Rt Hon Boris Johnson MP
Prime Minister
10 Downing Street
London SW1A 2AA

16 November 2020

Dear Prime Minister,

Energy-from-waste (EfW) incineration capacity in the UK is poised to expand by 20 million tonnes by 2030, more than doubling current capacity and locking the country into an additional 10 million tonnes of fossil-derived CO_2 emissions per year, primarily from burning plastics.[1] By failing to consider whether this growth is compliant with the Paris Agreement and the UK's net zero obligations, the Government effectively inhibits the full decarbonisation of the power sector.[2] Moreover, the EfW sector's expansion impairs the transition to a circular economy and hinders green job growth, thus depriving the UK economy of a critical economic boost.[3]

We, the undersigned, call for **concerted government action to decarbonise the waste sector**—including through consideration of net-zero obligations regarding planned EfW incinerators—noting that the Committee on Climate Change has warned that the UK is not on track to meet the fourth or fifth carbon budgets (2023–27 and 2028–32) and that 'progress will need to accelerate' if the UK is to achieve net zero by 2050.[4]

Delivering on net zero requires transitioning to a circular economy for CO_2 savings.[5] The good news is that the UK is uniquely positioned to jump-start a **world-leading transformation of the waste and resource sector** as part of its post-Covid recovery. Through regulatory reform and a dedicated investment programme, the Government can accelerate the transition towards a zero-carbon, zero-waste circular economy. Even a moderate, entirely workable shift will allow the UK to:

- slash UK CO_2 emissions by 15%—or 68 million tonnes per year—by 2030;[6]
- reduce pollution, thus improving air quality and public health;
- inject £35 billion into the economy by 2030 via recycling, repair, reuse, rental, and remanufacturing;[7]
- create more than 200,000 new jobs and tackle unemployment;[8] and
- make a decisive contribution to attaining climate neutrality by 2050.[9]

We call on the Government to secure these benefits and to propel the country swiftly up the waste hierarchy, in part by implementing the following evidence-based policy and legal instruments:

- a **waste and resource sector law that requires net-zero carbon** by 2035, inclusive of EfW incineration emissions, in line with targets set by the governments of Denmark, Finland, Norway, and Sweden;[10]
- a recycling target of 70% by 2030 under the **Environment Bill**, as per the Committee on Climate Change recommendation for meeting the UK carbon budgets and a net-zero-carbon economy by 2050;[11]
- a 'residual' (non-recyclable) waste reduction target of 50% by 2030 in statutory instruments under the **Environment Bill**;
- a **law on waste market reform** to attract investment in recycling infrastructure and to level the playing field, with provisions for a market regulator and annual auctions for the processing of residual waste and recyclates (recyclables);
- a circular economy capital investment programme as part of the **National Infrastructure Strategy**, to mobilise infrastructure investment that will support reuse, repair, remanufacturing, and recycling of scrap steel, glass, paper and board, plastics, and biowaste;
- a **law on product reuse and repair** that sets out targets for the reuse of durable products, mandatory product labelling of lifespan and repairability, and consumer right-to-repair rules; and
- an update to the 2014 **National Planning Policy for Waste** to require waste planning authorities to demonstrate that no readily recyclable dry or organic materials are sent to landfill or EfW incineration, as part of the identification and planning of waste management infrastructure.[12]

We propose these and other measures in the annexed **Circular Economy Blueprint**, designed to help the Government establish the **infrastructure, regulatory framework, and market conditions required for true resource recovery and material efficiency** at the national level. By taking steps now, the Government can deliver on DEFRA's vision for product reuse, repair, and remanufacture, as outlined in the 2018 Resources and Waste Strategy, while also weaning the UK off EfW incineration, landfilling, and recyclate exports.

We look forward to collaborating with you and the UK Government as a matter of priority—in an effort to decarbonise the waste sector and facilitate a green recovery that is aligned with the Paris Agreement.

Sincerely,

Sian Sutherland, Co-Founder, **A Plastic Planet**
Biofuelwatch
City to Sea
Countryside Management Association
Carina Millstone, Executive Director, **Feedback**
Mike Childs, Head of Science, Policy and Research, **Friends of the Earth**
Richard Dixon, Director, **Friends of the Earth Scotland**
Antoinette Vermilye, Co-founder, **Gallifrey Foundation**
Green House Think Tank
Greenpeace UK
Lucy Siegle, Chair, **Real Circularity Coalition**
Resource Recovery from Waste, University of Leeds
ShareAction
The Climate Coalition
Liz Hosken, Director, **The Gaia Foundation**
UK Without Incineration Network (UKWIN)
UK Youth Climate Coalition
XR Zero Waste
Zero Carbon Campaign
Zero Waste Europe

Jon Cruddas, MP, Dagenham and Rainham
Baroness Jones of Moulsecoomb, Green Party Life peer
Leonie Cooper AM, London Assembly Member
Caroline Russell AM, London Assembly Member, Green Party
Cllr Jeremy Ambache, Wandsworth Council
Cllr Jonathan Essex, Surrey County Council
Cllr Simon Pickering, (Green Party) Chair of Environment Committee, Stroud District Council
Cllr Paula Walker, Wandsworth Council

George Monbiot, author and activist
Esméralda de Belgique, journalist and activist, chair of Friendship Belgium
Georgia Elliott-Smith, UNESCO Special Envoy for Youth & the Environment
Derek Wall, author, *Climate Strike: The Practical Politics of Climate Crisis*
Dr Les Levidow, Senior Research Fellow, Open University
Professor Steffen Boehm, Organisation & Sustainability, University of Exeter Business School

Annex to the open letter on transitioning to a circular economy without more EfW incineration

The aim of this annex is twofold. For one, it challenges the legitimacy of calls for an expansion of energy-from-waste (EfW) incineration capacity in the UK. More importantly, however, it presents an initial blueprint of potential regulations and initiatives for kick-starting a sweeping transformation of the UK's waste and resource sector, with the aim of accelerating the transition towards net-zero carbon as well as zero waste, a goal that is soundly articulated in the Welsh Government's recent circular economy consultation document:

> We want to achieve our aim of Wales being a zero waste nation by 2050. This means that any discarded materials are recycled and re-circulated within the Welsh economy, with no loss of materials from the system—effectively a 100% recycling rate from all sectors.[13]

This blueprint is designed to help the Government build back better as part of our post-Covid recovery, while also meeting greenhouse gas emissions targets on the way to net-zero carbon emissions. The blueprint is not meant to be exhaustive or conclusive; rather, it is offered as a **platform for action**.

The annex draws on the rapidly growing literature on how best to transition away from the traditional take–make–dispose model to achieve genuine circularity based on a zero-waste economic model. It comprises the following sections:

1 **How energy-from-waste incineration undermines circularity and the net-zero carbon target**
This section spells out why EfW incineration is considered a form of 'leakage' from the circular economy and underscores that the ongoing expansion of EfW incineration capacity hampers the UK's ability to deliver on its net-zero carbon ambitions. It identifies six key factors that make the technology a poor choice for waste and resource management, namely that it:

I. destroys resources instead of recovering them, costing the UK billions per year
II. impairs the transition to a circular economy by preventing material reuse and recycling
III. slows economic recovery and hinders job growth in the circular economy
IV. inhibits the full decarbonisation of the power sector
V. is among the costliest means of generating energy and managing waste
VI. presents serious financial risks as EfW facilities become stranded assets.

2 **Transforming the UK's waste and resource sector: a blueprint for regulatory reform and structural investment**
This section proposes measures the Government could implement in six key areas to bring about what the UK Committee on Climate Change calls a 'step-change towards a circular economy':

I. implement enhanced programmes to prevent waste arisings
II. introduce regulations to improve product lifespan, reuse, repair, and remanufacturing
III. increase the rate and quality of recycling
IV. require more detailed reporting on product and waste flows
V. make recycling more attractive than EfW incineration
VI. deliver a circular economy infrastructure investment strategy.

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List of abbreviations

C&I	commercial and industrial
CAPEX	combined capital expenditure
CCC	Committee on Climate Change
CCS	carbon capture and storage
CCU	carbon capture and utilisation
CfD	Contract for Difference
CHP	combined heat and power
CO_2e	carbon dioxide equivalent
EfW	energy-from-waste
GVA	gross value added
HNIP	Heat Networks Investment Project
kWh	kilowatt-hour
MHCLG	Ministry of Housing, Communities and Local Government
MRF	material recovery facility
$MtCO_2e$	millions of tonnes of carbon dioxide equivalent
MWh	megawatt-hour
OPEX	operational expenditure
OPRL	On-Pack Recycling Label
PV	photovoltaic
RDF	refuse-derived fuel

1 How energy-from-waste incineration undermines circularity and the net-zero carbon target

The UK Government has the power to usher in a momentous transformation of the waste and resource sector to accelerate the transition towards a genuine, zero-waste circular economy. We argue that the continued reliance on energy-from-waste (EfW) incineration impedes this transformation, as EfW incineration is incompatible with the three principles on which the circular economy is founded: designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.[14] The failure to uphold these principles is what makes burning materials a form of 'leakage' from the circular economy. We hold that the continued inclusion of EfW incineration as a core component of waste and resource management would not only slow our economic recovery following the Covid-19 pandemic, but also be disastrous for climate change mitigation, since 'fossil emissions from energy from waste plants are growing rapidly', as the Committee on Climate Change (CCC) notes in its 2020 Progress Report to Parliament.[15]

Moreover, we wish to underscore that a continued expansion of EfW incineration capacity in the UK heightens risks associated with overcapacity, including sunk costs and stranded assets. As Green Alliance cautions: 'The history of waste treatment in Scandinavian countries clearly shows the unfortunate consequences, indeed the avoidable folly, of starting at the wrong end of the material cycle and over investing in EfW. It should be **a warning to the UK not to make the same mistake**' (emphasis added).[16]

This point is echoed by Prof. Stephen Jenkinson, waste management veteran and former chairman of the UK's resource and waste management industry trade body, the Environmental Services Association (ESA), who states: 'Many countries are applying an incineration tax to disincentivise destruction of waste over recovery. Denmark, once paladin of incineration, has now understood it has over-relied upon incineration to the detriment of material recovery and needs to import waste to keep its plants running. **Britain risks making the same mistake**' (emphasis added).[17]

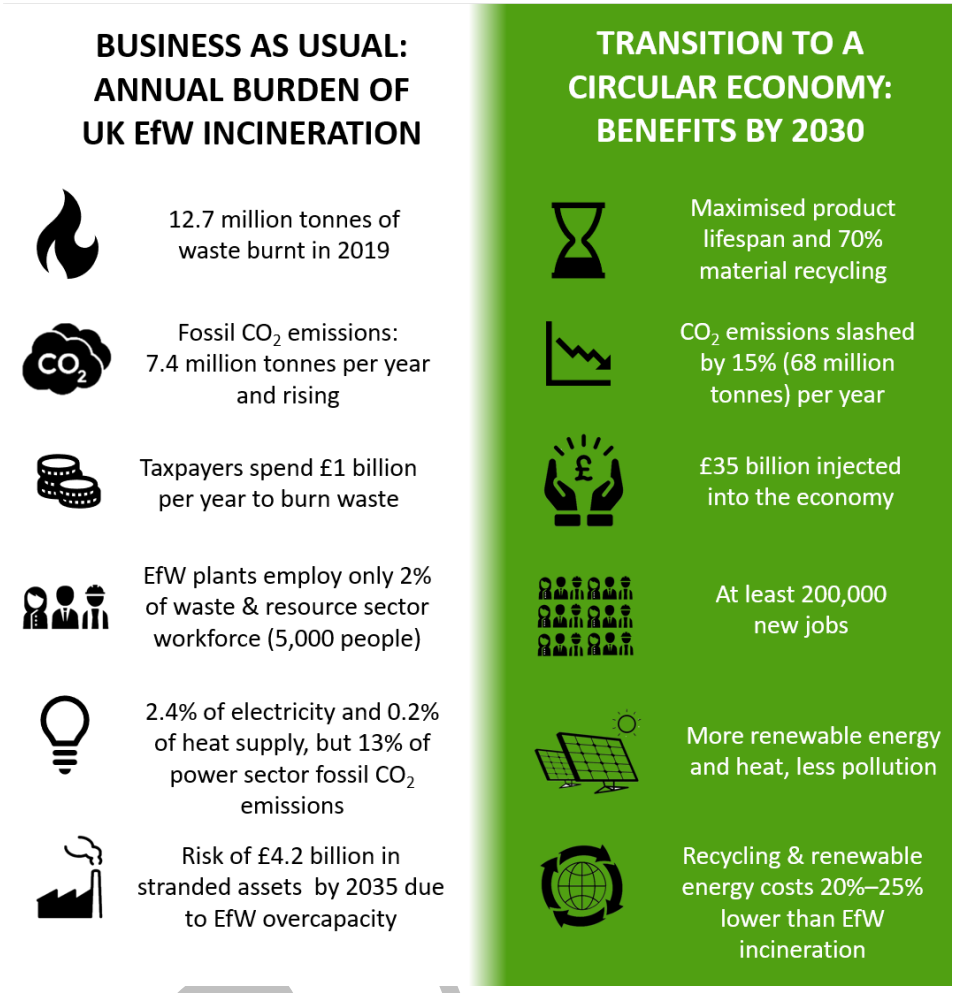
This annex offers clarity on why exacerbating our dependency on EfW incineration cannot be part of the transition to a circular economy. As aptly stated by Dr Alan Whitehead MP, 'We are at a turning point. The future is net zero; it cannot be incineration.'[18] This vision of the future outshines EfW expansion on several fronts: the shift towards circularity will reduce pollution and greenhouse gas emissions, create far more jobs, and prevent the UK from destroying resources and forgoing value-added activities, instead injecting billions of pounds into the UK economy—while public health and well-being improve.[19]

This section identifies six key reasons why EfW incineration is a poor choice for waste and resource management (see Figure A). Specifically, it explains that EfW incineration:

I. destroys resources instead of recovering them, costing the UK billions per year
II. impairs the transition to a circular economy by preventing material reuse and recycling
III. slows economic recovery and hinders job growth in the circular economy
IV. inhibits the full decarbonisation of the power sector
V. is a costly means of generating energy and managing waste
VI. presents serious financial risks as EfW facilities become stranded assets.

The following elaboration of these points underscores that we need to stop wasting resources, which means that we need to stop planning and constructing new incinerators. Building this understanding among policy-makers and industry professionals is critical if the UK is to meet its circular economy targets and achieve its ambitious carbon budgets. An expansion of EfW incineration capacity is inconsistent with the Paris Agreement and the UK's legally binding net-zero commitments. If ministers fail to consider whether the planned construction of incinerators is compliant with climate obligations, the Government will effectively inhibit the decarbonisation of the UK economy.

Figure A EfW incineration vs. a transition to the circular economy in the UK[20]



I. EfW incineration destroys resources instead of recovering them, costing the UK billions per year.

- **Burning resources perpetuates avoidable dependency on imports.** More than half of the 'residual' waste that is currently incinerated is actually recyclable or digestible, meaning that the scale of resource destruction through EfW incineration is massive—and that it is set to grow as the proportion of recyclable arisings increases. In England, for instance, an estimated 53% of the residual waste is readily recyclable, 27% is potentially recyclable, 12% is potentially substitutable for recyclable materials, and only 8% is difficult to recycle or substitute, based on estimates by WRAP.[21] In comparison to the amounts of material collected for recycling, at least three times as many textiles and plastic, and five times as much food waste is incinerated every year in the UK's municipal waste streams.[22] This resource destruction is part of the reason that the UK is highly import-dependent: 79% of the materials used to produce goods and services in 2017 were imported.[23]

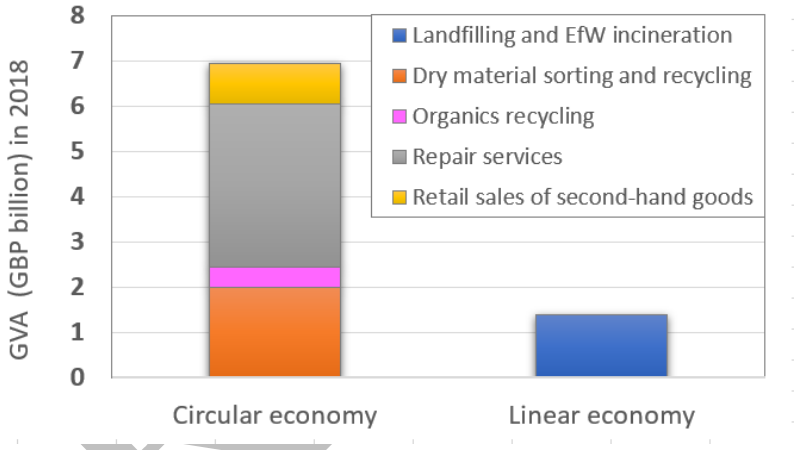
- **Incineration means less bang for our buck.** As shown in Figure B, the current gross value added (GVA) associated with pursuing circular economy strategies for local authority-collected waste streams is already five times larger than the GVA of landfill and EfW incineration (£7 billion vs. £1.4 billion), even though the recycling rate is lower than the rate of landfilling and incineration (45% vs. 55%). Indeed, recycling and composting alone contribute roughly 80% more to the economy than do landfilling and EfW incineration (£2.5 billion vs. £1.4 billion). At the same time, England's local authorities spend three times more on landfilling and incineration per year than they do on dry and organic recycling services, including on gate fees (£2 billion vs. £0.6 billion).[24] These disparities indicate that the economic benefits of pursuing a circular economy—by utilising waste streams as resources—far outweigh those of disposal in landfill and

through incineration. The following GVA breakdown illustrates this point:

- the circular economy provides £7 billion in GVA per year:
  - £2 billion from dry material recovery, including sorting and recycling;
  - £0.5 billion from organics recycling through anaerobic digestion and composting;
  - £3.6 billion from repair services, including IT equipment, appliances, and other household goods; and
  - £0.9 billion from retail sales of second-hand goods;
- the linear economy contributes about £1.4 billion in GVA per year through landfilling and EfW incineration.[25]

- **A modest step up the waste hierarchy would add £35 billion to the wider UK economy.** A detailed WRAP analysis shows that moderate improvements in recycling, repairing, renting out, and remanufacturing materials would generate far greater economic returns—direct benefits in the waste and resource sector, and indirect ones in other sectors—than the use of landfill and incineration to dispose of and destroy the same resources. An increase in recycling rates from 45% to 65% would add £5.3 billion in GVA; a 5% growth in repair activities would add £1.5 billion in GVA; 25% more renting and leasing would add £7.8 billion; and a 20% expansion in the remanufacturing sector would add £20.9 billion to the economy across all sectors.[26]

Figure B Gross value added (GVA) by the circular economy vs. the linear economy, 2018[27]



II. EfW incineration impairs the transition to a circular economy by preventing material reuse and recycling. Policy Connect claims to have 'found no evidence to support claims that EfW incineration inhibits recycling rates',[28] yet ample data and documentation are in fact readily available.

- **EfW incineration competes for recyclables.** At the system level, waste incineration and recycling compete for the same materials,[29] as evidenced by the fact that more than half of the materials that are currently being incinerated in EfW facilities are readily recyclable.[30] Once EfW infrastructure is in place, a local authority is contractually obligated to allow the incinerator operator to process collected waste in the EfW facility, typically for 10 years or more.[31] Such contracts create negative trade-offs by maintaining a higher demand for virgin raw materials and imports than would be the case in a circular economy, in which recycling would meet demand.[32]

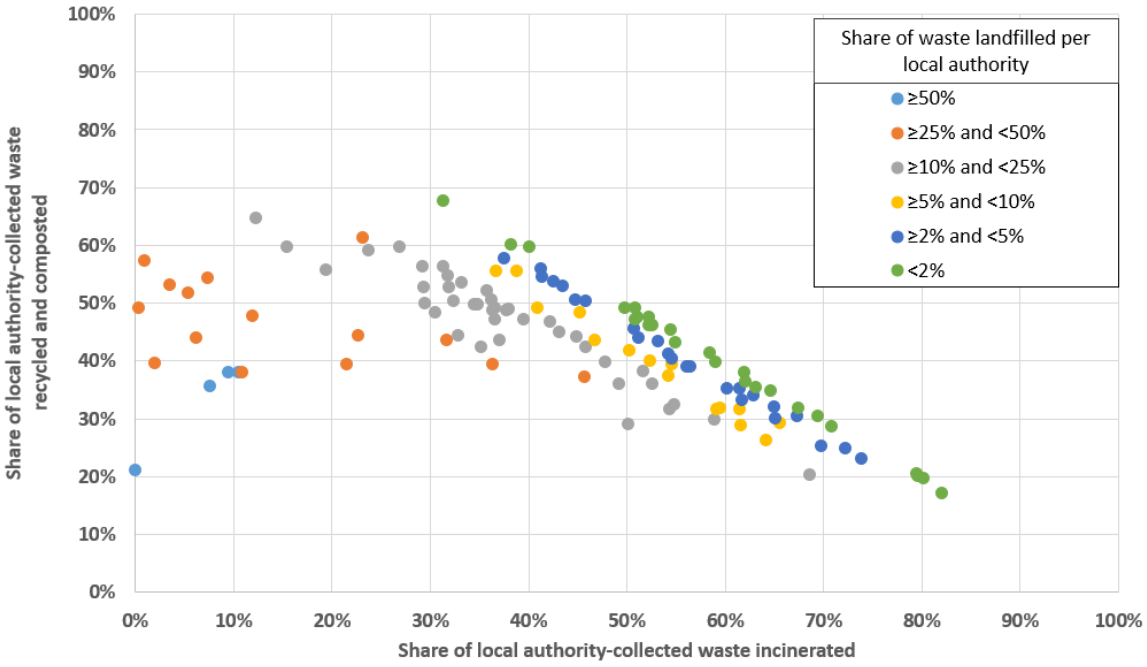
- **High incineration rates keep recycling rates low.** DEFRA data on waste collected by 123 local authorities show a clear relationship between above-average incineration rates and lower recycling rates when controlling for landfilled waste (see Figure C).[33] After a local authority has reduced its landfilling share of collected waste to below 15%, the share of incinerated waste becomes highly linearly correlated with the share of recycled and composted waste: each 1% increase in EfW incineration results in a 0.8% reduction in recycling and composting.[34] At a landfilling share of collected waste below 10%, each 1% increase in EfW incineration results in a 0.94% reduction in recycling and composting.[35] Of the local authorities with landfilling rates below 10%, 55 incinerate more than 50% of their waste, 26 incinerate more than 60%, and 7 incinerate more than 70%. Their poor recycling performance, combined with low landfilling,

indicates that they are incinerating a significant amount of readily recyclable materials.

- **The more we incinerate, the less we recycle, and vice versa.** Areas with the lowest rates of incineration tend to have the highest rates of recycling and vice versa. In 2018/19, the UK's South West had the lowest rate of incineration (28.4%) and the highest rate of recycling (49.8%), whereas London had the highest rate of incineration (59.3%) and the lowest rate of recycling (30.2%).[36]

- **Sustained increases in recycling rates necessitate cuts in EfW incineration, says the CCC.** In commenting on Policy Connect's claim that EfW does not hinder recycling, the CCC notes: 'The premise that EfW does not inhibit recycling rates is based on 2017 European data […] this same dataset shows that those countries with the highest recycling rates (e.g. Germany, Austria, Slovenia) also have significantly lower EfW rates than other countries with low landfill. And given this is a historical snapshot, it doesn't consider the future – continued increases in recycling will eventually have to come at the expense of EfW, if landfill has already largely disappeared.'[37]

Figure C The share of waste recycled and composted vs. the share of waste incinerated, with control for the share of waste landfilled per local authority, 2017/18 (N=123)[38]



Note: For each of the 123 local authorities in this sample, the dot colour indicates the share of waste landfilled. These data show a clear relationship between above-average incineration rates and lower recycling rates when controlling for landfilled waste.

III. EfW incineration slows economic recovery and hinders job growth in the circular economy. If encouraged to expand, as detailed in Section 2 of this annex, the circular economy will serve as a job engine: since reuse, repair, remanufacturing, and recycling are more labour-intensive processes than EfW incineration, they offer far greater job creation potential.

- **Compared to the circular economy, EfW incineration is a low-employment sector:**

  - Once operational, an incinerator whose construction may have required an investment of £145–£200 million[39] typically employs only 30–40 people.[40]

  - For every 10,000 tonnes of waste processed, an estimated 1–2 permanent jobs are created through EfW incineration, compared to 6 jobs through landfilling, 36 jobs via recycling, and

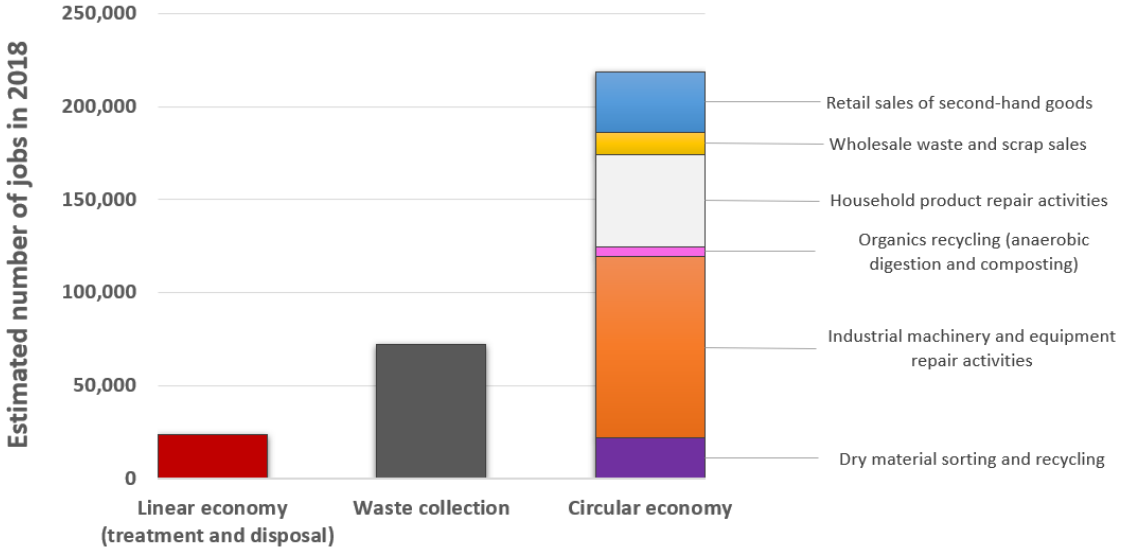
more than 200 jobs through the reuse of products such as textiles and appliances.[41]

- **EfW incineration accounts for just 2% of jobs in the waste and resource sector.** Repair and reuse jobs alone outnumber landfill and EfW incineration jobs by a factor of 15. It is worth noting that repair and reuse activities are not currently reflected in official waste and resource data, but rather in other categories, in line with national and international reporting standards.[42] Since these activities are part of the circular economy, however, this annex includes repair and reuse jobs in the employment figures for the waste and resource sector. Overall, the sector employs a total of 223,900 people, only 2% (5,000) of whom work in EfW incineration. In the following breakdown, the jobs that are exclusively linked to the circular economy are *italicised*, while linear economy jobs are underlined:

  - 72,000 in waste collection (for both the linear and circular economies);
  - 23,000 in treatment and disposal of non-hazardous wastes, as follows:[43]
    - 5,000 in EfW incineration, including in planning, operations, and construction;
    - 8,500 in landfilling;
    - *5,500 in organics recycling (anaerobic digestion and composting);* and
    - 4,000 in other waste treatment operations;
  - 6,000 in the treatment of hazardous wastes;
  - *22,000 in dry material recovery, including sorting and recycling*;
  - *191,400 in repair and reuse:*
    - *97,400 in industrial machinery and equipment repair;*
    - *49,500 in household product repair activities;*
    - *11,900 in the wholesale waste and scrap business; and*
    - *32,600 in retail sales of second-hand goods* (see Figure D).[44]

- **A significant shift from EfW incineration to a circular economy would cause a job boom.** An increase to 70% recycling (the 2030 target recommended by the CCC) and to 20% remanufacturing would translate into **more than 200,000 new jobs** overall, or 54,000 net additional jobs, based on evaluations by WRAP and Green Alliance.[45]

Figure D Jobs in the linear economy (including landfilling and EfW incineration), waste collection, and the circular economy, 2018[46]



IV. EfW incineration inhibits the decarbonisation of the power sector and cannot help the UK deliver on its net-zero carbon ambitions. Incinerator emissions have a relatively high CO_2 concentration—one 'similar to coal',[47] as roughly one tonne of carbon dioxide equivalent (CO_2e) is released for every tonne of waste that is incinerated. About half of this CO_2 derives from fossil sources such as plastic.[48] Since EfW incinerator emissions are included under the power sector, not the waste sector, government data show that they inhibit the decarbonisation of the energy supply rather than of waste management.

- **Greenhouse gas emissions from EfW incineration have increased 12-fold since 2000.** In 2019, the UK's 54 EfW incinerators released more than 12 million tonnes of CO_2e, including 7.4 million tonnes of fossil-based CO_2e emissions—a 12-fold increase over the 0.6 million tonnes of fossil-based CO_2e emitted in 2000, based on BEIS and CCC data (see Figure E).[49]

- **Grid decarbonisation has undermined the justification for EfW incineration.** Due to the progressive decarbonisation of electricity supplied via the National Grid, the relative climate change impact of incinerators in the power sector is growing rapidly.[50] The average carbon intensity of the grid in 2019 was 214 grams per kilowatt-hour (kWh), while the current average fossil carbon emission intensity of energy from EfW incineration is four times that: 860 grams per kWh.[51]

- **EfW incineration accounts for an unduly large proportion of power sector emissions.** EfW incineration accounted for 13% of the 57 million tonnes of power sector emissions from fossil-fuel sources in 2019 (see Figure F), while generating only 2.4% of the UK's electricity and a mere 0.2% of the UK's heat supply.[52]

- **The coal phase-out exposes EfW incineration as incompatible with UK climate targets.** It is no longer possible to obtain substitution benefits by replacing coal with EfW incineration since coal has been almost entirely phased out of the National Grid, accounting for just 2% of 2019 power generation.[53] Dominic Hogg of Eunomia concurs: 'When coal is phased out for generating electricity, incineration of unrecycled waste will be the most CO_2-intensive form of generation. This doesn't make sense if the government's trying to reduce CO_2 emissions.'[54]

- **No measures are in place to slow or stop the expansion of EfW incineration capacity.** Seventeen EfW facilities are currently in the late stages of commissioning or under construction; at full capacity, they will add an estimated 2 million tonnes of fossil-based CO_2 emissions per year to UK totals.[55] Industry-driven efforts to build further capacity can be expected in the absence of a moratorium or other regulations (see Section 2 of this annex).[56]

- **EfW incineration is not the only—nor the least carbon-intensive—alternative to landfill.** Construction of new EfW facilities is partly justified based on the claim that a redirection of waste from landfill to EfW incineration 'saves' greenhouse gas emissions by preventing the biodegradable portion of that waste from releasing CO_2e emissions through decomposition in landfill.[57] In terms of greenhouse gas emissions, this argument fails to acknowledge that incineration is a poor substitute for landfilling, especially in relation to the following alternatives (see Figure G):

  - **organic waste prevention:** For every tonne of food waste we avoid by not producing the food in the first place, we prevent an estimated 3.74 tonnes of CO_2e.[58] Similarly, if we reduce paper and board usage by 1 tonne—such as by cutting back on packaging or using digital devices instead of printing—we avoid an estimated 1.7 tonnes in CO_2e.[59]

  - **non-organic waste prevention:** Waste prevention through reuse, light-weighting, and the avoidance of packaging can bring about far greater reductions in greenhouse gas emissions than would be secured by shifting from landfilling to EfW incineration. Indeed, preventing the use of 1 tonne of glass saves an estimated 0.9 tonnes of CO_2e; the same principle applies with respect to preventing the use of 1 tonne of plastic (1.9 tonnes of CO_2e saved), steel (2.1 tonnes of CO_2e saved), aluminium (12 tonnes of CO_2e saved), and textiles (24.3 tonnes of CO_2e saved).[60]

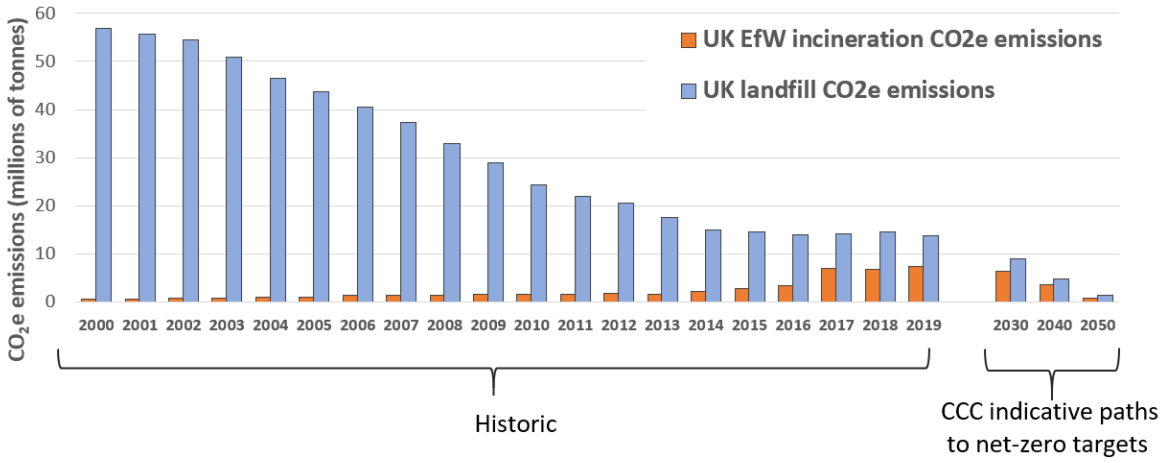
- **organic material recycling:** Anaerobic digestion of organic waste is preferable to EfW incineration in that the process is nearly fossil CO_2-neutral[61] and can generate high-standard natural fertiliser (digestate), which can replace artificial fertiliser,[62] as well as biogas, which can replace natural gas for heating. For every tonne of organic material digested, anaerobic digestion emits 0.14–0.34 fewer tonnes of CO_2e than would be released if that tonne were sent to EfW incineration.[63]

- **non-organic material recycling:** Recycling of all materials yields significant CO_2 reductions by reining in the demand for energy-intensive processes across the supply chain, including mining, processing, and manufacturing. Every tonne of glass that is recycled saves an estimated 0.2–0.7 tonnes of CO_2e, in part by obviating the need for virgin materials. The CO_2e savings are somewhat higher for every tonne of recycled steel (0.5–1.8 tonnes CO_2e), dense plastic (0.6–1.8 tonnes CO_2e), waste electric and electronic equipment (WEEE) (1.3–1.5 tonnes CO_2e), and textiles (1.8–8.0 tonnes CO_2e), and significantly higher for every tonne of aluminium (9–12 tonnes CO_2e).[64]

- **Delivering on net zero requires transitioning to the circular economy for CO2 savings.** The total impact of the transition to a high-value circular economy—with a focus on ratcheting up waste prevention, reuse, and recycling—is expected to **save 68 million tonnes of CO_2 per year by 2030**,[65] or **15% of the UK's total emissions**, based on 2018 data.[66] Given that the CCC has warned that the UK is not on track to meet the fourth or fifth carbon budgets (2023–27 and 2028–32) and that 'progress will need to accelerate' if the UK is to meet the net-zero target by 2050,[67] the transition to a circular economy is an essential contributor to achieving the UK's climate ambitions.[68]

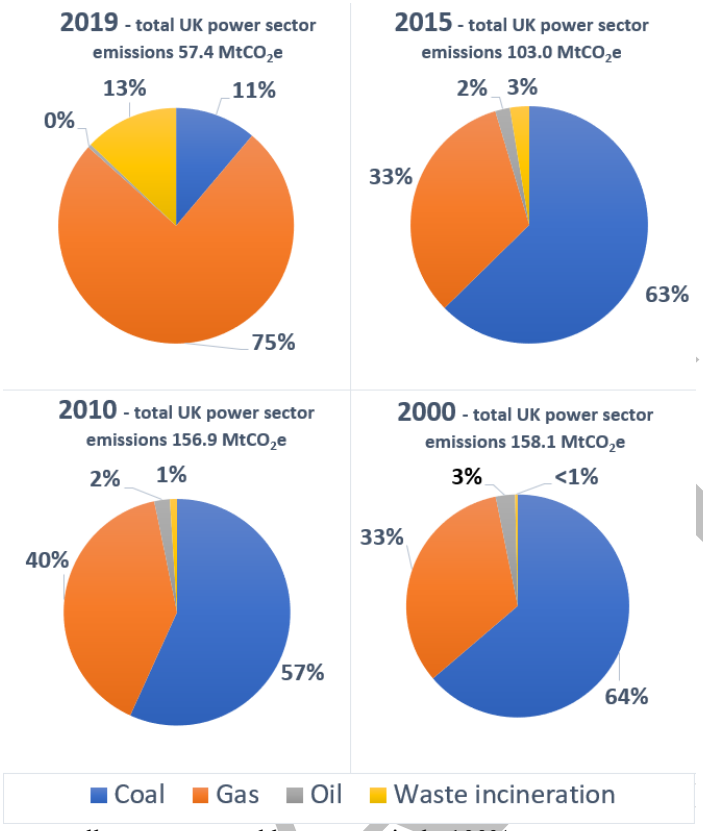
- **Technology that limits CO2 emissions will make the cost of EfW incineration rise steeply.** The CCC indicates that to ensure power sector decarbonisation, EfW incineration facilities will necessarily have to integrate costly carbon capture and storage (CCS) technology.[69] The most recent CCS technology estimates show that, as a result, energy-generation costs will increase by £136 per megawatt-hour (MWh),[70] causing a marked increase in the cost of EfW incineration, as discussed in point V, below.

Figure E Fossil-based CO_2 emissions from EfW incineration and biogenic methane emissions from landfill, 2000–19, with indicative paths to reach net-zero carbon for both disposal methods by 2030, 2040, and 2050, derived from Committee on Climate Change (CCC) values[71]



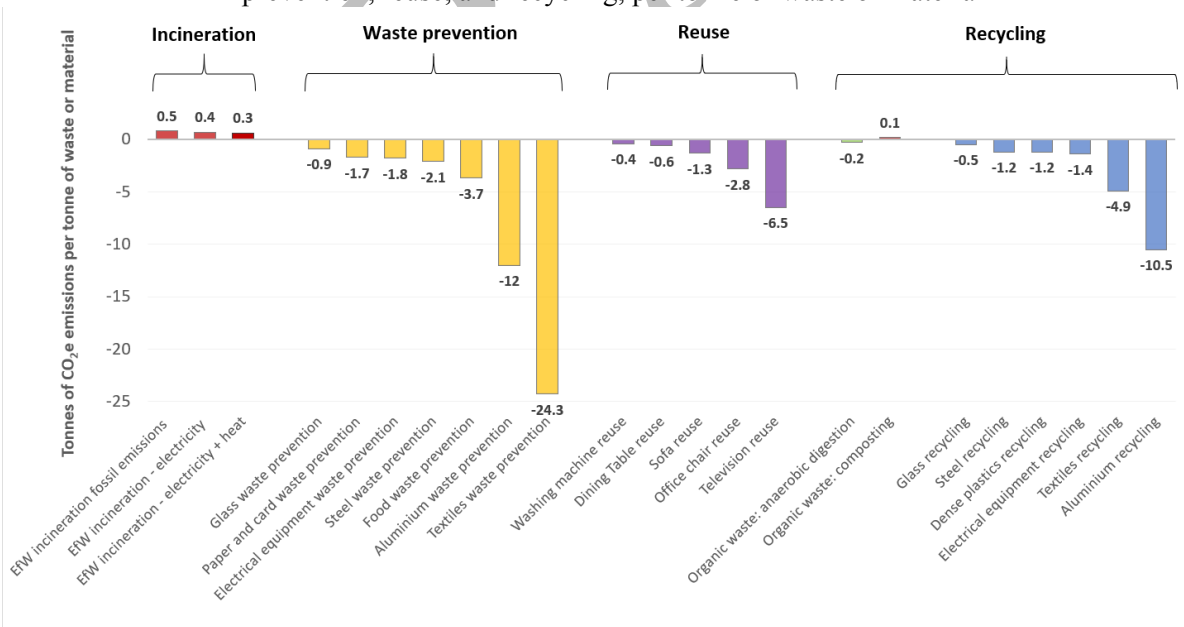
Note: This figure presents landfill emissions from biogenic sources, namely methane released from decomposing organic material, converted into CO_2 equivalent values (CO_2e). EfW incineration emissions in the figure are due to the burning of fossil-derived materials (excluding biogenic values), primarily plastics. This approach is based on the latest standardised greenhouse gas emissions accounting practices as set out by the Intergovernmental Panel on Climate Change.[72]

Figure F Fossil CO_2e emissions caused by coal, natural gas, oil, and EfW incineration in the generation of electricity, as a % of total power sector emissions, in millions of tonnes of CO_2e ($MtCO_2e$) for 2019, 2015, 2010, and 2000[73]



Note: Due to rounding, not all percentages add up to precisely 100%.

Figure G Tonnes of CO_2e emissions generated or saved through EfW incineration, waste prevention, reuse, and recycling, per tonne of waste or material[74]



Note: UK-wide fossil emissions from EfW incineration are estimated at 0.51 tonnes per tonne of fossil CO_2e emissions.[75] Carbon emissions accounting of EfW incineration typically present the replacement of electricity from the grid as a counterfactual. The idea is that when a new EfW incineration plant begins to produce electricity, it replaces other power sources.[76] If, for example, EfW incineration replaces electricity from the grid at the 2019 grid carbon intensity of 214 grams per kWh, then total emissions that have been accounted for drop to 0.39 tonnes per tonne of fossil CO_2e emissions.[77] If compensation for heat generation is factored in, they go down to 0.29 tonnes per tonne of fossil CO_2e emissions, based on the replacement of gas consumption in heating.[78]

V. EfW incineration is a costly means of generating energy and managing waste,[79] as compared to alternative options that combine recycling and energy generation. Initially, waste incineration was intended only as a waste disposal alternative to landfill, yet today it is funded and planned for as a combined solution for waste disposal and energy generation. As noted in point II, above, more than half of the 'residual' waste that is currently being sent to incineration in the UK could be recycled—if recycling programmes were to be upgraded. Therefore, a circular economy-based counterfactual for EfW incineration is recycling combined with renewable energy generation. In this comparison, the quality, uniformity, and degree of contamination of materials collected for recycling, also referred to as *recyclate*, need to be taken into account, as these factors can significantly alter the monetary value of recycling.[80] Accordingly, the following assessment presents comparative cost estimates based on the recycling of low- and high-quality recyclate:

- **The combined cost of high-value recycling and renewable energy is 20%–25% lower than EfW incineration**, if the costs of EfW carbon emissions are excluded. New EfW facilities commissioned by 2025 will provide electricity and heat at an estimated cost of £248 per MWh to cover capital and operational costs, and at £152 per MWh for facilities generating electricity only, based on 2020 BEIS calculations.[81] These costs are displayed in Figure H, which compares the combined costs of high-value recycling and renewable energy relative to EfW incineration, using a baseline EfW incineration value of 1.63 tonnes of waste for every MWh of energy generated.[82] The comparison reveals that the cost of recycling combined with solar photovoltaic (PV) or wind energy is 20% to 25% lower than the cost of EfW incineration, based on a like-for-like comparison of combined waste disposal with energy generation vs. recycling and energy generation, given the following rates:
  - high-value recycling plus solar PV electricity: £136/MWh (of which £44/MWh is for solar PV electricity);
  - high-value recycling plus offshore wind electricity: £149/MWh (of which £46/MWh is for offshore wind electricity);
  - EfW incineration electricity, excluding gate fee compensation: £152/MWh;
  - high-value recycling and geothermal combined heat and power (CHP): £225/MWh (of which £133/MWh is for geothermal CHP electricity and heat); and
  - EfW CHP incineration electricity and heat, excluding gate fee compensation: £248/MWh (see Figure H).[83]
- **The combined cost of low-value recycling and renewable energy is 20%–50% higher than EfW incineration**, if the costs of EfW carbon emissions are excluded. The savings demonstrate the importance of single-stream source separation, standardisation of packaging materials, and other recyclate collection quality improvements. The comparison is based on the following rates:
  - recycling of low-value recyclates plus solar PV electricity: £221/MWh (of which £44/MWh is for solar PV electricity);
  - recycling of low-value recyclates plus offshore wind electricity: £234/MWh (of which £46/MWh is for offshore wind electricity);
  - EfW incineration electricity, excluding gate fee compensation: £152/MWh;
  - recycling of low-value recyclates and geothermal electricity and heat: £310/MWh (of which £133/MWh is for geothermal electricity and heat); and
  - electricity and heat from EfW incineration, excluding gate fee compensation: £248/MWh (see Figure H).[84]

- **Artificially high gate fees under long-term contracts spur investment in EfW incinerators.**[85] The main reason why investments in new EfW incineration facilities are highly competitive—in contrast to recycling investments—is that plant operators can continue to charge local authorities artificially high gate fees that do not reflect the actual cost of producing energy while incinerating waste. At an average cost of £89 per tonne of waste, gate fees for EfW incineration in the UK are currently more than three times higher than the average gate fee paid for material recovery facilities (£25), which provide recovery operations before sales of materials to recycling plants or exporters.[86] These gate fees, which are paid by local authorities, account for a staggering 70% of the revenues of EfW incinerator operators.[87] A few factors have led to inflated gate fees: the high cost of landfilling (including the landfill tax),[88] limited competition,[89] and the tender-based waste contract market structure, which allows waste operators to lock excessive EfW incinerator gate fees into contracts for ten or more years, at levels just below the cost of landfilling. As a consequence, local authorities effectively subsidise EfW facilities or, to be more precise, they subsidise the price of electricity from EfW facilities. By paying gate fees, local authorities—in other words, the taxpayers—effectively pay about 60% of the actual cost of energy provided by EfW CHP incinerators, meaning that electricity consumers pay £103 per MWh generated instead of the £248 it actually costs to provide that MWh. For EfW incinerators that provide only electricity, the subsidy effect is even greater: local councils effectively pay 75% of the true cost of the electricity, allowing plant operators to charge consumers £39 per MWh generated rather than the £152 it actually costs to provide that MWh (see Figures H and I).[90] The fact that the subsidy effect is greater for electricity-only plants helps to explain why few EfW incinerators are built with heat energy delivery in the UK.[91] As long as waste operators can charge local authorities artificially high gate fees, electricity-only EfW incineration will remain financially far more attractive than recycling source-separated waste and using renewable energy.

- **Skewed market conditions limit investments in recycling facilities.** Gate fees for EfW incineration are currently 3.5 times higher than gate fees for recycling.[92] From a financial perspective, this gate fee discrepancy indicates that EfW incineration is a highly inefficient way to manage waste and produce electricity and heat. If the waste sector and its markets were regulated by a market regulator based on competitive dynamic pricing without artificial price setting due to the landfill tax, a shift from EfW technology to recycling would already be under way, given the relative costs of alternative technologies. As noted in Annex 2, regulation of the waste sector could usefully:

  - include an auction system—similar to those employed in the electricity sector—based on processing lots of residual waste and source-separated recycling in the wholesale market (between local authorities on the one hand and waste collectors and processors on the other) such that gate fees may be set on an annual basis in a transparent competitive manner; and

  - incorporate waste disposal fees in direct costs to households, such as via pay-as-you-throw systems and deposit return schemes, which add the fees to product prices in the business-to-consumer retail market. The evidence for pay-as-you-throw schemes demonstrates that cities and local authorities with such schemes achieve significant reductions in waste arisings, higher recycling rates, and lower overall waste management costs.[93]

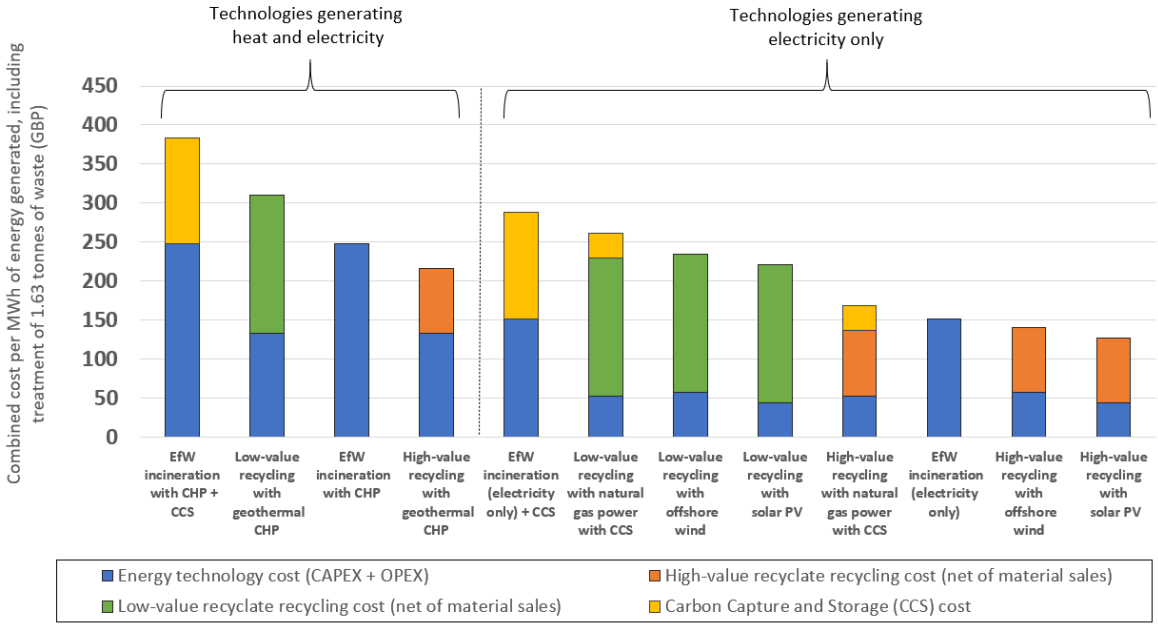
- **Commingled and low-value materials reduce the profitability of recycling.** In addition to the skewed market conditions mentioned above, suboptimal material design and collection systems tip the scales in favour of investments in EfW incineration over recycling. As a consequence, significant amounts of low-quality materials with limited uniformity and elevated contamination levels make their way into the waste system, at a high cost to local authorities. As noted in point III of Section 2, below, these deficiencies could be addressed through efforts such as:

  - **single-stream collections or multi-stream collections with kerbside sorting**, instead of commingled streams. In addition to reducing the need for material recovery facilities and thus minimising capital costs, this approach would ensure more uniform recyclate streams and reduce contamination levels.

- **standardisation of high-quality recyclable materials,** especially for packaging. This approach would improve the value of end-of-life materials by design and would introduce a level playing field for companies, in part by removing disincentives that keep businesses from investing in or purchasing packaging made of high-value recyclable materials. Such standardisation would encourage companies to replace multi-layer, multi-material packaging with readily recyclable alternatives that are already available.[94]

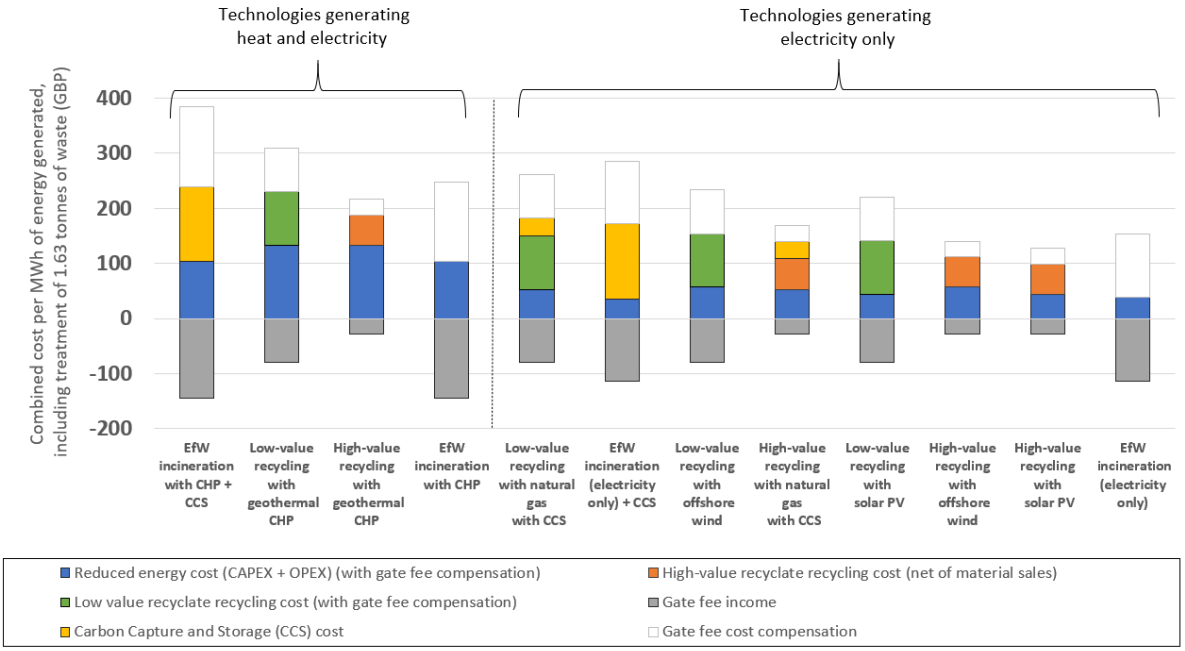
- **EfW incinerators that go clean by installing CCS will no longer be financially viable**, even with artificially high gate fees. Installing CCS technology will add an estimated £136 per MWh of generated energy, as noted above.[95] This added expense will push up the cost of EfW incineration with electricity and heat recovery to £384 per MWh, rendering the technology more costly than any other alternative, unless the costs of CCS can be reduced drastically in the medium term. By 2025, EfW incineration will be more than twice as expensive as natural gas-based electricity with CCS, which will cost an estimated £177 per MWh when combined with recycling (see Figure H).[96]

Figure H Technology cost comparison: EfW incineration vs. recycling and renewable energy, excluding gate fees[97]



Note: The energy technology costs are based on combined capital expenditure (CAPEX) and operational expenditure (OPEX) data from BEIS cost models. Costs of material recovery and recycling are net of recovered and recycled material sales, estimated based on local-authority recycling costs from MHCLG.

Figure I Company cost comparison: EfW incineration vs. recycling and renewable energy, including gate fee compensation[98]



Note: Gate fees, which are paid by local authorities, are income for waste operators (grey bar: negative cost) and effectively reduce technology costs (white bar: cost reduction impact). The energy technology costs are based on combined capital expenditure (CAPEX) and operational expenditure (OPEX) data from BEIS cost models. The costs of material recovery and recycling are net of recovered and recycled material sales, estimated based on local-authority recycling costs from the Ministry of Housing, Communities and Local Government (MHCLG).

VI. EfW incineration presents a serious financial risk as EfW facilities become stranded assets in the medium term. This risk applies particularly to EfW projects in the pipeline, due to the high likelihood that residual waste arisings will decline substantially by 2030, in response to increasing waste prevention, reuse, and recycling.

- **Business as usual means that EfW incineration capacity will expand significantly**, given the 20 million tonnes of additional capacity in the current planning pipeline. Unless the UK introduces measures to halt this expansion, the problem of overcapacity is unavoidable:
  - Current capacity: A total of 54 EfW incinerators treated 12.6 million tonnes of residual waste in 2019, or 45.5% of all residual waste generated, with a combined EfW plant operational capacity of 14.6 million tonnes.[99]
  - Capacity in 2024 and 2030: According to Tolvik's figures, the UK's EfW capacity will grow to at least 18.5 million tonnes per year by 2024, as five plants are in the late commissioning stages and another 11 plants are already under construction. This projection is likely to be an underestimate, however, as it anticipates a slowdown in the number of plants being realised—an improbable scenario given that, as noted above, a further 20 million tonnes of EfW incineration capacity are in the pipeline and half of these projects have already been granted planning consent.[100] If capacity expansion continues at pace, and just 50% of the projects that are planned, approved, or under construction are realised, total EfW operational capacity will rise to 21.8 million tonnes by 2024, and to 25 million tonnes by 2030.[101]

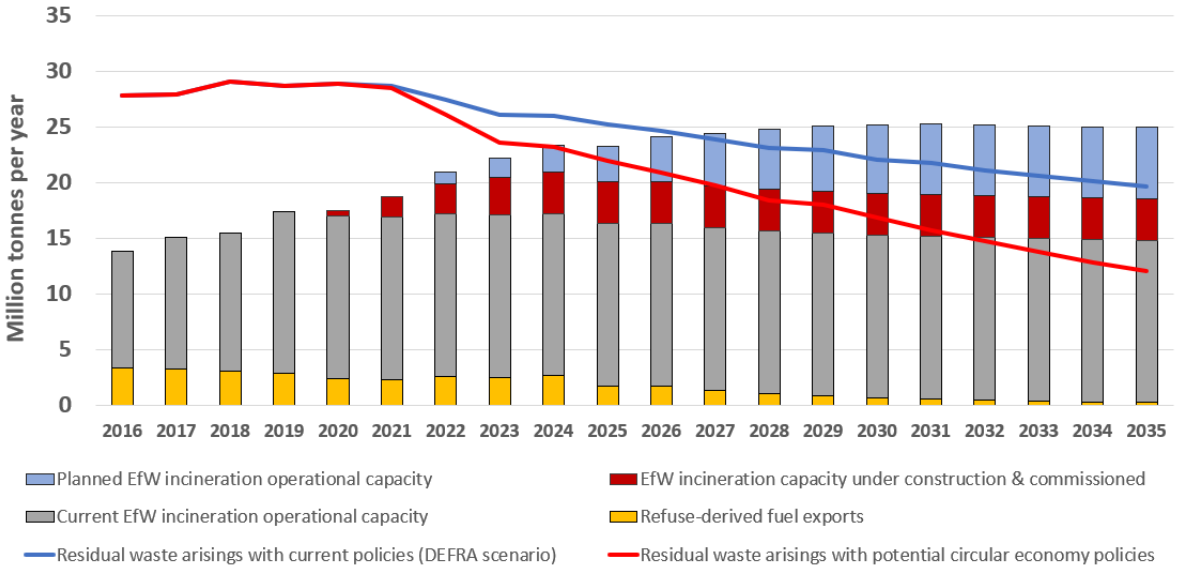
- **Meeting UK recycling targets will lead to substantial EfW incineration overcapacity**, in line with decreases in residual waste arisings.
    - If the UK reaches a 60% recycling rate by 2030, total residual waste arisings will drop down to between 17 and 23 million tonnes, according to simulations by leading waste and resource sector companies, including Biffa, Eunomia, FCC Environment, and SLR.[102]
    - DEFRA expects waste prevention, reuse, and recycling based on current policies to cut residual waste down to 22 million tonnes by 2030 and to 20 million tonnes by 2035.[103]
    - A comparison of DEFRA's residual waste forecasts and EfW incineration expansion projections cited above points to a **high risk that EfW incineration overcapacity will reach at least 5 million tonnes by 2035**.[104] This assessment assumes that the UK Government is serious about achieving its 65% recycling target by 2035 and that it will succeed in nearly eliminating exports of refuse-derived fuel (RDF) by the same date (see the blue line in Figure J).[105]
- **EfW incineration capacity already exceeds the supply of truly residual waste arisings.** None of the waste and resource sector evaluations referenced in the previous bullet point consider the impacts of a rapid, comprehensive shift towards a zero-residual-waste economy, which would be particularly disruptive for EfW incineration.[106] As noted above, 53% of the 'residual' waste that is being incinerated is in fact readily recyclable or digestible, according to studies by WRAP and DEFRA.[107] If that portion were to be recycled or digested instead of incinerated, and if overall waste arisings were to drop by just 10% through waste prevention programmes, residual waste arisings would decrease from 28.7 million tonnes in 2016 to 12 million tonnes by 2035.[108] As a result, the UK would potentially face 14 million tonnes of EfW incineration overcapacity by 2035, assuming RDF exports are nearly eliminated by then (see the red line in Figure J).[109]
- **Overcapacity heightens the risk that incinerators will become stranded assets.** Investors and public bodies face sunk costs as the UK moves up the waste hierarchy and residual waste streams dwindle, incineration needs plummet, and recycling rates increase. Local authorities that have taken on financial investment risks may be left to pay off debts for stranded plants.
- **An overcapacity of 5 million tonnes in 2035 means £4.2 billion in stranded EfW assets.** An EfW incinerator costs about £9 million per MW of energy-generation capacity,[110] which is equivalent to an investment of £165 million for a facility that can process 200,000 tonnes per year. As mentioned above, DEFRA's waste arisings calculations indicate that the UK faces a high risk of 5 million tonnes of overcapacity by 2035, which would correspond to £4.2 billion in stranded EfW incineration assets.
- **Overcapacity has already become a reality in other countries.** Denmark, the Netherlands, and Sweden already have significant EfW incineration overcapacity. The UK can learn from these examples and reduce the risk of stranded EfW assets.
    - In Denmark, which currently registers a waste incineration overcapacity of 0.5 million tonnes,[111] the government is decommissioning EfW facilities with an eye to reducing capacity by 35% by 2030, in line with residual waste reduction targets and in order to meet its new goal for a climate-neutral waste sector by 2030 (see Table A in Section 2). The Danish climate plan for a green waste sector and circular economy states: 'Overcapacity in Danish incineration plants means that the plants—in order to fill up the furnaces—import large amounts of waste for incineration in Denmark. This waste contains significantly more plastic than Danish waste, and it therefore increases the Danish CO_2 emissions.'[112] To facilitate this transition, the Danish government has instituted a stranded asset pool of DKK 200 million (£25 million) to compensate local authorities for stranded EfW decommissioning costs.[113]

- The Netherlands has an overcapacity of 2 million tonnes, which is expected to grow to 5.4 million tonnes by 2022, relative to its domestic residual waste arisings. Dutch EfW incineration facilities remain in operation by importing residual waste from the UK.[114]

- Sweden has an overcapacity of 2.3 million tonnes, which is fed through imports from Norway and the UK.[115]

- In the medium term, as residual waste arisings dwindle and less feedstock is available for incineration, the Netherlands and Sweden will inevitably have to manage sunk costs to reach zero carbon targets.

Figure J DEFRA and potential circular economy policy scenarios for residual waste arisings by 2035 vs. current and planned EfW incineration capacity[116]



2 Transforming the UK's waste and resource sector: a blueprint for regulatory reform and structural investment

The circular economy aims to maintain the value of materials and products as long as possible by returning them into the resource cycle at the end of their service life, while minimising the generation of waste. In contrast, the UK's waste and resource sector largely continues to follow the linear take–make–dispose model. Indeed, the UK economy forgoes more than 120 million tonnes of waste, more aptly called *end-of-use resources*, by landfilling, incinerating, and exporting recyclate and refuse-derived fuel (RDF), as well as by backfilling (replacing excavated soil with construction and demolition waste).[117] These materials are lost in the sense that they cannot be reutilised within the UK economy. To replace them, new materials need to be imported, processed, and manufactured into products.

The UK's recycling performance also indicates that the economy remains excessively linear. At present, the country recycles only 45%[118] of materials—well short of the 50% target for 2020 and endangering the ability to meet DEFRA's goal of 65% recycling by 2035, let alone 70% recycling by 2030, as recommended by the UK's Committee on Climate Change (CCC).[119] In addition, only 2% of products are close to fulfilling their service life potential through repair, reuse, and remanufacturing; the remainder—98%—is disposed of prematurely.[120] In the words of the CCC:

> 'Achieving significant emission reductions in the waste sector **requires a step-change towards a circular economy**, **moving away from landfill and incineration** (and the associated methane and fossil CO_2 emissions), and towards a reduction in waste arisings and collection of separated valuable resources for re-use and recycling' (emphasis added).[121]

The CCC vision echoes the policy direction taken up by Scandinavian countries, Finland, and the Netherlands, which are in the process of shifting towards a full circular economy by moving away from both landfill and incineration. Their approach differs markedly from the one put forward by Policy Connect in its *No Time to Waste* report, which misleadingly suggests that a 'more "Scandinavian" policy approach entails […] circular new policy that drives investment into EfW infrastructure to meet increased UK demand'.[122] If the UK were to follow a truly 'Scandinavian' approach, the Government would institute an incineration tax, set targets to reduce residual waste arisings, institute a landfill ban on all recyclable waste, implement a CO_2 tax on waste incineration, and declare its intention to halt the expansion of and subsequently reduce EfW incineration capacity (see Table A).

In the context of transforming the waste and resource sector, two mutually reinforcing elements are critical to a successful shift away from landfill and incineration: regulatory reform and structural investment.

Aligning waste sector policies with the Paris Agreement is an imperative, particularly in view of: 1) the exclusion of EfW infrastructure emissions from waste sector reporting;[123] 2) the lack of emission limits for EfW infrastructure in the UK National Planning Policy Framework; and 3) the exclusion of EfW plant emissions from the UK Emissions Trading Scheme and other carbon taxation instruments under consideration.[124] The UK Government can close this policy gap by enacting legislation that requires the **waste and resource sector to decarbonise by 2035**, a target that would be in line with those already introduced in all the Scandinavian countries and Finland (see Table A).[125]

The Government will also need to promote policies to achieve targets of **50% residual waste reduction by 2030** and **zero residual waste by 2050**, while implementing regulatory changes to mobilise the infrastructure investment required for a net-zero-carbon, zero-waste future. Setting targets for a 50% reduction in residual waste by 2030 and zero residual waste by 2050 across the UK would create a surge in recovery and recycling rates, which would free up more product components and material feedstock. In turn, these would promote domestic manufacturing of valuable raw materials such as paper, board, compost, and yarn. Domestic remanufacturing of batteries, appliances, machines, and equipment would undergo a similar expansion, while leading to a reduction in imports and corresponding savings.

As WRAP has shown, the benefits of fostering a circular economy—and keeping materials in circulation for as long as possible—include saving 21 million tonnes of material and, by 2030, preventing more than 38 million tonnes of waste from being sent to landfill and incineration.[126] The transition also promises to help tackle structural employment, notably by **creating more than 200,000 jobs and injecting £35 billion into the UK economy**. What is more, the transition will help the UK **avoid 68 million tonnes of CO_2 emissions per year by 2030—**or **15% of total emissions**.[127]

Table A Key policies and regulatory instruments to reduce landfilling and incineration in Denmark, Finland, the Netherlands, Norway, and Sweden

Policy/instrument	Denmark[128]	Finland[129]	Netherlands[130]	Norway[131]	Sweden[132]
National circular economy strategy	Yes: 2018	Yes: 2016	Yes: 2016	Yes: December 2020	Yes: 2020
Target for a climate-neutral waste sector	Yes: 2030	Yes: 2035	No	Yes: 50% reduction by 2030 via CCS and 100% by 2050	Yes: 2045
Specific residual waste reduction targets	Yes: 30% reduction target (2020–30)	No	Yes: 50% reduction for C&I waste (2012–22), 58% for household waste (2014–20), and 70% for household waste (2020–25)	No	No
Landfill ban on recyclable waste	Yes: ban on all waste suitable for recycling or incineration, including biodegradable waste (as of 1997)	Yes: ban on organic waste (as of 2016) and total ban on recyclable waste (as of 2025)	Yes: ban on recyclable waste for landfilling (as of 1995), since extended to 64 waste categories	Yes: ban on organic waste (as of 2009)	Yes: ban on organic waste (as of 2005)
Policy to maintain or reduce waste incineration capacity	Yes: reduction of EfW capacity from 3.95 to 2.6 million tonnes (2020–30), supported by a local authority stranded asset compensation fund of DKK 200 million	Yes: maintain current capacity (1.6 million tonnes)	Yes: reduction of landfill and incineration of Dutch waste from 10 to 5 million tonnes combined (2012–22); current capacity to be maintained, with operations using imported RDF	Yes: maintain current capacity (1.8 million tonnes)	Yes: incineration of fossil-origin waste to cease so as to reach 2045 net-zero emissions goal
Consideration or application of a waste incineration tax	Yes: if reduction of EfW incineration capacity is insufficient	Yes: evaluation of impacts to be completed by end 2020	Yes: implemented in 2015 at £12/tonne, raised to £30/tonne in 2020 (equivalent to landfill tax)	No	Yes: instituted in 2006, abolished in 2009, reinstated in 2020 at £7/tonne; to be raised to £9/tonne in 2021 and £11/tonne in 2022
CO_2 tax on waste incineration	Yes: instituted in 2013 for non-biodegradable waste for EfW plants with a capacity of 20 MW or more	Expected: evaluation of impacts to be completed by end 2020	Yes: to be implemented as of 1 January 2021	Yes: for plants with a capacity of 20 MW or more, mainly for energy generation, soon to cover all waste incinerators	Yes: instituted for plants with a capacity of 20 MW or more under the EU Emissions Trading Scheme

This section presents measures the Government can implement in six key areas to bring about what the CCC calls a 'step-change towards a circular economy'—and to align actions with stated ambitions. In particular, the Government can take steps to:

I. implement enhanced programmes to prevent waste arisings
II. introduce regulations to improve product lifespan, reuse, repair, and remanufacturing
III. increase the rate and quality of recycling
IV. require more detailed reporting on product and waste flows
V. make recycling more attractive than EfW incineration
VI. deliver a circular economy infrastructure investment strategy.

By taking decisive action in each of these areas, the Government will future-proof the waste and resource sector, promote practices that maximise the value of resources and, in so doing, buttress a cutting-edge national waste and resource treatment system that provides hundreds of thousands of jobs as well as widespread beneficial outcomes. Specifically, the Government should:

I. Implement enhanced programmes to prevent waste arisings. The UK's waste prevention programmes date back to 2013 and are currently under revision. In 2019, Northern Ireland published its updated waste prevention programme, which does not include quantitative targets except for reducing food and drink waste arisings by 20% by 2025 compared to 2015. In updating the waste prevention policy, the UK should:

- **Set ambitious targets with explicit actions for reducing all waste arisings** and require that progress against these new goals be consistently monitored and reported.[133]

- **Require local authorities to implement a zero-residual-waste strategy for households** using ambitious five-year targets. DEFRA could integrate such a requirement in the Environment Bill and its statutory instruments, based on its proposed exploration of reductions in the per capita tonnage of residual waste.[134] An instructive case study is the Dutch VANG programme, which underpins efforts to cut residual waste from 240 kg per household in 2014 to 100 kg in 2020 and 30 kg in 2025.[135] As of 2018, the average weight of residual waste had dropped to 170 kg per household.[136]

- **Expand efforts to reduce single-use plastics and packaging waste,** which together account for the majority of plastic waste. The Government could consider introducing instruments such as:

  - **a ban on expanded polystyrene food and beverage containers, as well as on products made of oxo-degradable plastic**, so as to deliver outcomes that are in line with or better than those promoted in EU Directive 2019/904;[137]

  - **a target to reduce product packaging density** (the weight of packaging per volume of product) for non-food products to incentivise light-weight and new packaging options, as already introduced by industry leaders;[138] and

  - **a target for packaging reuse to incentivise industrial take-back and reuse schemes** as part of extended producer responsibility initiatives.

- **Promote the Food Waste Reduction Roadmap among industry partners[139]** to help eliminate the preventable edible portion of food waste—which currently accounts for 60% of commercial and industrial (C&I) arisings and 67% of residual waste in England.[140] Doing so would assist the UK in meeting the requirement for separate food waste collection by 2023,[141] while helping Scotland prepare for its ban on landfilling biodegradable waste by 2025.[142] Progress in this area could be supplemented through measures that prevent supermarkets from throwing away or destroying unsold food (as is already the case in France)[143] and that require companies that process and sell large amounts of food to establish a food waste tracing and prevention programme.

II. Introduce regulations to enhance product lifespan, reuse, repair, and remanufacturing, with a focus on durable goods such as electronic equipment, home appliances, textiles, and furniture:

- **Instate national targets for reuse**. Lessons could be learnt from Spain, which in 2018 introduced a 3% reuse target for household appliances and a 4% target for IT equipment, and from the Flemish region of Belgium, which has a reuse target of 7 kg of material per person by 2022.[144]

- **Adopt legislation to increase the longevity of products and enhance their reparability**, including by ensuring that spare parts for equipment and appliances are available for at least ten years after the time of purchase. In this context, the UK could introduce 'right to repair' rules that match or surpass the updated EU Ecodesign Directive (2009/125/EC).[145]

- **Require a minimum guaranteed lifespan of equipment and appliances** sold on the UK market to tackle premature and planned obsolescence.

- **Introduce ease-of-repair criteria through a dedicated programme with industry**. The aims should include enhanced ease of disassembly, access to parts, and provision of repair information[146] to support the UK's product repair sector and social repair initiatives, such as Restart.[147]

- **Require manufacturers to include lifespan and repairability information on their labels**, as such details have been shown to influence purchasing decisions.[148]

III. Increase the rate and the quality of recycling. The CCC's 2020 Progress Report emphasises the need to roll out universal collection of separated food waste, garden waste, and other recycling across England in 2022–24.[149]

- **Increase the rate of recycling** by taking steps to:

  - **Introduce a legally binding recycling target of 70% by 2030 for England** in the Environment Bill, in accordance with the CCC's 2020 Progress Report, which stresses that achieving this goal 'will be key to phasing out waste exports and limiting fossil emissions from energy-from-waste plants'.[150]

  - **Allow local authorities to institute pay-as-you-throw or save-as-you-sort schemes** for residents,[151] while guarding against illegal dumping, fly-tipping, and contamination of recycling streams. The evidence for such schemes demonstrates that cities and local authorities with pay-as-you-throw schemes achieve significant reductions in waste arisings, higher recycling rates, and lower overall waste management costs.[152]

- **Enhance the collection, segregation, and treatment of recyclables** by electing to:

  - **Standardise the collection of recyclables by 2023**,[153] including by mandating the use of standardised bag colours and sizes across the UK, as a way to help industry provide a uniform waste-to-resource market.

  - **Standardise materials used for all packaging by 2023**, in collaboration with industry. Include composition standardisation of packaging for recyclability across food- and non-food-grade packaging (for example, uniform requirements of polymers for plastics packaging) by updating the 2007 regulations on producer responsibility obligations for packaging waste.[154]

- **Ensure biowaste is collected separately by 2023**, as envisioned in the Waste Management Plan for England,[155] with the goal of diverting it from landfill and incineration and redirecting it towards anaerobic digestion (AD), composting, or other organic waste recycling practices. Treated biowaste can be used to replenish English farming soils, which urgently need organic carbon, with the dual aim of future-proofing English agriculture[156] and increasing soil carbon sequestration as a means of reducing atmospheric CO_2 levels.[157]

- **Impose a ban on the EfW incineration of separately collected biowaste**, along with penalties for non-compliance, to ensure that the 2030 'zero food waste to landfill' target does not lead to dramatic increases in food waste to incineration.

- **Impose mandatory biowaste sorting and recycling for businesses** that handle large amounts of food waste. A useful reference is the French Grenelle II law, which requires businesses that produce more than a threshold tonnage of biowaste per year to sort and recycle their own food waste; the threshold dropped from 120 tonnes in 2012 to 10 tonnes in 2016.[158]

- **Mandate single-stream collection, including for glass and for paper and board waste.** While this practice is not currently required in England, it is recommended by the British paper and glass industries based on the success of this approach in Wales.[159] Separate glass and separate paper and board collection improves both the quantity and the value of these waste resource streams. In Wales glass recycling is nearing 90% (vs. 68% in England),[160] and 65% of paper and board collected in Wales is processed in the UK (vs. 40% in England),[161] thanks to high collection quality (see point VI, below). Separate glass collection also prevents commingled waste streams from causing damage to processing equipment in material recovery facilities.[162]

- **Establish an initiative to reduce contamination**[163] in source-separated waste streams under existing industry programmes (such as the UK Plastics Pact or the Business Food Waste Prevention programme).[164] Immediate goals can include replacing sticky labels on fruit and vegetables with laser-coding; further improving glues and residues for use in pre-processing; and substituting recyclable packaging for multi-material packaging that cannot be source-separated.[165]

- **Improve labelling to encourage proper recycling**, such as by deciding to:

  - **Mandate the use of standardised recycling labels on all packaging** to reduce consumer confusion. To ensure full participation, the Government could establish its own label scheme. Alternatively, it could fund the On-Pack Recycling Label (OPRL) initiative to make the label widely available and to align it with ongoing improvements in source-separated recycling systems.[166] The OPRL scheme is currently voluntary and comes at a charge for retailers and brand owners, reducing the incentive for industry to adopt the label.

  - **Require producers to display the percentage of recycled content on product labels** to incentivise the use of recycled content from a marketing perspective.

IV. Require more detailed reporting on product and waste flows based on an assessment of the current collection and reporting of statistics on product reuse, product lifespan, and remanufacturing, so as to enable the evidence-based setting and evaluation of policy targets and standards.

- **Require reporting of durable product stocks and flows in the economy**, including lifespan, reuse, repair, and remanufacturing information. Without such data, it will not be possible to measure the circular economy for products. DEFRA and the ONS could jointly institute requirements as part of extended producer responsibility programmes, and by setting up a reporting standard in collaboration with retailers, reuse centres, and repair companies.

- **Require waste collection operators and processors to submit quarterly reports** on the capacity of EfW incineration, mechanical biological treatment, landfill, RDF processing, material recovery facilities (MRFs), and recycling facilities in relation to both local authority-collected waste and C&I arisings,[167] and make standardised local, regional, and national data readily available online. Transparency and access to reliable data is critical to an accurate understanding of the changing relationship between arisings and treatment capacity, as well as of the risk of overcapacity;[168] transparency will also facilitate sector transformation planning.

- **Require businesses that process and sell a large quantity of food to report on food waste** to support the (voluntary) Courtauld 2025 food reduction targets and UN Sustainable Development Goal 12.3 (halving per capita food waste by 2030).

- **Require EfW incinerator operators to report on the waste flows and CO2e emissions** of individual facilities on a monthly basis, including on the material composition of the waste inputs and its fossil or biogenic origin, and make the corresponding, standardised local, regional, and national data available online. At present, this data is accessible only in an aggregate format in the National Atmospheric Emissions Inventory, as the majority of incinerator operators do not publish their CO_2e emissions data.[169] The reporting should include fossil-derived and biogenic emissions, as specified under the reporting requirements of the Intergovernmental Panel on Climate Change (IPCC): 'if incineration of waste is used for energy purposes, both fossil and biogenic CO2 emissions should be estimated. Only fossil CO2 should be included in national emissions under Energy Sector while biogenic CO2 should be reported as an information item also in the Energy Sector.'[170]

V. Make recycling more attractive than EfW incineration by reforming financial incentives to level the playing field for investors. The current market system of gate fees, subsidies, and financial support schemes has led to significant market distortions that artificially lower the risk and increase the profitability of investments in EfW incineration and RDF treatment plants, while increasing the risk and limiting the profitability of recycling investments.[171] Operators are keeping EfW incinerator and RDF gate fees slightly below the total landfill gate fee (including the landfill tax of £94.15 per tonne as of April 2020), instead of charging market prices based on infrastructure cost, supply, and demand.[172] In the absence of a well-functioning, dynamic residual waste and recycling market, there is limited incentive to invest in recycling infrastructure and providing for high-quality material streams for recycling. Indeed, in the absence of a competitive market structure and viable alternatives, local authorities are incentivised to sign long-term contracts with operators of EfW incinerators. As highlighted by the UK Competition & Markets Authority: 'The data analysed showed that longer and broader domestic waste collection contracts which can limit competition remain in use by some local authorities and are associated with statistically significantly higher local authority spending.'[173] To address these challenges, the UK Government should:

- **Modernise and revitalise the market by taking steps to:**

  - **Establish a waste and resource market regulator** whose principal duty is to protect the interests of consumers, while also supporting decarbonisation and other government policies, in line with the statutory framework set by Parliament (not unlike Ofwat for water and Ofgem for gas and electricity).

  - **Place the costs of waste generation and and rewards of source separation on residents** by developing the business-to-consumer (retail) market, such as through pay-as-you-throw schemes and deposit return schemes.

- **Replace long-term waste management contracts with an annual auction system.** This shift will involve moving the wholesale market away from static gate fees per tonne with a lock-in of chosen processing routes (currently EfW, landfill, MRFs, or RDF) and instead to bidding for processing lots based on expected residual waste arisings and source-separated recycling streams. This approach introduces responsiveness into the market and flexibility in processing routes, allowing for adjustments to changes in the amount and composition of residual waste. It is similar to the successful electricity market auction system regulated by Ofgem, which has aided greatly in driving down power-sector carbon emissions.[174] As the first country in the world to institute such an auction system in its electricity market, the UK is uniquely positioned to demonstrate that the same approach can be applied to residual waste and recyclate.

- **Apply minimum and maximum gate fees per tonne** within the new auction market system—such as a £60/tonne minimum for food waste, in line with Western European rates—to equalise risks and stabilise the market.[175]

- **Level the playing field by holding EfW incineration to the same standards** as all other energy sources:

  - **Amend the National Policy Statements for energy infrastructure** so that renewable energy and low-carbon options include only EfW incinerators that operate as combined heat and power (CHP) plants *and* that are equipped with either carbon capture and storage (CCS) or carbon capture and utilisation (CCU) technology. From an energy perspective, the main advantage of EfW incineration is that it can deliver a large supply of heat; with CCS or CCU, that supply can be carbon-neutral.[176] The planning framework should be amended to ensure that new incinerators make full use of their waste heat, and that they are equipped with CCS or CCU.[177] Without such requirements, EfW incineration plants cannot achieve carbon neutrality. Even with CHP, EfW incineration emits more CO_2 per kWh produced than the current UK grid mix, which means it cannot be treated as a low-carbon source (see point IV in Section 1 of this annex).[178]

  - **Include EfW incineration in the UK Emissions Trading Scheme and the carbon emissions tax,** as a way of introducing competitive abatement costs for CO_2 emitted by EfW facilities and ensuring a level playing field for all energy-generating assets.[179]

  - **Amend the Contract for Difference (CfD) scheme** to allow EfW incinerators only if they are equipped with CCS or CCU, as only low-carbon sources should be considered in the government CfD bidding rounds that support technologies in providing a stable, long-term electricity price. At present EfW, CHP incinerators can bid in Pot 1—'established' technologies—including in the upcoming fourth allocation round, which begins in 2021.[180]

VI. Deliver a circular economy infrastructure investment strategy. What is needed is a public–private investment and transformation programme akin to Defra's Waste Infrastructure Delivery Programme (WIDP). As part of the Treasury's National Infrastructure Strategy, such a programme can be supported by post-Brexit import–export trade instruments. It can be designed to provide a significant boost to the UK's post-Covid economic recovery, attracting investment from the private sector by allocating funds to circular economy infrastructure and innovation. In addition to locking circularity into the recovery, this approach is able to **create more than 200,000 additional jobs and inject more than £35 billion into the UK economy**.[181] To these ends, the Government should:

- **Integrate a circular economy pillar in the new capital investment programme** of the National Infrastructure Strategy. Doing so will help mobilise post-Brexit public–private infrastructure investment, which could be operationalised in the following areas via the proposed national infrastructure bank, whose initial asset base is expected to be £20 billion.[182]

- **Remanufacturing.** Only 1%–2% of end-of-life durable goods are used in remanufacturing, mainly in the automotive and aerospace sectors.[183] Indeed, this domain has been at a standstill despite an estimated £20.9 billion opportunity.[184] The Government can help to energise remanufacturing by mobilising investment for world-class demonstration facilities. These can draw on and showcase the UK research community's wealth of cutting-edge knowledge in various focus areas, such as robotic disassembly (University of Birmingham),[185] remanufacturing planning and logistics (University of Strathclyde),[186] and material knowledge for remanufacturing (University of Exeter).[187]

- **Reuse and repair.** A lack of structural support has limited the professionalisation of reuse and repair operations in the UK. An investment programme that brings together local authorities and non-profits could stimulate the sector's development. By opening 500 reuse and repair centres and training more than 1,000 repair technicians, for instance, such a programme would significantly prolong the average lifespan of appliances, furniture, and other durable goods, while providing a substantial number of local jobs.

- **Low-emission steel production.** An estimated 10 million tonnes of steel scrap is produced every year in the UK, but 80% of it is exported instead of being put to use in domestic steel plants. At the same time, UK industries require about 15 million tonnes of steel per year and therefore need to import large quantities.[188] The Government can safeguard the future of the steel industry and dramatically reduce its CO_2 emissions by mobilising investment in the transformation of existing blast furnace steel plants into energy-efficient electric arc furnaces,[189] which process scrap steel and release less than half of the CO_2 emissions generated by traditional plants.[190]

- **Glass.** Whereas Wales recycles nearly 90% of its glass, England only recycles 68% and sends the remainder to landfill or EfW incineration. The main difference is that Wales has a kerbside glass collection system. As a result, British Glass has called on local authorities to transition to separate collection systems. A government investment programme could facilitate that shift and ensure similarly high recycling levels in England, Scotland, and Northern Ireland, while substantially boosting the UK glass economy (see point III, above).[191]

- **Paper and board.** The UK is experiencing a significant processing gap: only 3 million of the 7.3 million tonnes (just over 40%) of source-separated paper and board are used in domestic paper mills. A main cause is the low quality of the feedstock, which is attributable to commingled collection. The most effective way to resolve this problem is a switch to source separation of paper and board, which the Government can support through a dedicated investment programme that helps local authorities make the transition.[192]

- **Plastics.** The UK suffers from a significant plastic reprocessing capacity gap: while about 1 million tonnes of plastic per year are treated in material recovery facilities, less than half (440,000 tonnes) is recycled into new packaging in reprocessing facilities. The plastics packaging tax, which will come into force in April 2022, is expected to exacerbate this challenge.[193] The Government could usefully launch an investment programme to start boosting capacity before the tax takes effect, alongside measures to strongly reduce the usage of single-use plastics.

- **Biowaste.** Substantial investment in processing capacity is required by 2023, when biowaste collections will become obligatory. An additional 5 million tonnes of biowaste—including up to 3 million tonnes of food and up to 1 million tonnes of garden waste—that are currently being disposed of in landfill will need to be processed separately.[194]

- **Align the capital investment programme with past, current, and new smaller investment programmes** that cover lessons learnt, complementarity, and continuation, including the £18 million Resource Action Fund,[195] the WRAP Cymru £6.5 million Circular Economy Fund,[196] and the £20 million 2015–20 London Waste and Recycling Board Funds.[197]

- **Carry out an infrastructure needs assessment to inform the capital investment programme.** Evaluate all material and waste streams in the context of a circular economy, including the current and planned capacity for reuse, repair, remanufacturing, and recycling.[198]

- **Promote innovation in the circular economy through a five-year catalyst programme with Innovate UK**. A budget of around £400 million distributed in about ten rounds would serve to fund a large number of small and medium-sized businesses that are developing circular economy solutions, including better design, durability, reuse, refurbishment, remanufacturing, and advanced recycling solutions that deliver material reductions, product life extensions, enhanced recycling quantities and quality, and carbon savings.[199]

- **Align waste infrastructure investments with circular economy and net-zero targets.** In its Sustainable Finance regulation, the European Union specifies that an economic activity qualifies as 'contributing substantially to the transition to a circular economy, including waste prevention, re-use and recycling' if it 'minimises the incineration of waste and avoids the disposal of waste […], in accordance with the principles of the waste hierarchy'.[200] In accordance with this principle, the UK Government should:

  - **Reduce the risk of stranded assets** by charging DEFRA with examining 'how waste reduction and higher recycling rates will impact the utilisation of (and need for further) energy from waste plants' and by tasking it with drafting guidance notes to 'help align local authority waste contracts and planning policy to these findings', in line with the CCC's 2020 recommendations.[201]

  - **Prohibit public investment in the construction of new EfW incineration capacity**. When it was state-owned, the Green Investment Bank invested most of its funds in EfW incineration projects. This trend has continued since in 2017, when the bank was privatised as the Green Investment Group: all of its investments have gone to large-scale incineration, largely in partnership with incineration giant Covanta.[202] To prevent public funds from being drawn into infrastructure with a significant carbon footprint, the Government should direct investment away from EfW incineration facilities and towards circular infrastructure activities. As the CCC underscores in its 2020 Progress Report, 'Local authorities and private waste management firms need to urgently invest in collection infrastructure and new recycling, composting and anaerobic digestion facilities. There must be sufficient treatment capacity made available before the landfill ban for biodegradable wastes comes into force [in 2025], so that increases in incineration or exports are avoided.'[203]

  - **Extend and upgrade the £320 million Heat Networks Investment Project (HNIP)**, which will come to an end in 2022. An extended HNIP can become a focal point for the delivery of long-term zero carbon heating across the UK. It would serve to ensure that a majority of the 54 operational EfW incinerators fully utilise their waste heat and switch to supplying predominantly heat instead of electricity for as long as they remain in use, since less costly renewable sources are readily available for the provision of electricity. At present, only ten EfW incinerators are operating in CHP mode in the UK.[204] An estimated £1.8–3 billion in public investment is needed to unlock £13–22 billion in private investment through the HNIP.[205] An extended HNIP should include arrangements to include a diversity of current and future heat sources alongside EfW incinerators, including industrial waste heat, heat pumps, and geothermal energy.

Notes

More sources and details are available upon request.

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[1] Current operational EfW incineration capacity stands at 14.6 million tonnes. As of December 2019, the total capacity of all active projects under development was 20 million tonnes; these projects comprise proposed plants for which planning consent is being sought, for which planning consent has been secured, and for which appeals or new

[2] Emissions from EfW incineration fall under the UK's power sector emissions.

[3] For details and sources, see Annex 1, attached.

[4] Committee in Climate Change, Reducing UK emissions: Progress Report to Parliament, June 2020, https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/.

[5] For details, see point IV of Annex 1, attached.

[6] The values are based on Figure 2 in Kate Scott and John Barrett, Resource consumption, industrial strategy and UK carbon budgets, Briefing Note 4, Centre for Industrial Energy, Materials and Products (CIE-MAP), University of Leeds, 2016, http://ciemap.leeds.ac.uk/wp-content/uploads/2018/05/Briefing-Note-4.pdf. The study and summary Figure 2 show a circular economy carbon emissions reduction potential of 361.3 to 429.2 million tonnes of CO_2e across ten different sectors of the economy. For details on the methodology, see Kate Scott, Jannik Giesekam, John Barrett, and Anne Owen, Bridging the climate mitigation gap with economy-wide material productivity, *Journal of Industrial Ecology*, 23(4), 918–31, https://onlinelibrary.wiley.com/doi/full/10.1111/jiec.12831.

[7] Patrick Mahon, Keith James, and Peter Sainsbury, How moving to a circular economy can help the UK to build back better, WRAP, 29 June 2020, https://wrap.org.uk/sites/files/wrap/How%20a%20Circular%20Economy%20can%20help%20us%20Build%20Back%20Better.pdf.

[8] Julian Morgan and Peter Mitchell, Opportunities to tackle Britain's labour market challenges through growth in the circular economy, WRAP and Green Alliance, 2015, https://www.wrap.org.uk/sites/files/wrap/Opportunities%20to%20tackle%20Britain's%20Labour%20Market%20Challenges%20full%20report.pdf.

[9] For details and sources, see Annex 2, attached.

[10] The Scandinavian countries and Finland have all set a target for a carbon-neutral waste and resource sector: Denmark's target is 2030, Finland's is 2035, Sweden's is 2045, and Norway is aiming for a 50% reduction by 2030 and 100% by 2050. See Annex 2 for more details and sources.

[11] The Committee in Climate Change specifies: 'Achieving a 70% recycling rate at the latest by 2030 in England (with this target to be included in the Environment Bill) and in Northern Ireland, and by 2025 as already proposed in Wales and Scotland, will be key to phasing out waste exports and limiting fossil emissions from energy from waste plants.' Committee in Climate Change, Reducing UK emissions: Progress Report to Parliament, June 2020, https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/.

[12] WRAP defines 'readily recyclable materials' as 'those for which recycling markets are well-established; such materials are currently widely recycled across the UK'. WRAP, Overview of Waste in the UK: Hospitality and Food Service Sector: An overview of waste in the UK hospitality and food service sector, November 2013, https://www.wrap.org.uk/sites/files/wrap/Overview of Waste in the UK Hospitality and Food Service Sector FINAL.pdf.

[13] Welsh Government, Beyond Recycling: A strategy to make the circular economy in Wales a reality, Consultation Document, 2020, https://gov.wales/sites/default/files/consultations/2019-12/consultation-circular-economy-strategy.pdf.

[14] Ellen MacArthur Foundation, The Circular Economy in Detail, n.d., https://www.ellenmacarthurfoundation.org/explore/the-circular-economy-in-detail.

[15] Committee on Climate Change, Reducing UK emissions: Progress Report to Parliament, June 2020, https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/.

[16] Libby Peake, Scandinavians call their waste incineration 'crazy', so why copy them?, Green Alliance, 20 July 2020, https://greenallianceblog.org.uk/2020/07/20/scandinavians-call-their-waste-incineration-crazy-so-why-copy-them/.

[17] Stephen Jenkinson, Reviewing biowaste treatment in the UK, Resource, 14 August 2020, https://resource.co/article/reviewing-biowaste-treatment-uk. See also EUWID, Danish ministers call for cuts to waste imports, 20 May 2020, https://www.euwid-recycling.com/news/business/single/Artikel/danish-ministers-call-for-cuts-to-waste-imports.html.

[18] Dr Alan Whitehead, speaking at a Westminster Hall debate on waste incineration facilities, 11 February 2020, https://hansard.parliament.uk/Commons/2020-02-11/debates/D1799344-3D26-4DF0-94C1-3AEB397AF375/WasteIncinerationFacilities.

[19] While it is beyond the scope of this annex to examine the health impacts of EfW incineration, a growing body of evidence links long-term exposure to pollution emitted by EfW facilities to various conditions and health risks,

including with reference to ultra-fine particulate matter and metals. See, for example: James Langley, EfW plants 'cause deaths' of 15 Londoners per year, Letsrecycle.com, 21 October 2020, https://www.letsrecycle.com/news/latest-news/efw-plants-cause-deaths-of-15-londoners-per-year/; Agostino Di Ciaula et al., Biomonitoring of Metals in Children Living in an Urban Area and Close to Waste Incinerators, *International Journal of Environmental Research and Public Health*, 17(6), https://www.mdpi.com/1660-4601/17/6/1919; Peter W. Tait et al., The health impacts of waste incineration: a systematic review, *Australian and New Zealand Journal of Public Health*, 44(1), https://onlinelibrary.wiley.com/doi/full/10.1111/1753-6405.12939; UK Without Incineration Network, Waste Incineration and Particulate Pollution: A failure of governance, 2018, https://ukwin.org.uk/btb/Particulate_Pollution_July_2018.pdf.

[20] This figure summarises findings from Annex 1; for sources, see the references cited in throughout the annex. The £1 billion estimate for expenditure on incineration is based on an estimated EfW incineration share of the expenditures for waste disposal from the Ministry of Housing, Communities & Local Government, Local authority revenue expenditure and financing England: 2018 to 2019 budget, Items 582 (waste disposal) and 584 (recycling), 2019, https://www.gov.uk/government/statistics/local-authority-revenue-expenditure-and-financing-england-2018-to-2019-budget-individual-local-authority-data.

[21] DEFRA, Resources and Waste Strategy: Monitoring Progress, 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/907029/resources-and-waste-strategy-monitoring-progress.pdf.

[22] Resource Recovery from Waste Programme, Energy from Waste and a Circular Economy: A Response from the Resource Recovery from Waste Programme to the Policy Connect Call for Evidence on Energy from Waste, July 2020, https://resourcerecoveryfromwaste.files.wordpress.com/2020/07/policy-connect-evidence-call-efw_response-rrfw_final.pdf.

[23] UK Office for National Statistics, Material footprint in the UK: 2017, 2020, https://www.ons.gov.uk/economy/environmentalaccounts/articles/materialfootprintintheuk/2017.

[24] Ministry of Housing, Communities & Local Government, Local authority revenue expenditure and financing England: 2018 to 2019 budget, Items 582 (waste disposal) and 584 (recycling), 2019, https://www.gov.uk/government/statistics/local-authority-revenue-expenditure-and-financing-england-2018-to-2019-budget-individual-local-authority-data.

[25] The ONS unhelpfully lumps together the treatment and disposal of non-hazardous waste through landfilling, EfW incineration, anaerobic digestion, and composting, arriving at a combined GVA of £1.86 billion. Waste flow quantities indicate that about 25% of this GVA is generated by anaerobic digestion and composting (£0.46 billion), while landfilling and EfW incineration account for nearly 75% (£1.40 billion). Office for National Statistics, Non-financial business economy, UK: Sections A to S, 2020, https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveysectionsas. Note that the GVA is estimated at £3.61 billion for waste collection and £0.32 billion for hazardous waste treatment and disposal, including nuclear waste treatment, disposal, and storage.

[26] Keith James, Peter Mitchell and Dorothea Mueller, Extrapolating resource efficient business models across Europe, WRAP, 2016, http://www.rebus.eu.com/wp-content/uploads/2017/07/Extrapolating-resource-efficient-business-models-across-Europe.pdf.

[27] Figure B data source: Office for National Statistics, Non-financial business economy, UK: Sections A to S, 2020, https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveysectionsas.

[28] Oliver Feaver, No Time to Waste: Resources, Recovery & the Road to Net-Zero, Policy Connect, July 2020, https://www.policyconnect.org.uk/sites/site_pc/files/report/1326/fieldreportdownload/policyconnect-notimetowaste-final.pdf.

[29] As Jeff Seadon of Auckland University of Technology points out: 'The waste materials that are easiest to source and have buyers for recycling—like paper and plastic—also produce most energy when burned.' Jeff Seadon, Climate explained: seven reasons to be wary of waste-to-energy proposals, The Conversation, 11 December 2019, https://theconversation.com/amp/climate-explained-seven-reasons-to-be-wary-of-waste-to-energy-proposals-128630.

[30] DEFRA, Resources and Waste Strategy: Monitoring Progress, 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/907029/resources-and-waste-strategy-monitoring-progress.pdf; WRAP, Commercial and Industrial Waste in Wales, 2020, http://www.wrapcymru.org.uk/sites/files/wrap/Composition%20analysis%20of%20Commercial%20and%20Industrial%20waste%20in%20Wales_0.pdf.

[31] The duration of contracts between local authorities and waste operators varies substantially, covering anywhere from a minimum of 5 years to about 30 years. The typical length is more than 10 years, as noted by industry consultants Tolvik: 'The "term" gate fee data is based on contracts of minimum 5 years (more typically 10 years+), with a credit worthy waste supplier and often has a deferred commencement date (i.e. the contract term only starts once a new EfW is operational).' See Tolvik, UK Energy from Waste Statistics: 2017, June 2018, https://www.tolvik.com/wp-content/uploads/2018/06/Tolvik-UK-EfW-Statistics-2017.pdf. The London Assembly Environment Committee made a similar point in 2018: 'Investing in more EfW can negatively affect long term

recycling rates. This investment needs to be paid for by an assured income stream, usually through contracts with local authorities to pay the EfW operator to take waste. Contracts are often lengthy—the majority are over 20 years. The terms of contracts, such as minimum annual payments, or a low fee per tonne of waste, can undermine the financial viability for the local authority of reducing waste, or sending it to other destinations such as recycling.' See London Assembly Environment Committee, Waste: Energy from Waste, 2018, https://www.london.gov.uk/sites/default/files/waste-energy_from_waste_feb15.pdf.

[32] Resource Recovery from Waste Programme, Energy from Waste and a Circular Economy: A Response from the Resource Recovery from Waste Programme to the Policy Connect Call for Evidence on Energy from Waste, July 2020, https://resourcerecoveryfromwaste.files.wordpress.com/2020/07/policy-connect-evidence-call-efw_response-rrfw_final.pdf.

[33] DEFRA, Local Authority Collected Waste Statistics: Local Authority Data, 11 December 2018, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766014/LA_and_Regional_Spreadsheet_201718_rev2.xlsx.

[34] Significant at R^2=0.86.

[35] Significant at R^2=0.94.

[36] DEFRA, Statistics on waste managed by local authorities in England in 2018/19, 2019, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918853/201819_Stats_Notice_FINAL_accessible.pdf.

[37] The quote is drawn from email correspondence of 13 August 2020, in which the CCC comments about Policy Connect's *No Time to Waste*, stating: 'The CCC has read the Policy Connect report, but we were not asked to make a contribution or to review it. Policy Connects assumption is that England will struggle to meet Defra's 2035 municipal recycling targets (65%), and hence the amount of residual waste will be large, requiring EfW. They also position EfW as the necessary means to avoid landfill and exports. However, the CCC's scenarios for Net Zero rely on 70% recycling across the UK at the latest by 2030 (and increases beyond this to 2050), large reductions in food waste over the next 10 years, and a large near-term update in recycling, AD [anaerobic digestion] and composting to be able to ban biodegradable wastes from landfill by 2025. The CCC's scenarios as to what is required for Net Zero are therefore much more ambitious than current policy in England and NI (Scotland and Wales are closer to being on-track), and hence the assumptions underlying the Policy Connect report. The premise that EfW does not inhibit recycling rates is based on 2017 European data, showing that countries with higher recycling also have lots of EfW, in comparison to countries with low recycling rates and the rest landfilled. However, this same dataset shows that those countries with the highest recycling rates (e.g. Germany, Austria, Slovenia) also have significantly lower EfW rates than other countries with low landfill. And given this is a historical snapshot, it doesn't consider the future – continued increases in recycling will eventually have to come at the expense of EfW, if landfill has already largely disappeared.'

[38] Figure C data source: DEFRA, Local Authority Collected Waste Statistics: Local Authority Data, 2018, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766014/LA_and_Regional_Spreadsheet_201718_rev2.xlsx.

[39] DEFRA, Incineration of Municipal Solid Waste, 2013, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/221036/pb13889-incineration-municipal-waste.pdf.

[40] The estimate is based on employment figures at four UK EfW incinerators: Greatmoor (345,000 tonnes per year) 'provides around 40 permanent jobs' (Buckinghamshire Council, Energy from waste, n.d., https://www.buckscc.gov.uk/services/waste-and-recycling/energy-from-waste/); Irvine (180,000 tonnes per year) 'estimate that between 25 and 30 permanent jobs would be created at the site' (Andy Hamilton, Jobs created after Irvine waste recycling plant plans approved, *Irvine Times*, 23 January 2020, https://www.irvinetimes.com/news/18183257.jobs-created-irvine-waste-recycling-plant-plans-approved/); Drakelow (169,000 tonnes per year) 'will generate over 30 long-term permanent jobs' (Jenny Moody, Dozens of jobs coming to Burton and South Derbyshire at new power plant, DerbyshireLive, 14 May 2020, https://www.derbytelegraph.co.uk/burton/dozens-jobs-coming-burton-south-4126285); and Alton (330,000 tonnes per year), with '40 permanent jobs once operational' (NS Energy, Veolia seeks planning approval for advanced energy recovery facility in UK, 2 July 2020, https://www.nsenergybusiness.com/news/veolia-advanced-energy-recovery-uk/).

[41] RREUSE Network, Briefing on job creation potential in the re-use sector, 2015, http://www.rreuse.org/wp-content/uploads/Final-briefing-on-reuse-jobs-website-2.pdf.

[42] On the whole, current DEFRA and ONS reporting distinguishes between activities related to *materials* and those associated with *products*, such as repair and reuse. More to the point, repair and reuse activities are not currently reflected in official waste and resource data; there is no reporting on products in circulation (in-use stock or disused stock); and the ONS reports on industry repair and reuse under 'manufacturing' and on household goods repair and reuse under 'other service activities', meaning that both the GVA (the impact on the economy) and the jobs generated by reuse and repair are attributed to 'manufacturing' and to 'other service activities' rather than to the waste and resource sector.

[43] The number of EfW incineration jobs is estimated based on 12.63 million tonnes of residual waste processed in 2019 and a total of 2 jobs created per 10,000 tonnes of waste processed, plus another 2,500 jobs estimated in the planning and construction of new EfW facilities. Note that the ONS figure of 23,000 involved in non-hazardous waste treatment includes anaerobic digestion and composting, landfilling, the disposal of fallen livestock, and solvent waste disposal. Disaggregated data for these statistics are not directly available. We estimate that out of the 23,000 involved in non-hazardous waste treatment, 5,000 are involved in EfW incineration; 8,500 in landfilling across close to 500 landfill sites; 5,500 in organics recycling across 579 anaerobic digestion sites and 323 composting sites; and 4,000 in various other waste treatment operations, including fallen livestock treatment (about 100 companies) and solvent waste treatment. See Office for National Statistics, Non-financial business economy, UK: Sections A to S, 2020, https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveysectionsas.

[44] Peter Mitchell, Employment and the circular economy: Job creation through resource efficiency in London, WRAP, London Sustainable Development Commission, Mayor of London, London Waste and Recycling Board, 2015, https://www.london.gov.uk/sites/default/files/lsdc_et_al_-_circular_economy_jobs_report_2015.pdf; Office for National Statistics, Environmental Goods and Services Sector (EGSS) estimates, 2020, https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalgoodsandservicessectoregssestimates.

[45] Julian Morgan and Peter Mitchell, Opportunities to tackle Britain's labour market challenges through growth in the circular economy, WRAP and Green Alliance, 2015, https://www.wrap.org.uk/sites/files/wrap/Opportunities%20to%20tackle%20Britain's%20Labour%20Market%20Challenges%20full%20report.pdf.

[46] Figure D data source: Office of National Statistics, Non-financial business economy, UK: Sections A to S, 2020, https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveysectionsas.

[47] Dennis Gammer and Susie Elks, Energy from Waste Plants with Carbon Capture: A Preliminary Assessment of Their Potential Value to the Decarbonisation of the UK, Catapult Energy Systems, May 2020, https://es.catapult.org.uk/reports/energy-from-waste-plants-with-carbon-capture/?download=true.

[48] Committee on Climate Change, Reducing UK emissions: Progress Report to Parliament, June 2020, https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/.

[49] Total emissions from waste incineration reached 7.6 million tonnes of CO_2e emissions ($MtCO_2e$) in 2019: 7.4 $MtCO_2e$ from EfW incineration and 0.2 $MtCO_2e$ from waste incineration without energy recovery. The latter are counted as waste sector emissions in UK statistics. The value of 7.6 $MtCO_2e$ for 2019 is based on provisional BEIS greenhouse gas emissions statistics per fuel type, as listed under 'other emissions', a category that covers waste incineration with and without energy recovery. BEIS, Provisional UK greenhouse gas emissions national statistics, 2020, https://www.gov.uk/government/collections/provisional-uk-greenhouse-gas-emissions-national-statistics. For previous years, these values are aligned with Committee on Climate Change data on EfW incineration. Committee on Climate Change, Net Zero Technical Report: Net-Zero Exhibits—Power and Hydrogen, 2019, https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-Report-Power-chapter-exhibits-Web.xlsx. See also Committee on Climate Change, Reducing UK Emissions: Progress Report to Parliament, June 2020, https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/; Tolvik Consulting, UK Energy from Waste Statistics: 2019, May 2020, https://www.tolvik.com/wp-content/uploads/2020/05/Tolvik-UK-EfW-Statistics-2019-Report-June-2020.pdf.

[50] UKWIN, Evaluation of the climate change impacts of waste incineration in the United Kingdom, October 2018, rev. edn. April 2019, https://ukwin.org.uk/files/pdf/UKWIN-2018-Incineration-Climate-Change-Report.pdf.

[51] Carbon intensity is calculated from data provided by the National Grid in partnership with the Environmental Defense Fund, the University of Oxford, and WWF (Carbon Intensity API, n.d., https://carbonintensity.org.uk/). Carbon intensity from EfW incineration is based on 455 kg of fossil CO_2 per tonne of waste and 531 kWh of net energy generated per tonne of input. For parameter values, see Tolvik Consulting, UK Energy from Waste Statistics: 2019, May 2020, https://www.tolvik.com/wp-content/uploads/2020/05/Tolvik-UK-EfW-Statistics-2019-Report-June-2020.pdf; Dennis Gammer and Susie Elks, Energy from Waste Plants with Carbon Capture: A Preliminary Assessment of Their Potential Value to the Decarbonisation of the UK, Catapult Energy Systems, May 2020, https://es.catapult.org.uk/reports/energy-from-waste-plants-with-carbon-capture/?download=true; and Ramboll, North London Heat and Power Project: Carbon Impact Screening Edmonton ERF, 2019, http://northlondonheatandpower.london/media/udfapcyh/nlwa-carbon-impact-study-report-ver-2-f.pdf.

[52] The share of EfW carbon emissions in the power sector is 13%, or 7.4 millions of tonnes of carbon dioxide equivalent ($MtCO_2e$) of a total of 57.3 $MtCO_2e$, as shown in Table B, below. The other figures—2.4% of the power sector electricity supply and 0.2% of the heat supply—are based on the 7.7 TWh electricity and 1.4 TWh heat supply generation figures in Tolvik Consulting, UK Energy from Waste Statistics; 2019, May 2020, https://www.tolvik.com/wp-content/uploads/2020/05/Tolvik-UK-EfW-Statistics-2019-Report-June-2020.pdf. The heat supply value of 760 TWh is based on Ofgem, Decarbonisation of heat, 2016, https://www.ofgem.gov.uk/system/files/docs/2016/11/ofgem_future_insights_programme_-

_the_decarbonisation_of_heat.pdf. The value of 324 TWh of electricity supplied in the UK is based on BEIS, Fuel used in electricity generation and electricity supplied, 2020, https://www.gov.uk/government/statistics/electricity-section-5-energy-trends.

Table B Fossil-based emissions used to estimate the share of EfW incineration in power sector emissions, in $MtCO_2e$

Power source	**2000**	**2010**	**2015**	**2019**
Coal	102	89.8	65.4	6.4
Natural gas	52.7	63.3	34.1	43.3
Oil	4.5	3.5	2.1	0.3
EfW incineration*	0.6	1.6	2.7	7.4
Total	**159.3**	**158.2**	**104.3**	**57.3**

Note: * Excluding emissions from waste incineration without energy recovery (0.2 $MtCO_2e$ in 2019), which are counted under the waste sector in UK emissions statistics. Total emissions from both types of waste incineration (with and without energy recovery) reached 7.6 $MtCO_2e$ in 2019.
Sources: Committee on Climate Change, Reducing UK Emissions: Progress Report to Parliament, June 2020, https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/; BEIS, Provisional UK greenhouse gas emissions national statistics, 2020, https://www.gov.uk/government/collections/provisional-uk-greenhouse-gas-emissions-national-statistics

[53] Simon Evans, UK low-carbon electricity generation stalls in 2019, 2010, https://www.carbonbrief.org/analysis-uk-low-carbon-electricity-generation-stalls-in-2019#:~:text=Coal%20accounted%20for%20just%202,gas%20and%20higher%20CO2%20prices.
[54] Roger Harrabin, Should we burn or bury waste plastic?, BBC News, 20 February 2018, https://www.bbc.co.uk/news/science-environment-43120041.
[55] Tolvik Consulting, UK Energy from Waste Statistics: 2019, May 2020, https://www.tolvik.com/wp-content/uploads/2020/05/Tolvik-UK-EfW-Statistics-2019-Report-June-2020.pdf.
[56] Construction News, How new energy-from-waste players avoid being burned, 21 November 2019, https://www.constructionnews.co.uk/agenda/contractors-guide-energy-waste-sector-21-11-2019/.
[57] Nowadays the majority of landfills are equipped with landfill gas capture, yet these systems only capture about 50% of the methane released from landfill and a significant portion is released as CO_2 during decomposition. For an overview of the release pathways, see: Kimberley Pratt and Michael Lenaghan, The climate change impact of burning municipal waste in Scotland: Technical Report, 2020, https://www.zerowastescotland.org.uk/sites/default/files/ZWS%20%282020%29%20CC%20impacts%20of%20incineration%20TECHNICAL%20REPORT.pdf. Moreover, when the captured methane is used for heating or other purposes, it is converted into CO_2 emissions when burnt. For more details, see DEFRA, Energy from waste: A guide to the debate, 2014, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/284612/pb14130-energy-waste-201402.pdf.
[58] The emissions saved include those that would have been generated through the production, processing, consumption, and disposal of food as waste. Martin Bowman and Krysia Woroniecka, Bad Energy: Defining the true role of biogas in a net zero future, Feedback, 2020, https://feedbackglobal.org/wp-content/uploads/2020/09/Feedback-2020-Bad-Energy-report.pdf; Peter C. Slorach, Harish K. Jeswani, Rosa Cuéllar-Franca, and Adisa Azapagic, Assessing the economic and environmental sustainability of household food waste management in the UK: Current situation and future scenarios, *Science of the Total Environment*, vol. 710, 25 March 2020, https://www.sciencedirect.com/science/article/pii/S0048969719355755.
[59] Eunomia, The Potential Contribution of Waste Management to a Low Carbon Economy, 2015, http://www.eunomia.co.uk/wp-content/uploads/2015/11/Technical-Appendices-EN-1.pdf.
[60] Emissions saved include those that would have been generated through mining, extracting, processing, manufacturing, and disposing of the materials. Eunomia, The Potential Contribution of Waste Management to a Low Carbon Economy, 2015, http://www.eunomia.co.uk/wp-content/uploads/2015/11/Technical-Appendices-EN-1.pdf.
[61] Note that this excludes the greenhouse gas emissions balance of growing the crops or producing the organic material in the first place, as this will be equal regardless of the processing route. More information about the total greenhouse gas balance can be found in Ofgem, Guidance for Anaerobic Digestion generators: SEG sustainability criteria and reporting requirements, 2019, https://www.ofgem.gov.uk/system/files/docs/2019/12/seg_sustainability_guidance_final_0.pdf.
[62] European Biogas Association, Digestate Factsheet: the value of organic fertilisers for Europe's economy, society and environment, n.d., https://www.europeanbiogas.eu/wp-content/uploads/2019/07/Digestate-paper-final.pdf.
[63] Eunomia, The Potential Contribution of Waste Management to a Low Carbon Economy, 2015, http://www.eunomia.co.uk/wp-content/uploads/2015/11/Technical-Appendices-EN-1.pdf; Mark Walker et al.,

Assessment of micro-scale anaerobic digestion for management of urban organic waste: A case study in London, *Waste Management*, vol. 61, March 2017, 258–68, https://doi.org/10.1016/j.wasman.2017.01.036.
[64] Eunomia, The Potential Contribution of Waste Management to a Low Carbon Economy, 2015, http://www.eunomia.co.uk/wp-content/uploads/2015/11/Technical-Appendices-EN-1.pdf.
[65] CIE-MAP, Resource consumption, industrial strategy and UK carbon budgets, 2018, http://ciemap.leeds.ac.uk/wp-content/uploads/2018/05/Briefing-Note-4.pdf.
[66] In 2019 the UK's total CO_2 emissions were estimated at 451 million tonnes, based on which a savings of 68 million tonnes translates into a 15% reduction in economy-wide CO_2 emissions. Data source: Committee on Climate Change, Reducing UK emissions: Progress Report to Parliament, June 2020, https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/.
[67] Committee on Climate Change, Reaching Net Zero in the UK, n.d., https://www.theccc.org.uk/uk-action-on-climate-change/reaching-net-zero-in-the-uk.
[68] CIE-MAP, Resource consumption, industrial strategy and UK carbon budgets, 2018, http://ciemap.leeds.ac.uk/wp-content/uploads/2018/05/Briefing-Note-4.pdf.
[69] Committee on Climate Change, Reducing UK emissions: Progress Report to Parliament, June 2020, https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/.
[70] Dennis Gammer and Susie Elks, Energy from Waste Plants with Carbon Capture: A Preliminary Assessment of Their Potential Value to the Decarbonisation of the UK, Catapult Energy Systems, May 2020, https://es.catapult.org.uk/reports/energy-from-waste-plants-with-carbon-capture/?download=true.
[71] Figure E data source sources: Committee on Climate Change, Net Zero Technical Report: Net-Zero Exhibits—Power and Hydrogen, 2019, https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-Report-Power-chapter-exhibits-Web.xlsx; Committee on Climate Change, Reducing UK Emissions: Progress Report to Parliament, June 2020, https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/.
[72] Intergovernmental Panel on Climate Change, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, vol. 5, 2019, https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol5.html.
[73] Figure F data sources: Committee on Climate Change, Net Zero Technical Report: Net-Zero Exhibits—Power and Hydrogen, 2019, https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-Report-Power-chapter-exhibits-Web.xlsx; Committee on Climate Change, Reducing UK Emissions: Progress Report to Parliament, June 2020, https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/; BEIS, Digest of United Kingdom Energy Statistics 2020, 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/924591/DUKES_2020_MASTER.pdf.
[74] Figure G data sources: Eunomia, The Potential Contribution of Waste Management to a Low Carbon Economy, 2015, http://www.eunomia.co.uk/wp-content/uploads/2015/11/Technical-Appendices-EN-1.pdf; Tolvik Consulting, UK Energy from Waste Statistics: 2019, May 2020, https://www.tolvik.com/wp-content/uploads/2020/05/Tolvik-UK-EfW-Statistics-2019-Report-June-2020.pdf.
[75] Tolvik Consulting, UK Energy from Waste Statistics: 2019, May 2020, https://www.tolvik.com/wp-content/uploads/2020/05/Tolvik-UK-EfW-Statistics-2019-Report-June-2020.pdf.
[76] Note that this assumption is only valid for newly built EfW incineration facilities, and not for ones that replace existing EfW plants that already produce electricity.
[77] Values are based on compensation of 0.61 kWh of grid mix replaced per tonne of waste incinerated, given a 22% incineration efficiency and a 10 GJ per tonne calorific value, which results in an efficiency of 1.64 tonnes of waste per kWh of electricity generated. The calculation is based on the average grid mix carbon intensity of 214 grams per kWh, or a total reduction of 130 grams per tonne of waste incinerated (0.61 kWh per tonne incinerated multiplied by 214 grams per kWh). Instead of using average grid carbon intensity values as counterfactuals, some studies use carbon intensity values associated with natural gas power plants. This approach is misleading because EfW incineration facilities do not provide a 1:1 replacement of natural gas power. Cited values are drawn from BEIS, Electricity Generation Costs 2020, 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/911817/electricity-generation-cost-report-2020.pdf.
[78] The calculation is based on an estimated 0.4 MWh of heat produced per tonne of waste incinerated and a carbon intensity for gas boilers of 236 kg of CO_2 equivalent per MWh, resulting in 94 kg of CO_2e per tonne of waste. Values are drawn from Ramboll, North London Heat and Power Project: Carbon Impact Screening Edmonton ERF, 2019, http://northlondonheatandpower.london/media/udfapcyh/nlwa-carbon-impact-study-report-ver-2-f.pdf.
[79] Note that recovery operations differ from disposal operations, whereby EfW incineration serves to treat hazardous waste or non-hazardous waste that is currently difficult to recycle. See Chartered Institution of Wastes Management, The R1 Energy Efficiency Formula, 2020, https://www.ciwm.co.uk/ciwm/knowledge/the-r1-energy-efficiency-formula.aspx.
[80] The quality of collected materials for recycling also affects costs to local authorities, since lower-quality materials with higher contamination levels increases the cost of processing and recycling. The result is a rise in gate fees to waste operators or material recovery facilities for processing the source-separated recycling materials.

[81] BEIS, Electricity Generation Costs 2020, 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/911817/electricity-generation-cost-report-2020.pdf.
[82] The baseline EfW incineration value of 1.63 tonnes of waste that provides for 1 MWh of energy by incineration is calculated based on two assumptions: 1) that 10 GJ of energy is contained in a tonne of waste (2.78 MWh/tonne), and 2) that EfW incineration efficiency is 22%, implying an energy loss of 78% in the conversion and from parasitic load. Both assumptions are from BEIS, Electricity Generation Costs 2020, 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/911817/electricity-generation-cost-report-2020.pdf.
[83] The cost values for high-value recycling are based on the net cost of recycling after sales of recycled materials, excluding material recovery, estimated at £31 per tonne, based on the net revenue burden of recycling per household for England (see SUEZ, The Economics of Change in the Resources and Waste Sector, 2019, https://www.suez.co.uk/-/media/suez-uk/files/publication/suez-economicsofchange-2019941.pdf). The assumption here is that the low recycling rate in England (43% in 2018/19) means that primarily high-value materials are recycled, which results in a low marginal cost of recycling. For example, the material recovery facility cost of separating commingled waste is equivalent to the gate fee of £17 per tonne for England (see Hannah Dick and Peter Scholes, Comparing the costs of alternative waste treatment options: WRAP gate fees 2018/19 report, 2019, https://www.wrap.org.uk/sites/files/wrap/WRAP%20gate%20fees%20report%202019.pdf). That translates into a £28 cost for processing 1.63 tonnes. The renewable energy costs are drawn from BEIS, Electricity Generation Costs 2020, 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/911817/electricity-generation-cost-report-2020.pdf.
[84] The cost values for high-value recycling are based on the net cost of recycling after sales of recycled materials, excluding material recovery, estimated at £31 per tonne, based on the net revenue burden of recycling per household for Wales (see SUEZ, The Economics of Change in the Resources and Waste Sector, 2019, https://www.suez.co.uk/-/media/suez-uk/files/publication/suez-economicsofchange-2019941.pdf). The assumption here is that the much higher recycling rates in Wales (above 65%, which is among the highest in the world) means that a significant stream of low-value materials is recycled, which results in a high marginal cost of recycling. For example, the material recovery facility cost of separating commingled waste is equivalent to the gate fee of £49 per tonne for Wales (see Hannah Dick and Peter Scholes, Comparing the costs of alternative waste treatment options: WRAP gate fees 2018/19 report, 2019, https://www.wrap.org.uk/sites/files/wrap/WRAP%20gate%20fees%20report%202019.pdf). That translates into a £80 cost for processing 1.63 tonnes. The renewable energy costs are drawn from BEIS, Electricity Generation Costs 2020, 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/911817/electricity-generation-cost-report-2020.pdf
[85] Note that the evaluation here concerns investments in new EfW incineration capacity, in contrast to existing EfW incinerators, which have already amortized their capital investment costs. The evaluation also excludes the costs of polluting, such as carbon pricing costs, and other externalities, given that these are currently not priced in and thus do not have an impact on EfW incineration investment decisions.
[86] Hannah Dick and Peter Scholes, Comparing the costs of alternative waste treatment options: WRAP gate fees 2018/19 report, 2019, https://www.wrap.org.uk/sites/files/wrap/WRAP%20gate%20fees%20report%202019.pdf.
[87] Simon Rawlinson and Matthew Hicks, Cost Model Energy from Waste, Building Magazine, 22 April 2010, https://www.slideshare.net/matthewhicks/efw-cost-model-from-building-magazine.
[88] Key evidence that EfW incineration gate fees follow the price of landfill gate fees + the landfill tax over time is the parallel increase in both, as shown in Table C.

Table C Landfill tax and gate fees vs. EfW incineration gate fees, 1996–2020

Year	Landfill tax per tonne	Landfill tax + landfill gate fee per tonne	EfW incineration gate fee per tonne
1996	£13	£48	
1999	£17	£51	
2000	£18	£52	£50–66
2003	£22	£53	£62–78
2005	£26	£56	
2010	£50	£75	£78–90
2015	£87	£99	£85–90
2020	£94	£114	£85–90

Note: Values are in 2018 real prices.
Data sources: Credit Suisse, Energy from Waste: the next downside risk, 2013, https://research-doc.credit-suisse.com/docView?sourceid=em&document_id=x529593&serialid=9tJdZlDpO3IAxfhYGLt9Zn5SYWx9KMTsn

%2FS70UOA4nc%3D; EU Commission, Waste management options and climate change, 2001, https://ec.europa.eu/environment/waste/studies/pdf/climate_change.pdf; Eunomia, 'Biostabilisation' of Wastes: Making the Case for a Differential Rate of Landfill Tax, 2008, http://www.organics-recycling.org.uk/dmdocuments/Eunomia_Jan_2008_report.pdf; Eunomia, Costs for Municipal Management in the EU, 2002, https://ec.europa.eu/environment/waste/studies/pdf/eucostwaste.pdf; Institute for Fiscal Studies, Rates of Landfill Tax 1996–2015, n.d., www.ifs.org.uk/uploads/publications/ff/landfill.xls; London Assembly, London Assembly Environment Committee's Response to the Public Consultation Draft of the Municipal Waste Management Strategy, 2002, https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/archives/assembly-reports-environment-waste_dec02.pdf; WRAP, Gate Fees Report 2008: Comparing the cost of alternative waste treatment options, https://www.wrap.org.uk/sites/files/wrap/W504GateFeesReport%20FINAL.pdf; WRAP, Gate fees report 2015/2016: Comparing the costs of waste treatment options, 2016, https://www.wrap.org.uk/sites/files/wrap/Gate%20fees%20infographic%20020616.pdf; WRAP, Gate fees report 2018/2019: Comparing the costs of alternative waste treatment options, 2019, https://www.wrap.org.uk/gatefees2019

In a 2013 analysis of the UK EfW market, investment bank Credit Suisse describes price setting of EfW incineration gate fees relative to landfilling: 'There is currently c6mt of EfW capacity in the UK, with c40mt of waste going to landfill p.a. This drives the perceived opportunity for investment in EfW, as operators can charge only a small discount to the all-in landfill cost (gate fee + tax) for waste intake, and earn additional revenue from power generation.' Credit Suisse, Energy from Waste: the next downside risk, 2013, https://research-doc.credit-suisse.com/docView?sourceid=em&document_id=x529593&serialid=9tJdZlDpO3IAxfhYGLt9Zn5SYWx9KMTsn%2FS70UOA4nc%3D.

Waste and resource industry stakeholders have similarly noted: 'The lack of alternatives to landfill within the UK was stated as a secondary consideration but all stakeholders said they would use local facilities if available and the costs were comparable. It was noted by several that gate fees at UK & Irish EfW facilities seem to track the increased cost of landfill rather than becoming a more competitive option as landfill tax rates increase.' Chartered Institution of Wastes Management, Research into SRF and RDF Exports to other EU countries, 2013, https://www.ciwm.co.uk/Custom/BSIDocumentSelector/Pages/DocumentViewer.aspx?id=QoR7FzWBtisamYEcWSfL6SxAJRLAPT9vf9UOxY7TX%252bRTmuWeo5keV9skGlWyOY%252bUp7ncAXRDbF5GQWy%252bL3ZD1svIqkmjQD8b%252bRybjUOcZx%252bbtUeOK%252boD%252bWOteFwHaqlYgAzUrm8WMLMdw9l4vZRVeLc0jOqrhVN1UXyICTOMcvHDJhyoW%252b1C2Q%253d%253d.

For further evidence, see section 6.3 in Environment Agency, Evidence: reasons for trends in English refuse derived fuel exports since 2010, 2015, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/438906/Reasons_for_trends_in_English_refuse_derived_fuel_exports_since_2010_report.pdf.

[89] The UK Competition & Markets Authority concluded that local authorities are still entering into longer and broader domestic waste collection contracts, which can limit competition and are associated with authority spending that is statistically significantly higher. See UK Competition & Markets Authority, Local authority waste contracts: CMA analysis, 2017, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/657858/local-authority-waste-contracts-cma-analysis.pdf.

[90] BEIS, Electricity Generation Costs 2020, 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/911817/electricity-generation-cost-report-2020.pdf.

[91] Tolvik Consulting, UK Energy from Waste Statistics: 2019, May 2020, https://www.tolvik.com/wp-content/uploads/2020/05/Tolvik-UK-EfW-Statistics-2019-Report-June-2020.pdf.

[92] Hannah Dick and Peter Scholes, Comparing the costs of alternative waste treatment options: WRAP gate fees 2018/19 report, 2019, https://www.wrap.org.uk/sites/files/wrap/WRAP%20gate%20fees%20report%202019.pdf.

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