Incineration Overcapacity Methodology

Technical paper on UKWIN's incineration overcapacity modelling (September 2022)

Overview

This paper sets out and explains the data, methodology and assumptions underpinning UKWIN's comparison of incinerator feedstock and capacity in England which takes account of the UK Government's proposed Environmental Target for "halving the waste that ends up at landfill or incineration by 2042" relative to a 2019 base year.[i]

When looking at incineration capacity it is important to consider the level of residual waste up to 2042, when the proposed halving of residual waste will have taken place, as it would be counterproductive to allow new incineration capacity to be built now when this capacity would undermine or make more difficult achievement of the target to halve residual waste.

UKWIN's modelling anticipates a fall in 'residual municipal waste arisings' in England, which includes both household waste and business (Commercial & Industrial) waste that is similar to household waste, starting with the levels of waste anticipated by Defra in the Government's Resources and Waste Strategy and gradually halving this quantity of waste by 2042 following the trajectory set out by Defra in their Environmental Targets modelling.[ii]

This modelling is combined with information about those incinerators that are operational, under construction, or at various stages of the planning and permitting pipelines. This allows an estimate to be made of current and future incineration capacity against current and future feedstock.

Incinerator Feedstock Methodology

The approach applied when modelling available incinerator feedstock is set out below:

1. According to Defra statistics, the total amount of household residual waste managed in England in 2016 was 12.5Mt.[iii] However, incinerators can also burn business (C&I) waste. As such, the modelling starts with the 27.8Mt figure for municipal residual waste in 2016 set out in the Government's Resources and Waste Strategy.[iv] Around 55% of this waste was business (C&I) waste that was similar in nature and composition to household waste.

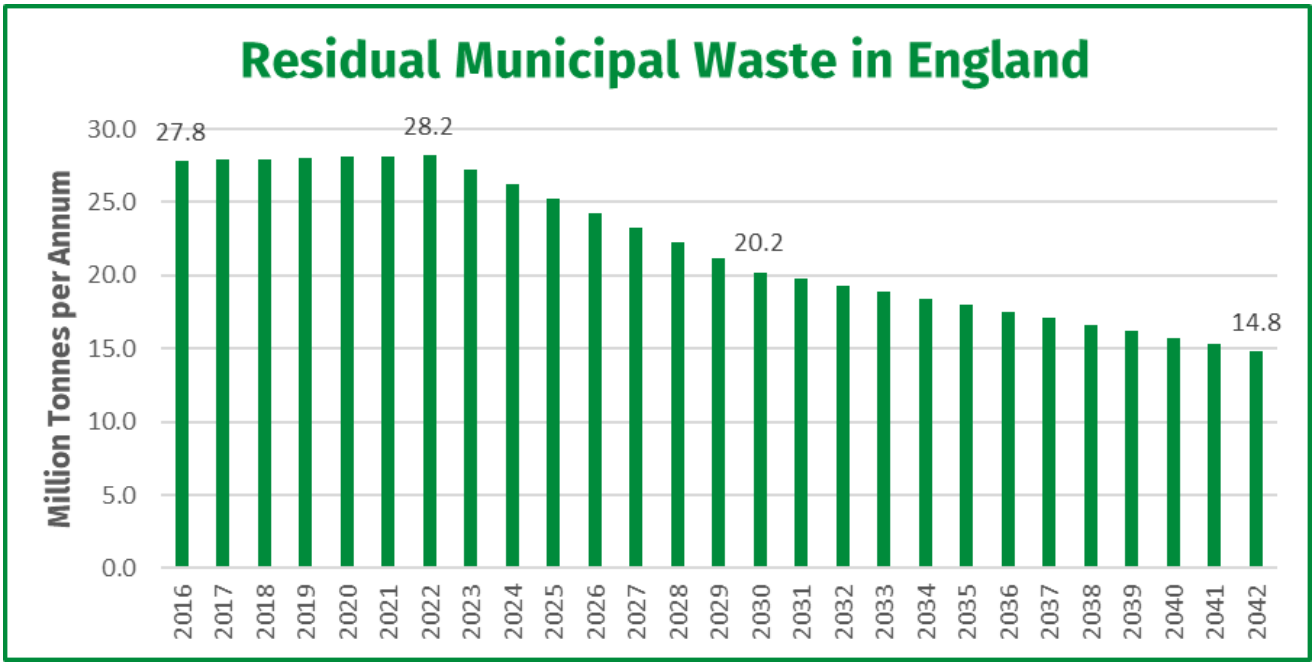
2. Assuming this 27.8Mt figure halves by 2042 before account is taken for population growth, this reduces residual waste to 13.9Mt. In line with Defra's Environmental Target modelling, this assumes residual waste remained stable between 2016 and 2022, then falls relatively rapidly between 2023 and 2030 (representing 60% of the reduction) and then at a slightly slower rate between 2031 and 2042 (representing 40% of the reduction).

3. The residual waste figures are then increased by 0.26% for each year after 2016 to account for population growth using an average per-year increase based on the Office of National Statistics 2020-based interim national projects for 2020-2045. This means that the resultant figure is increased by 1.57% in 2022, 3.66% in 2030, and 6.8% in 2042.[v]

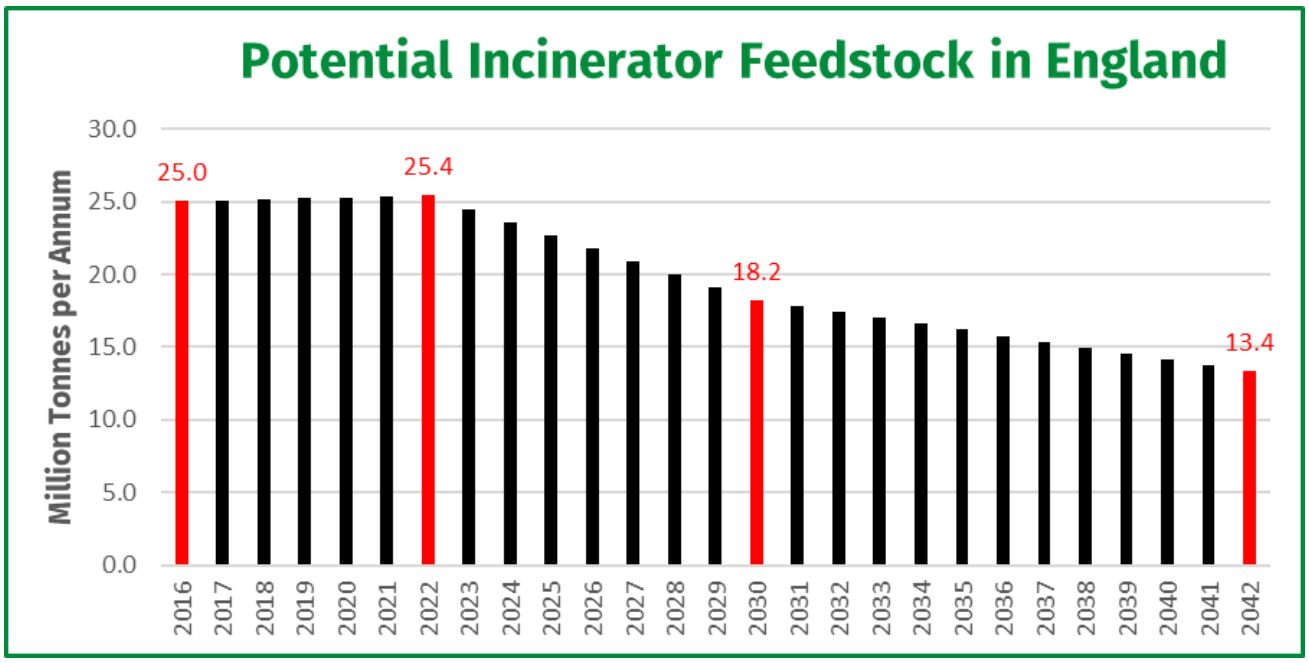
4. Assuming 90% of the feedstock will be available for incineration, in recognition of the fact that some of the material (roughly 10%) would either be sent to other facilities, such as cement kilns, or would be material such as oversized objects and small 'fines' like grit and gravel that are not generally compatible with moving grate incinerators.

This analysis results in available incinerator feedstock falling from 25.0 million tonnes in 2022 to 13.4 million tonnes in 2042, as shown below.

The chart below shows estimates of total English residual municipal (including C&I) waste:



The chart below shows potential incinerator feedstock which is assumed to be 90% of total residual municipal (including C&I) waste in England:



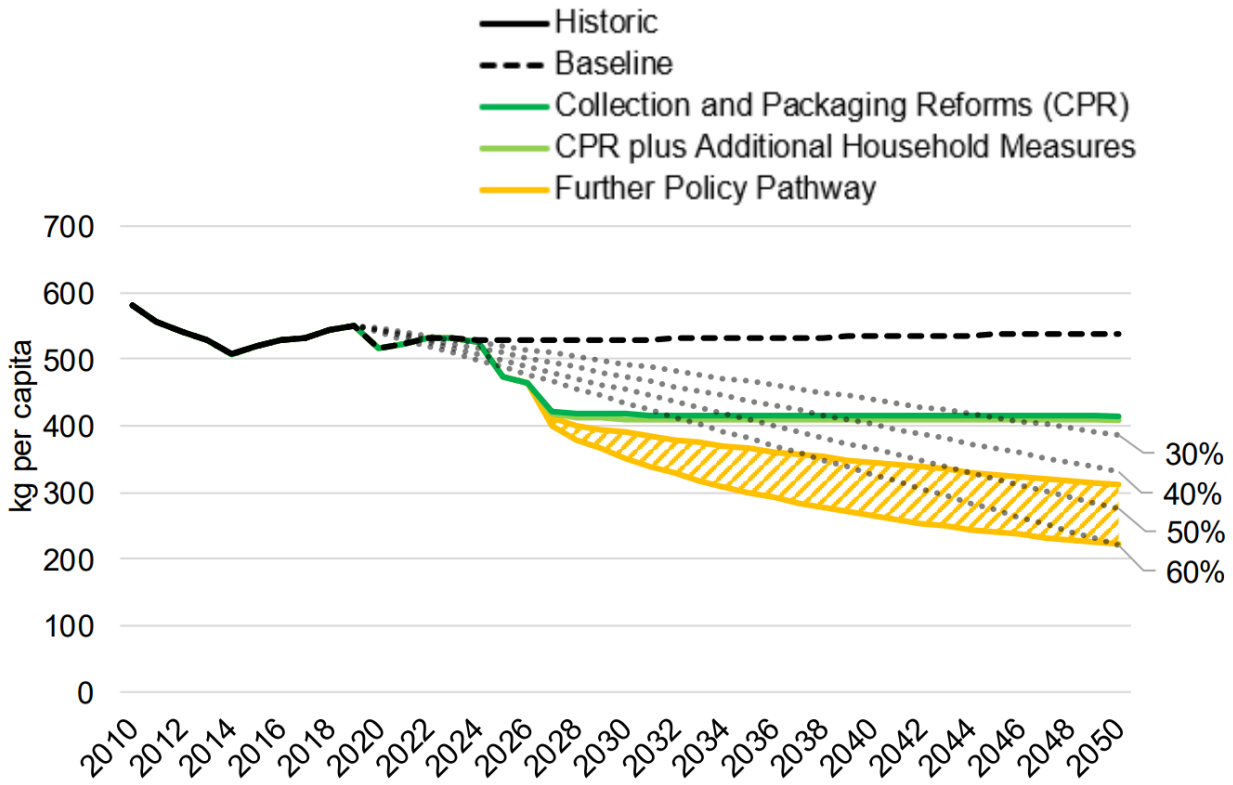
As noted above, the pace of the fall in arisings reflects the approach taken by Defra in their April 2022 Environment Act Targets Impact Analysis: Waste Reduction.[vi]

While UKWIN's analysis only goes up to 2042 and only considers a 50% reduction, Defra's Impact Analysis considered reducing residual waste (excluding major mineral waste) to 60% of 2019 levels by 2050 as being feasible.

Defra's analysis shows residual waste per capita as relatively stable between 2016 and 2022, followed by dramatic falls towards the end of this decade as a result of the implementation of Collection and Packaging Reforms and other measures, followed by a more gradual fall towards 2050 based on the impact of additional measures from the 2030s and beyond.

The 'shape' of the fall up to 2042 is irrelevant to the position in 2042, which is the focus of UKWIN's analysis. However, it is relevant to the illustration of the position in 2022 and to the additional analysis showing year-on-year estimates that help indicate when incineration capacity might exceed available feedstock. Figure 3 from Defra's Impact Assessment is reproduced below:

Figure 3: Residual waste excl. major mineral waste after potential future policies, up to 2050



The UK Government's commitment to significant falls in residual waste and their belief that such reductions are achievable is set out within the Impact Assessment, which notes that:

- "The modelled trajectories…provide further evidence that our proposed target ambition level is ambitious but achievable and that our illustrative policy pathway is a sensible illustration of the level of waste reduction that may be achieved."
- "A legally binding long-term target gives a clear signal to industry of the direction of future government policy. This will increase investor confidence and encourage industry to invest in infrastructure and research that will improve the circularity of the economy."
- "The target will be met by using a range of government policy levers. These levers could include regulation that puts in place rules and standards that producers must follow which will encourage all of industry to improve their products recyclability, repairability and reusability."

Incineration Capacity Methodology

UKWIN used the following sources to identify incineration facilities, their headline capacities, and their operational status:

- Tolvik's UK Energy from Waste Statistics – 2021 report, published in May 2022[vii]
- BEIS' REPD database (July 2022)[viii]
- Environmental Permit documents[ix]
- Planning applications and consents[ix]
- Press reports and statements made on operator/applicant websites.

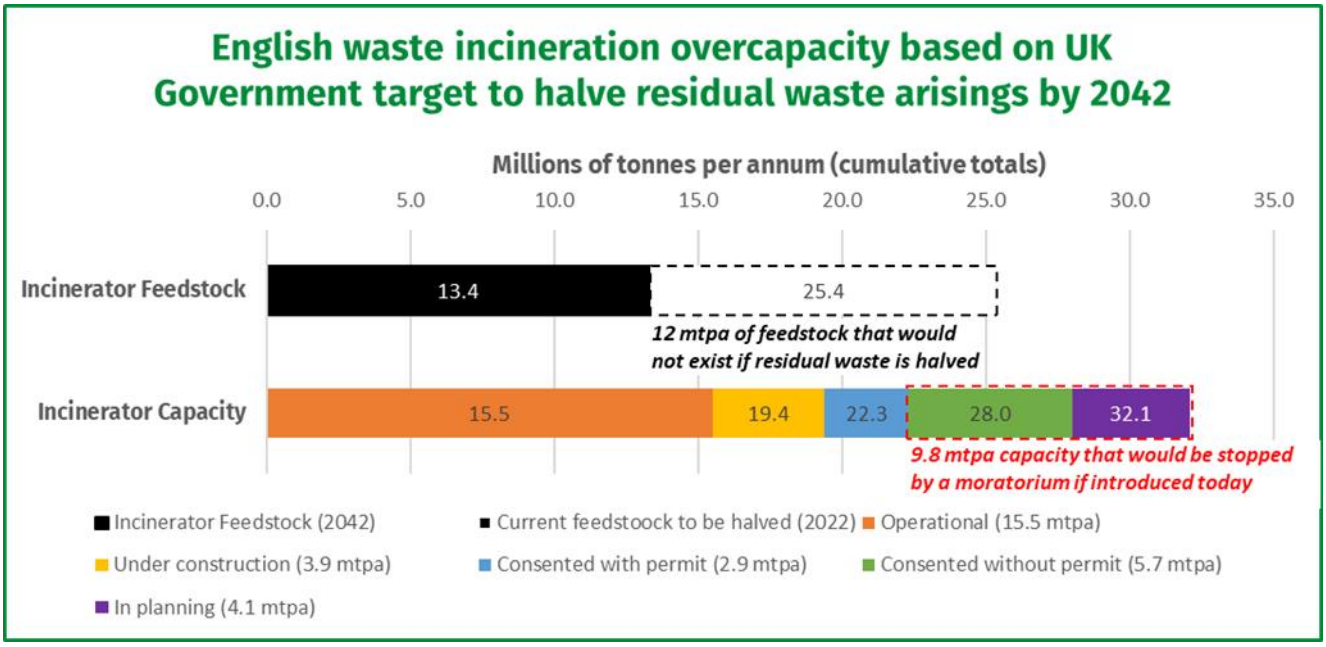
UKWIN assessed headline incineration capacity based on the following categories:

- **Operational** – 50 plants with a combined capacity of 15,482 ktpa. It is assumed that currently operational capacity, having been granted permanent planning permission, will remain operational (with or without refurbishment). Where we know capacity will not coexist (e.g. Edmonton and its rebuild) it has been omitted to avoid double counting. As set out in the robustness assessment below, it is likely that by the time any moratorium is implemented additional capacity will have entered construction.
- **Under Construction** – 11 plants with a combined capacity of 3,906 ktpa
- **Consented and permitted** – 8 plants with a combined capacity of 2,872 ktpa
- **Consented without permit issued** – 19 plants with a combined capacity of 5,730 ktpa
- **In planning** – 10 plants with a capacity of 4,068 ktpa

A list of all of these incinerators and their respective capacities is set out in at the end of this paper, reflecting the situation as it was on 1st September 2022.

Modelling Results

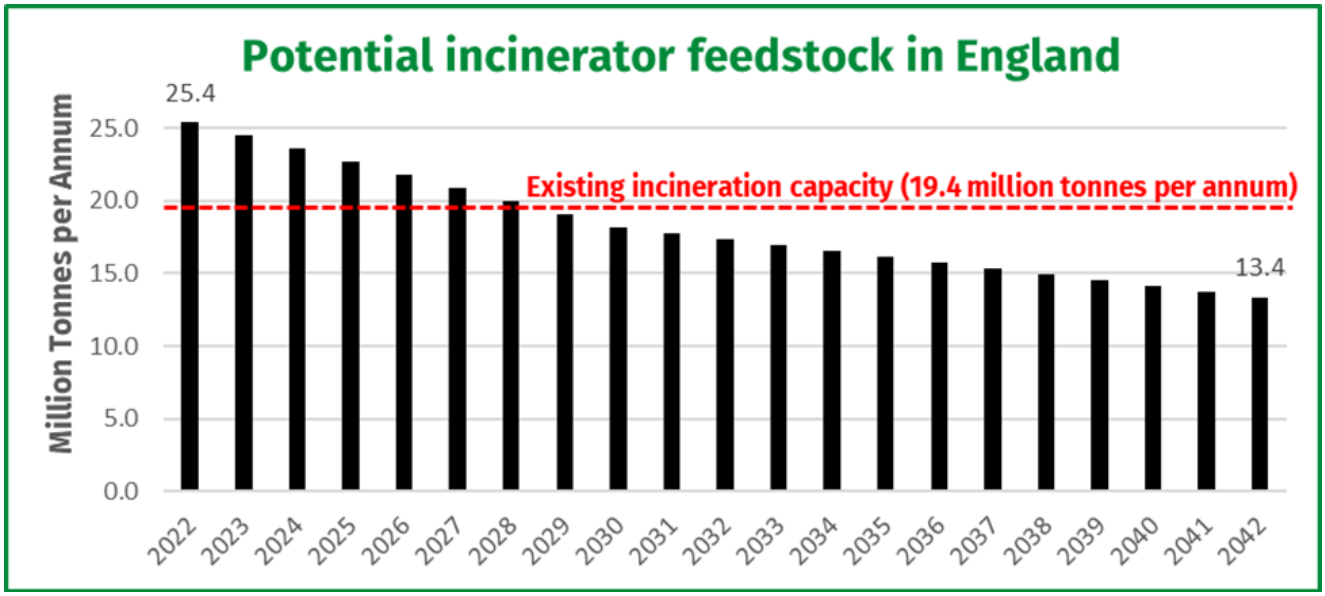
The result of the modelling can be summarised as follows:



The 'Incinerator Feedstock' section of the chart shows waste volumes are around 25.4Mt in 2022, and that these are expected to fall by 12Mt by 2042 to 13.4Mt. The 'Incineration Capacity' section shows that we do not expect to have enough feedstock to make use of the 19.4Mt of incineration capacity that is already operational and under construction, let alone to feed the 12.7Mt of proposed capacity that has yet to enter construction.

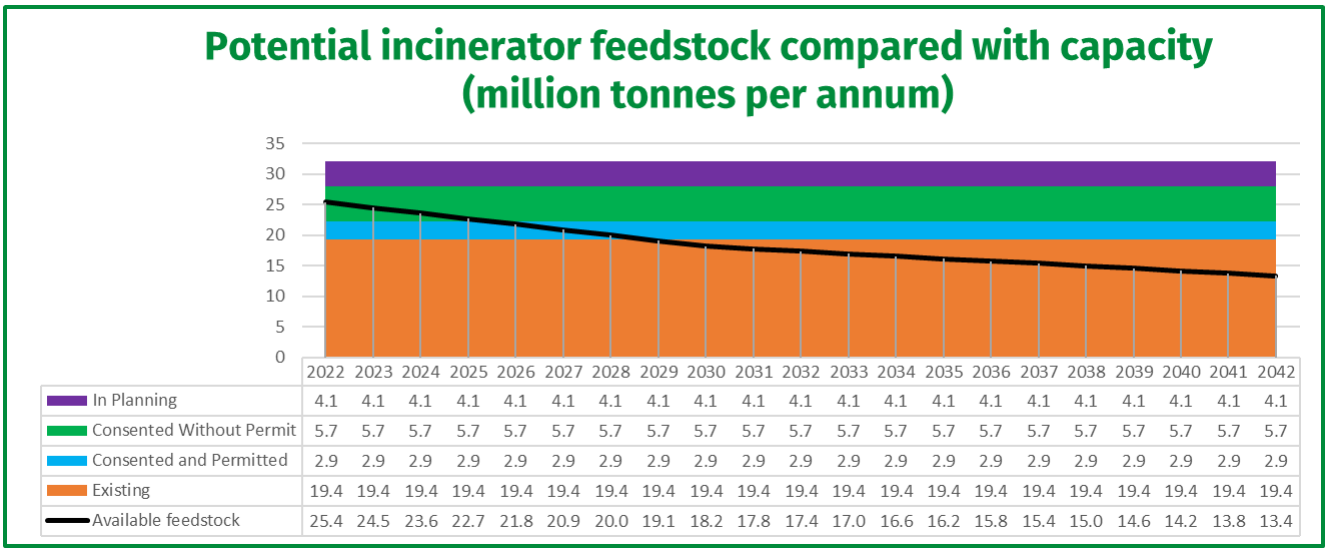
The chart above also shows that for a moratorium to capture a significant proportion of the potential overcapacity in the pipeline it must include not only the 4.1Mt of capacity which has yet to obtain planning permission but also the 5.7Mt of capacity which has planning permission but has yet to be granted an Environmental Permit by the Environment Agency.

While the previous chart is useful for showing how the situation in 2042 could differ from the current situation in 2022, it underplays the immediacy of the overcapacity problem by leaving out the intervening years. Falling waste can be combined with existing incineration capacity to show how soon incineration capacity in England could outstrip feedstock supply, even if no new incinerators enter construction.



The chart above indicates that England could have more operational incineration capacity than feedstock by 2028/2029. The 19.4Mt figure for existing capacity represents capacity which is either currently operational or currently under construction (and expected to become operational by 2025 at the latest).

The full information from the two charts can be combined as follows:



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
In Planning	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Consented Without Permit	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Consented and Permitted	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Existing	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4
Available feedstock	25.4	24.5	23.6	22.7	21.8	20.9	20.0	19.1	18.2	17.8	17.4	17.0	16.6	16.2	15.8	15.4	15.0	14.6	14.2	13.8	13.4

The chart above highlights how if further capacity enters construction then the level of incineration overcapacity could be significantly greater within this decade and beyond.

The robustness of assumptions regarding incineration capacity and feedstock availability

While at present incinerators are operating to around 90% of their headline capacity,[vii] the use of the full headline capacity for the modelling process, when combined with an assumption that 90% of residual municipal waste will be available for incineration, is more likely to underestimate than to overestimate actual capacity relative to the falls of waste arisings anticipated as England moves to halve residual waste by 2042. As such, we consider the conclusions are robust to relevant uncertainties regarding both future capacities and future feedstock availability.

Actual levels of overcapacity could be higher than modelled due to factors such as:

- **Changes in waste composition**. Headline capacity figures are typically based on a nominal calorific value (CV) of the feedstock, which in turn is typically based on current waste composition. However, as set out below, changes in feedstock composition are expected to reduce the CV even when reductions in food waste are factored in, thus increasing the amount of waste that an incinerator can treat by around 20%. This is explored in more detail in the next section below.

- **The feedstock requirements of RDF production.** Many incinerators, especially newer merchant plants, are designed to treat Refuse Derived Fuels (RDF) as either the sole/primary feedstock or as a significant fraction of the feedstock. Capacity figures would be even higher if the modelling accounted for the fact that, due to moisture loss, it takes more than one tonne of waste to produce a tonne of RDF. As UKWIN set out in its evidence to the Scottish Incineration Review, the production of RDF can result in the loss of around 20-30% of the input waste stream due to moisture loss.[x]

- **Additional capacity entering construction or obtaining planning/permitting consents**. It is likely that additional incinerators would have entered construction by the time any moratorium on new incineration capacity would be in place. It is also possible that during this period new consents will be issued for proposed plants. This means that the level of overcapacity is likely to be higher than the figure for 'existing capacity' even if some of that existing capacity is subsequently decommissioned.

- The potential for **increased use of cement kilns and other alternative capacity** to treat RDF. The model assumes that 10% of residual municipal waste will not be available for incineration. By assuming a percentage, rather than subtracting a fixed quantity, the impact of that assumption reduces as total residual municipal waste falls. This means the number of tonnes of waste available for incineration by 2042 is only reduced from 14.8Mt to 13.4Mt – a reduction of only around 1.4 million tonnes. This, to some extent, mirrors the fact that levels of RDF export are currently falling.

  However, these trends could reverse. It is also possible that for commercial reasons some RDF will continue to be exported, for example to mainland Europe, and this would further decrease available feedstock.

  Furthermore, while Eunomia has estimated that around 1 million tonnes of waste will be used in UK cement kilns by 2030[xi], this figure could be far higher by 2042, especially if the UK ETS covers burning waste at incineration plants but not at cement kilns or co-incineration plants and/or as cement kilns increasingly pursue biowaste to reduce their own fossil CO_2 impacts.

The impact of changes in waste composition on incineration capacity

The quantity of waste feedstock that an incinerator can burn is not based on the tonnes of waste it can process but rather on the calorific value (CV) of energy that the turbine and engine are designed to manage. As such, changes in feedstock composition can impact on the effective capacity of an incinerator (as measured in tonnes per annum or 'tpa').

The UK Government intends to reduce the amount of plastics and food waste going to incineration through a range of measures such as deposit return schemes, extended producer responsibility, the consistency framework, the plastics tax, inclusion of incineration in the UK ETS, and the mandatory separate collection of food waste.

These changes are expected to alter the composition of the waste feedstock used for incinerators, with an anticipated overall lowering of the CV of the waste feedstock. A lower CV would result in an increase in the effective capacity of incineration facilities. For example, feedstock changes in Wales meant that the maximum capacity of the Cardiff incinerator was increased from 350,000 tpa to 425,000 tpa because "lower average calorific value of waste is being generated – meaning more waste is needed to maintain the energy output".[xii]

The expectation that England will follow a similar trend, with more waste needed to feed a given incinerator, means that for projecting future incineration capacity reliance on historic rates of incineration would inevitably underestimate future levels of incineration capacity.

As headline figures for many incinerators are based on historic feedstock assumptions, it is possible that many will end up burning more than their headline capacity figures. This is especially true for plants designed to process a high volume of plastics (which have a high CV) and/or low volumes of food waste (which has a low CV).

The impact on capacity of changes in feedstock composition will differ for each incinerator. However, we can get a sense of the scale of impact based on feedstock composition data published by the Riverside incinerator operator.[xiii]

The Riverside operator's feedstock composition analysis includes data on the respective contribution of dense plastic, plastic film, putrescibles (e.g. food waste) and other waste types by weight and CV. This can be used to determine how much reducing one element of the waste stream would lower the CV, and therefore the increase in other waste categories (paper, card, wood, etc.) that would be necessary to deliver the same input CV.

For example:

- Assuming that plastic film and dense plastics are completely removed from the feedstock and that all other categories increase proportionally, it would take around 31% more waste by weight to deliver the same calorific value.
- Assuming that 90% of plastic film and dense plastics are removed from the feedstock, and that 50% of putrescible waste is also removed, it would take around 21% more waste by weight to deliver the same calorific value.

As such, reductions in the quantities of plastic in the feedstock can significantly increase the effective capacity of existing waste incinerators even when other changes in feedstock composition arising from increased food waste collection are taken into account.

List of incinerators and headline capacity

50 operational incinerators with a combined capacity of 15,482 ktpa

Location	Facility	Operator	Capacity (ktpa)
Halton	Runcorn	Viridor	1,100
Bexley	Riverside	Cory	785
Stockton-on-Tees	Tees Valley	Suez	756
Wakefield	Ferrybridge FM1	WTI	625
Wakefield	Ferrybridge FM2	WTI	725
Kent	Kemsley	WTI	657
Enfield	Edmonton	Council	620
Bedfordshire	Rookery South	Covanta / Veolia	585
Kent	Allington	FCC	560
Middlesborough	Wilton 11	Suez	500
S. Gloucestershire	Severnside	Suez	467
Lewisham	SELCHP	Veolia	464
Slough	Lakeside	Viridor / Grundon	450
Birmingham	Tyseley	Veolia	441
Bristol	Avonmouth	Viridor	377
Croydon	Beddington Lane	Viridor	347
Buckinghamshire	Greatmoor	FCC	345
Staffordshire	Four Ashes	Veolia	340
Oxfordshire	Ardley	Viridor	326
North Yorkshire	Allerton Park	Amey	320
Coventry	Coventry	Council	315
Suffolk	Great Blakenham	Suez	295
Plymouth	Devonport	MVV	265
Sheffield	Sheffield	Veolia	245
East Sussex	Newhaven	Veolia	242
Cornwall	Cornwall	Suez	240
Worcestershire	Hartlebury	Severn	230
Southampton	Marchwood	Veolia	220
Portsmouth	Portsmouth	Veolia	220
Stoke-on-Trent	Hanford	MESE	210
Nottingham	Eastcroft	FCC	200
Lincolnshire	North Hykeham	FCC	190
Gloucestershire	Javelin Park	UBB	190
Leeds	Leeds	Veolia	190
Huddersfield	Kirklees	Suez	150
Hull	Energy Works ACT	Engie	125
Gtr. Manchester	Bolton	Suez	120
Wolverhampton	Wolverhampton	MESE	118
Hampshire	Chineham	Veolia	110
Dudley	Dudley	MESE	105
Shropshire	Battlefield	Veolia	102
Warwickshire	Baddersley	Equitix	100
Milton Keynes	Milton Keynes ACT	Amey	94
Peterborough	Peterborough	Viridor	85
West Sussex	Lancing	Enviropower	75
Devon	Exeter	Viridor	60
Surrey	Eco Park ACT	Suez	60
NE Lincolnshire	NewLincs	Tiru	56
Isle of Wight	Isle of Wight	Amey	30
Isle of Man	Isle of Man	Suez	50

11 incinerators in construction with a combined capacity of 3,906 ktpa

Location	Facility	Operator	Capacity (ktpa)
Cheshire	Lostock	FCC	600
Cheshire	Protos	Biffa/Covanta/GIG	500
Slough	Slough	SSE/CIP	480
Leeds	Enfinium	efinium	410
West Bromwich	Kelvin	efinium	395
Leicestershire	Newhurst	Biffa/Covanta/GIG	350
Merseyside	Hooton Park ACT	BWSC/Cogen	266
Derbyshire	Drakelow ACT	Vital	180
Somerset	Bridgwater	Equitix/Iona	100
Enfield	Edmonton	Council	80

8 incinerators consented and permitted with a combined capacity of 2,872 ktpa

Location	Facility	Operator / Applicant	Capacity (ktpa)
Bexley	Riverside 2	Cory	655
Braintree	Rivenhall	Indaver	595
Stockton	Billingham Reach	TeesEco	375
Goole	Southmoor	Peel Environmental	350
Lancashire	Heysham	Veolia	330
Doncaster	Kirk Sandall	BH Energy Gap	300
Tipton, Dudley	Bloomfield Road Pyrolysis Plant	High Energy Fuels	180
Exeter	Hill Barton	Exeter Waste to Energy	87

19 incinerators consented without a permit issued with a capacity of 5,730 ktpa

Location	Facility	Operator / Applicant	Capacity (ktpa)
Grimsby	South Humber Bank	Eggborough Power	754
Cleveland	Graythorpe	Graythorp Energy	560
Ratcliffe-on-Soar	EMERGE	Uniper UK	500
Darwen	Darwen	Suez	500
Redcar	Recar	PMAC Energy	450
Walsall	The WandE	BH EnergyGap	436
Preston, Lancs	Longridge Road	Miller Turner Group	400
Tilbury	Tilbury 2	Tilbury Green Power	350
Corby	Corby Willowbrook	Corby Limited	260
Carlisle	Kingmoor	Fortum Carlisle	250
Melton	Melton	Thermeco (Seneca)	250
Horsham	Horsham	Britaniacrest	180
Bristol	Avonmouth LCEF	Zeus Renewables	156
Corby	Brookfield Plantation	ESF Energy	154
Swindon	Keypoint	Rolton Group	150
Reading	Reading Quarry	J Mould (Reading)	150
Malton	Knapton	Knapton Green Energy	130
Kidderminster	Kidderminster	Power Generation Solutions	75
Telford	Telford	Cartwrights Waste Disposal	25

10 incinerators awaiting a planning application decision with a capacity of 4,068 ktpa

Location	Facility	Operator / Applicant	Capacity (ktpa)
Boston, Lincolnshire	BAEF	Alternative Use Boston	1,200
Flixborough	North Lincolnshire GEP	Solar 21	760
Fenland, Cambs	Medworth	MVV	625
Grangetown, Redcar	Tees Valley	Not decided	450
Alton, Hampshire	Alton ERF	Veolia	330
Westbury, Wiltshire	Northacre	Hills Group	243
Portland, Dorset	Portland	Powerfuel Portland	200
Pitsea, Essex	Archers Fields	Whitehair	150
Consett, Durham	Consett	Genesis Project	60
Parley, Dorset	Chapel Lane	Eco Sustainable Solutions	50

References

[i] HM Government's 'Delivering on the Environment Act: new targets announced and ambitious plans for nature recovery' (16th March 2022) available at https://www.gov.uk/government/news/delivering-on-the-environment-act-new-targets-announced-and-ambitious-plans-for-nature-recovery

[ii] Defra's 'Consultation on environmental targets' (2022) available at https://consult.defra.gov.uk/natural-environment-policy/consultation-on-environmental-targets/

[iii] Page 9 of 'Statistics on waste managed by local authorities in England in 2016/17' available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664594/LACW_mgt_annual_Stats_Notice_Dec_2017.pdf

[iv] Page 77 of HM Government's 'Our Waste, Our Resources: A strategy for England – Evidence Annex' (December 2018) available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/765915/rws-evidence-annex.pdf

[v] According to the Office of National Statistics (ONS) analysis: "Over the 25-year period between mid-2020 and mid-2045, England is projected to have the largest increase in population, at 6.7%". See 'National population projections: 2020-based interim' (January 2022) available at https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2020basedinterim

[vi] Defra's 'Environment Act Targets Impact Analysis: Waste Reduction' available at https://consult.defra.gov.uk/natural-environment-policy/consultation-on-environmental-targets/supporting_documents/Resource%20efficiency%20and%20waste%20reduction%20targets%20%20Impact%20Assessment.pdf

[vii] Tolvik's 'UK Energy from Waste Statistics – 2021' available at https://www.tolvik.com/wp-content/uploads/2022/05/Tolvik-UK-EfW-Statistics-2021_Published-May-2022.pdf

[viii] BEIS' 'Renewable Energy Planning Database: quarterly extract' available at https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract

[ix] For Environmental Permit documents and information about planning applications and consents see the entries on UKWIN's 'Map and Table of existing and potential UK incinerators' available at https://ukwin.org.uk/incinerators/

[x] UKWIN's 'Submission to the Scottish Incineration Review' (February 2022) available at https://ukwin.org.uk/files/pdf/UKWIN-Submission-to-Scottish-Incineration-Review-February-2022.pdf

[xi] Eunomia's 'Residual Waste Infrastructure Review (12th Issue)' (7th August 2017) available at http://www.eunomia.co.uk/reports-tools/residual-waste-infrastructure-review-12th-issue/

[xii] 'Wales' giant waste incinerator is set to expand - and people are furious' (13th March 2017) available at https://www.walesonline.co.uk/news/wales-news/hundreds-people-say-should-no-12729274

[xiii] 'Cory Riverside Energy case study' available at https://www.ice.org.uk/engineering-resources/case-studies/cory-riverside-energy-a-carbon-case/

This technical paper was prepared to accompany UKWIN's briefing on incineration overcapacity

Authors: Josh and Shlomo Dowen, UKWIN
Webpage: https://ukwin.org.uk/overcapacity
Contact: coordinator@ukwin.org.uk

♻ **Printed on recycled paper**