Report

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Energy from Waste: A New Perspective

VOLUME 1: THE REGIONAL CAPACITY GAP

Roland Berger

PREFACE

The introduction of landfill diversion targets in the 1990s and the adoption of the Waste Framework Directive in 2008 resulted in a strong impetus to pursue holistic waste management in the European Union (EU). The UK, however, has lagged its prominent EU peers in achieving certain targets set by the EU. Historically, energy from waste (EfW) capacity development in the UK was slow, resulting in a huge gap between residual waste and EfW capacities. This status quo, however, started to evolve since 2011. The country saw the development of several new incineration facilities. Many domestic and international investors have since shown strong interest in acquiring some of the largest and most profitable EfW facilities.

As investors evaluate the commercial viability of their investments, it is crucial to assess the long-term EfW demand-supply dynamics and infrastructure capacity gap. While there is substantial literature on EfW capacity gap at the national level, a similar abundance of information and analyses is unavailable for the local levels. This is a critical information gap as EfW facilities often have localised catchment areas. Therefore, any meaningful assessment needs to extend this analysis to the level of the region or the catchment area of the EfW facility in consideration.

In this three-volume series we provide a new perspective on EfW demand-supply dynamics and its evolution in England at the county level.

- **Volume 1: The regional capacity gap**
- **Volume 2: The future of residual waste**
- **Volume 3: The 2030 capacity gap**

Providing such a detailed view has many challenges as there is no official data on addressable commercial and industrial (C&I) waste arisings, waste arising by material is not tracked at the local authority level, and there are slightly different reporting standards across nations. Our analysis and insights are built on a multidimensional dataset derived from reliable sources and a combination of regional macroeconomic, population, and sociological statistics, alongside temporal efficiency factors.

In this volume [Volume 1], we estimate residual waste and compare it with EfW capacity to determine the EfW capacity gap in England at the county level.

FAST FACTS & CONTENTS

33 of the 47
English counties do not have access to sufficient EfW capacity to meet future Landfill targets without exports

<5% to over 100%
range in county level EfW capacity

1 / Waste management in England

In June 2011, the British government published The Review of Waste Policy in England, setting out its ambitions for waste management in the country. Then, in 2018, the Department for Environment, Food and Rural Affairs (Defra) published Resources and Waste Strategy for England, which outlined its 30-year vision for the country. The strategy emphasised a continued need to minimise waste, promote resource efficiency, and move towards a circular economy. It also identified EfW efficiency development as a policy to bolster England's resource recovery capabilities, a key element of the UK's circular economy initiative.

The operative structure of waste management in England can be broadly divided into three key stages: Arisings, Collection, sorting and processing, and Treatment. → A

ARISINGS

Waste is generated from almost all business and personal activities. However, its composition, collection, and treatment depend largely on its source. There are two key sources of waste arisings relevant to EfW facilities: household and C&I. Other sources such as construction & demolition (C&D), mining, quarrying, and agriculture, while generating the majority of total waste arisings, have negligible amounts ending up in an EfW facility. This is because these source industries primarily generate inert mineral wastes and soils (wood waste generated is treated in specialist facilities not factored within this report).

COLLECTION, SORTING AND PROCESSING

Household and a small proportion of C&I waste collections (from businesses generating 'household-like' waste in urban settings) are facilitated by local authorities, sometimes through third-party waste management companies. This is classified as municipal waste or municipal solid waste (MSW). Waste collections happen at the kerbside and at household waste recycling centres (HWRC), also known as civic amenity sites. Depending on the extent and quality of separation at source, collected waste is sent for sorting and processing to extract the recyclate and the waste types requiring specialist treatment.

C&I waste is mostly collected through a similar process, managed primarily by third-party waste management companies. C&I waste is known to have better separation at source than municipal or household waste.

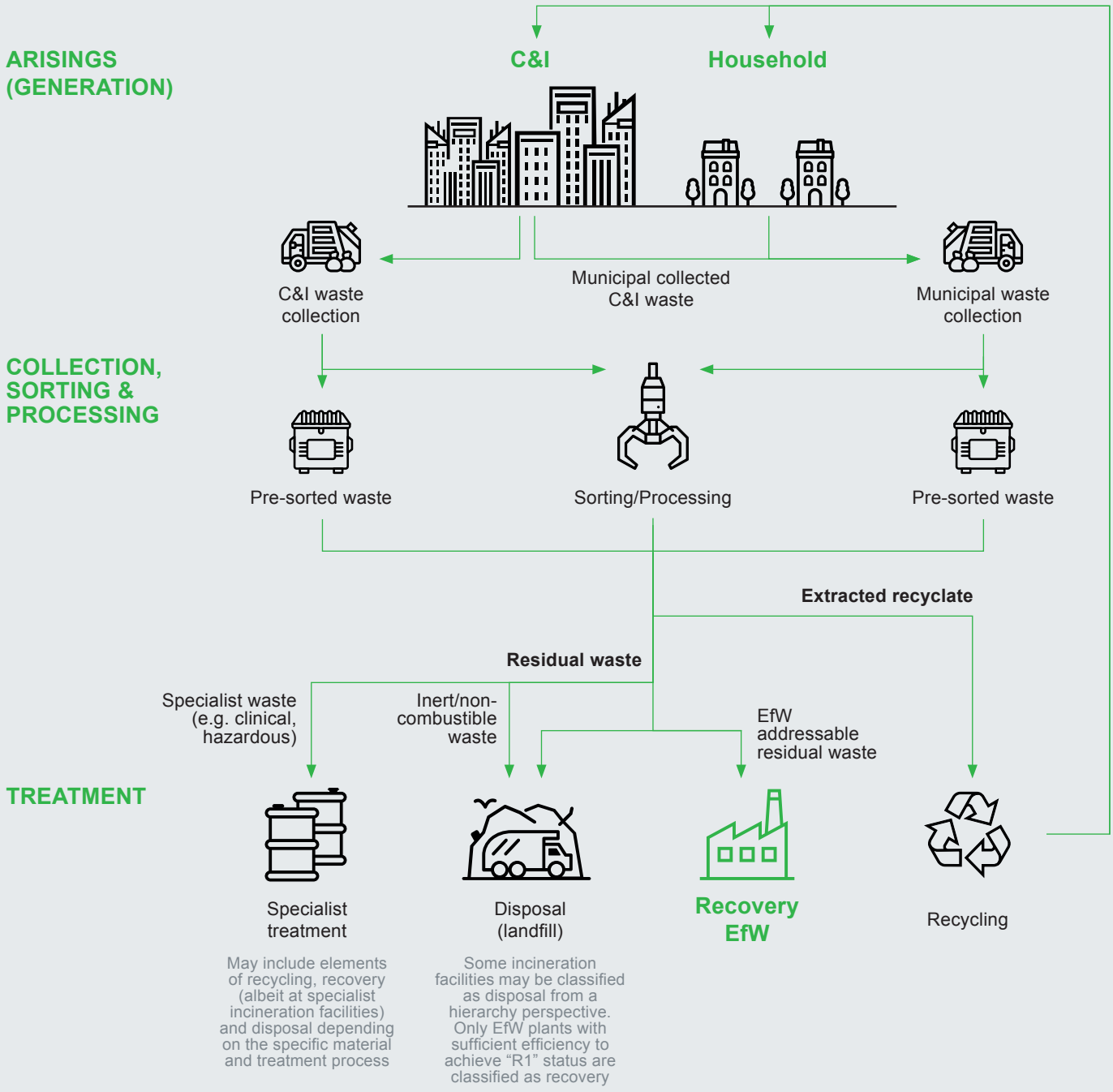
TREATMENT

The hierarchy of waste treatment is driven by the EU Waste Framework Directive of 2008. Recycling is the first step in the hierarchy, aimed at the removal of recyclates to the maximum extent possible and extracting the residual waste. A portion of this residual waste, such as hazardous and clinical waste, is sent for specialist treatment. The remaining residual waste has two treatment options: recovery at a domestic or international EfW facility or disposal at a domestic landfill. The choice is primarily driven by price, based on an evaluation of gate fees and transportation costs. In most cases, significant taxation on landfill and

additional export costs (bailing and shipping) renders recovery at domestic EfW facilities as the best option.

Residual waste may undergo additional treatment, such as removal of moisture and inert or incombustible materials, as well as shredding and composition homogenisation. The resulting higher quality waste – classified as refuse derived fuel (RDF) or solid recovered fuel (SRF) – is a requirement for exports to EfW facilities in the EU.

A / Waste management process for household and C&I waste in England



Source: Defra, EA, Roland Berger

2/ History of EfW in England

EfW facilities have a straightforward operating model:

Combustible residual waste represents the fuel source	EfW facilities accept this waste from municipal and C&I sources for a gate fee per tonne	The waste undergoes thermal treatment and releases its underlying calorific content	The heat produced is converted into electricity or used in local households and businesses	Resulting emissions are captured and cleaned before the residual waste gases are released into the atmosphere

Historically, EfW in England had a tarnished image due to the use of early incinerators as disposal-only facilities. These facilities were built to reduce the volume of waste by burning it (resulting in high greenhouse gas emissions) rather than producing energy from it. However, since the introduction of landfill diversion targets in the mid-1990s, a new generation of EfW infrastructure emerged in the country. This infrastructure development accelerated after the EU introduced its Waste Framework Directive of 2008. England has seen its volumes of domestic incineration grow from 3.6 million tonnes across 18 facilities in 2009 to around 11.5 million tonnes across 43 facilities in 2019. This infrastructure now forms a source of low-carbon, sustainable energy for the country that meets rigorous emissions standards.

EfW is a capital-intensive business. Sizeable EfW infrastructure projects cost hundreds of millions of pounds, can take 10 years or more from concept to commissioning, and remain operational for over 25 years. Traditionally, such investments required a guarantee of the supply of suitable residual waste, spanning decades beyond commissioning. Long-term municipal contracts were necessary to secure financing for a project. Today, after years of experience of building and operating EfW facilities in the country, investors/financiers do not need the absolute guarantee of a long-term municipal contract. The market for residual waste is moving from a 'contracted' market to a 'spot' market. Investment and financing can be secured if operators can prove they can commercially attract residual waste in their catchment area from municipal or C&I sources.

This necessitates a higher level of investor and financier confidence in the long-term demand-supply dynamics of the catchment area. Therefore, understanding the evolution of the capacity gap between residual waste and EfW capacity at a regional or catchment area level is of paramount importance to any investor looking to build or acquire such facilities.

In the following sections we demonstrate how, by first understanding the current availability of residual waste, and subsequently the current EfW capacity, we can build a picture of the regional EfW capacity gap across England.

3/ Regional residual waste

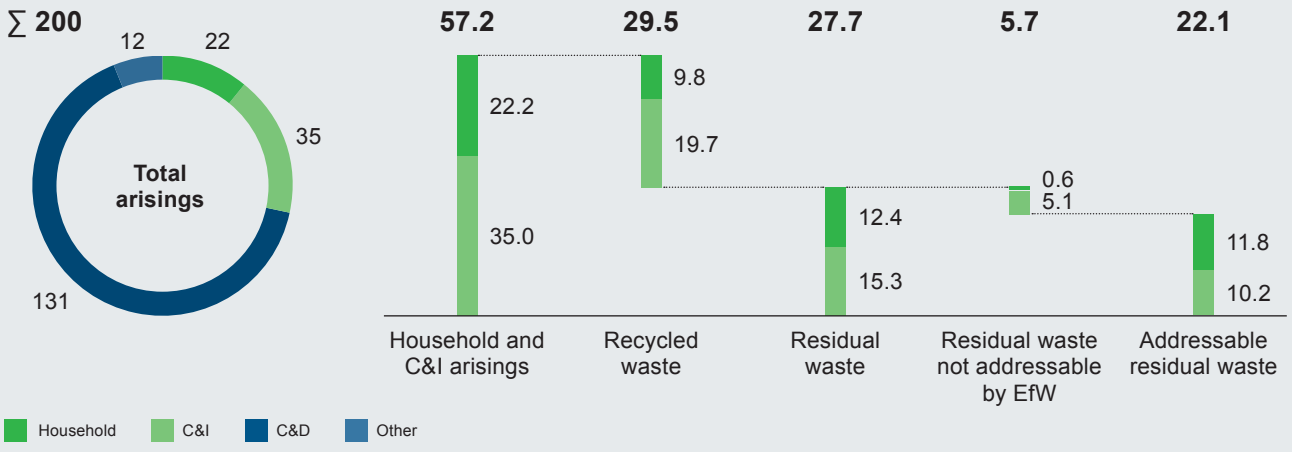
Management of waste is subject to an idealised hierarchy and energy recovery is the least preferred option after landfill. Post reuse, recycling, and removal of non-addressable material, only 53% of household and 29% of C&I waste arisings are accessible for treatment in an EfW facility. → B

At the national level, this derivation of addressable residual waste can be easily explained. In 2019, total waste arisings in England are estimated to be c. 200 million tonnes. Of this, relevant, combustible waste – accounted for by household and C&I sources – is estimated at 57 million tonnes. C&D and other sources (including mining, quarrying, and agriculture), which account for nearly three-quarters of the total arisings, are not broadly relevant for EfW facilities.

From the 57 million tonnes of relevant waste, 30 million tonnes of recyclate is estimated to have been extracted (corresponding to recycling rates of 44% for household and 56% for C&I waste respectively), resulting in just under 28 million tonnes of residual waste. Given the varying levels of recycling achieved across material types and sources, the composition of residual waste is quite different from that of waste arisings. While this residual waste largely contains materials that can be treated in an EfW facility, a small proportion of it must be processed by specialist facilities or sent to landfill. Such waste includes hazardous, clinical, and sewage waste. After subtracting this non-addressable waste, what remains is addressable residual waste for an EfW facility – estimated at 22 million tonnes for England in 2019. The source distribution of this addressable residual waste is relatively balanced between household and C&I, albeit with notably different material compositions.

While understanding the volume of addressable residual waste at a national level is useful, it is necessary to develop a picture at a regional level. This is because residual waste does not often travel longer distances due to high transportation costs. Therefore, EfW facilities often have localised catchment areas.

B / EfW addressable residual waste in England by source, 2019 [million tonnes]



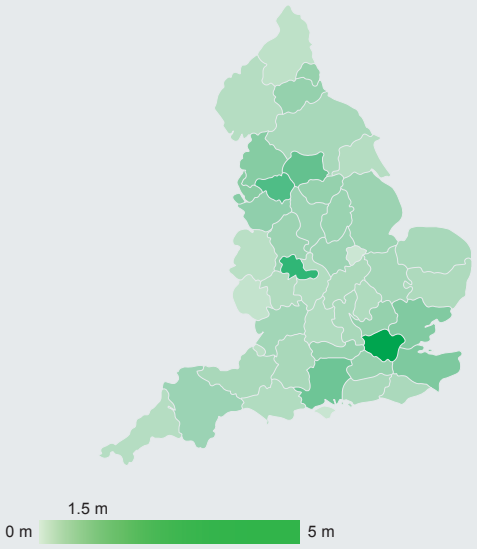
Source: Defra, EA, Oxford Economics, ONS, Roland Berger

To attain a regional view, we extend the above calculation to a local authority level and consider differences in relative household and C&I arisings, waste material composition, and material-specific recycling rates. Each of these factors have a significant impact on the volume and composition of residual waste, creating an additional dimension of complexity that must be evaluated.

As one might expect, waste arisings are concentrated heavily in London, but also in the broader South East and the region surrounding the M62 Corridor. We see significant difference in the source mix, most notably as you move towards the north of England. → C

For example, household waste accounts for only 41% and 50% of addressable residual waste in London and the South East respectively, compared with 56% in Yorkshire and 61% in the North East.

C / Addressable residual waste by English county, 2019



Source: Defra, Lets Recycle, EfW Operator Information/resources, Roland Berger

REGIONAL RESIDUAL WASTE DERIVATION METHODOLOGY

To derive addressable residual waste by region we have created a proprietary matrix of waste arisings by local authority, material type, source of generation, and recycling rate. This matrix has enabled us to estimate the volume and composition of residual waste by local authority, and hence the proportion of this residual waste that would be suitable for treatment at EfW facilities.

In addition to our knowledge and experience in this sector, we have utilised reliable sources, leveraging Defra where possible, and have applied a combination of regional macroeconomic, population, and sociological statistics, alongside temporal efficiency factors, to build a detailed multidimensional dataset from which we extract our insights.

For the purpose of this publication series, we have limited the geographic scope to England, rather than the UK. We have made this decision for two key reasons:

1. England accounts for roughly 85% of UK waste arisings, and owing to its lower recycling rate than the UK average, an even greater proportion of residual waste.
2. Granularity, reliability, and timeliness of data is generally superior for England, particularly when compared with Wales and Ireland.

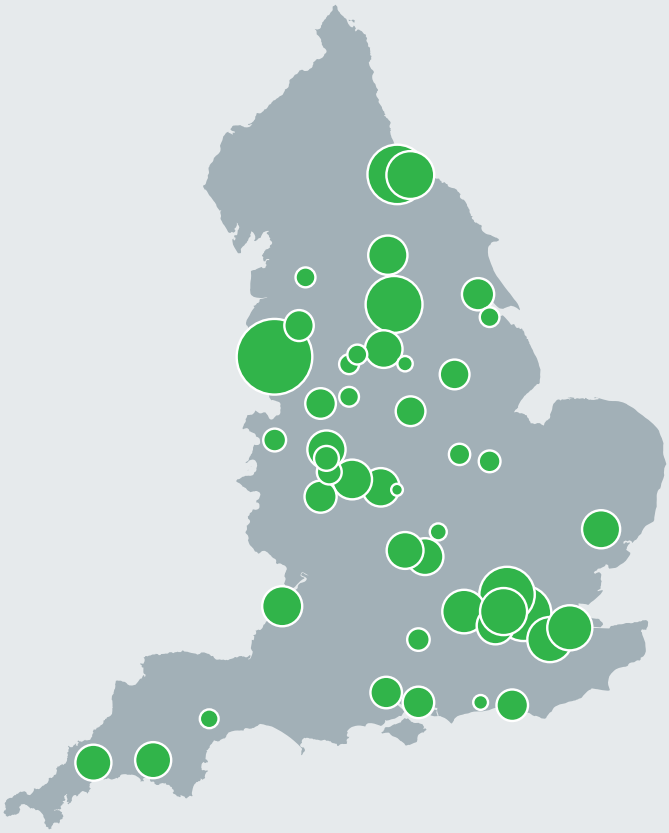
Our methodology extends to a granular forecast of the addressable residual waste, which will be detailed in the second volume of this series.

4/ Regional EfW capacity

The headline EfW capacity in England was 13.0 million tonnes in 2019. The capacity of individual facilities varies widely, from c. 50 thousand tonnes per annum for the smallest facility to 1,100 thousand tonnes per annum for the largest. Capacity is a function of the maximum power output of a given plant, which in turn is determined by its scale, technology, operational performance, and the average calorific value of the waste processed. This puts a limit on annual input tonnage of residual waste. For the purpose of this volume of the publication series, we only consider capacity in terms of volume of waste processed. The impact of the shifting average calorific value of residual waste will be explored in Volume 2.

In 2019, despite a headline capacity of 13.0 million tonnes, the operational capacity achieved was around 11.5 million tonnes, due to imperfect utilisation rates. The effective operational capacity in England, taking into account the fact that some English facilities can serve nearby Sottish and Welsh local authorities, and visa-versa, amounts to 11.8 million tonnes. The effective operational capacity

D / EfW capacity in England, 2019



EfW facility (bubble size represents annual headline capacity)

Source: EfW Operator information/resources, Roland Berger

is therefore a more appropriate measure to use when looking at the capacity in England, and will be used from here on in, unless otherwise stated.

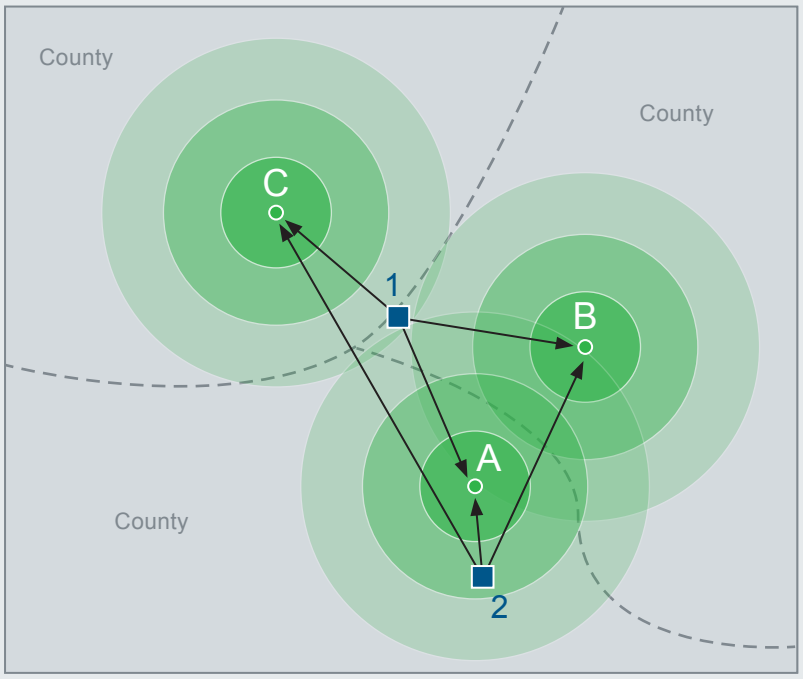
As of 2019, England was home to 43 EfW facilities dedicated to household and C&I waste. In addition to these facilities, we have included eight cement production plants that use RDF as feedstock for their kilns. The capacity is highly clustered around major cities such as London, Birmingham, Leeds, and Manchester. Pockets of modest capacity in East Anglia and across the South Coast also exist. → D

While this data alone may imply certain geographical gaps in EfW capacity, we must compare it with regional residual waste volumes to derive meaningful inference regarding regional EfW capacity gap. We have allocated the capacity of each such facility to surrounding local authorities through a capacity allocation methodology, which is grounded in extensive EfW facility contract data. → E

The catchment area of an EfW facility is typically highly localised due to high transport costs. This is reflected in the contract data, which shows a clear decline in the number of municipal contracts with any EfW facility located beyond a 50 kilometre radius of the population-weighted centroid of a local authority.

Each facility can draw waste from multiple local authorities, and in turn, a local authority may send waste to multiple facilities. Furthermore, these linkages are correlated with the distance between the population-weighted centroid of the local authority and the EfW facility. This makes it imperative to consider this complexity in order to suitably model capacity distribution.

E / Capacity allocation schematic



Source: Roland Berger

CAPACITY ALLOCATION METHODOLOGY

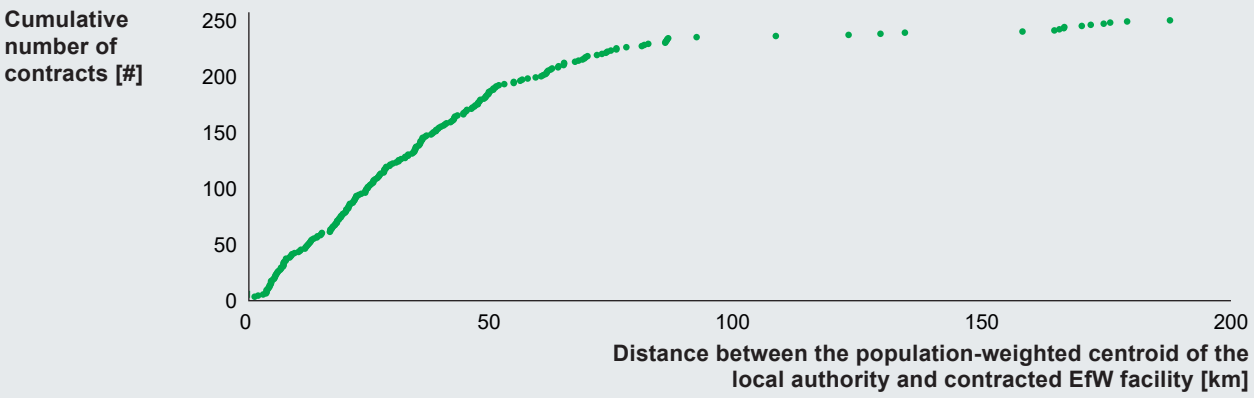
Our analysis of EfW capacity allocation to local authorities has been limited to England. The capacity within England has been defined as the capacity allocated to English local authorities, rather than the capacity situated in the country. Thus, facilities in Scotland and Wales are included given their proximity, and therefore ability to serve English regions. Likewise, some of the capacity situated in England will be allocated to authorities within Scotland and Wales.

Additionally, we consider only non-specialist EfW facilities (i.e. those capable of processing mixed residual waste derived from the majority of household and C&I sources) and cement production facilities. Specialist EfW facilities, such as those focused on clinical, hazardous, and sewage waste are typically much smaller in scale and operate under different technologies, contracts, and catchment regions. These waste types are also excluded from our residual waste estimation. We have also excluded 14 wood waste specialist facilities, largely due to their significant contractual exposure to C&D, forestry, and agricultural waste arisings. These 14 facilities combined have an operational capacity of about 1.2 million tonnes per year. These facilities however, to some extent, draw upon household, and C&I residual waste sources. Therefore, a proportion of their operational capacity acts to reduce the national capacity gap and should be considered in any EfW site-specific catchment analysis.

Capacity allocation is based primarily on distance using the capacity allocation methodology. This is built on extensive contract data on average distances to EfW facilities from waste disposal authorities. → F

While not covered in this series, the logic of this methodology can be reversed to evaluate the catchment supply of residual waste for specific (existing or planned) EfW facilities. Such a catchment analysis should form a critical part of any commercial evaluation, with less emphasis on the nation-wide capacity gap dynamics.

F / Waste disposal contracts by distance to contracted EfW facilities



Source: EfW operator information, BDS Marketing, Roland Berger

5/ Regional capacity gap

Having estimated both the volume of regional residual waste and the regional EfW capacity, we can now build a picture of the regional EfW capacity gap within England. This gap is defined as the difference between available residual waste in the region and current EfW capacity. → G

It is worth mentioning at this stage that the national capacity gap has been a well-published topic of significant discussion in recent years. Much work has gone into understanding the extent of today's gap and its expected development over the coming decade. It is therefore no surprise that we conclude that there indeed exists a significant EfW capacity gap in England. We estimate this gap was around 10 million tonnes (excluding RDF exports) in 2019. To put it another way, EfW capacity in England is only enough to treat c. 50% of addressable residual waste in the country.

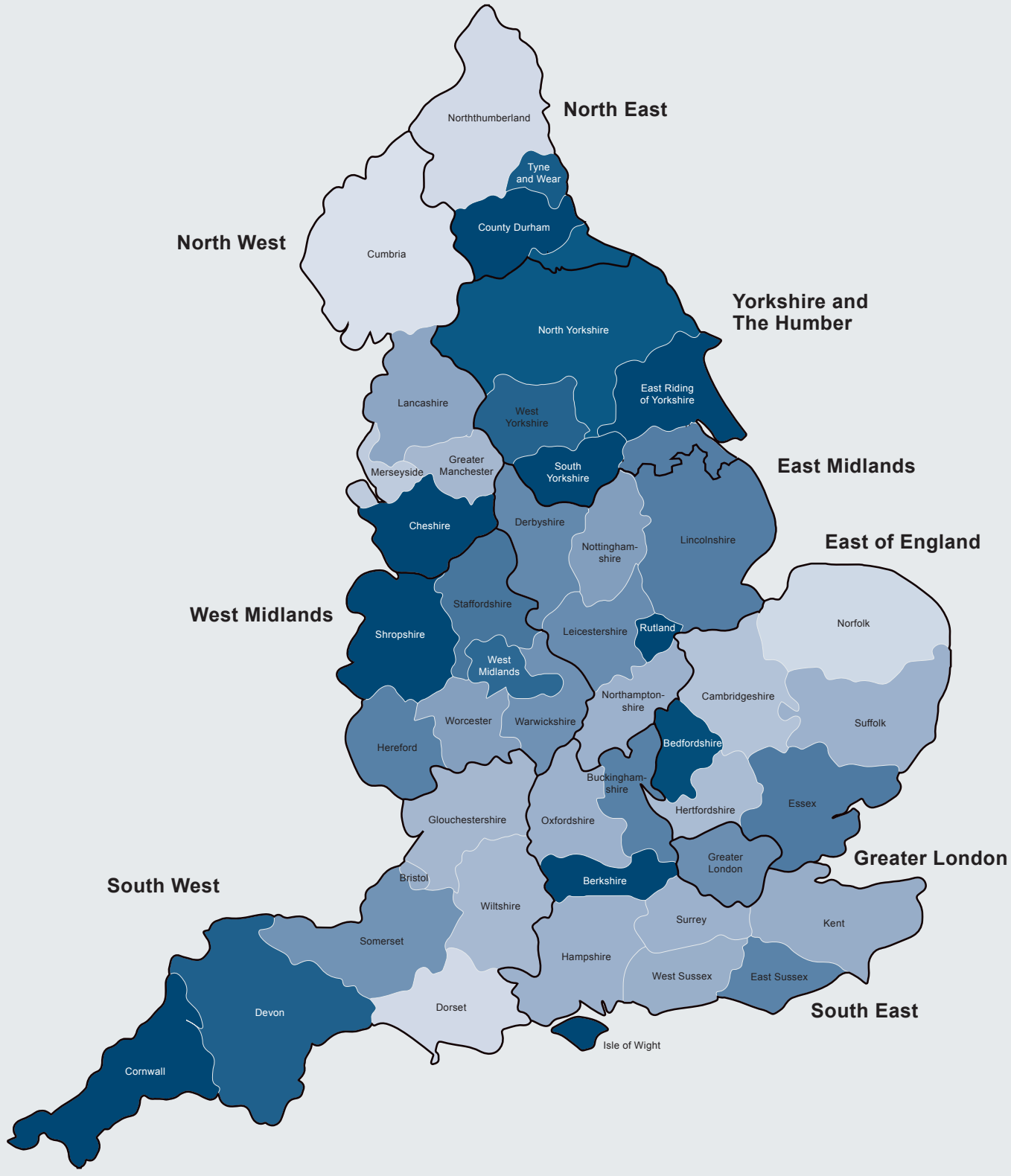
Through our regional lens, we can now begin to understand the subtleties behind this national capacity gap:

1. Significant capacity gaps exist in some counties, most notably Cumbria, Northumberland, Norfolk, Dorset, and many counties across the South West and East of England.
2. 33 of the 47 English counties, including Greater London, currently do not have access to sufficient EfW capacity to meet the national landfill diversion target of 2035, without exporting RDF.
3. Conversely, a number of capacity hotspots exist, in Yorkshire, Durham, and the far South West.

One important aspect of the capacity gap we are yet to explore is the export market. In 2010, the Environmental Agency permitted the export of RDF for energy recovery. This allowed England to offset its EfW infrastructure shortfall, and importing EU countries to offset their residual waste shortfall, which resulted from the 2008-2009 economic recession.

Since then, exports rose sharply and currently amount to around 3 million tonnes of RDF per year. However, with the expansion of domestic infrastructure, additional costs associated with exports, rising international gate fees, and a weakened pound, it is expected that currently exported volumes of waste would likely remain in the UK should enough EfW capacity exist.

G / EfW capacity gap in England by county [capacity as a share of addressable residual arisings, %]



Source: Defra, EA, Oxford Economics, ONS, BDS Marketing, Lets Recycle, Roland Berger

LOOKING AHEAD

While the importance of understanding the picture today is hopefully self-evident, the avid readers among you will reflect upon the importance of visualising the environment a decade from now, and beyond. Although the national picture shows a significant capacity gap today, it is being squeezed from both a residual waste and EfW capacity perspective.

On the one hand, residual waste faces a double whammy of declining waste arisings per capita or per unit of economic output, and an increase in recycling rate. On the other hand, EfW infrastructure in England continues to grow with over 4 million tonnes of capacity forecast to be commissioned in the coming five years.

COVID-19 is causing a significant impact, both on waste arisings and the financial health of the waste management industry. While the longer-term impact is yet unclear, the immediate impact is already being seen, with as much as a 50% decline in C&I arisings during the first month of the lockdown.

We aim to address these issues in the next volume of this series: "The future of residual waste".

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