ISSUE 2

Recycling – who really leads the world?

Identifying the world's best municipal waste recyclers

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Research Questions

- How do leading European recycling nations compare to the rest of the world?
- What are the common characteristics of the top recycling nations?
- How can we make reported recycling rates more comparable?
- What are the common anomalies in reported statistics that mask the ‘real’ recycling rate?

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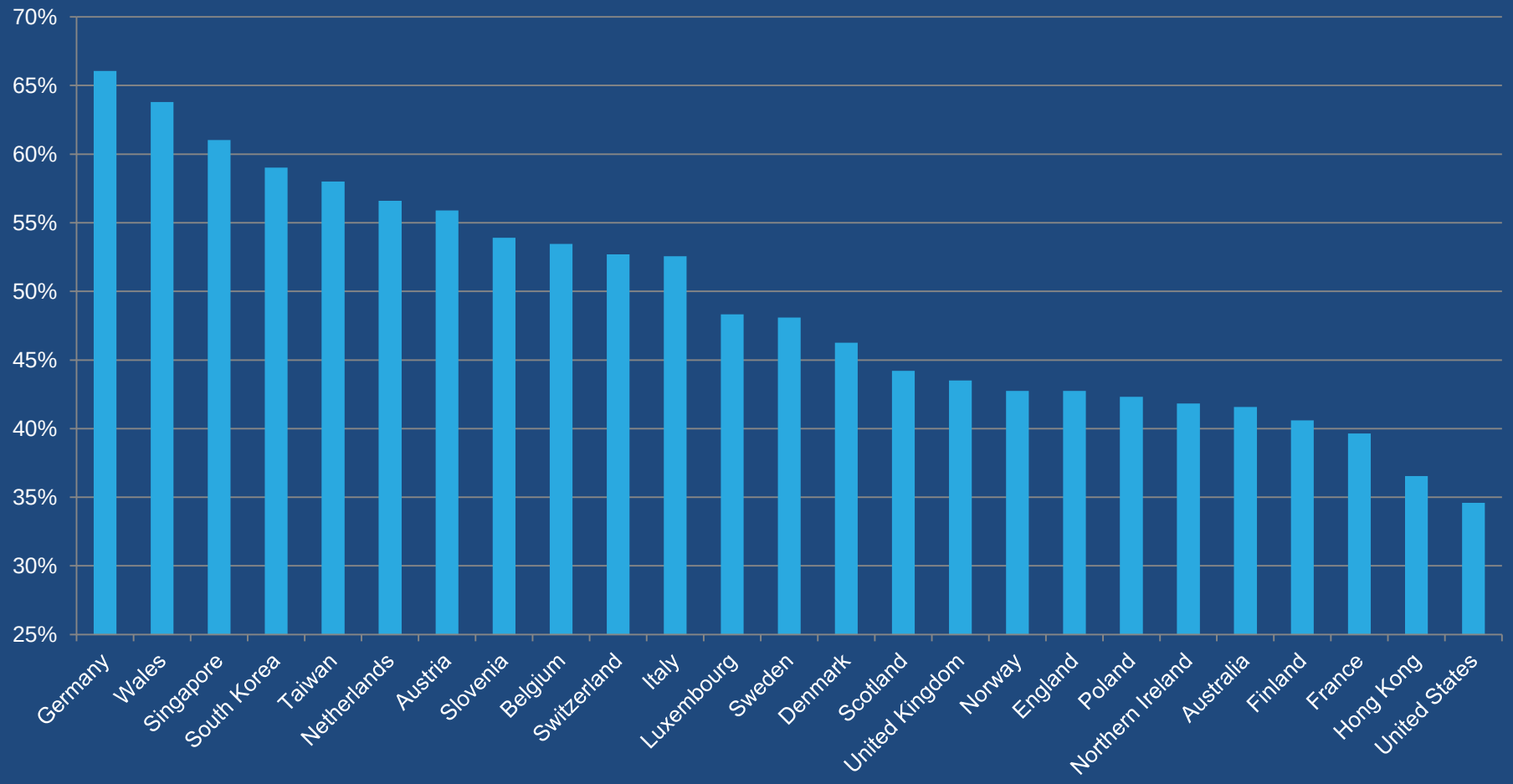
Introduction

- Around the world, recycling rates are widely reported – but different measurement methods make comparisons difficult; some eye-catching recycling rate claims need to be treated with caution
- By compiling reported recycling rate figures from sources including Eurostat and OECD we have identified the top 25 performers
- By examining the data in more detail and understanding what is and isn't included in the different measurement methods we have compared the top performers to set out a ‘Top 10’ league table
- These results have been updated from the original version published in March 2017, based on newly reported recycling rates where available and additional research on recycling rate measurement protocols in the Top 10 countries

Top 25 MSW Recyclers - Reported Recycling Rate



Sources: Various - *see method section for references*

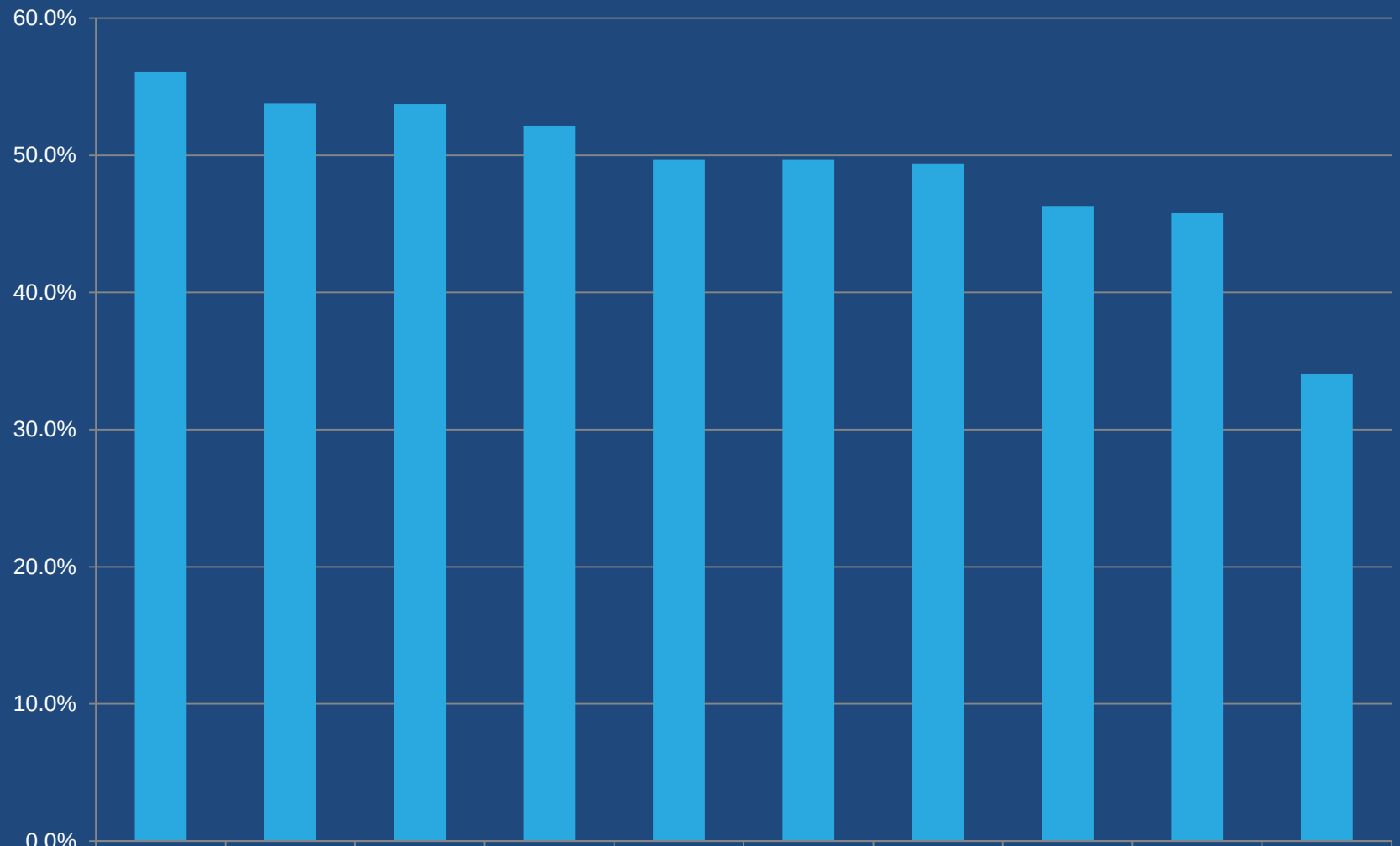
Top performers

- EU member states are well represented in high performers, as are several Asian states
- A recycling rate of over 50% is needed to qualify for the ‘top 10’
- Large variation between UK nations is apparent when they are shown separately - Wales is comfortably ahead
- But we are not comparing like with like…

Towards a Better Comparison

- Digging further into the underlying data and the recycling practices in each country allows us to identify where discrepancies lie in how recycling is reported. The main differences are in how the following are accounted for (or not) in reported figures:
  - Inclusion of Construction and Demolition (C&D) wastes
  - Inclusion of Commercial and Industrial (C&I) waste
  - Incinerator Bottom Ash (IBA) (and metals recovered from IBA)
  - Contamination within dry recycling and biowaste
  - Inputs to/outputs from Mechanical and Biological Treatment
  - Recycling processing losses
- By adjusting for these discrepancies we have attempted to resolve a comparable set of recycling rates for both MSW and household waste that better reflect the amount of waste that is actually recycled

Top 10 from Longlist - Adjusted Recycling Rate - MSW



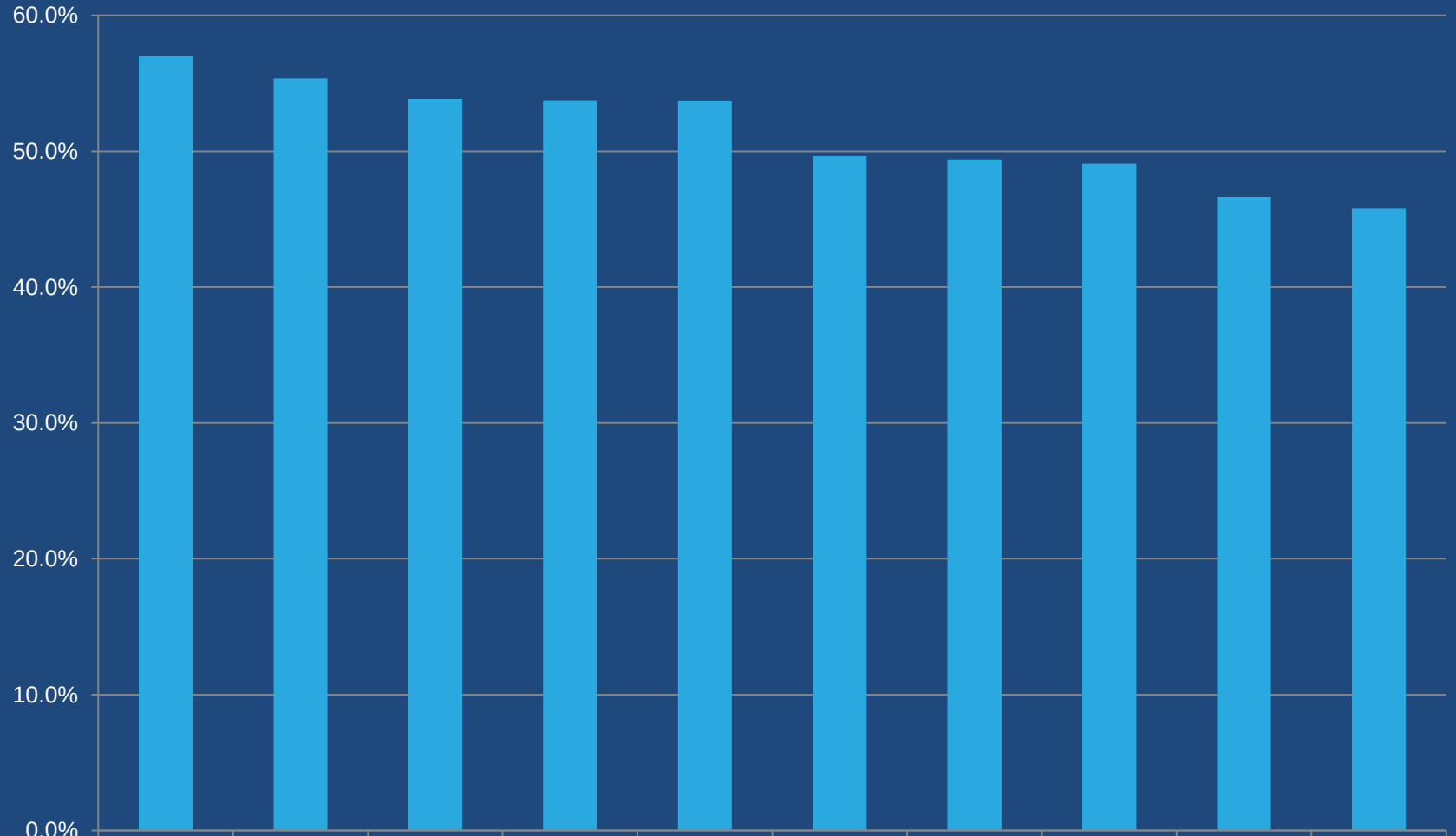
	Germany	Austria	South Korea	Wales	Switzerland	Italy	Belgium	Netherlands	Slovenia	Singapore
MSW Recycling Rate	56.1%	53.8%	53.7%	52.2%	49.7%	49.7%	49.4%	46.3%	45.8%	34.0%

(See method section for details of adjustments made)

MSW and Household Recycling Rate Adjustments

- MSW Adjustments:
  - C&D waste (e.g. rubble)
  - Non-'household-like' C&I
  - IBA and IBA metals
  - Overcounting MBT inputs
  - Wood incinerated rather than recycled
  - Undercounting of processing rejects
- HH Adjustments - as MSW plus:
  - All C&I

Top 10 from Longlist - Adjusted Recycling Rate - Household Waste



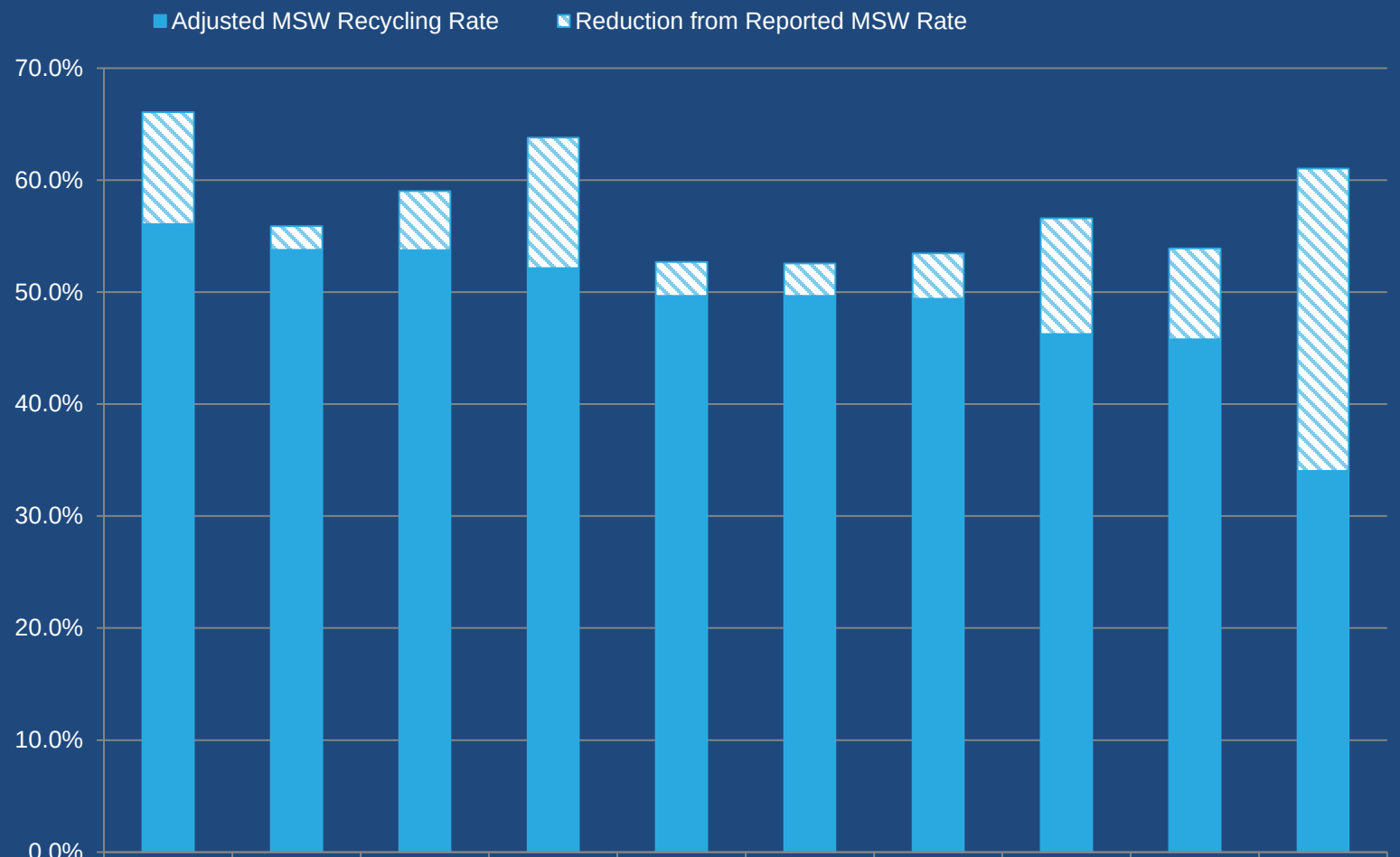
	Germany	Taiwan	Wales	Austria	South Korea	Switzerland	Belgium	Italy	Netherlands	Slovenia
HH Recycling Rate	57.0%	55.4%	53.9%	53.8%	53.7%	49.7%	49.4%	49.1%	46.6%	45.8%

(See method section for details of adjustments made)

Germany holds the top spot

- Germany remains top of the adjusted league tables for both MSW and HH
- Austria, Wales and S Korea are in top 5 for both MSW and HH
- Largest adjustments are for: Singapore, Wales, the Netherlands & Germany

Top 10 - Adjusted Recycling Rate and Reduction from Reported Rate - MSW



	Germany	Austria	South Korea	Wales	Switzerland	Italy	Belgium	Netherlands	Slovenia	Singapore
Reduction from Reported MSW Rate	10.0%	2.1%	5.3%	11.6%	3.0%	2.9%	4.1%	10.3%	8.1%	27.0%
Adjusted MSW Recycling Rate	56.1%	53.8%	53.7%	52.2%	49.7%	49.7%	49.4%	46.3%	45.8%	34.0%

(See method section for details of adjustments made)

Levers for high performance

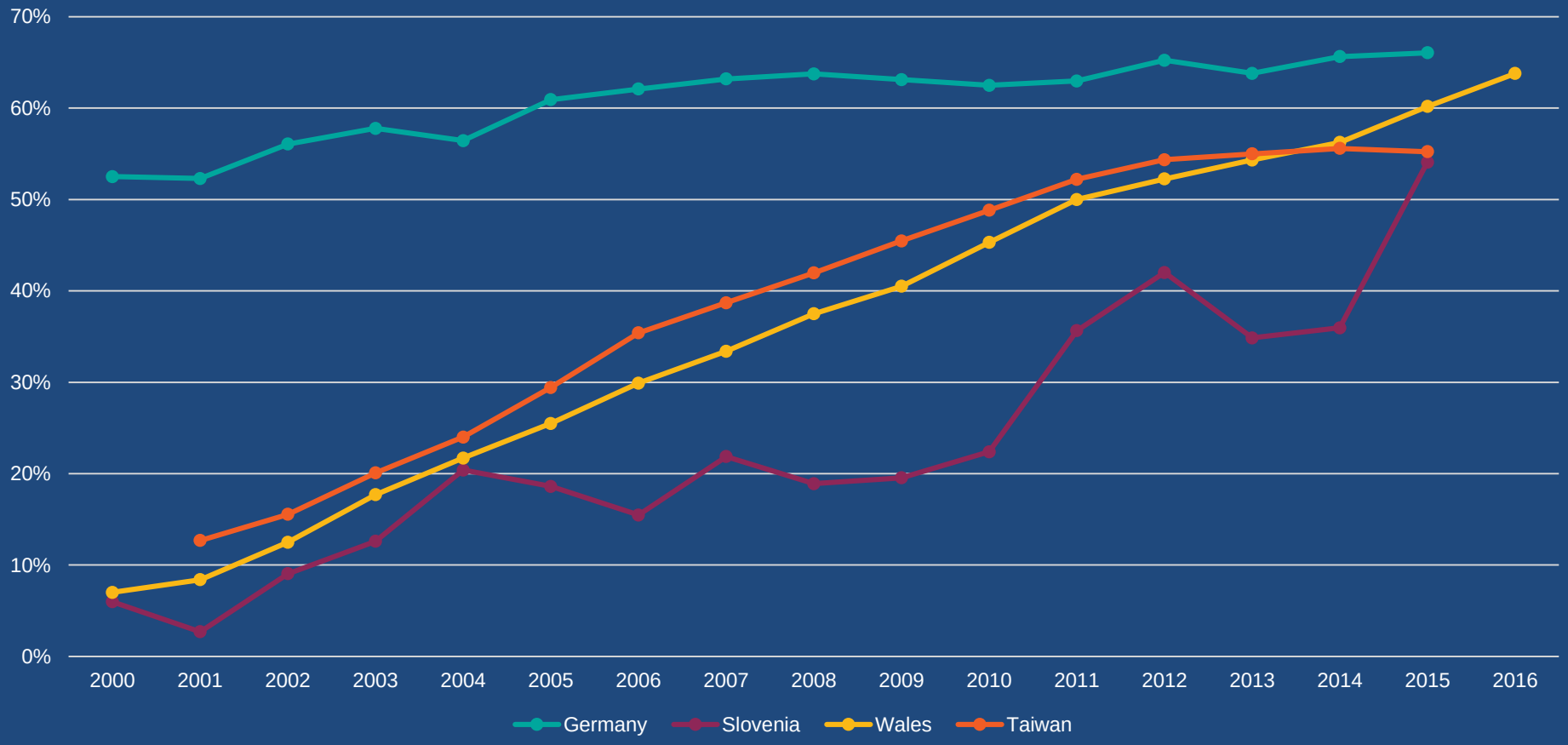
Looking at waste management policy, legislation and collection services in the leading nations suggests high performance is at least in part due to:

- **Comprehensive schemes to enable people to recycle e.g. mandatory separate collection of dry materials and biowaste**
- **Clear performance targets and policy objectives e.g. recycling targets, requirements to separate certain materials from residual waste (supported by measures such as landfill bans)**
- **Funding for recycling, e.g. government funding, Extended Producer Responsibility schemes**
- **Financial and behavioural incentives to directly and indirectly encourage citizens to recycle e.g. taxes on residual waste treatment and disposal, restrictions on residual waste bins, differential 'Pay As You Throw' and Deposit Refund Schemes**

How might the Top 10 change in the future?

- Several countries have ambitious targets e.g. Wales ambition to be ‘zero waste nation’ by 2050
- The EU will adopt a new 2030 target (likely to be at least 65%)
- Which country is most likely to challenge Germany for the top spot?

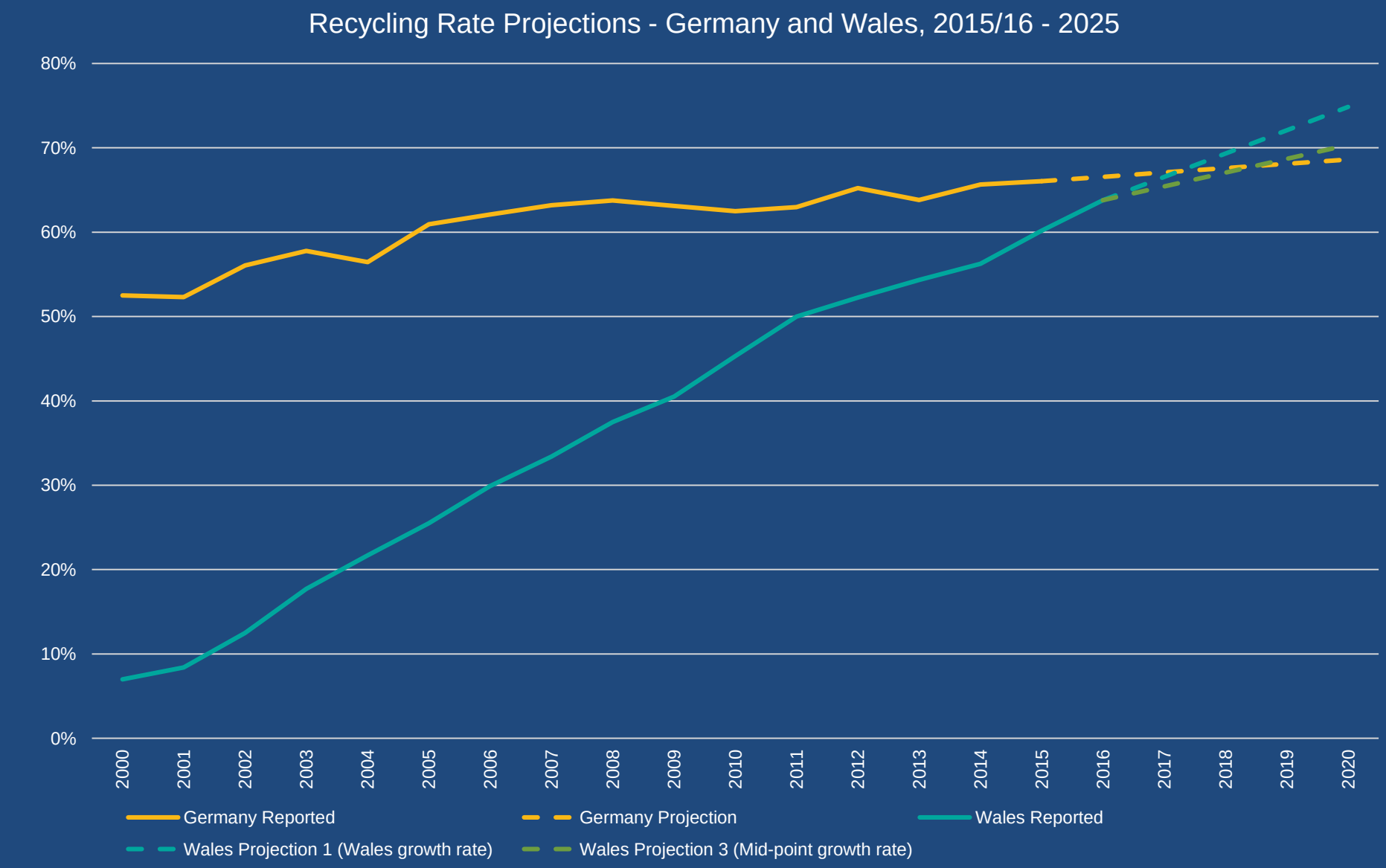
MSW Reported Recycling 2000 - 2016



Source: OECD / Eurostat / Welsh Government – see *method* section for details

Challenging for the top spot

- Based on the trajectory of reported MSW recycling rate increases, Wales looks to be the closest to overtaking Germany in the short term
- Extrapolating from historic recycling rate increases for Wales and Germany provides a means of forecasting (next chart).
- Assuming that:
  - Germany's rate continues to increase at the average annual rate of increase achieved since it passed 60%; and Wales' rate continues to increase at the average annual rate of increase it has achieved since it passed 50%; then
  - Wales (69.3% reported / 57.7% adjusted) could overtake Germany (67.6% reported / 57.6% adjusted) as early as 2018.



Source: OECD / Eurostat / Welsh Government

Conclusions

- Fair comparison of rates between countries remains difficult;
- Highlighting the need for common definitions e.g. for municipal waste, recycling, bio-waste recycling, as well as a common measurement standard.
- This should aim to measure genuine recycling i.e. measuring as close as possible to final outputs from recycling process or consistent method of accounting for non-recyclable elements such as contamination and processing loss which in reality is disposed of to landfill or EfW.
- For the top performers there are a number of common legislation, policy and service design levers that countries with ambitions to improve their recycling rate should consider.

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Recycling – Who really leads the World?
Issue 2 Technical Notes

1.0 Introduction

In this updated report, building on initial work published in March 2017, Eunomia and the European Environmental Bureau (EEB) have compared municipal waste recycling rates on as equal a footing as possible, to answer the question: *which is the world's leading recycling nation?*[1] In doing so, we have used updated waste statistics (where publicly available), as well as additional research with country experts, to supplement our previous research.

This work is intended to identify the leading recycling nations in order to shine a spotlight on what these countries are doing to enable such positive performance on recycling. In so doing, we hope to contribute to the debate on how best to measure 'real' recycling, in line with the principles of the Waste Hierarchy, and in a way that is as consistent as possible within Europe and further afield.

2.0 Method

2.1 Longlisting

In order to develop an initial longlist of 25 high performing recycling nations, Eunomia identified two key data sets: Eurostat's Environmental Data Centre on Waste[2] and the OECD iLibrary on Municipal Waste.[3] The advantage of using the data collected by Eurostat and OECD is that some level of vetting has already been carried out on the data.

For each nation, the most recent available year was used. As at October 2017, most nations have reported 2015 data, but in some cases data is only available from earlier years. Where more recent figures were publicly available these have been used. For example, the recycling rates quoted for UK nations are the most recent waste statistics published by the governments in each of the four nations. There are differences in the basis on which these figures are calculated. Household waste figures only are used for Scotland, while for the other nations municipal waste figures are used. The UK government also prepares a "waste from households" report, which adjusts each of the four nations' statistics to make them more consistent, and to remove any non-household waste. The latest version of this report

[1] Eunomia and Resource Media (2017) *Recycling – Who really leads the world*
[2] *European Data Centre on Waste*, accessed 10 March 2017, http://ec.europa.eu/eurostat/web/waste/transboundary-waste-shipments/key-waste-streams/municipal-waste
[3] *Municipal Waste*, http://www.oecd-ilibrary.org/environment/data/oecd-environment-statistics/municipal-waste_data-00601-en?isPartOf=/content/datacollection/4de0116a-en

covers 2015, and also includes an overall assessment of UK municipal waste recycling, which is used as the source for the UK's overall recycling rate.[4]

The wide coverage of high-recycling nations provided by these resources was supplemented by additional research on non-OECD nations that have high recycling rates. In practice, there are few such nations, with the figures quoted for Singapore and Taiwan standing out.

[4] Defra (2016) *UK Statistics on Waste*, December 2016, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/593040/UK_statsonwaste_statsnotice_Dec2016_FINALv2_2.pdf

The data underlying the longlist is set out in Table 1.

Table 1: Waste Generation and Treatment (Kg per Capita)

Country	Year	Source	Population (000s)	Waste Generated	Landfill	Incineration	Other Recovery	Material Recycling	Composting and Digestion	Recycling Rate
1. Germany	2015	OECD	81,202	628.6	59.3	196.7		300.7	114.6	66.1%
2. Wales	2016/17	Welsh Government	3,100	512.8	48.7	125.8	0.3	327.2		63.8%
3. Singapore	2016	Singapore Government	5,607	1394.6	543.1			850.5		61.0%
4. South Korea	2014	OECD	50,424	361.3	60.9	91.5		209.9	3.3	59.0%
5. Taiwan	2016	Taiwan EPA	23,492	317.6	3.9	127.4	2.6	159.7	24.5	58.0%
6. Netherlands	2016	Netherlands Government	16,981	560.6	12.5	209.7		171.5	145.7	56.6%
7. Austria	2015	OECD	8,538	566.4	16.8	214.6		145.3	177.0	55.9%
8. Slovenia	2015	OECD	2,067	448.1	101.7	76.5	14.3	208.1	34.3	53.9%
9. Belgium	2015	OECD	11,369	414.1	78.4	179.7		142.1	79.2	53.5%
10. Switzerland	2015	OECD	8,129	741.8		350.6		236.7	154.5	52.7%
11. Italy	2016	Italy EPA (ISPRA)	60,656	496.2	122.5	96.7		153.4	107.4	52.6%
12. Luxembourg	2015	OECD	563	632.7	111.5	215.7		180.4	125.1	48.3%
13. Sweden	2015	OECD	9,799	446.6	3.6	228.7		144.6	69.8	48.1%

Country	Year	Source	Population (000s)	Waste Generated	Landfill	Incineration	Other Recovery	Material Recycling	Composting and Digestion	Recycling Rate
14. Denmark	2015	OECD	5,611	799.3	9.1	420.4		217.9	151.8	46.3%
15. Scotland	2015	SEPA	5,400	457.2	213.1	41.9		202.1		44.2%
16. United Kingdom	2015	UK Gov - Defra	64,532	489.2	115.0	153.5		133.3	79.4	43.5%
17. Norway	2015	OECD	4,904	446.0	15.1	233.5	6.3	116.5	74.4	42.8%
18. England	2016/17	UK Gov - Defra	55,268	476.2	74.8	184	13.8	127.1	76.5	42.8%
19. Poland	2015	OECD	38,016	285.7	129.7	37.9		75.4	46.0	42.3%
20. Northern Ireland	2015/16	NI Gov - Daera	1,900	510.1	205.4	90.0	1.4	122.3	91.1	41.8%
21. Australia	2015	OECD	23,941	557.2	260.6	64.9		231.7		41.6%
22. Finland	2015	OECD	5,493	498.5	57.3	238.9		140.2	62.1	40.6%
23. France	2015	OECD	66,498	502.3	134.8	174.4		111.8	86.7	39.6%
24. Hong Kong	2014	Hong Kong Government	7,240	776.2	492.7			283.6		36.5%
25. United States	2014	OECD	318,857	735.3	386.7	94.3		188.9	65.5	34.6%

2.2 Top 10 Analysis

2.2.1 Adjusted Recycling Rates

Even within the EU and OECD statistics, there are considerable variations in how waste statistics are reported. For those countries in our longlist reporting recycling rates of over 50%, we have used publicly available data and reports, supplemented with interviews with professionals with in-depth knowledge of the data sources and measurement methods used in those countries (see Appendix A.2.0), to explore the reported figures in greater depth.

From this we have made adjustments to the reported kg/capita figures for the key waste management components included in Table 1 i.e.: waste generated, landfill, incineration, other recovery, material recycling, composting and digestion, to arrive at an adjusted recycling rate for i) Municipal Solid Waste (MSW) and ii) Household Waste.

Percentage recycling rate is calculated as:

$$\frac{(material\ recycling + composting\ and\ digestion)}{waste\ generated}$$

The extent to which Construction and Demolition (C&D) and Commercial and Industrial (C&I) waste is included in the statistics for MSW recycling in each nation varies. For that reason, we have attempted, with the data that is publicly available, to adjust for these discrepancies to create an adjusted MSW recycling rate. We have then attempted to make a further adjustment to exclude this C&D and non-household-like C&I to calculate a comparable household recycling rate (HH).

For both the MSW and HH recycling rate calculations we have made additional adjustments, based on publicly available credible data sources and supplemented by information provided by country experts. A description of the types of adjustments made are shown in Table 2 and details of actual kg/person adjustments made for each element and country can be found in Appendix 2.4.

Table 2: Adjustments

Adjustment	Rationale	Countries Affected
Construction & Demolition Waste	• C&D waste e.g. rubble subtracted from waste generated and (where applicable) from material recycled and composted and digested	Germany Singapore Netherlands Italy

Adjustment	Rationale	Countries Affected
Commercial & Industrial Waste	• Non-C&D, non 'household-like' Commercial and Industrial waste removed from MSW calculation • All C&I removed from HH calculation • C&I waste added to waste generated and material recycled for Taiwan (reported figures = HH only)[5]	Germany (HH only) Singapore Wales (HH only) Taiwan (C&I added for MSW) Note: this has the impact of dropping Taiwan outside the top 10 for MSW due to the relatively large amount of C&I collected but low proportion of this waste that is recycled) Netherlands (HH only)
IBA	• Incinerator Bottom Ash subtracted from material recycling figure where included	Wales
IBA Metals	• Metals recovered from IBA subtracted from material recycling figure where included (where total IBA not included)	Wales Austria Belgium
MBT	• An estimate for the amount of material inputs to Mechanical Biological Treatment that is sent to landfill or incineration rather than being recycled subtracted from recycling figure	Germany Austria Slovenia

[5] Taiwan's reported recycling rate appears to exclude C&D and C&I wastes. In order to improve comparability for the adjusted MSW recycling rate, these wastes have been added rather than subtracted to Taiwan's figures for waste generated and recycled based on figures published by the Taiwan Government. It has not been possible however to distinguish between C&D and C&I waste.

Adjustment	Rationale	Countries Affected
Wood Waste	• Wood waste that is sent for incineration is subtracted from material recycling where included in reported figures	Netherlands
Bulky Waste	• Where bulky waste is recycled but excluded from reported recycling figures this has been added back in to material recycling	Taiwan
Contamination Rejects	• An estimate has been applied for the percentage loss of material recycling and composting/digestion due to contamination with material that cannot be recycled. Estimates are based on published data if available, otherwise an estimate according to the prevailing collection system in place. For example, higher reject rates are assumed for material collected comingled or from bring systems compared to that collected via a kerbside sort doorstep collection system	All except Singapore

2.3 Contributory Factors for High Recycling Performance

A high-level review of the legislative, policy and collection service infrastructural conditions in each of the countries identified within the Top 10 list reveals a number of common elements in place - Table 3. Given their commonality across the high performing countries it can be inferred that these elements have a positive contribution to strong recycling performance.

Table 3: Legislative, Policy and Collection Service Landscape[6]

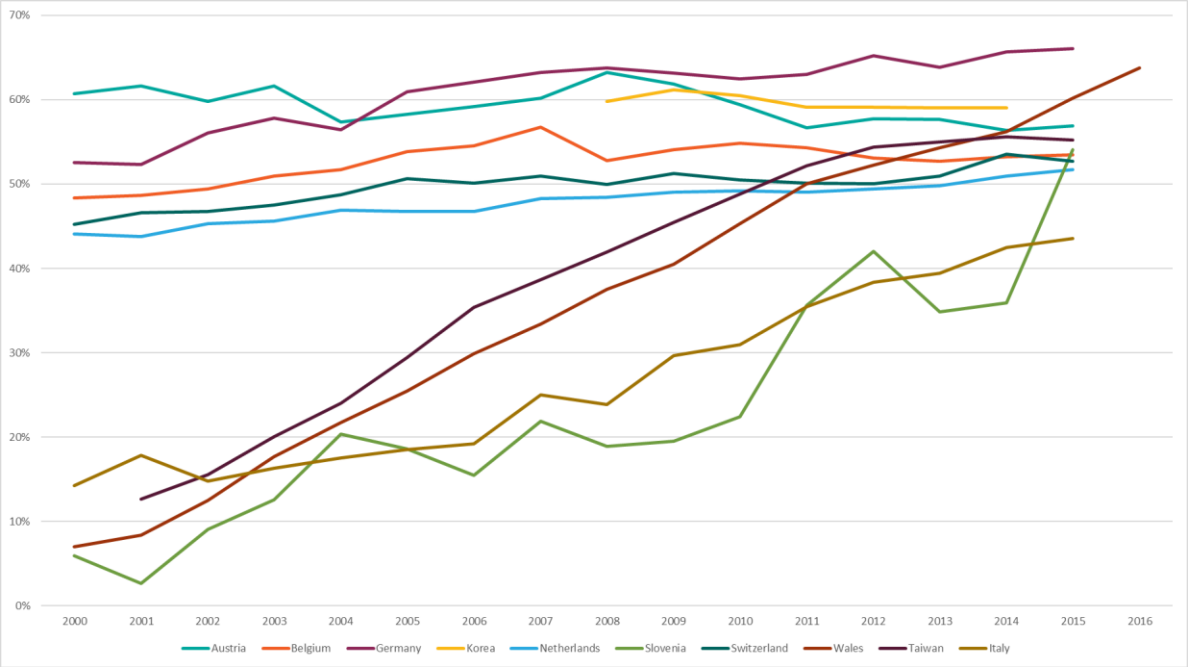
Legislative / Policy / Collection Service Element											
Widespread separate collection of key dry recyclable materials	✓		✓	✓	✓	✓	✓	✓	✓	✓	
Widespread separate collection of biowaste	✓		✓	✓	✓	✓	✓	✓	✓		✓
Landfill and/or incineration bans for some materials	✓	✓	✓	✓	✓		✓	✓			
Statutory recycling rate/separate collection targets	✓	✓		✓	✓	✓	✓	✓	✓	✓	
Restrictions on collection of residual waste e.g. fortnightly or less collections, restrictions on bin volume				✓			✓	✓	✓		
Variable-rate charging (e.g. Pay As You Throw)		✓			✓	✓	✓	✓	✓		✓
Extended Producer Responsibility scheme(s)	✓	✓			✓	✓	✓	✓			✓
Deposit Refund Scheme(s) for packaging	✓	✓	✓		✓	✓	✓	✓			✓

[6] In some countries, legislation and policy is set at a regional or municipality level. In these instances, there may be regional variation in the implementation of the elements identified.

2.4 Future Projections

Figure 1 shows that based on reported recycling rates Germany has claimed and kept the number one spot since 2005. A number of countries have reported a significant increase in recycling rate since the early 2000's. Wales and Taiwan have shown the largest increase over the last fifteen years to leave them closing in on Germany's lead. The drivers of recycling performance will of course vary from country to country. The scope of this relatively small research exercise has prevented us from being able to complete a robust regression analysis on each country to provide a detailed forecast of what might happen to recycling rates in these top performing countries in the future.

Figure 1: Reported Recycling Rate Increases by Country, 2000 - 2016

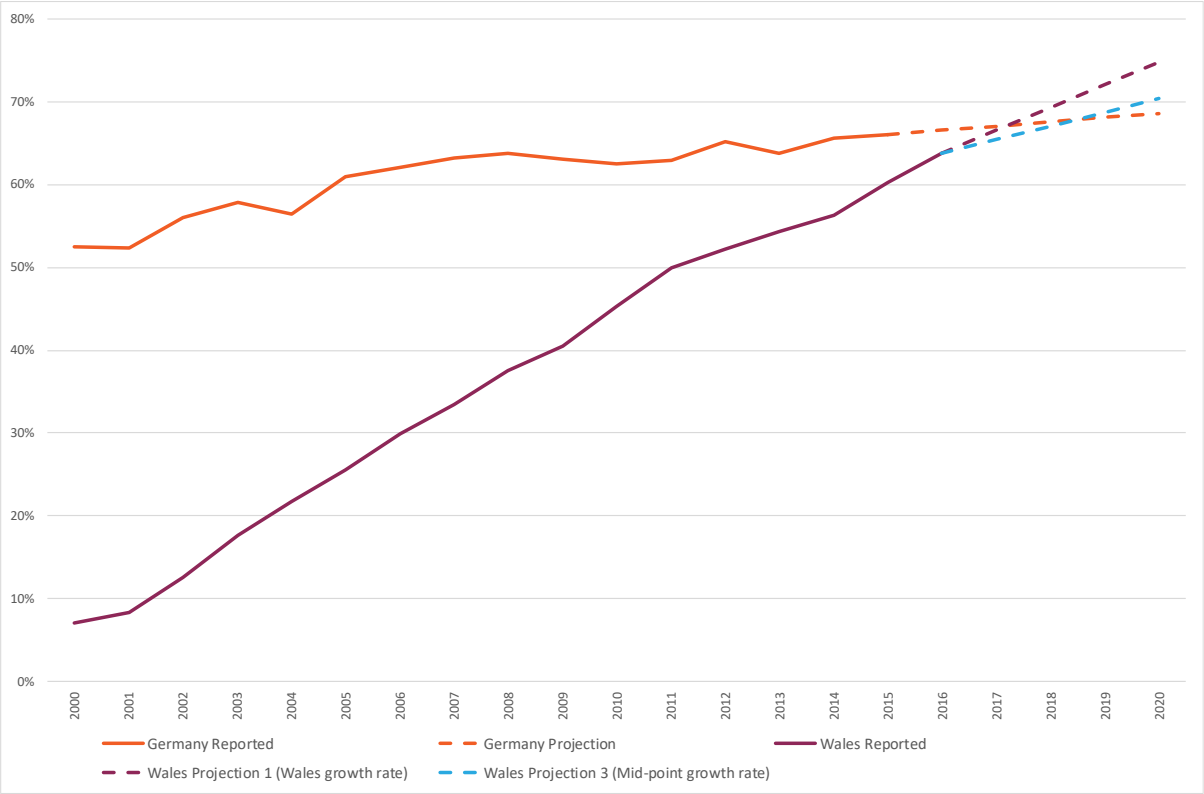


Sources: See Table 1

Comparing the annual increase in recycling rate between Germany and Wales since 2000 however, allows for speculation on what could happen in the future. Figure 2 shows projected future recycling rates based on Germany's recycling rate continuing to increase at the rate of its average annual increase since it reached 60%. For Wales the projected growth is based on it continuing to achieve an annual rate of increase based on the historic average since it passed 50% (Projection 1). Projection 2 is based on Wales' recycling rate growing at a mid-point rate between the historic German and Welsh increase.

These speculative scenarios suggest that Wales (69.3% reported / 57.7% adjusted) could overtake Germany (67.6% reported / 57.6% adjusted) to claim the number one spot as early as 2018 or by 2019 if its recent rate of increase slows towards that of Germany.

Figure 2: Recycling Rate Projections, Germany and Wales, 20015/16 - 2025



A.1.0 Recycling Rate Adjustments

A.1.1 Germany

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
C&D	-4.2 MSW & HH	Deducted from both waste generated and material recycling
C&I	-68.7 from waste generated -21.8 from material recycled -16.0 from composted	All adjustments for HH only No adjustment for MSW
IBA	None	N/A
Metal recovery from IBA	None	N/A
MBT	-11.4 from material recycling	Germany reports approx. half of inputs to MBT processes as recycled. A credible recent German report estimates that only 6% should be counted as recycled.[7]
Waste wood	None	N/A
Bulky waste	None	N/A
Contamination within material recycling	-38.1 MSW -35.2 HH	Germany's recycling figures include some contamination within its dry recycling. Adjustments based on Eunomia work for the European Commission and DGAW report.

[7] Deutsche Gesellschaft für Abfallwirtschaft e.V. (2016) *Quotenzauber Neue Berechnungsgrundlagen als Herausforderungen für die deutsche Kreislaufwirtschaft*, January 2016, http://www.dgaw.de/wp-content/uploads/dgaw-pm-artikel-recyclingquote-20160129-endfassung_1454338264.pdf

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
Contamination within biowaste composted/anaerobically digested	-11.5 MSW -9.9 HH	Germany's recycling figures include some contamination within its organic waste. Adjustments based on Eunomia work for the European Commission and DGAW report.

A.1.2 South Korea

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
C&D	None	N/A
C&I	None	N/A
IBA	None	N/A
Metal recovery from IBA	None	N/A
MBT	None	N/A
Waste wood	None	N/A
Bulky waste	None	N/A
Contamination within material recycling	-18.9 MSW & HH	Bring based systems often encounter relatively high levels of contamination. Research suggests recycling is measured as collected or after initial sort latest. Therefore, adjustment estimate based on description of collection system
Contamination within biowaste composted/anaerobically digested	-0.2 MSW & HH	Research suggests recycling is measured as collected or after initial sort latest. Therefore, adjustment estimate based on description of collection system

A.1.3 Austria

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
C&D	None	N/A
C&I	None	N/A
IBA	None	N/A
Metal recovery from IBA	-4.3 MSW & HH	Austria reports metals recovered from IBA as recycled, reduction therefore based on the tonnage of material incinerated.
MBT	-6.3 MSW & HH	In 2014 Austria reported some 274,000 tonnes of outputs from MBT plants as composted, when in practice this material was sent to landfill.[8] Reduction estimate based on relative reduction in number of operational MBT plants in 2016 compared to 2014.
Waste wood	None	N/A
Bulky waste	None	N/A
Contamination within material recycling	-2.8 MSW & HH	Eunomia research for the European Commission indicates that Austria appears to account quite scrupulously for contamination and rejects. The level of unreported contamination should therefore be low.
Contamination within biowaste composted/anaerobically digested	-4.3 MSW & HH	Eunomia research for the European Commission indicates that Austria appears to account quite scrupulously for contamination and rejects. The level of unreported contamination should therefore be low.

[8] European Environment Agency (2016) *Municipal Waste - Austria*, October 2016, http://www.eea.europa.eu/publications/managing-municipal-solid-waste/austria-country-paper-on-municipal/at_download/file

A.1.4 Wales

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
C&D	-40.9 MSW & HH	Wales counts significant amounts of rubble collected at household waste recycling centres towards its recycling rate, but this material is not consistently counted as municipal waste across Europe. The figures were deducted from both waste generated and material recycling. Calculated from Welsh Government figures.
C&I	-30.9 From waste generated -3.6 from recycled -3.8 from composted For HH	Removes all non-C&D-non-household for HH calculation. Calculated from Welsh Government figures.
IBA	-28.5 MSW & HH	Wales reports a significant amount of IBA as recycled, whether as metals or as aggregate. Calculated from Welsh Government figures
Metal recovery from IBA	-2.9 MSW & HH	Calculated from Welsh Government figures
MBT	None	N/A
Waste wood	None	N/A
Bulky waste	None	N/A
Contamination within material recycling	-6.4 MSW -6.2 HH	Reporting of dry recycling accounts extensively for material rejected at the initial sorting stage, and to some degree at later stages. Estimate of 4% based on approx. 50% of collections being kerbsort with remainder comingled and bring bank material.

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
Contamination within biowaste composted/anaerobically digested	-2.4 MSW -2.3 HH	Reporting of biowaste accounts for material rejected at the gate and during the recycling process. The level of unreported contamination should therefore be low, and is estimated at 2.5%

A.1.5 Switzerland

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
C&D	None	N/A
C&I	None	N/A
IBA	None	N/A
Metal recovery from IBA	None	N/A
MBT	None	N/A
Waste wood	None	N/A
Bulky waste	None	N/A
Contamination within material recycling	-15.1 MSW & HH	Calculated from research report data.[9]
Contamination within biowaste composted/anaerobically digested	-7.7 MSW	Estimate based on Haupt et al report.

[9] Haupt, M., Vadenbo, C. and Hellweg, S. (2016) Circular Economy: Do We Have the Right Performance Indicators? Journal of Industrial Ecology.

A.1.6 Italy

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
C&D	-5.8 MSW & HH	Based on data from Zero Waste Europe
C&I	None	N/A
IBA	None	N/A
Metal recovery from IBA	None	N/A
MBT	None	N/A
Waste wood	None	N/A
Bulky waste	None	N/A
Contamination within material recycling	-8.9 MSW & HH	Estimate based on information from Zero Waste Europe
Contamination within biowaste composted/anaerobically digested	-2.7 MSW -5.4 HH	Estimate based on information from Zero Waste Europe

A.1.7 Belgium

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
C&D	-5.8 MSW & HH	Based on data from Zero Waste Europe
C&I	None	N/A
IBA	None	N/A
Metal recovery from IBA	None	N/A
MBT	None	N/A
Waste wood	None	N/A
Bulky waste	None	N/A

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
Contamination within material recycling	-12.8 MSW & HH	Estimate based on collection system (most recycling counted at point of collection or first sort (cans, plastics, cartons))
Contamination within biowaste composted/anaerobically digested	-4.0 MSW & HH	Estimate based on collection system (composting counted at point of collection)

A.1.8 The Netherlands

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
C&D	-27.6 from waste generated -26.0 from recycled MSW & HH	Calculated from Netherlands government figures
C&I	-6.0 from waste generated -0.8 from recycled	Removes all non-C&D non-household. Calculated from Netherlands government figures
IBA	None	N/A
Metal recovery from IBA	None	N/A
MBT	None	N/A
Waste wood	-22.6 MSW & HH	Based on paper from Dutch Waste Management Association[10]
Bulky waste	None	N/A

[10] Dutch Waste Management Association (2017) *Measuring actual recycling will boost quality*. Wastematters.eu October 2017

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
Contamination within material recycling	-14.7 MSW -14.6 HH	Estimate based on information from Netherlands Government
Contamination within biowaste composted/anaerobically digested	-7.3 MSW & HH	Estimate based on information from Netherlands Government

A.1.9 Slovenia

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
C&D	None	N/A
C&I	None	N/A
IBA	None	N/A
Metal recovery from IBA	None	N/A
MBT	-5.0	MBT is widely used, but no definitive figure on how much recycling is overcounted is available. Estimate therefore applied but could be an underestimate.
Waste wood	None	N/A
Bulky waste	None	N/A
Contamination within material recycling	-30.5 MSW & HH	Our previous research on Slovenia's recycling system indicates that recycling is often measured prior to any significant level of sorting having been carried out. The level of unreported contamination is therefore high. Estimate based on high reliance on bring collection systems.
Contamination within biowaste	-1.7 MSW & HH	Slovenia reports relatively little biowaste composting. Limited

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
composted/anaerobically digested		information is available on the performance of the biowaste collection system, and we have assumed that 5% less biowaste than is reported as recycled may in the end be used beneficially.

A.1.10 Singapore

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
C&D	-284.5 from waste generated -282.8 from recycled MSW & HH	Closer examination of Singapore's recycling statistics indicates that a very large amount of construction, demolition, commercial and industrial waste is likely to be included in the total, resulting in very high waste generation per capita - almost five times as much per capita as Taiwan, for example.[11] Singapore reports very high recycling rates of some of these materials. Together the following waste types account for 31% of waste and 39% of recycling: • Construction Debris • Used slag • Scrap tyres • Ash & Sludge Others (stones, ceramic, rubber, etc.). Adjustments calculated from Singapore government figures
C&I	-465.4 from waste generated -348.6 from recycled	Singapore's figures also include high levels of materials that may form part of the household stream, but are likely to principally derive from commercial sources (e.g. metals, wood).

[11] Singapore Government *Waste Statistics and Overall Recycling*, accessed 10 March 2017, http://www.nea.gov.sg/energy-waste/waste-management/waste-statistics-and-overall-recycling

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
		Adjustments calculated from historic Singapore government figures on HH recycling (recent figures include C&D and C&I in the reported recycling rate)
IBA	None	N/A
Metal recovery from IBA	None	N/A
MBT	None	N/A
Waste wood	None	N/A
Bulky waste	None	N/A
Contamination within material recycling	None	Some news reports suggest a high proportion (30-50%) of material collected for recycling is non-recyclable. However, it is not clear how/if this is accounted for in the Government reported figures so no adjustment has been made.
Contamination within biowaste composted/anaerobically digested	None	N/A

A.1.11 Taiwan

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
C&D	None	N/A
C&I	+807.6 to waste generated +145.6 to recycled MSW only	Reported recycling data is for household only, therefore C&I figures (from Taiwan Government) added back in to form comparable MSW figures
IBA	None	N/A

Adjustments to Reported Recycling Rate	Adjustment (Kg/person)	Notes
Metal recovery from IBA	None	N/A
MBT	None	N/A
Waste wood	None	N/A
Bulky waste	+2.6 MSW & HH	Bulky waste recycled appears to be excluded from overall recycling figures, therefore added back in for comparison
Contamination within material recycling	-18.5 MSW -9.7 HH	While Taiwan appears to practice some degree of co-mingled collection of dry recyclables, Taiwan Government information indicated reprocessors are highly audited therefore estimate based on assumed low unaccounted-for reject rates
Contamination within biowaste composted/anaerobically digested	-1.2 MSW & HH	Little information was found regarding the measurement of contamination in food waste although Taiwan Government information indicated reprocessors are highly audited therefore estimate based on assumed low unaccounted-for reject rates

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