avoid double counting. The non-household data was adjusted to allow for post-collection losses • Once non-household MSW has been factored in, figures for municipal wood and metal arisings were unusually high and were adjusted down • **Recommendations:** Implement a more reliable method of gathering information on non-household municipal waste – this is expected to be addressed through a new electronic waste data system for the UK. Clearly distinguish municipal and non-municipal materials, especially wood and metal. Account for home composting.
Finland	• No adjustments were made to Finland's reported recycling rate. Statistics Finland provides a breakdown of total municipal solid waste

Country	Data adjustments
	and household MSW. The figures used do not appear to include any non-municipal wastes. Post-collection losses from dry or organic recycling appear to have been accounted for. **Recommendations:** Provide specific non-household municipal waste figures. Separate food waste and other organic waste in compositional reporting.
France	• Figure for non-household municipal waste arisings was unusually low (c17% of MSW) and was adjusted up to 40% • Post-collection losses from dry or organic recycling do not appear to have entirely been accounted for, and recycling was adjusted down accordingly **Recommendations:** Review whether all non-household MSW is being accounted for in arisings and recycling. Improve segregation of data between household and non-household, especially as regards collection. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics.
Germany	• Figure for non-household municipal waste arisings was unusually low (c10% of MSW) and was adjusted up to 40% • All waste entering MBT seems to be accounted for as recycled and the proportion accounted for as recycling was adjusted down to 6% • Post-collection losses from dry or organic recycling do not appear to have entirely been accounted for by Germany, and recycling was adjusted down accordingly **Recommendations:** Review whether all non-household MSW is being accounted for in arisings and recycling. Improve segregation of data between household and non-household, especially as regards collection. Ensure that a methodology is implemented to account for waste actually recycled through MBT rather than using tonnages entering MBT facilities. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics.
Greece	• Figure for non-household municipal waste arisings was unusually low (c16% of MSW) and was adjusted up to 40% • Post-collection losses from dry or organic recycling do not appear to have entirely been accounted for, and recycling was adjusted down accordingly **Recommendations:** Review whether all non-household MSW is being accounted for in arisings and recycling. Improve segregation of data between household and non-household, especially as regards collection.

Country	Data adjustments
	Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics.
Ireland	• Post-collection overseas losses from dry recycling do not appear to be accounted for by Ireland, and recycling was adjusted down accordingly **Recommendations:** Ensure that a methodology is implemented to account for post-collection losses overseas and show its impact in published statistics
Italy	• Small amounts of construction waste were removed from the municipal waste arisings and recycling data **Recommendations:** Review the waste being reported as municipal to remove construction waste.
Netherlands	• Figure for non-household municipal waste arisings was unusually low (c10% of MSW) and was adjusted up to 40% • Small amounts of construction waste were removed from the municipal waste arisings and recycling data **Recommendations:** Review whether all non-household MSW is being accounted for in arisings and recycling. Improve segregation of data between household and non-household, especially as regards collection. Review the waste being reported as municipal to remove construction waste.
Northern Ireland	• The published recycling rate relates to waste from all sources collected by municipalities. No published figure brings together waste collected by municipalities and non-household municipal waste collected by the private sector. Non-household data was sourced from 2019 WRAP estimates produced for the government, based on a mixture of survey and site data. Non-household waste had to be removed from the material collected by municipalities to avoid double counting. The non-household data was adjusted to allow for post-collection losses • **Recommendations:** Implement a more reliable method of gathering information on non-household municipal waste – this is expected to be addressed through a new electronic waste data system for the UK. Clearly distinguish municipal and non-municipal materials. Account for home composting.
Norway	• Figures for municipal wood and metal arisings and recycled are unusually high and were adjusted down • Construction and demolition waste was removed from the municipal waste arisings and recycling data

Country	Data adjustments
	• **Recommendations:** Review how wood and metal are categorised to exclude non-municipal material. Review the waste being reported as municipal to remove construction waste.
Poland	• Figure for non-household municipal waste arisings was unusually low (c14% of MSW) and was adjusted up to 40% • A small amount of industrial waste, construction and demolition waste and other non-municipal wastes, such as soil, combustion waste, or dredging wastes, were removed from the municipal waste arisings and recycling • Figures for municipal wood arisings and recycled are unusually high and were adjusted down • Post-collection losses from dry or organic recycling do not appear to have entirely been accounted for by Poland, and recycling was adjusted down accordingly **Recommendations:** Review whether all non-household MSW is being accounted for in arisings and recycling. Improve segregation of data between household and non-household, especially as regards collection. Review the waste being reported as municipal to remove non-municipal waste. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics.
Scotland	• Small amounts of non-municipal material (e.g. soil) were removed from the household arisings and recycling data • The published recycling rate relates to waste from all sources collected by municipalities. No published figure brings together waste collected by municipalities and non-household municipal waste collected by the private sector. Non-household municipal waste was added through analysis of Scottish Environment Protection Agency data on business waste generated by waste type and economic sector, equalling 36% of MSW. • Small amounts of IBA were accounted for as recycled and were excluded from the recycling tonnages • CLO compost was removed from organics recycling • **Recommendations:** Implement a more reliable method of gathering information on non-household municipal waste – this is expected to be addressed through a new electronic waste data system for the UK. Clearly distinguish municipal and non-municipal materials. Account for

Country	Data adjustments
	home composting. Provide a better reporting system for large quantities of material that is currently reported as 'other residual treatment'.
Serbia	• The published data does not distinguish household and non-household municipal waste. A standardised split therefore had to be applied • The organic recycling data was adjusted to allow for post-collection losses • **Recommendations:** Distinguish between household and non-household waste in data to enable a better assessment of the relative performance of the two sources of MSW. Clearly distinguish municipal and non-municipal materials in national level reporting. Clearly distinguish between food waste and other organic waste. Produce data on waste generation/collection as distinct from treatment. Account for home composting.
Slovenia	• Figures for municipal wood and metal arisings are unusually high and were adjusted down • Figure for metals recycled exceeds figure for collected and was adjusted down • Post-collection losses from dry or organic recycling do not appear to have been accounted for by Slovenia, and recycling was adjusted down accordingly **Recommendations:** Improve segregation of data between household and non-household, especially as regards collection. Review unusually high apparent recycling rate for non-household material. Review how wood and metal are categorised to exclude non-municipal material. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics. Account for home composting.
Spain	• Figure for non-household municipal waste arisings was unusually low (c19% of MSW) and was adjusted up to 40% • All waste entering MBT seem to be accounted for as recycled and the proportion accounted for as recycling was adjusted down to 6% • Small amounts of non-municipal material (e.g. rubble and soil) were removed from the household arisings and recycling data **Recommendations:** Review whether all non-household MSW is being accounted for in arisings and recycling. Improve segregation of data between household and non-household, especially as regards collection. Ensure that a methodology is implemented to account for waste actually

Country	Data adjustments
	recycled through MBT rather than using tonnages entering MBT facilities. Clearly distinguish municipal and non-municipal materials.
Sweden	• Figure for non-household municipal waste arisings was unusually low (c19% of MSW) and was adjusted up to 40% • Figures for non-household municipal recycling were adjusted up to maintain overall non-household rate **Recommendations:** Review whether all non-household MSW is being accounted for in arisings and recycling. Improve segregation of data between household and non-household, especially as regards collection. Improve segregation of data for food waste and green waste.
Turkey	• Figure for non-household municipal waste arisings was unusually low (c17% of MSW) and was adjusted up to 40% • All waste entering MBT seem to be accounted for as recycled and the proportion accounted for as recycling was adjusted down to 6% • Post-collection losses from dry or organic recycling do not appear to have been accounted for by Turkey, and recycling was adjusted down accordingly • **Recommendations:** Review whether all non-household MSW is being accounted for in arisings and recycling. Improve segregation of data between household and non-household, especially as regards collection. Ensure that a methodology is implemented to account for waste actually recycled through MBT rather than using tonnages entering MBT facilities. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics. Account for home composting.
Wales	• Small amounts of non-municipal material (e.g. soil) were removed from the household arisings and recycling data • The published recycling rate relates to waste from all sources collected by municipalities. No published figure brings together waste collected by municipalities and non-household municipal waste collected by the private sector. Non-household data was sourced from a 2018 survey, which required analysis to remove non-municipal waste, and non-household waste had to be removed from the material collected by municipalities to avoid double counting. The non-household data was adjusted to allow for post-collection losses. • The survey implies a very large amount of non-household municipal waste (c. 54% of MSW) and was adjusted down to 40%.

Country	Data adjustments
	• Figures for non-household municipal recycling were adjusted up to maintain overall non-household rate • Incinerator metals are not accounted for in the municipality-level data, and was added back in. **Recommendations:** Implement a more reliable method of gathering information on non-household municipal waste – this is expected to be addressed through a new electronic waste data system for the UK. Clearly distinguish municipal and non-municipal materials, especially wood and metal. Account for home composting.
Argentina	• The most recent data was from 2019 and published national waste statistics do not include a recycling rate, so recycling had to be estimated using municipal waste tonnages reported nationally. **Recommendations:** Collect and publish national statistics annually, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
Brazil	• The published data does not distinguish household and non-household municipal waste. A standardised split therefore had to be applied • The organic recycling data was adjusted to allow for post-collection losses **Recommendations:** Distinguish between household and non-household waste in data to enable a better assessment of the relative performance of the two sources of MSW. Ensure that a methodology is implemented to account for post-collection losses for organic materials and show its impact in published statistics.
Chile	• The published data does not distinguish household and non-household municipal waste. A standardised split therefore had to be applied • Non-municipal waste (e.g. sludge) were removed from the arisings and recycling figures • The dry recycling data was adjusted to allow for post-collection losses • **Recommendations:** Distinguish between household and non-household waste in data to enable a better assessment of the relative performance of the two sources of MSW. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics. Clearly distinguish between MSW and non-municipal waste.
Colombia	• The published data does not distinguish household and non-household municipal waste. A standardised split therefore had to be applied

Country	Data adjustments
	• The dry and organic recycling data was adjusted to allow for post-collection losses • **Recommendations:** Distinguish between household and non-household waste in data to enable a better assessment of the relative performance of the two sources of MSW. Clearly distinguish municipal and non-municipal materials in national level reporting. Clearly distinguish between food waste and other organic waste. Produce data on waste generation/collection as distinct from treatment. Provide clearer information on how data is collected. Account for home composting.
Mexico	• Published national waste statistics do not include a recycling rate, so recycling had to be estimated using municipal waste tonnages reported nationally but containing gaps, making any adjustments necessary to try to achieve a national estimate of MSW recycling. • **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
Peru	• Published national waste statistics do not include a recycling rate, so recycling had to be estimated using municipal waste tonnages reported nationally. • Non-municipal waste (e.g. rubble and soil) were removed from the municipal tonnage figures **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example. Clearly distinguish between MSW and non-municipal waste, and between household and non-household sources.
Saudi Arabia	• No published national statistics, so recycling had to be estimated using academic reports, making any adjustments necessary to try to achieve a national estimate of MSW recycling. **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
Canada	• Significant amounts of non-municipal material (e.g. construction waste) were removed from the household and non-household arisings and recycling data

Country	Data adjustments
	• After this first adjustment, the figure for non-household municipal waste arisings remained unusually high (c55% of MSW) and was adjusted down to 40% • Post-collection losses from dry or organic recycling do not appear to have been accounted for by Canada, and recycling was adjusted down accordingly **Recommendations:** Review the waste being reported as household and non-household to remove all non-municipal material such as construction waste and forestry and agriculture waste. Review how other waste streams such as wood and metals are reported under non-household waste to exclude non-municipal waste. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics. Account for home composting.
US	• The published data does not distinguish household and non-household municipal waste. A standardised split therefore had to be applied with non-household waste estimated as 40% of MSW • Post-collection losses from dry or organic recycling do not appear to have been accounted for by the US, and recycling was adjusted down accordingly **Recommendations:** Distinguish between household and non-household waste in data to enable a better assessment of the relative performance of the two sources of MSW. Clearly distinguish municipal and non-municipal materials in national level reporting. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics. Account for home composting.
India	• No published national statistics, so recycling had to be estimated using academic reports, making any adjustments necessary to try to achieve a national estimate of MSW recycling. **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
Pakistan	• No published national statistics, so recycling had to be estimated using academic reports, making any adjustments necessary to try to achieve a national estimate of MSW recycling. **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.

Country	Data adjustments
Botswana	• No published national statistics, so recycling had to be estimated using academic reports, making any adjustments necessary to try to achieve a national estimate of MSW recycling. • **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
Egypt	• Published national waste statistics do not include a recycling rate, so recycling had to be estimated using academic reports, making any adjustments necessary to try to achieve a national estimate of MSW recycling. • **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
Ghana	• No published national statistics, so recycling had to be estimated using academic reports, making any adjustments necessary to try to achieve a national estimate of MSW recycling. • **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
Kenya	• No published national statistics, and no evidence of formal recycling. • **Recommendations:** As the waste management system develops, regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
Nigeria	• No published national statistics, and no evidence of formal recycling. • **Recommendations:** As the waste management system develops, regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
South Africa	• A range of construction, demolition and industrial wastes were removed from the published data • The published data does not distinguish household and non-household municipal waste. A standardised split therefore had to be applied • The dry and organic recycling data was adjusted to allow for post-collection losses **Recommendations:** Distinguish between household and non-household waste in data to enable a better assessment of the relative performance of

Country	Data adjustments
	the two sources of MSW. Provide clearer information on how data is collected. Account for post-collection losses. Account for home composting.
Australia	• The published data does not distinguish household and non-household municipal waste. A standardised split therefore had to be applied with non-household waste estimated as 40% of MSW • Small amounts of construction waste were removed from the municipal waste arisings and recycling data • Figures for municipal metal arisings and recycled are unusually high and were adjusted down • Post-collection losses from dry or organic recycling do not appear to have been accounted for by Australia, and recycling was adjusted down accordingly **Recommendations:** Distinguish between household and non-household waste in data to enable a better assessment of the relative performance of the two sources of MSW. Review the waste being reported as municipal to remove construction waste. Review how metals are categorised to exclude non-municipal material. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics. Account for home composting.
China	• Published national waste statistics do not include a recycling rate, and only includes so recycling had to be estimated using municipal waste tonnages reported nationally but containing gaps, making any adjustments necessary to try to achieve a national estimate of MSW recycling. • **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
Japan	• Figure for non-household municipal waste arisings was unusually low (c30% of MSW) and was adjusted up to 40% • Significant amounts of non-municipal material (e.g. construction waste) were removed from the municipal arisings and recycling data • Small amounts of IBA were accounted for as recycled and were excluded from the recycling tonnages • Post-collection losses from dry or organic recycling do not appear to have entirely been accounted for by Japan, and recycling was adjusted down accordingly

Country	Data adjustments
	Recommendations: Review whether all non-household MSW is being accounted for in arisings and recycling. Improve segregation of data between household and non-household, especially as regards collection. Review the waste being reported as municipal to remove all non-municipal material such as construction waste. Exclude IBA from the reported recycled tonnages. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics. Account for home composting.
New Zealand	• The published data does not distinguish household and non-household municipal waste. A standardised split therefore had to be applied with non-household waste estimated as 40% of MSW • Large amounts of construction waste were removed from the municipal waste arisings data • Figures for municipal wood arisings and recycled are unusually high and were adjusted down • Figures for municipal hazardous waste arisings are unusually high and were adjusted down • No organics recycling is reported whilst there are several municipal composting sites in the country, so an estimate of organics recycling was added in • Post-collection losses from dry or organic recycling do not appear to have been accounted for by New Zealand, and recycling was adjusted down accordingly • **Recommendations:** Distinguish between household and non-household waste in data to enable a better assessment of the relative performance of the two sources of MSW. Review the waste being reported as municipal to remove construction waste. Review how wood and hazardous waste are categorised to exclude non-municipal material. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics. Account for municipal composting and home composting.
Singapore	• The published data does not distinguish household and non-household municipal waste. A standardised split therefore had to be applied with non-household waste estimated as 40% of MSW • Large amounts of non-municipal material (e.g. construction waste) were removed from the municipal arisings and recycling data

Country	Data adjustments
	• Figures for municipal metal and wood arisings and recycled are unusually high and were adjusted down • **Recommendations:** Distinguish between household and non-household waste in data to enable a better assessment of the relative performance of the two sources of MSW. Review the waste being reported as municipal to remove all non-municipal waste such as construction waste. Review how wood and metal waste are categorised to exclude non-municipal material. Account for home composting.
South Korea	• Figure for non-household municipal waste arisings was unusually low (c26% of MSW) and was adjusted up to 40% • Large amounts of non-municipal material (e.g. waste marked as unknown) were removed from the municipal arisings and recycling data • Small amounts of IBA were accounted for as recycled and were excluded from the recycling tonnages • Post-collection losses from dry or organic recycling do not appear to have entirely been accounted for by South Korea, and recycling was adjusted down accordingly **Recommendations:** Review whether all non-household MSW is being accounted for in arisings and recycling. Improve segregation of data between household and non-household, especially as regards collection. Clearly distinguish municipal and non-municipal materials in national level reporting, and specify all waste type including the current unknown category. Exclude IBA from the reported recycled tonnages. Ensure that a methodology is implemented to account for post-collection losses and show its impact in published statistics. Account for home composting.
Taiwan	• The published data does not distinguish household and non-household municipal waste. A standardised split therefore had to be applied with non-household waste estimated as 40% of MSW • The reported total municipal waste seems to exclude a significant amount of waste which is informally recycled. Those tonnages were added to the municipal arisings but not to the recycling **Recommendations:** Distinguish between household and non-household waste in data to enable a better assessment of the relative performance of the two sources of MSW. Include all municipal tonnages within the household and non-household waste arisings, including waste recycled informally. Account for home composting.

Country	Data adjustments
Thailand	• Published national waste statistics do not include a recycling rate, or a split between household and non-household MSW. However, 'utilisation before disposal' figures are provided and were used to calculate a recycling rate for MSW. **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
Timor-Leste	• Published national waste statistics do not include a recycling rate and only include household waste. • **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.
Vietnam	• Figure for non-household municipal waste arisings was unusually low (c6% of MSW) and was adjusted up to 40% for urban areas and estimated at 5% for rural areas • Published national waste statistics do not include a recycling rate, so recycling had to be estimated using municipal waste tonnages reported nationally but containing gaps, making any adjustments necessary to try to achieve a national estimate of MSW recycling. **Recommendations:** Regularly collect and publish national statistics, including a municipal recycling rate. The principles used by the EU in the reporting required from member states provides a useful example.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