Wheelabrator TECHNOLOGIES

Deadline 5: Applicant's Response to Submissions at Deadline 4

Appendix A - Tolvik UK Energy from Waste Statistics 2019

Wheelabrator Kemsley (K3 Generating Station) and Wheelabrator Kemsley North (WKN) Waste to Energy Facility Development Consent Order

PINS Ref: EN010083

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June 2020 – Deadline 5

TOLVIK CONSULTING

The Waste and Bioenergy Experts

UK Energy from Waste Statistics – 2019

May 2020

INTRODUCTION

Tolvik's sixth annual report on the UK Energy from Waste ("EfW") sector brings together data from a range of sources into a single document. Thanks to excellent co-operation between the Environment Agency, Environmental Services Association and individual EfW operators, there has been significant progress in the standardisation of reporting via the Annual Performance Reports ("APR") prepared by operators which has greatly facilitated the preparation of this report.

As we develop the report each year, so the range of subjects covered is expanded. For the first time, and in line with increased stakeholder interest, this year we have undertaken a preliminary assessment of the carbon intensity of EfWs per tonne of waste processed. Such analysis is, given the lack of an agreed methodology, subjective and we would particularly welcome any feedback on our calculations. Meanwhile the sections on operations, consumable usage and emissions to air have been developed as more data becomes available.

For consistency with previous years, the focus of this report continues to remain upon conventional moving grate EfWs and Advanced Conversion Technology ("ACT") facilities in the UK generating energy from the combustion of Residual Waste.

Residual Waste is defined as non-hazardous, solid, combustible mixed waste which remains after recycling activities. This definition is a little broader than that for Municipal Waste but primarily includes wastes falling within European Waste Catalogue ("EWC") 19 12 10, 19 12 12 and 20 03 01. The report continues to exclude EfW facilities in Jersey and the Isle of Man and facilities solely processing Waste Wood or other biomass wastes. The latter are subject to a report we issued in April 2020.

Please also note, where applicable, prior year data has been updated to reflect the latest available information and data may not add up to the total due to rounding.

We would like to take the opportunity to thank all those who have assisted us in the preparation of this report.

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Front Cover Image: Dunbar EfW, fully operational in 2019 Courtesy: Viridor

1. SUMMARY OBSERVATIONS

- In 2019 the tonnage of Residual Waste processed at EfWs in the UK was up 9.9% when compared with the previous year to 12.6 Million tonnes ("Mt").
- At the end of 2019, there were 53 EfWs operational or in late commissioning and 11 EfWs in construction with one EfW "mothballed".
- During the year, the total Headline Capacity of EfWs which were operational or in construction increased by 1.6Mt when compared with 2018. This increase was a result of 3 new projects and increases in consented capacity at existing facilities.
- During 2019 EfWs in the UK exported 6,700GWh of electricity - circa 2% of the UK total power generation - together with just under 1,400GWh of heat.

Measuring carbon impacts	Last year's report pointed to the fact that incineration tax was increasingly a subject for debate. Since then, driven in part by the extension of the incineration tax in the Netherlands to imports from the UK and in part by its planned CO_2 tax, there has been an increased interest in the carbon impact of EfW in the UK. Our work in recent months has highlighted that there is currently limited consistency in the way in which the carbon impact of EfW is calculated both in the UK and Europe. Whilst it is acknowledged that setting the basis for calculation is potentially complex, it appears to us that analysis is currently being used more as a exercise to promote a particular project or theme, rather than as a robust assessment of environmental performance.
Power export reliability	For the second successive year total power export from UK EfWs, when measured in terms of kWh generated per tonne of waste processed, fell as the result of major turbine/generator failures.
Challenges around commissioning and early operations **for ACTs**	Overall EfW inputs in 2019 were in line with our projections. This was because, unlike previously, we factored in significant commissioning delays on a number of projects. ACT commissioning remains challenging – as highlighted by the effective "mothballing" of Sinfin Road ACT in Derby. After at least four years of construction the seven ACT facilities which combusted waste, collectively processed just 27% of their Headline Capacity.
Existing consents (both planning & permits) **will continue to be increased**	As reported last year, operators continue to look to increase consents for existing EfWs, both to reflect improved operations and provide operators with additional flexibility. Care will be needed going forward not to prejudice stakeholders, who may come to view such increases not as a (positive) consequence of optimisation but as part of a deliberate developer strategy to create a larger facility by "stealth".
Construction capacity	Following the departure of a number of construction companies from the sector in recent years, there has been limited liquidity in the EfW construction market. However new entrants are now slowly appearing, and existing players focusing on core strengths, hopefully better informed by past challenges and with a robust assessment of the risks involved.

2. MARKET OVERVIEW

The EfWs falling within the scope of this report are listed in Appendix 1.

As at December 2019 there were 48 fully operational EfWs in the UK, with a further 6 EfWs accepting waste during the year (including the mothballed facility).

The Total Headline Capacity of those EfWs which were fully operational or in late stage commissioning was 15.40Mtpa with a further 3.10Mtpa of EfW capacity either in construction or about to commence construction.

Mtpa	Fully Operational	In Late Stage Commissioning	Total Headline Capacity	In Construction	Total
2015	8.87	1.21	10.08	4.16	14.24
2016	10.48	1.28	11.76	4.16	15.92
2017	11.85	0.41	12.26	3.64	15.90
2018	12.42	1.07	13.50	3.37	16.87
2019	**14.60**	**0.80**	**15.40**	**3.10**	**18.50**

Figure 1: Headline Capacity (as at December 2019) Source: Tolvik analysis

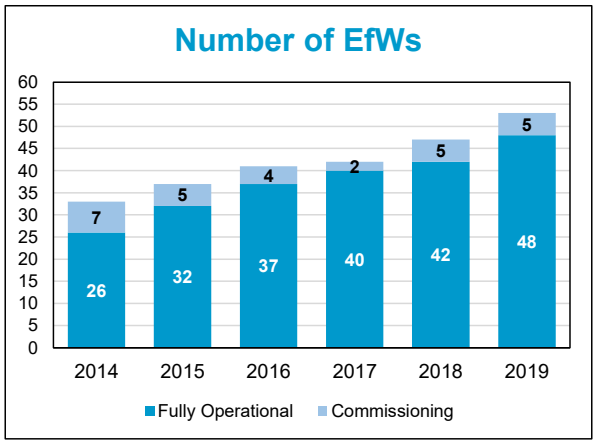


Figure 2: Number of EfW Facilities

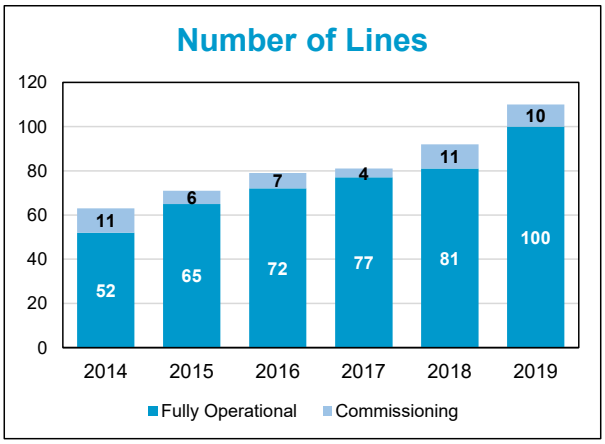


Figure 3: Number of Lines at EfW Facilities

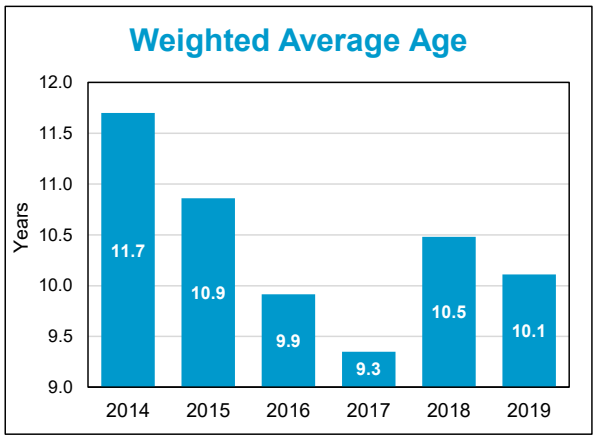


Figure 4: Weighted Average Age by Capacity (as at December 2019) Source: Tolvik analysis

Figure 4 shows the capacity-weighted average age of UK EfWs – as can be seen over the last 4 years the average age has been maintained at 9-10 years as new EfWs become operational at a sufficient rate to maintain the average.

In time the average age will start to rise slowly as the proportion of new EfW capacity becoming operational to existing capacity will inevitably decline.

3. WASTE INPUTS

In 2019 a total of 12.63Mt of Residual Waste was processed in UK EfWs, an increase of 9.9% on 2018. This is in line with Tolvik's 2019 projection in the previous report of 12.6Mt.

Total inputs were the equivalent, for EfWs fully operational throughout the year, to 89.7% of the total Headline Capacity – not dissimilar to the figure for previous years.

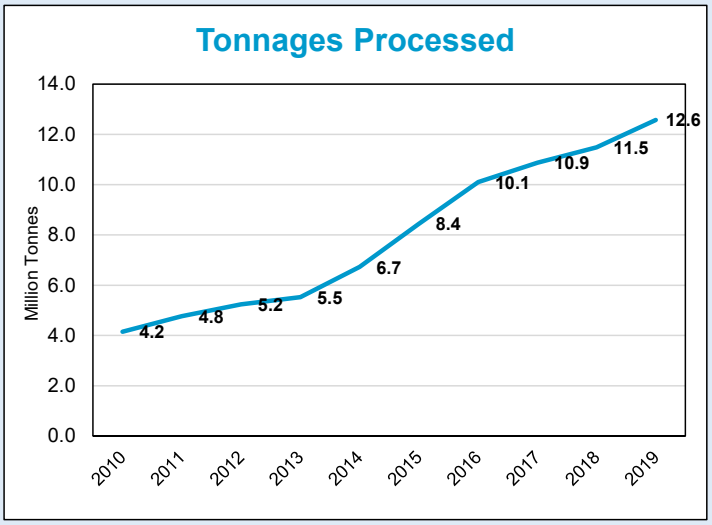


Figure 5: Total Tonnage of waste accepted at EfWs in 2010-2019
Source: APR

Mt	Input Tonnage	Inputs as % of Headline Capacity
2015	8.45	89.0%
2016	10.10	91.0%
2017	10.88	90.8%
2018	11.49	90.9%
2019	**12.63**	**89.7%**

Figure 6: Annual EfW Inputs
Source: APR

The Role of EfW in the UK Residual Waste Market

In 2019 provisional data suggests that Residual Waste inputs to EfWs in the UK represented 45.5% *(2018: 41.8%)* of the overall UK Residual Waste market.

2019 saw the total tonnage of Residual Waste sent to EfW in the UK exceed the tonnage sent to landfill for the first time.

It is estimated that in 2019 RDF Exports from the UK declined by around 16% when compared with 2018.

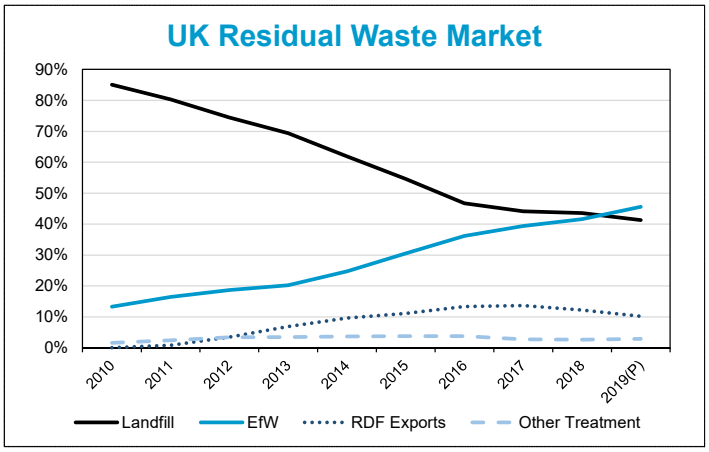


Figure 7: Development of the UK Residual Waste Treatment; 2019 Estimate
Source: Tolvik analysis

EfW Inputs by Waste Source and Type

Based on a detailed review of APRs for 2019 and Wastedataflow[1] for 2018/19 and other available data, it is estimated that in 2019 81.5% of all EfW inputs were derived from Residual Local Authority Collected Waste ("LACW") with the rest being Commercial and Industrial ("C&I") Waste.

The modest increase in Residual C&I Waste inputs is expected to rapidly increase in the next few years as more "merchant" EfW capacity in the UK becomes operational.

Year	Waste Source	
	LACW	C&I Waste
2015/16	85.1%	14.9%
2016/17	83.2%	16.8%
2017/18	84.4%	15.6%
2018	82.4%	17.6%
2019	81.5%	18.5%

Figure 8: Inputs by Waste Source Source: Wastedataflow, APR

Input by EWC Codes

According to available data, 68.9% of inputs to EfW in 2018 (the last year for which data was available) was unprocessed Municipal Waste with a further 28.2% of inputs being Residual Waste arising after prior treatment.

Year	EWC Code		
	20 03 xx	19 12 10/12	Other Codes
2017	68.7%	30.5%	0.8%
2018	68.9%	28.2%	2.9%

Figure 9: Inputs by EWC Source: EA Incinerator Waste Returns[2]

In 2019 17kt (0.1% of total inputs) of Clinical Waste were reported by operators as being processed by EfWs. This tonnage has been excluded from the analysis in this report.

Net Calorific Value of Residual Waste

Tolvik's most recent analysis of data relating to the Net Calorific Value ("NCV") of waste (from a variety of sources, some of which was under confidentiality) relates to 2017. This data suggested that the average NCV for Residual LACW in 2017 was 8.9MJ/Kg and for Residual C&I Waste was 11.0MJ/Kg. As previously reported, there is a very wide range of results and so these averages need to be treated with caution.

Operator Market Shares

In 2019 Viridor passed Veolia in having the greatest market share by operator based on input tonnages. MES, MVV and Amey are not shown in the table but each had a share of >2%.

Operator	2019 Input (kt)	Share
Viridor	2,786	22.1%
Veolia	2,344	18.6%
Suez	2,216	17.6%
FCC	1,490	11.8%
MFE/WTI	864	6.8%
Council	818	6.5%
Cory	743	5.9%
Other	1,375	10.9%
Total	**12,626**	**100.0%**

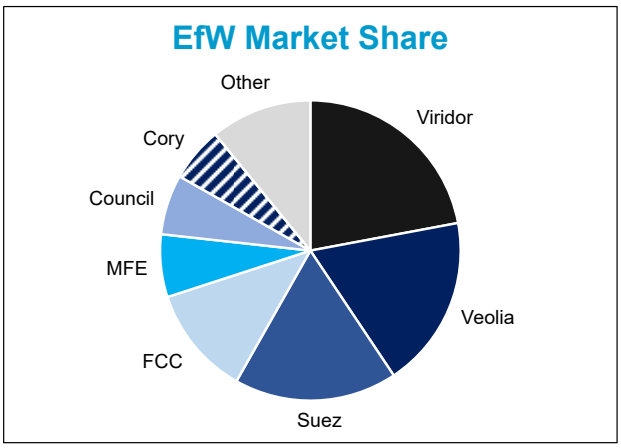


Figure 10: 2019 Share of Input Tonnage (includes Joint Ventures) Source: Tolvik analysis

4. ENERGY

It is estimated that the total power exported by EfWs in the UK in 2019 was 6,703GWh – approximately 2.0% of total UK generation. Power export issues at a number of operational EfWs meant that for a second successive year the total power export per tonne fell – to 531kWh/tonne of inputs.

	Est. Gross Power Generation GWh_e	Net Power Export GWh_e	Parasitic Load (excl. power import)	Parasitic Load (incl. power import)	Average Net kWh/tonne input	Net Heat Export GWh_{th}
2015	5,460	4,636	15.1%	N/A	549	554
2016	6,210	5,291	14.8%	15.3%	524	730
2017	7,228	6,258	13.4%	14.1%	575	865
2018	7,150	6,230	12.9%	13.9%	542	1,112
2019	**7,769**	**6,703**	**13.7%**	**16.2%**	**531**	**1,384**

Figure 11: 2019 Power Generation Source: Tolvik analysis

With the change in the mix of operational EfWs, average parasitic loads (expressed as a percentage of total power generation) rose slightly after a number of years of steady improvement.

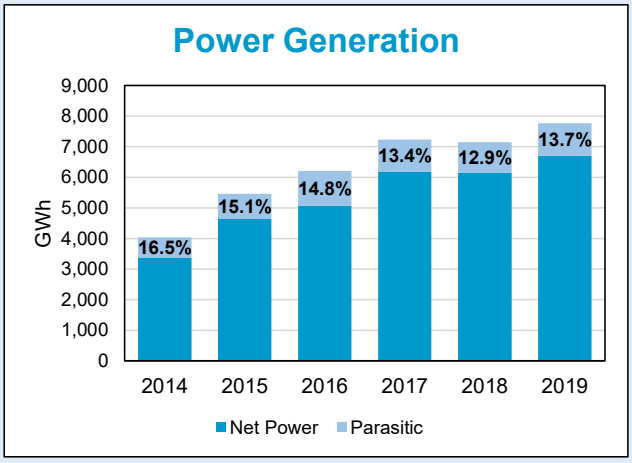


Figure 12: Power Generation from EfW

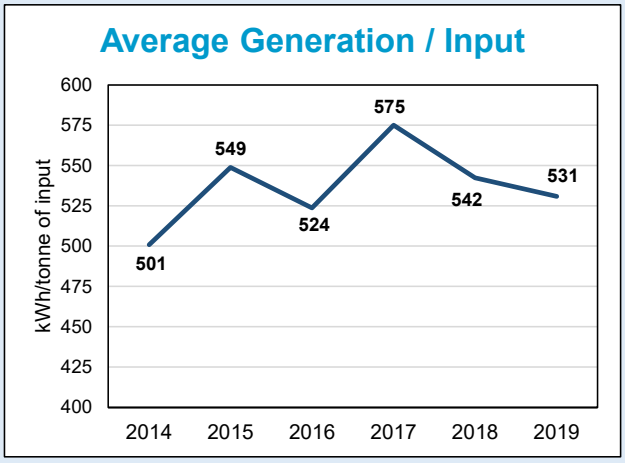


Figure 13: Average Power Generation per tonne of input

Power: Benchmarking

For each EfW for which data was reported, Figures 14 and 15 show the distribution of the average net power exported per tonne of input and the average parasitic power load for the year.

With an average 531kWh/t generated per tonne of waste input in 2019 *(2018: 542kWh/t),* across all EfWs the output ranged from Bolton with no power exported during the year (due to a fire in 2018) and Ardley (at 58kWh/t due to generator failure in January 2019) to 890kWh/t at Ferrybridge FM1 which for the third year generated the highest figure. The figure for Ferrybridge FM1 in part reflects its feedstock (solely RDF with a higher NCV), optimised design and the fact that it does not export heat.

The average parasitic load in 2019 was in part distorted by the figure for Ardley (see above) but in total 8 EfWs reported a parasitic load greater than 20%. This resulted in a much increased average in 2019 when compared with 2018. Severnside once again had the lowest parasitic load at 8.6%.

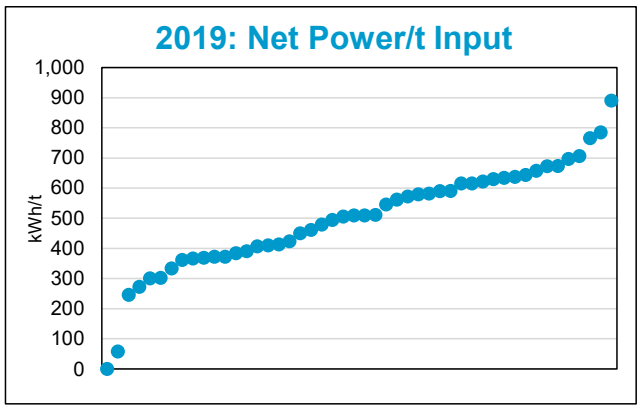


Figure 14: 2019 Net Power Exported per tonne of Input
Source: Tolvik analysis, 48 records

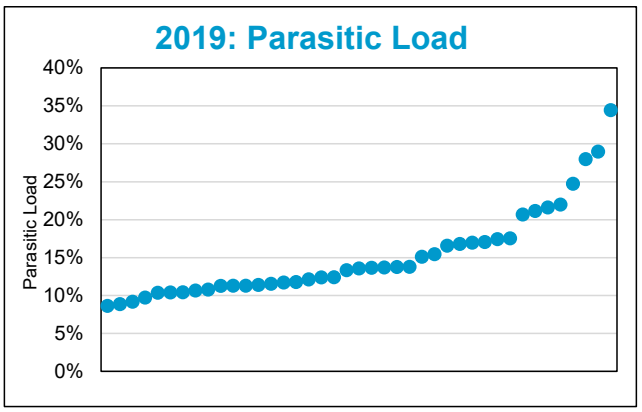


Figure 15: 2019 Parasitic Load Distribution
Source: Tolvik analysis, 42 records

Beneficial Heat Use

In 2019 10 EfWs in the UK exported heat for beneficial use alongside power with an estimated total export of 1,138GWh$_{th.}$ *(2018: 1,112GWh$_{th}$)*. Across all EfWs this was the equivalent of 110kWh$_{th}$/tonne of inputs *(2018: 97kWh$_{th}$/tonne)*.

EfW	Est. Export GWh$_{th}$			Heat/Steam Offtake
	2017	2018	2019	
Eastcroft	224	332	420	Enviroenergy for electricity generation and hot water
Runcorn	405	408	405	Steam supply to Ineos
Wilton 11	-	100	303	Adjacent Wilton International site
Sheffield	96	112	111	District heating operated by Veolia
Devonport	54	59	48	Adjacent naval dock yard
Gremista	40	40	40	District heating on the Shetland Islands *(estimated)*
SELCHP	37	38	39	District heating operated by Veolia
Coventry	5	11	13	District heating operated by Engie
NewLincs	3	3	3	To local industry
Leeds	-	8	2	District heating operated by Vital Energi
Total	**865**	**1,112**	**1,384**	

Figure 16: Reported heat exports from EfWs Source: APR

5. OPERATIONS

For the first time this report considers EfW availability based on operational hours, as reported by operators in their APR, for both waste combustion and also turbine operations.

Across those EfWs which were operational for the whole of 2019, the average availability based on waste combustion was the highest for 3 years. It is noteworthy that the weighted average availability, a measure which favours larger capacity EfWs, was only very modestly higher than the simple average. The availability based on turbine operations was much lower at 81.9% reflecting the previously noted technical issues at a number of EfWs.

Figure 17 also shows, IBA and APCr produced per tonne of input waste have fallen modestly in recent years.

	Availability - Hours			% of Input Tonnage		
	Waste Combustion - Simple Average	Waste Combustion – Weighted Average	Turbine Operations – Simple Average	Incinerator Bottom Ash ("IBA")	Air Pollution Control Residue ("APCr")	Metals Recovery (if reported)
2015	88.3%	88.7%	N/A	20.4%	3.5%	1.9%
2016	90.2%	90.3%		20.2%	3.5%	1.9%
2017	88.6%	89.3%		20.1%	3.4%	1.9%
2018	87.3%	89.8%		19.9%	3.3%	1.9%
2019	**89.5%**	**90.0%**	**81.9%**	**19.4%**	**3.3%**	**1.9%**

Figure 17: Operational Data Source: APR

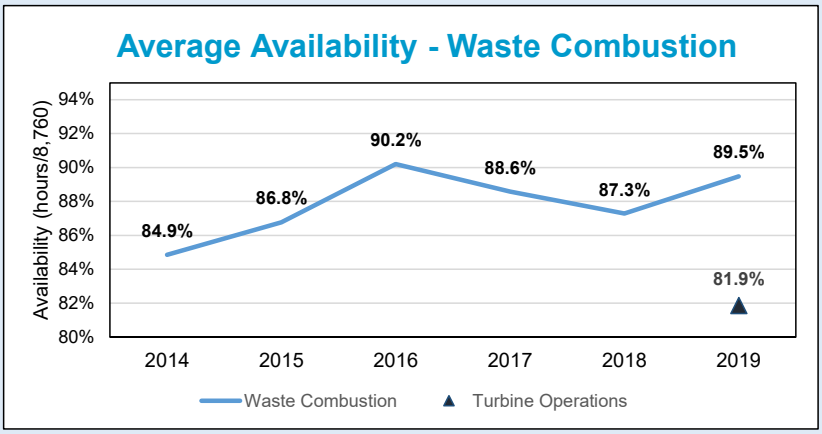


Figure 18: Average EfW Availability – Hours Source: Tolvik analysis

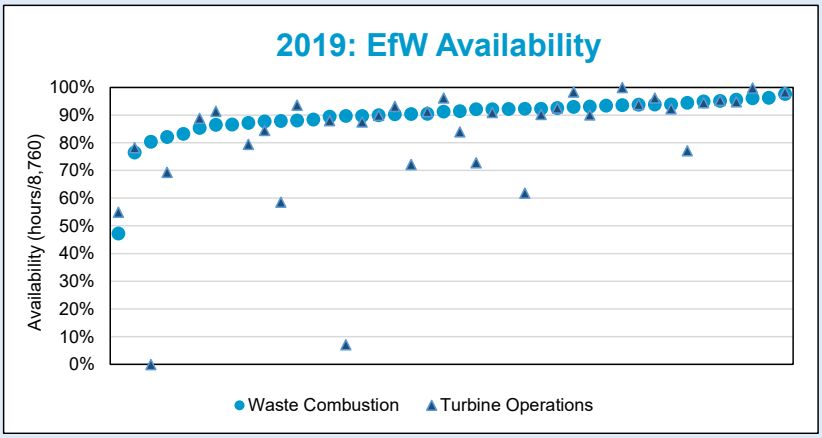


Figure 19: 2019 EfW Availability – Hours Source: Tolvik analysis, 42 records

Operator	Number of EfWs	Simple Average Availability	Capacity Weighted Average
MFE	1	96.1%	96.1%
Other	2	93.1%	93.6%
Veolia	10	93.7%	93.2%
Viridor	6	91.4%	91.8%
MVV	2	89.2%	91.5%
MESE	3	90.8%	89.5%
FCC	5	89.7%	88.7%
Public Sector	3	88.1%	88.2%
Suez	7	88.0%	88.2%
Cory	1	87.9%	87.9%
Amey	2	61.9%	69.9%
Average	**42**	**89.5%**	**90.0%**

Figure 20: 2019 Average Availability (Waste Combustion) by Operator – EfWs operational for the full year

During 2019 six EfWs reported an average Waste Combustion availability of greater than 95% for 2019. These ranged in scale from MFE's Ferrybridge FM1 down to Lancing together with three Veolia facilities and MVV's Devonport.

Milton Keynes ACT was the only EfW which had an availability below 75% - although a further 6 ACTs processed waste during the year none of the others were operational (i.e. post take-over) for the full year.

Seven facilities reported average Turbine Operations availability in excess of 95% during 2019. However 8 EfWs reported a figure below 75% including Bolton and Ardley (see previous section), three other Suez facilities, Riverside, Chineham and Milton Keynes ACT.

Outputs

Incinerator Bottom Ash

In 2019 IBA accounted on average for 19.4% *(2018: 19.9%)* of all waste inputs with the average percentage generated falling steadily over time. In total, the tonnage of IBA generated in 2019 was over 2.4Mt.

IBA outputs expressed as a percentage of waste inputs generally fell within the 11% - 33% range, with Allington, as a fluidised bed facility, once again reporting the lowest percentage. The largest totals relate to Milton Keynes ACT and Javelin Park – the latter being only operational for only part of the year. Almost all IBA is now recycled rather than landfilled.

Air Pollution Control Residues

In 2019 APCr generation was 3.3% of waste inputs *(2017: 3.4%)*. The total generation of APCr in 2019 is estimated to have been 420kt.

Four facilities generated more than 5% of APCr as a percentage of inputs – the fluidised bed facilities Allington, Baldovie together with Milton Keynes ACT and Lancing.

In 2019 it was estimated that around 35% of APCr was recycled. The previous estimate, for 2017, was of a figure nearer 20%.

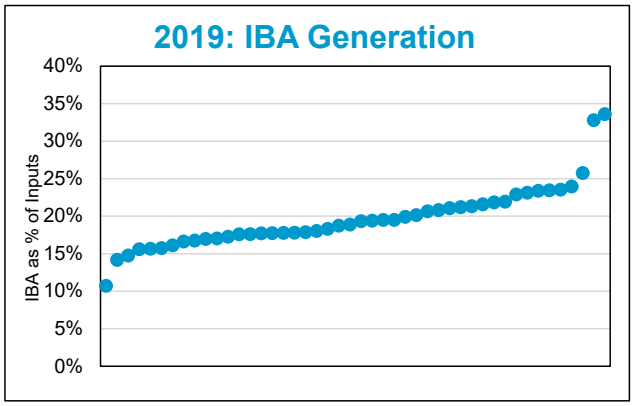


Figure 21: 2019 Distribution of IBA Generation (as % of inputs)
Source: Tolvik analysis, 46 records

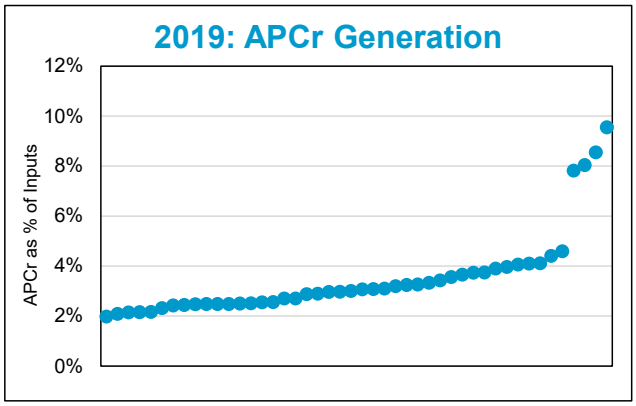


Figure 22: 2019 Distribution of APCr Generation (as % of inputs)
Source: Tolvik analysis, 46 records

Consumable Use

With the introduction of the standardised APR form in England, the level of data reporting relating to the use of consumables continues to rise although there have been several examples in which the data was clearly reported using incorrect units. In the analysis data is calibrated to "Specific Usage" i.e. usage per tonne of input. Fuel Oil has been reported for the first time in this report.

There are no discernible trends with respect to carbon or lime usage, but specific urea/ammonia usage appears to be in decline.

Consumable	Per tonne input	Low	Median	High
Total Water Usage	m^3	0.02	0.22	3.33
Activated carbon or coke	kgs	0.04	0.29	0.53
(Hydrated) lime or sodium bicarb	kgs	1.78	10.18	33.66
Urea	kgs	0.32	1.22	3.00
Ammonia	kgs	0.40	1.59	3.94
Fuel Oil	ltrs	0.01	1.35	22.55

Figure 23: 2019 Specific Consumable Usage (where reported) Source: APR

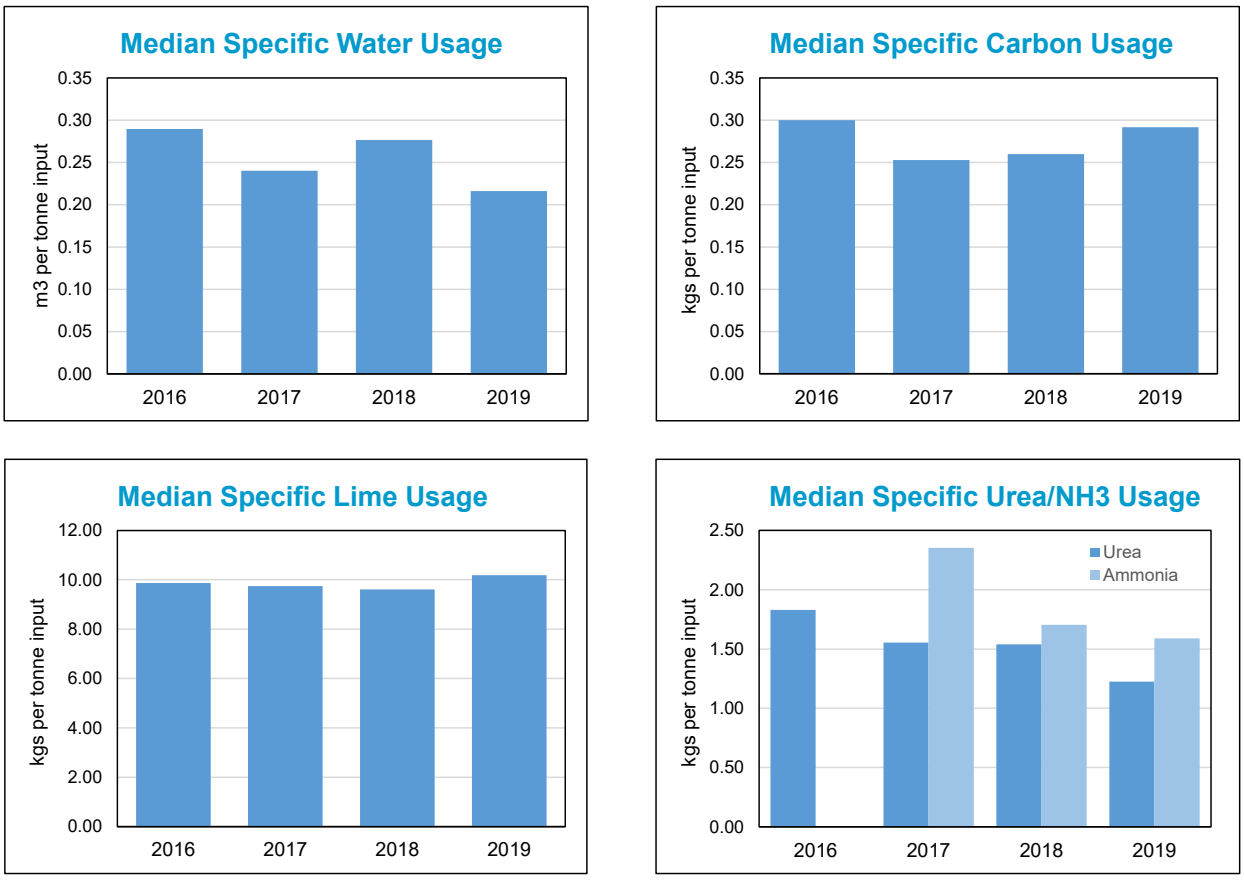


Figure 24: Trend in Specific Consumable Usage (where reported) Source: APR

Efficiency and R1

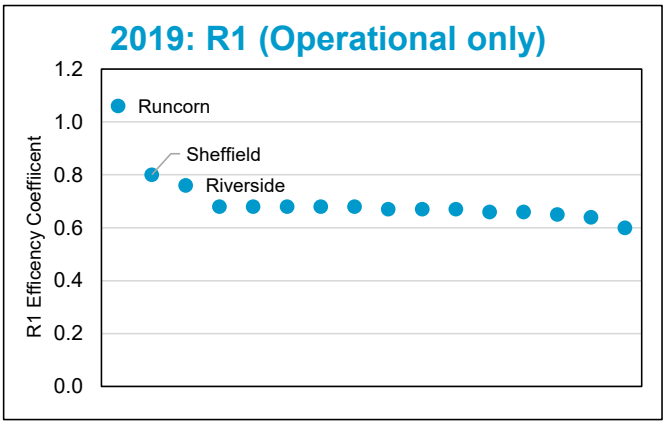


Figure 25: R1 (Operational Status only) in England Source: EA

As at February 2020, in England 28 EfWs with a total headline capacity of 10.3Mt were accredited as R1 ("Recovery") operations with 16 of the R1 calculations based on operational data and 12 on design data. To achieve R1 requires an efficiency coefficient of at least 0.60 (for existing EfWs) and 0.65 (for newbuilds).

No Scottish EfWs are reported as being R1 accredited.

Carbon Intensity of EfW (per tonne)

For the first time, the report considers the "carbon intensity" of EfW in the UK. As with many sectors there is a significant element of subjectivity in estimating the carbon intensity, recognising that EfWs accept a range of wastes and are not simply power stations but provide substitution impacts including diverting waste from landfill and, depending on their operational configuration, generating heat and contributing to recycling.

	Per tonne of Input Waste	Unit	Data Source	2017	2018	2019
	Average CO2 emitted	*tCO2*	*Pollution Inventory[3]*	*1.040*	*1.037*	*1.037*
	% Fossil		*WRAP Composition – 2017[4]*		*49.2%*	
Emissions	Fossil CO2 emitted	tCO2		0.512	0.510	0.510
	Other GHG emitted	tCO2e	*Pollution Inventory[3]*		0.016	
	Fuel/Imported Power	tCO2e	*APR and UK GHG Conversion Factor*	0.005	0.004	0.004
	Total Emissions	**tCO2e**		**0.533**	**0.531**	**0.531**
	Power Export	*MWh*	*Figures 11 and 17*	*0.575*	*0.542*	*0.531*
	Heat Export	*MWh*		*0.080*	*0.097*	*0.110*
	Recycling Benefit	*t*		*0.019*	*0.019*	*0.019*
Substitution Benefits	Power Export	tCO2e	*Converted using UK Government GHG Conversion Factors for company reporting for the applicable year[5]*	(0.202)	(0.154)	(0.136)
	Heat Export	tCO2e		(0.016)	(0.018)	(0.019)
	Recycling Benefit	tCO2e		(0.023)	(0.034)	(0.033)
	Total Benefit	**tCO2e**		**(0.241)**	**(0.206)**	**(0.188)**
	EfW Impact	**tCO2e**		**0.292**	**0.325**	**0.343**
	Avoided Landfill	*tCO2e*	*Average calculated from 4 EfW planning applications in 2019/20*		*(0.375)*	
	Net EfW Impact	***tCO2e***		***(0.083)***	***(0.049)***	***(0.032)***

Figure 26: Estimated Carbon Emissions per tonne of waste input

6. COMPLIANCE

Compliance in the EfW sector is a combination of operator self-monitoring, reporting to and monitoring by the relevant regulator.

EfWs, like most large industrial installations, are required under EU and UK law to monitor their emissions to air both continuously (on site) and periodically (by sample sent to an accredited laboratory). Emissions to water and composition of ash residues are also monitored at regular intervals.

Operators advise that measurement uncertainty, limits of detection for small samples and impact of background pollutant levels can all affect the analysis, but that the protocols used by the sector should be such that reported results are effectively a worst case.

There was a significant increase in the number of EfWs reporting in 2019. For continuously monitored emissions to air, data is available from all EfWs which achieved takeover in 2019 plus Javelin Park – whilst for periodically assessed emissions, information is available from 42 EfWs.

Across all continuously monitored emissions to air, on average in 2019 emissions were 28.8% of the Emissions Limit Value ("ELV") *(2018: 28.9%).* Meanwhile, for periodically monitored emissions, on average emissions were 8.5% of ELV *(2018: 7.6%).*

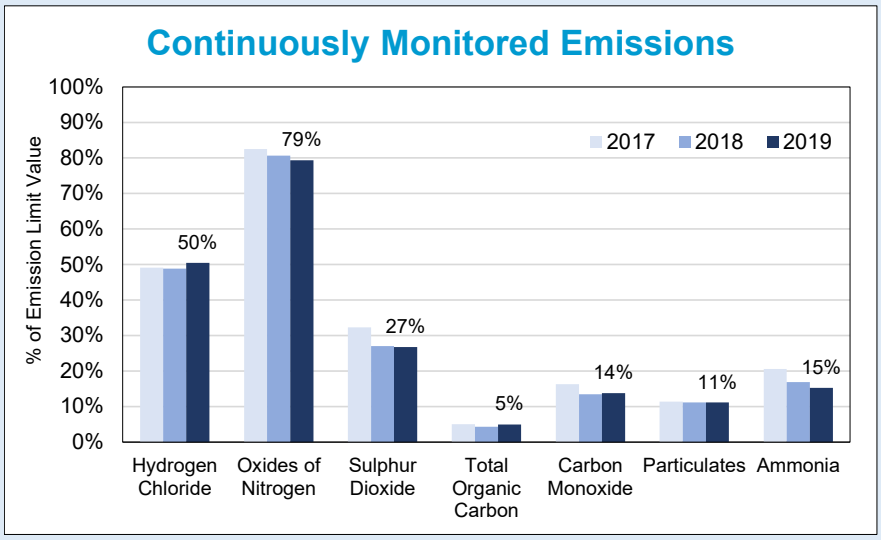


Figure 27: Continuously Monitored Emissions to Air Source: APR

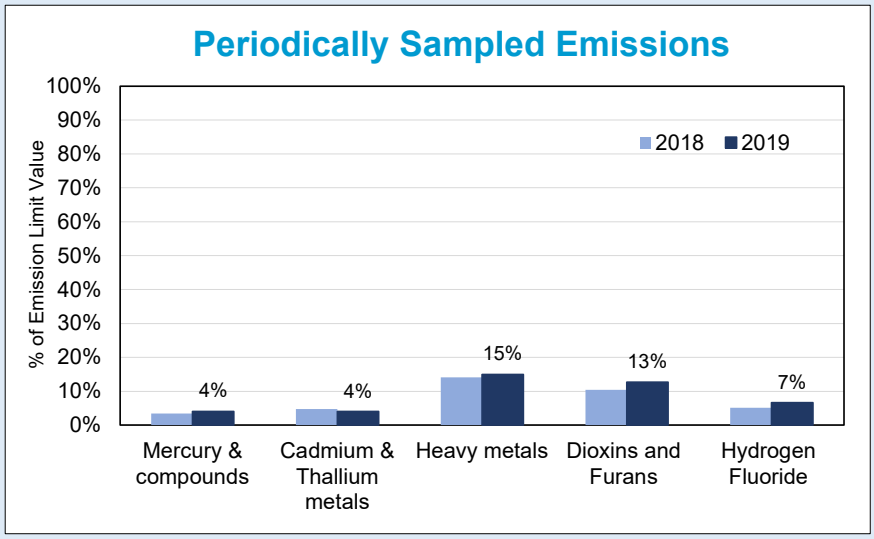


Figure 28: Periodically Monitored Emissions to Air Source: APR

It is to be noted that emission levels of Hydrogen Chlorides (HCl), Sulphur Dioxide (SOx) and Oxides of Nitrogen (NOx) are controlled by the dosing rate of consumable reagents (see Section 5). Typically in the UK, operators look to optimise resource consumption against achieving emissions levels within the specified ELV.

% of Emissions Limit Value	2017	2018	2019
Oxides of Nitrogen	82.5%	80.7%	**79.4%**
Hydrogen Chloride	49.1%	48.8%	**50.4%**
Sulphur Dioxide	32.3%	27.0%	**26.7%**
Ammonia	20.6%	16.9%	**15.2%**
Carbon Monoxide	16.3%	13.5%	**13.7%**
Particulates	11.4%	11.2%	**11.1%**
Total Organic Carbon	5.0%	4.3%	**4.9%**
Simple Average	31.0%	28.9%	**28.8%**

Figure 29: Continuously Monitored Emissions to Air Source: APR

Continuously Monitored

As Figure 30 shows for continuously monitored emissions there are no individual outliers in terms of simple average performance against ELV.

It is noted that both Milton Keynes ACT and Gremista had the lowest emissions expressed as a percentage of ELV.

Periodically Sampled

Figure 31 shows these periodic assessments in 2019 with those EfWs reporting data having results ranging between 3% and 29% of the ELV. The one outlying EfW, with an average of 29% of ELV, was impacted by a single sample which showed a large spike in heavy metals.

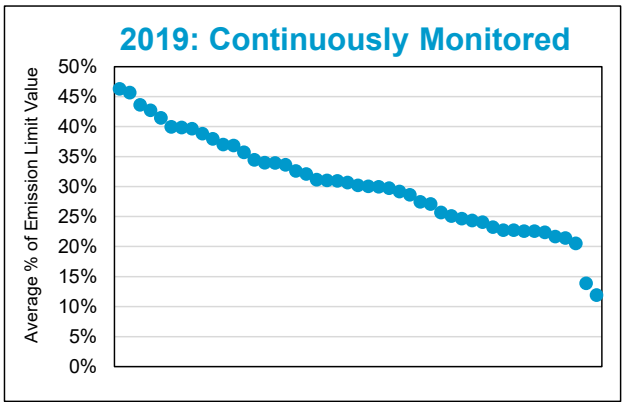


Figure 30: 2019 Distribution of Continuously Monitored Emissions Source: APR and Tolvik analysis

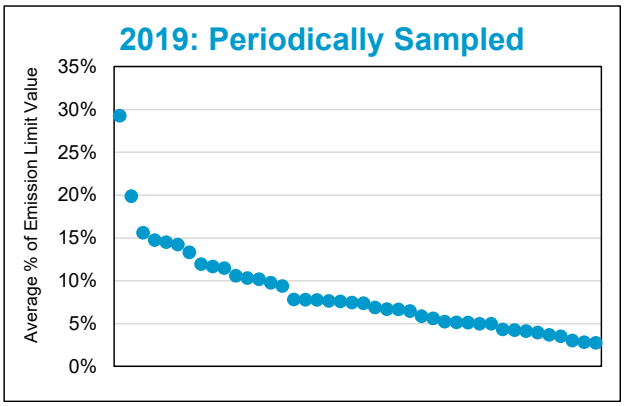


Figure 31: 2019 Distribution of Periodically Sampled Emissions Source: APR and Tolvik analysis

Abnormal Operations

Abnormal Operations	Unit	Year	Total	Number of EfWs Reporting	Per EfW
Abnormal Hours	Hours	2018	130	38	3.4
		2019	**96**	**42**	**2.3**
Abnormal Events	Instances	**2019**	**87**	**44**	**2.0**
Permit Breaches	Instances	**2019**	**127**	**39**	**3.3**

Figure 32: Abnormal Operations Source: APR

The detailed reporting of abnormal operations is relatively new and 2019 was the first year in which operators reported hours of abnormal operations, number of events and numbers of breaches.

There are no clear patterns. Of the 96 hours of abnormal operations in 2019 (down from 130 hours in 2018), two EfWs accounted for one third of the total. Five different EfWs reported more than 10 permit breaches.

Operational Risk Assessment ("OPRA") Scores

All permitted facilities have an OPRA score or equivalent provided by the relevant regulatory authority. A score of A represents the "best" assessment. Using the latest available data for 2019, the performance of the sector as measured by OPRA scores appears to have been relatively static save for one facility for the first time having been recorded with an "F".

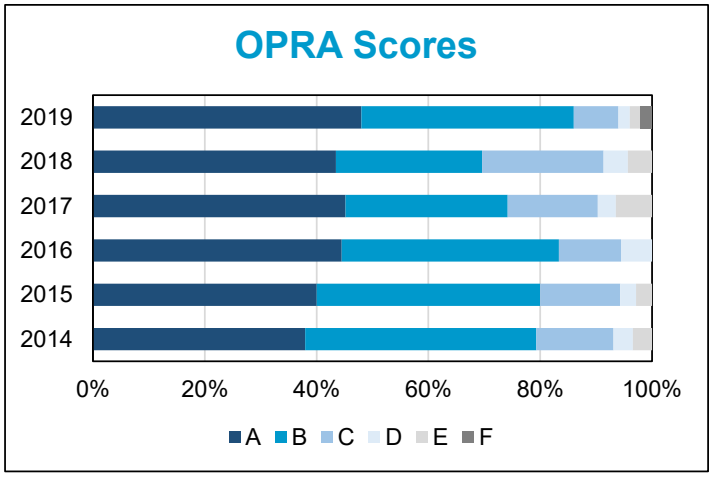


Figure 33: OPRA Scores by Facility Source: EA, SEPA (where available)

7. CAPACITY DEVELOPMENT

Based on EfWs which were operational or in construction as at December 2019, Section 2 identifies a Headline Capacity of 18.50Mt.

Headline Capacity is not suitable for projecting future EfW capacity in any analysis of the UK Residual Waste market; this is more appropriately measured by the "Operational Capacity". It is estimated (based upon the EfWs listed in Figures 37 to 40 in Appendix 1, that by 2024 the UK Operational Capacity will be **17.1Mt.** This reflects an increase of 0.2Mt from the 2018 projection – a relatively modest increase reflecting new EfW projects offset by an assumption that the Operational Capacity of ACTs in general is likely to be lower than previously modelled.

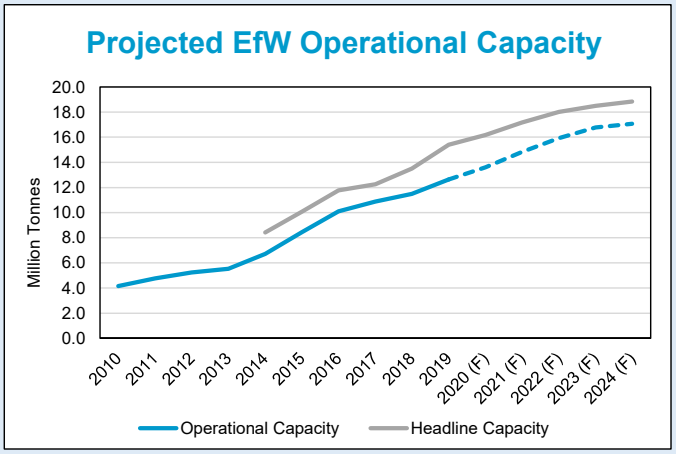


Figure 34: Projected UK EfW Operational Capacity Source: Tolvik analysis

EfW in Development – Additional Capacity

The Headline and Operational capacity beyond 2024 will be dependent on the development of additional EfWs. Tolvik's databases of active projects continued an upward trajectory and totalled 21.0Mt of Headline Capacity as at December 2019 *(2018: 16.3Mtpa).* The list included EfW projects seeking planning consent, have planning consent or for which planning consent has been refused but some form of appeal/new submission is expected.

Of this potential additional EfW capacity being considered:

- 50% has planning consent - reflecting an ongoing increase in new projects;
- 38% is being developed by those who are already active in the UK EfW market – either as an existing operator, as a funder and/or supported by international EfW operators. Previously it is projects backed by these parties that have been the most successful in reaching financial close.

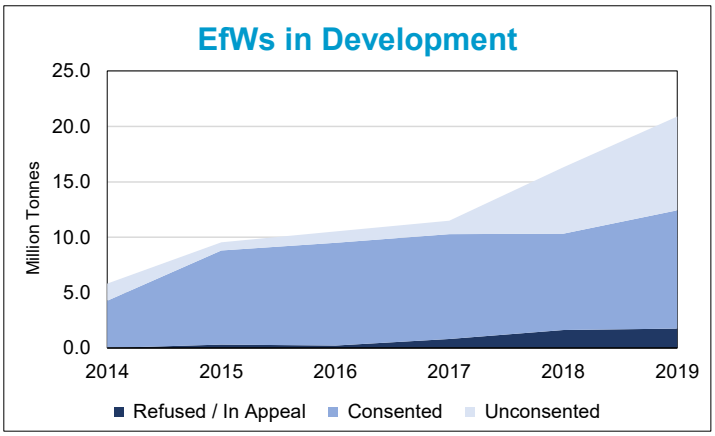


Figure 35: Historic EfW Capacity in Development

APPENDIX 1: ENERGY FROM WASTE FACILITIES INCLUDED IN THE REPORT

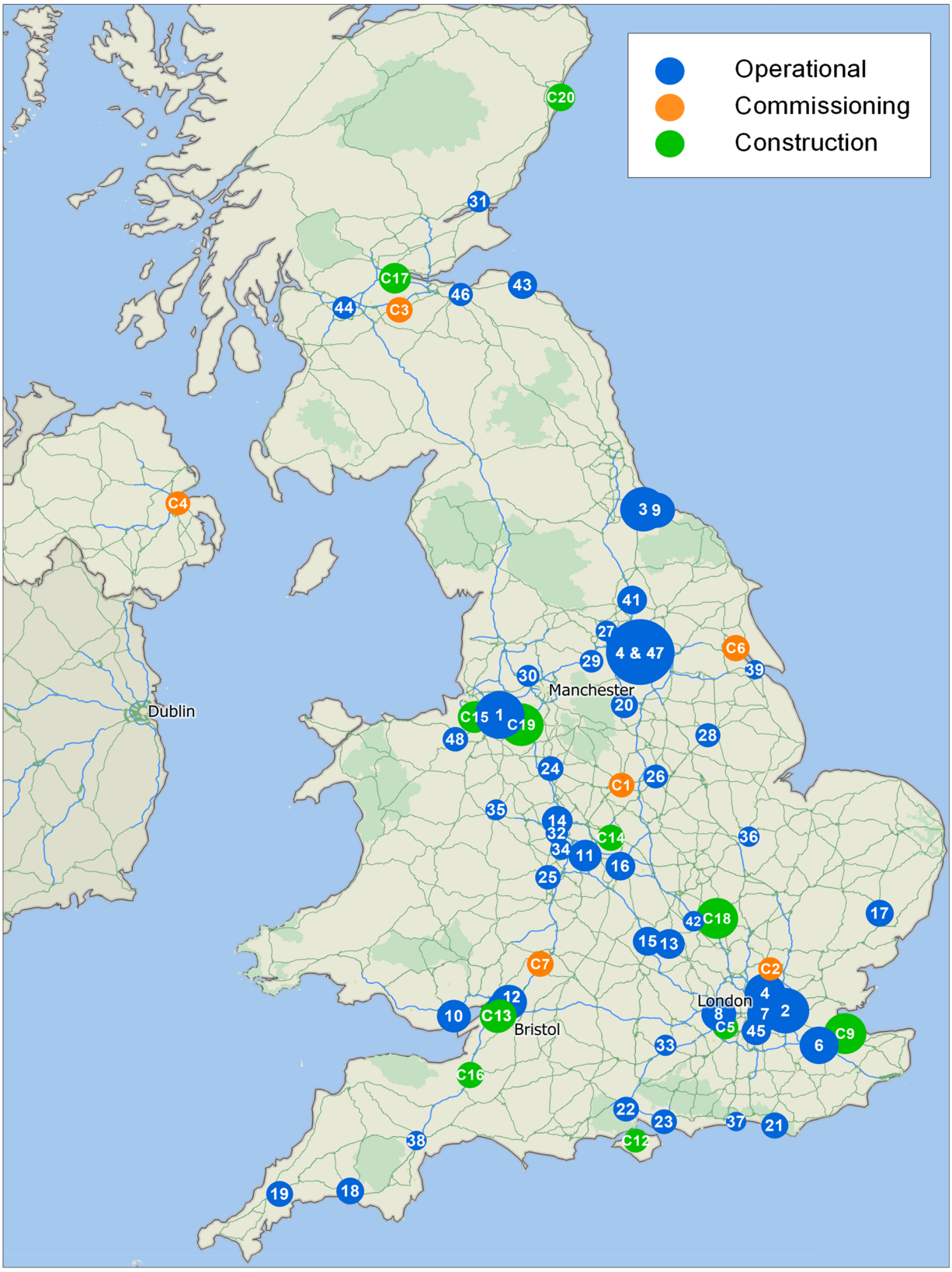


Figure 36: Location of EfW facilities (for further details on the EfWs shown see Figures 37-39)

Operational EfWs

	Permitted Name	Known As	Location	Operator	Capacity (ktpa)	Processed (ktpa) 2018	Processed (ktpa) 2019
1	Runcorn EfW Facility	Runcorn	Halton	Viridor	1,100	884	962
2	Riverside Resource Recovery Facility	Riverside	Bexley	Cory	785	740	743
3	Tees Valley - EfW Facility	Tees Valley	Stockton-on-Tees	Suez	756	637	651
4	Ferrybridge Multifuel 1	Ferrybridge FM1	Wakefield	MFE	725	647	667
47	Ferrybridge Multifuel 2	Ferrybridge FM2	Wakefield	MFE	675	0	129
5	EcoPark Energy Centre	Edmonton	Enfield	Council	620	518	498
6	Allington Waste Management Facility	Allington	Kent	FCC	560	492	488
9	Wilton 11 EfW	Wilton 11	Middlesborough	Suez	500	467	448
7	SELCHP ERF	SELCHP	Lewisham	Veolia	464	441	439
8	Lakeside EfW	Lakeside	Slough	Lakeside	450	431	427
10	Cardiff Energy Recovery Facility	Trident Park	Cardiff	Viridor	425	376	366
11	Tyseley ERF	Tyseley	Birmingham	Veolia	400	343	343
12	Severnside Energy Recovery Centre	Severnside	S.Gloucestershire	Suez	400	377	397
13	Greatmoor EfW	Greatmoor	Buckinghamshire	FCC	345	308	295
14	Staffordshire ERF	Four Ashes	Staffordshire	Veolia	340	336	337
15	Ardley EfW Facility	Ardley	Oxfordshire	Viridor	326	290	280
16	CSWDC Waste to Energy Plant	Coventry	Coventry	Council	315	289	299
45	Beddington Energy Recovery Facility	Beddington Lane	Croydon	Viridor	303	80	279
43	Dunbar Energy Recovery Facility	Dunbar	East Lothian	Viridor	300	40	251
17	SUEZ Suffolk - EfW Facility	Great Blakenham	Suffolk	Suez	295	264	267
18	Devonport EfW CHP Facility	Devonport	Plymouth	MVV	265	255	265
20	Sheffield ERF	Sheffield	Sheffield	Veolia	245	234	230
21	Newhaven ERF	Newhaven	East Sussex	Veolia	242	224	223
19	Cornwall Energy Recovery Centre	Cornwall	Cornwall	Suez	240	221	243
25	EnviRecover EfW Facility	Hartlebury	Worcestershire	Severn	230	200	201
22	Integra South West ERF	Marchwood	Southampton	Veolia	220	199	211
23	Integra South East ERF	Portsmouth	Portsmouth	Veolia	210	207	195
24	Stoke EfW Facility	Hanford	Stoke-on-Trent	MESE	210	186	179
26	Eastcroft EfW Facility	Eastcroft	Nottingham	FCC	200	177	188
48	Parc Adfer ERF	Parc Adfer	Deeside	WTI	200	0	58
28	Lincolnshire EfW Facility	North Hykeham	Lincolnshire	FCC	190	171	175
46	Millerhill Recycling and ERC	Millerhill	Edinburgh	FCC	190	16	142
27	Leeds Recycling and ERF	Leeds	Leeds	Veolia	180	187	174
44	Glasgow RREC	Polmadie ACT	Glasgow	Viridor	150	7	83
29	Kirklees EfW Facility	Kirklees	Huddersfield	Suez	150	124	134
30	Bolton ERF	Bolton	Gtr Manchester	Suez	120	29	76
31	Baldovie Waste To Energy Plant	Baldovie	Dundee	MVV	120	93	96
32	Wolverhampton EfW Facility	Wolverhampton	Wolverhampton	MESE	118	110	114
33	Integra North ERF	Chineham	Hampshire	Veolia	110	93	94
34	Dudley EfW Facility	Dudley	Dudley	MESE	105	94	96
35	Battlefield EfW Facility	Battlefield	Shropshire	Veolia	102	96	99
36	Peterborough EfW Facility	Peterborough	Peterborough	Viridor	85	81	80
37	Enviropower Ltd, Lancing	Lancing	West Sussex	Enviropower	75	60	55
38	Exeter ERF	Exeter	Devon	Viridor	60	58	58
39	Integrated Waste Management Facility	NewLincs	NE Lincolnshire	Tiru	56	51	51
40	Energy Recovery Plant	Gremista	Shetland Islands	Council	26	23	21
41	Allerton Waste Recovery Park	Allerton Park	North Yorkshire	Amey	320	244	255
42	Milton Keynes Waste Recovery Park	Milton Keynes ACT	Milton Keynes	Amey	94	27	39
	Other EfWs in Commissioning but not achieved Takeover in 2019					57	224
			Totals		**14,596**	**11,488**	**12,626**

Figure 37: Operational EfWs in 2019 Source: APR

Please note, those highlighted blue were fully operational for part of the year only

EfWs in Commissioning

	Permitted Name	Known As	Location	Operator	Start Date	Headline Capacity (ktpa)	Net Input 2019 (ktpa)
C1	Sinfin IWTC	Sinfin Road ACT	Derby	Mothballed	Q3 2014	0	49
C2	Hoddesdon EfW Plant	Hoddesdon ACT	Hertfordshire	Bouygues	Q2 2014	90	13
C3	Levenseat Renewable Energy	Levenseat ACT	West Lothian	Outotec	Q2 2015	180	20
C4	Full Circle Generation EfW	Belfast ACT	Belfast	Bouygues	Q3 2015	120	34
C7	Javelin Park ERF	Javelin Park	Gloucestershire	UBB	Q3 2016	190	68
C6	Hull Energy Works	Energy Works ACT	Hull	Engie	Q1 2016	227	40 (est)
				Total		**807**	**224**

Figure 38: EfWs In Commissioning as at December 2019 Source: Tolvik analysis

EfWs In Construction

	Permitted Name	Known As	Location	Developer	Start Date	Capacity (ktpa)
C5	Charlton Lane Eco Park	Eco Park ACT	Surrey	Suez	Q2 2016	60
C9	Kemsley Park EfW	Kemsley	Kent	WTI	Q3 2016	550
C12	Isle of Wight EfW	Isle of Wight	Isle of Wight	Amey	Q2 2017	30
C13	Severn Road RRC	Avonmouth	Bristol	Viridor	Q1 2017	350
C14	Baddersley EfW	Baddersley	Warwickshire	Equitix	Q1 2018	100
C31	Baldovie Waste To Energy Plant (New)	Baldovie	Dundee	MVV	Q1 2018	110
C15	Hooton Park Sustainable Energy	Hooton Park ACT	Merseyside	BWSC/Cogen	Q4 2018	266
C16	Bridgwater Resource Recovery	Bridgwater	Somerset	Equitix/Iona	Q4 2018	100
C17	Earls Gate Energy Centre	Earls Gate	Falkirk	Earls Gate	Q4 2018	237
C18	Rookery South ERF	Rookery South	C Bedfordshire	Covanta/GIG	Q1 2019	545
C19	Lostock Sustainable Energy Plant	Lostock	Cheshire West	FCC	Q1 2019	600
C20	NESS EfW Facility	Ness	Aberdeenshire	Indaver/Acconia	Q3 2019	150
				Total		**3,098**

Figure 39: EfWs In Construction in 2019 Source: Tolvik analysis

Developments January 2020 – May 2020

- Increases in permitted capacity have been approved for Suez EfWs Great Blakenham (26ktpa) and Severnside (100ktpa).
- Financial Close of new EfW Projects (or equivalent) are shown in Figure 40. Note Slough remains conditional.

Known As	Location	Developer	Start Date	Capacity (ktpa)
Newhurst	Leicestershire	Biffa/Covanta/GIG	Q1 2020	350
Drakelow ACT	Derbyshire	Vital	Q1 2020	180
Slough	Slough	SSE/CIP	Q2 2020	450

Figure 40: Financial Close in 2020 Source: Tolvik analysis

APPENDIX 2: INTERNATIONAL BENCHMARKS

Market Scale and Inputs

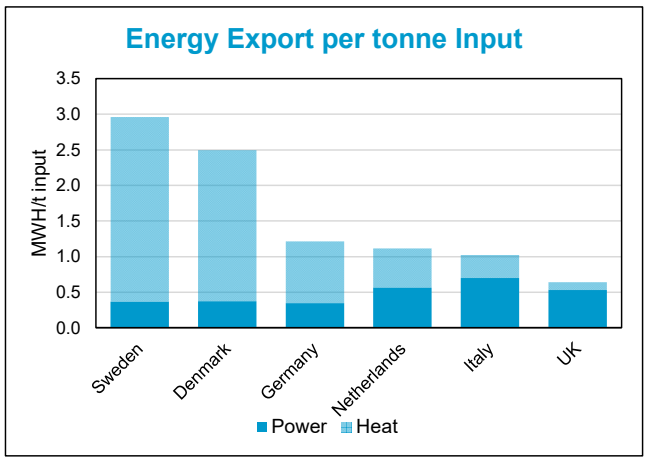
As in previous years, this report has pulled together the latest available published EfW data from other northern European countries for the purposes of a comparison with the UK EfW market. There will be differences in the categorisation of EfW facilities and in the calculation/measurement methodologies applied, but it is hoped that the data provides a useful high-level overview of some key operational metrics.

Country	Data Year	Reported Inputs (Mt)	Associated Capacity (Mt)	Inputs as % of Headline Capacity
Sweden [6]	2018	5.92	6.51	91.0%
Denmark [7]	2016	3.47	3.79	91.6%
Netherlands [8]	2018	7,48	8.20	91.2%
Germany [9]	2018	23.96	24.70	97.0%
Italy [10]	2018	6.33	N/A	N/A
UK	**2019**	**12.63**	**14.08**	**89.7%**

Figure 41: Reported EfW data used for benchmarking Sources: As per Appendix 3[6-10]

Heat and Power Generation

As Figure 42 shows, whilst in the UK EfWs are largely focussed on electricity export, in most other European markets energy is exported through a mix of power, hot water and steam. In 2018 Netherlands heat export fell steeply following the expiry of a large heat offtake contract.



Country	Electricity (MWh/t)	Heat (MWh/t)	Total (MWh/t)
Sweden	0.37	2.59	2.96
Denmark	0.37	2.12	2.49
Germany	0.35	0.87	1.22
Netherlands	0.56	0.55	1.12
Italy	0.70	0.32	1.02
UK	**0.53**	**0.11**	**0.64**

Figure 42: Latest European Benchmarks – Energy Export

Carbon

In Section 5 Tolvik estimated the carbon intensity of EfW in the UK. Figure 42 replicates this analysis for Germany and Netherlands and this section will be developed in future editions of this report.

tCO2e/t	Year	Emissions	Benefit	Net	Comment
Germany	2018	0.395	(0.589)	(0.194)	Power carbon intensity of 759g CO2e/kWh
Netherlands	2017	0.407	(0.473)	(0.067)	Low fossil content of waste = 36.9%
UK	**2019**	**0.531**	**(0.188)**	**0.343**	

Figure 43: Carbon Intensity of EfW per tonne Source: ITAD, Various publications in Netherlands

APPENDIX 3: DATA SOURCES

APR have either been provided by operators or released under the Freedom of Information Act.

EA: Contains public sector information licensed under the Open Government Licence v3.0.

NIEA: Contains public sector information licensed under the Open Government Licence v3.0.

NRW: Contains Natural Resources Wales information © Natural Resources Wales and database right.

SEPA: Contains SEPA data © Scottish Environmental Protection Agency and database right 2020.

(1) http://www.wastedataflow.org/ Q100 for four quarters Apr 2018 – Mar 2019

(2) Environment Agency: 2018 Waste Data Interrogator – Incinerator Waste Returns https://ea.sharefile.com/share/view/s199b45b16c541d6b

(3) 2018 Pollution Inventory Dataset – Version 1 https://data.gov.uk/dataset/cfd94301-a2f2-48a2-9915-e477ca6d8b7e/pollution-inventory

(4) WRAP: National municipal waste composition, England 2017 https://wrap.org.uk/content/quantifying-composition-municipal-waste

(5) https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019

(6) Sweden - Avfall Sverige: Svensk Avfallshantering 2019. Profu

(7) Denmark - BEATE Benchmarking af affaldssektoren 2016 Forbrænding

(8) Netherlands - Afvalverwerking in Nederlands, gegevens 2019

(9) Germany - ITAD: Jahresbericht 2018

(10) Italy - ISPRA: Rapporto Rifiuti Urbani Edizione 2019

APPENDIX 4: GLOSSARY

ACT	Advanced Conversion Technology
APCr	Air Pollution Control residue
APR	Annual Performance Reports
C&I	Commercial and Industrial Waste
EA	Environment Agency
EfW(s)	Energy from Waste (facilities)
ELV	Emission Limit Value
EWC	European Waste Catalogue
Headline Capacity	The maximum annual throughput contained within the Environmental Permit except where an operator has publicly reported an alternative figure.
IBA	Incinerator Bottom Ash
Kt (pa)	‘000s tonnes (per annum)
LACW	Local Authority Collected Waste
Mt (pa)	Million tonnes (per annum)
NIEA	Northern Ireland Environment Agency
NRW	Natural Resources Wales
OPRA	Operational Risk Assessment
RDF	Refuse Derived Fuel
Residual Waste	Solid, non-hazardous, combustible waste which remains after recycling either treated (in the form of a RDF or SRF) or untreated (as “black bag” waste).
SEPA	Scottish Environmental Protection Agency

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