Canford Energy from Waste
Combined Heat and Power Facility

# Environmental Statement Technical Appendix 7.1

## GHG Emission Calculations

June 2023

We inspire with energy.

# Contents

# 1. Introduction

1.1.1 This appendix provides additional details of calculations of greenhouse gas (GHG) emission impacts as reported in **ES Chapter 7: Climate Change and Greenhouse Gases**. It sets out the boundary of the assessment, data inputs or assumptions, and the output of the calculations. It should be read together with **ES Chapter 7: Climate Change and Greenhouse Gases**, which provides the policy context, explains the with- and without-development scenarios assessed, and characterises the significance of effects due to the net change in GHG emissions attributed to the Proposed Development.

1.1.2 This appendix was written in June 2023. References to published information sources are to the editions current at that time.

# 2. Overview of calculations

2.1.1 As described in **ES Chapter 7: Climate Change and Greenhouse Gases**, the Proposed Development would combust mixed residual waste to generate electricity and heat for supply to consumers, operating as a combined heat and power (CHP) energy from waste (EfW) Facility. Ash and metals left after combustion would be recycled.

2.1.2 Operation of the Proposed Development would displace other marginal electricity and heat generation sources for the energy it supplies. It would also displace other methods of treatment and/or disposal of the residual waste it combusts. This is likely to have been at another similar UK energy-from-waste facility, with Bridgwater or Avonmouth being representative examples.

2.1.3 The net GHG emissions due to the Proposed Development are calculated as the balance of these factors, i.e. the emissions caused by its operation compared to the emissions avoided in the baseline.

2.1.4 There are several sources of uncertainty and likely variability in parameters needed for the assessment. The net impacts are sensitive to several of these parameters and in some cases it has not been possible to identify a single best or most-likely value from available information. A scenario approach to the calculations has therefore been taken, with reasonable ranges for uncertain or variable parameters identified. The goal has been to provide an envelope of results within which the net impact of the Proposed Development is likely to lie.

2.1.5 For combustion of the residual waste, three biogenic:fossil carbon content[1] ratios of 45:50, 50:50 and 55:45 have been assessed, representing possible waste compositions. This is not a range that is predicted with certainty, as it will depend on the evolution of policy and practice for waste and resource management during the development's operating lifetime. However, this is considered to be a reasonable range to illustrate the degree to which the GHG emissions predicted for the Proposed Development are sensitive to any changes in the biogenic:fossil carbon content of the waste it combusts.

2.1.6 For each composition, the assessment has been made with marginal displaced electricity and heat generation emissions factors each year for the initial 25-years of operation (after which further changes are projected to be very minor).

2.1.7 GHG emissions from transporting locally-collected waste to a more distant EfW facility have also been calculated, to show the difference in this baseline scenario compared to transport to the Proposed Development.

2.1.8 There are several other sources of uncertainty and likely variability in parameters needed for the assessment, such as nitrous oxide emissions from the air pollution control system and the rate of metals recycling from bottom ash. Ranges of values have been used based on the Applicant's estimates, data aggregated from other operational EfW facilities and from published sources.

2.1.9 Further detail is given below and parameter values used are shown in **Table 6-1**.

[1] Biogenic carbon is that in plant-derived material (such as food waste) whereas fossil carbon is that in material derived from fossil fuels, such as plastics. Only fossil carbon is regarded as causing a net increase in atmospheric $CO_2$ concentration, having been released from long-term geological storage. Biogenic carbon was drawn down from the atmosphere by the plants during growth prior to being released again by combustion, so over this short cycle does not change the net atmospheric concentration, provided that the C content is released as $CO_2$ and not as $CH_4$ from a decomposition process.

# 3. Assessment boundary

3.1.1 The assessment boundary encompasses GHG emissions from operation of the Proposed Development, from use and management of its outputs, and from management of waste, electricity generation and heat generation in a baseline scenario without the Proposed Development. This includes scope 1, scope 2 and scope 3 emissions where applicable[2]. The main emission sources assessed are:

- combustion of waste in the Proposed Development;
- nitrous oxide ($N_2O$) emitted by the air pollution control system;
- re-use and recycling of ash and metals recovered from it;
- marginal electricity generation in the future baseline that is displaced by the Proposed Development;
- marginal heat generation in the future baseline that is displaced by the Proposed Development; and
- a potential scenario of transport of waste to other UK EfW facilities in the baseline.

## 3.2 Exclusions

*3.2.1* In some cases where data is not readily available, *de minimis* sources have been screened and excluded from the emission calculations. A materiality threshold of 1% of lifetime EfW emissions has been used to screen *de minimis* sources.

3.2.2 Construction-stage GHG emissions have been screened as non-material, as explained in the Assessment of Construction Effects section of **ES Chapter 7: Climate Change and Greenhouse Gases**. Decommissioning-stage emissions are also screened out as these are considered very unlikely to exceed construction-stage emissions.

## 3.3 Allocation and attribution

3.3.1 All calculated net GHG emissions within the assessment boundary are allocated and attributed to the Proposed Development, for the purpose of assessing its net impacts. No differential allocation or attribution based on operational control, ownership or equity share has been required.

[2] GHG emissions caused by an activity are often categorised into 'scope 1', 'scope 2' or 'scope 3', following the guidance of the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol suite of guidance documents (WRI and WBSCD, 2004). Scope 1 emissions are those released directly by the entity being assessed, e.g. from combustion of material at an installation. Scope 2 emissions are those caused indirectly by consumption of imported energy, e.g. from generating electricity supplied through the national grid to an installation. Scope 3 emissions are those caused indirectly in the wider supply chain, e.g., in the upstream extraction, processing and transport of materials used or the downstream disposal or recycling of waste products.

# 4. Proposed Development

4.1.1 Calculation of GHG emissions from combustion, energy export and recycling of ash and metals has been based on information about expected material flows, recovery rates and energy generation provided by the Applicant. This has been used together with data from similar operational EfW facilities around the UK and published analyses of waste carbon content and calorific value. The four main items of data are:

- the input waste composition and calorific value to achieve the target electricity generation at the design throughput and thermal efficiency;
- the carbon content of waste at those calorific values and proportion that is biogenic or fossil;
- the rate of recycling of ash and metals after combustion; and
- the rate of $N_2O$ emissions due to ammonia slip from the air pollution control system.

4.1.2 The Applicant has provided an indicative mass and energy balance for the EfW operation. The likely carbon content of residual waste combusted has been established from a range of published sources and operational EfW data.

4.1.3 The average carbon content for waste that is combusted has initially been calculated from a nationally-representative waste composition reported by WRAP (2017) for municipal solid waste (MSW) in England, combined with information from Defra research project WR1003 (Resource Futures, 2012). The carbon content data has initially been taken from research report WR1908 (Golder Associates, 2014), which reports ranges from several sources; from these, high, low and averaged values have been used in this comparison. The biogenic and fossil carbon proportions have been taken from the WR1003 report and Defra project WRT237 (ERM and Golder Associates, 2006). The average value calculated in this way for the typical waste composition is 0.237tC/t wet waste.

4.1.4 As a further corroboration, independent laboratory analyses of 23 waste samples from six operational EfW facilities between 2016 and 2019 have been reviewed. These record the net calorific value (NCV) and total carbon content measured in combustion tests. NCV and carbon content are linked and observed to follow a linear relationship, although with some variability in the carbon content at each NCV. The Applicant's indicative energy generation data is based on a relatively high NCV of approximately 10.9MJ/kg, or 3.03MWh/t. The carbon content of waste in the laboratory analyses has been scaled using the ratios of carbon to NCV in the sample data: maximum, minimum and mean[3] ratios of 0.083, 0.113 and 0.095, yielding carbon contents of 0.287 (0.250–0.343) tC/t wet waste at the Applicant's specified NCV. This range encompasses the values calculated from the national waste composition but is somewhat higher. It has been used in preference due to this being less likely to underestimate emissions and being likely more representative of the higher-NCV composition expected by the Applicant.

4.1.5 The biogenic to fossil carbon ratio calculated for a typical waste composition using Defra research data referenced in the preceding paragraphs, of approximately 50:50, has been used as the main scenario for analysis. As a sensitivity test, the assessment has been repeated with assumptions of 45:55 and 55:45 biogenic to fossil carbon ratios.

[3] which is the same as the median to three significant figures

4.1.6 One hundred percent oxidation (combustion) of available carbon to $CO_2$ has been assumed. This is conservative (over-estimating total GHG emissions) as typically up to around 5% of combustible carbon may be left unburned in the ash residue[4].

4.1.7 The Proposed Development will use a selective non-catalytic reduction (SNCR) system as part of its air pollution control with either urea or ammonia as the reagent. This can lead to $N_2O$ emissions. The final draft Best Available Techniques (BAT) Reference Document (BREF) for Waste Incineration (European Commission Joint Research Centre, 2019) indicates a range of 10–35 mg/Nm$^3$. 18 independent analyses of flue gas samples from two similar EfW facilities (from a different operator) in 2016 to 2019 have been reviewed. These samples suggest high variability in $N_2O$ emissions in practice, likely to be due to variations in exhaust temperature and $O_2$ levels (from excess combustion air) that influence $N_2O$ formation. The full range in the samples is 0.42–27.1 mg/Nm$^3$. In discussion with the operator of the sampled facilities, four values below 1 mg/Nm$^3$ were discarded as it is not confirmed that such low values could be maintained continuously. The median value and minimum to maximum range from the remaining samples is 9.63 (3.10–27.10) mg/Nm$^3$. The minimum and median value from the samples and the high end of the BREF range have been used in this assessment, in a low-high range. The annual stack efflux for the Proposed Development is predicted to be 1,752,140,084Nm$^3$/annum based on assumed 7,830 annual operating hours and the Nm$^3$/s value in the dispersion modelling reported in the ES.

4.1.8 The Proposed Development will need to use auxiliary fuel burners for start up and potentially occasionally when necessary to maintain the minimum required waste combustion temperature under some conditions. Auxiliary fuel consumption of around 806,000 litres/annum of gas oil has been estimated by the Applicant. GHG emissions from this have been calculated using the factor for fuel combustion and supply chain published by BEIS for company reporting (BEIS, 2023).

4.1.9 GHG emission reductions due recycling of metals recovered from the post-combustion ash have been calculated based on recovery rates estimated by the Applicant and factors for GHG emissions from production of virgin materials that are reduced by recycling.

4.1.10 For ferrous metal recycling, life-cycle analysis data provided by the World Steel Association (WSA, pers. comm., 2022) showing GHG emissions from producing various grades of steel from recycled metal compared to virgin material has been used to provide a high to low range. For non-ferrous metal recycling, similar data from the European Aluminium Association (EAA, 2018) have been used. These factors have been adjusted for future years based on the projected tightening of the emissions cap in the EU ETS, as they fall within the regulated emissions sector, to avoid overstating future benefits from recycling.

4.1.11 Re-use of incinerator bottom ash (IBA) as aggregates may yield GHG emission savings compared to primary aggregates production, but these are minor (due to the low carbon intensity of aggregates production)[5] and likely to be influenced more by transport distance to market, so have not been calculated. Carbonation of the IBA during storage and processing has not been assumed, to be conservative for the assessment[6]. There is also potential for re-use of APCr with carbonation as a limestone aggregate product. The potential benefit of this as a further mitigation measure has been discussed in **ES Chapter 7: Climate Change and Greenhouse Gases**.

4.1.12 Transport of waste to the Proposed Development site has been calculated based on the distance from a range of towns in the area served by it (around 10km to 60km), assuming transport by a mixture of refuse collection vehicles and bulked-up deliveries from waste

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[4] and the Best Available Techniques Reference Document (BREF) for Waste Incineration (European Commission Joint Research Centre, 2019) range is 1–3% of ash as unburned carbon on a dry weight basis, which with around 25% of wet waste left as ash and 24% initial carbon content of waste is broadly comparable, after moisture loss.

[5] as indicated in the in the Inventory of Carbon and Energy v3.0 (Hammond and Jones, 2019)

[6] This would in any case not materially affect total emissions, with likely absorption values being minor ($CO_2$ equivalent to 1-3% of ash dry mass potentially absorbed from atmosphere (N. Nolan, pers. comm., 2012).

transfer stations using articulated heavy goods vehicles (HGVs). Vehicle numbers have been estimated by the Applicant and are reported in the Transport Assessment (**ES Appendix 15.1**). HGV delivery of non-waste inputs and outputs (such as reagents and IBA) has also been included, using a conservative assumption of 300km transport for specialist materials/treatment facility as the origin or destination.

4.1.13 As a point of comparison representing the baseline scenario, HGV transport of waste from the local area to a EfW at Bridgewater has also been calculated, using one-way distance of 125km and assumed HGV payload of 20t for bulked-up waste.

4.1.14 Transport calculations have used the emission factor per vehicle-km at 50% laden (representing full inward and empty return journeys over the two-way distance) published by BEIS for company reporting in the UK (BEIS, 2023).

# 5. Baseline

## 5.1 Electricity generation baseline

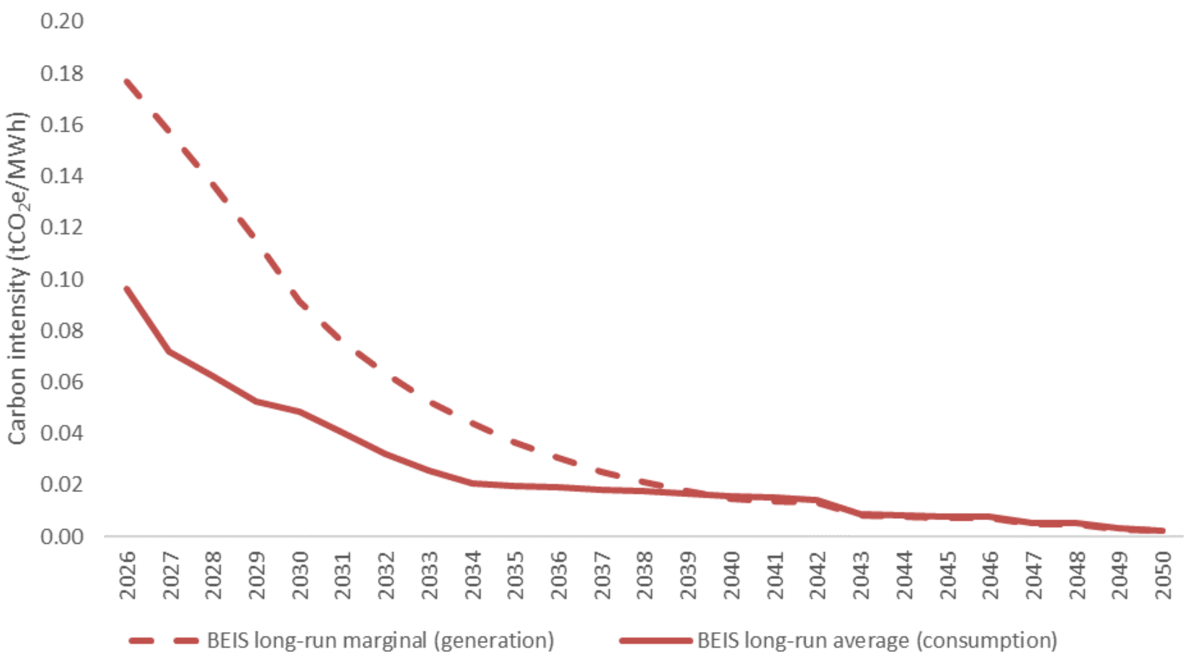
5.1.1 Electricity generated by the Proposed Development would displace an equivalent amount of electricity generation from other sources in a business-as-usual future baseline. To assess the net effect on GHG emissions, the marginal source of electricity generation displaced must be identified.

5.1.2 The marginal source displaced may in practice vary from moment to moment depending on the operation of the capacity market and interconnector flows in the single energy market. For the purpose of this assessment, longer-term trends (annual averages) have been used as it is not possible to predict shorter-term variations with confidence.

5.1.3 BEIS publishes projections of the carbon intensity of long-run marginal electricity generation and supply that would be affected by small (on a national scale) sustained changes in generation or demand (BEIS, 2023). BEIS's projections over the Proposed Development's operating lifetime (2026 onwards) are based on an interpolation from 2010's assumed marginal generator (a combined cycle gas turbine (CCGT) power station) to a modelled energy mix in 2030 consistent with energy and climate policy and predicted demand reduction scenarios by that point. A grid-average emissions factor is projected by BEIS for 2040 and the marginal factor is assumed to converge with it by that date, interpolated between 2030 and 2040; both factors are then interpolated from 2040 to a national goal for carbon intensity of electricity generation in 2050 and assumed to be constant after that point.

5.1.4 **Graph 5-1** illustrates the projected carbon intensity factors for displaced electricity generation and **Table 5-1** lists the BEIS marginal factor for the first 25-years of the Proposed Development's operation, after which there is little further change projected.

### Graph 5-1: Projected carbon intensity of electricity generation



## Table 5-1: Projected carbon intensity of marginal electricity generation

| Operating year | Calendar year | Carbon intensity ($tCO_2e/MWh$)* |
|---|---|---|
| **1** | 2028 | 0.1369 |
| **2** | 2029 | 0.1150 |
| **3** | 2030 | 0.0914 |
| **4** | 2031 | 0.0761 |
| **5** | 2032 | 0.0634 |
| **6** | 2033 | 0.0528 |
| **7** | 2034 | 0.0439 |
| **8** | 2035 | 0.0366 |
| **9** | 2036 | 0.0305 |
| **10** | 2037 | 0.0254 |
| **11** | 2038 | 0.0211 |
| **12** | 2039 | 0.0176 |
| **13** | 2040 | 0.0146 |
| **14** | 2041 | 0.0140 |
| **15** | 2042 | 0.0132 |
| **16** | 2043 | 0.0083 |
| **17** | 2044 | 0.0077 |
| **18** | 2045 | 0.0072 |
| **19** | 2046 | 0.0070 |
| **20** | 2047 | 0.0049 |
| **21** | 2048 | 0.0047 |
| **22** | 2049 | 0.0030 |
| **23** | 2050 | 0.0023 |
| **24** | 2051 | 0.0023 |
| **25** | 2052 | 0.0023 |

* excluding scope 3 emissions, which are not provided in the BEIS projection

## 5.2 Heat generation baseline

5.2.1 The marginal baseline for heating among local consumers that could be supplied by the Proposed Development is assumed initially to be typically gas boilers, but with an increasing likelihood of retrofit with air source heat pumps (ASHPs) for space heating or other low-carbon heating technologies (such as adaptation to hydrogen supply) over time in the baseline.

5.2.2 For this assessment, an efficient condensing natural gas boiler has been assumed as the initial marginal future baseline source that could be displaced by heat from the Proposed Development, with a subsequent transition to ASHP as a marginal source between the opening year and 2035 to broadly represent decarbonisation of the heating future baseline. The carbon intensity of electricity supplying ASHPs is from the BEIS projections for average as-consumed electricity.

5.2.3 The Applicant has estimated 5MW as an heat supply that is initially expected, subject to demand. No specific heat losses in the pipe network have been considered given the short run to Magna Business Park.

# 6. Summary of assessment parameters

6.1.1 **Table 6-1** summarises the parameters, values and data sources used in the GHG emission calculations.

**Table 6-1: Summary of parameters, values and data sources**

| Parameter | Value | | | Unit | Source |
|---|---|---|---|---|---|
| | Central | Low | High | | |
| **Displaced electricity generation** | See Table 5-1 | n/a | n/a | $tCO_2e/MWh$ | BEIS, 2023 |
| **Displaced heat generation (90% efficient gas boiler)** | 0.2374 | n/a | n/a | $tCO_2e/MWh$ | BEIS, 2023 |
| **ASHP efficiency** | 300 | n/a | n/a | % | Element Energy, 2021 |
| **Net electrical export** | 222,998 | n/a | n/a | MWh/annum | Applicant |
| **Net heat export** | 39,150 | n/a | n/a | MWh/annum | Applicant |
| **Annual operating hours** | 7,830 | n/a | n/a | hours | Applicant |
| **Waste throughput** | 260,000 | n/a | n/a | tpa | Applicant |
| **Biogenic:fossil carbon ratio** | 50:50 | 45:55 | 55:45 | ratio | Assumed |
| **$N_2O$ slip (EfW)** | 9.63 | 3.10 | 35.00 | $mg/Nm^3$ | EC, 2018 and other EfW monitoring |
| **Volumetric stack exhaust flow (EfW)** | 1,752,140,084 | n/a | n/a | $Nm^3$/annum | Applicant |
| **Aux fuel consumption** | 806,000 | n/a | n/a | litres/annum | Applicant |
| **Aux fuel emissions factor** | 0.0033508 | n/a | n/a | $tCO_2e$/litre | BEIS, 2023 |
| **HGV emissions factor >33t artic (50% laden)** | 0.001041 | n/a | n/a | $tCO_2e$/v-km | BEIS, 2023 |
| **HGV emissions factor >17t rigid (50% laden)** | 0.001129 | n/a | n/a | $tCO_2e$/v-km | BEIS, 2023 |
| **Ferrous recovery** | 3,744 | 4,992 | 2,496 | tpa | Assumed |
| **Non-ferrous recovery** | 1,330 | 1,716 | 944 | tpa | Assumed |

| | | | | | |
|---|---|---|---|---|---|
| **Ferrous recycling emissions factor (pre-ETS cap)** | 1.28 | 0.91 | 1.64 | $tCO_2e/t$ | WSA, pers. comm. 2022 |
| **Non-ferrous recycling emissions factor (pre-ETS cap)** | 6.19 | n/a | n/a | $tCO_2e/t$ | EAA, 2018 |
| **$CH_4$ GWP*** | 27 | 16 | 38 | ratio to $CO_2$ as 1 | IPCC, 2021 |
| **$N_2O$ GWP*** | 273 | 143 | 403 | ratio to $CO_2$ as 1 | IPCC, 2021 |

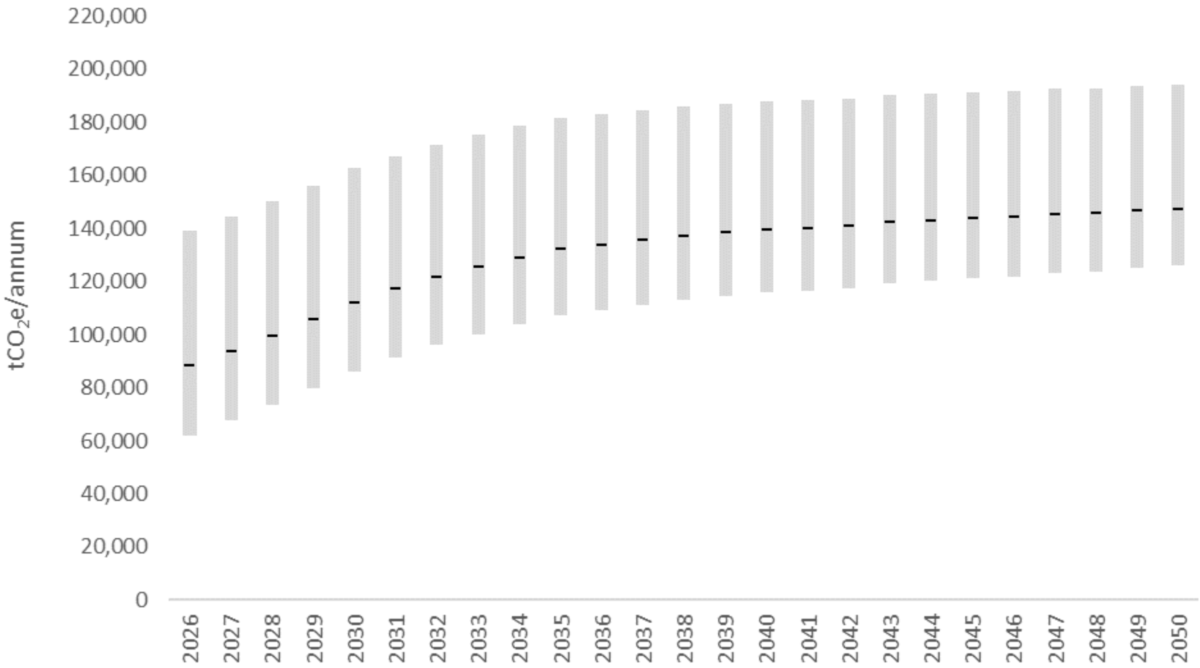
* including carbon-climate feedbacks and using the uncertainty range specified in the IPCC report

# 7. Calculation outputs

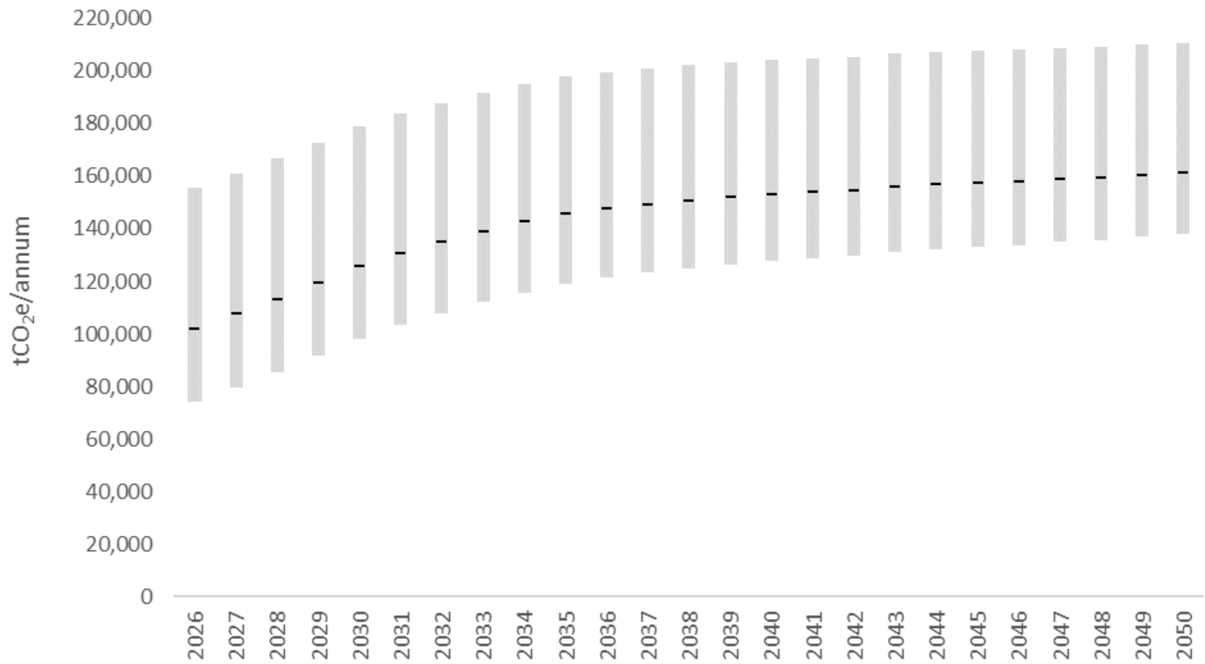
7.1.1 **Graph 7-1** to **Graph 7-3** show the net total emissions calculated in each year over the initial 25-years of the Proposed Development's operating lifetime for the three waste compositions and two energy scenarios (electricity-only and CHP) considered. **Graph 7-4** to **Graph 7-6** and **Table 7-1** to **Table 7-3** show the emissions breakdowns for year one and year 10 of operation.

7.1.2 Transport emissions to an alternative EfW facility at Bridgewater, in the future baseline, are calculated to be 3,383 $tCO_2e$/annum.

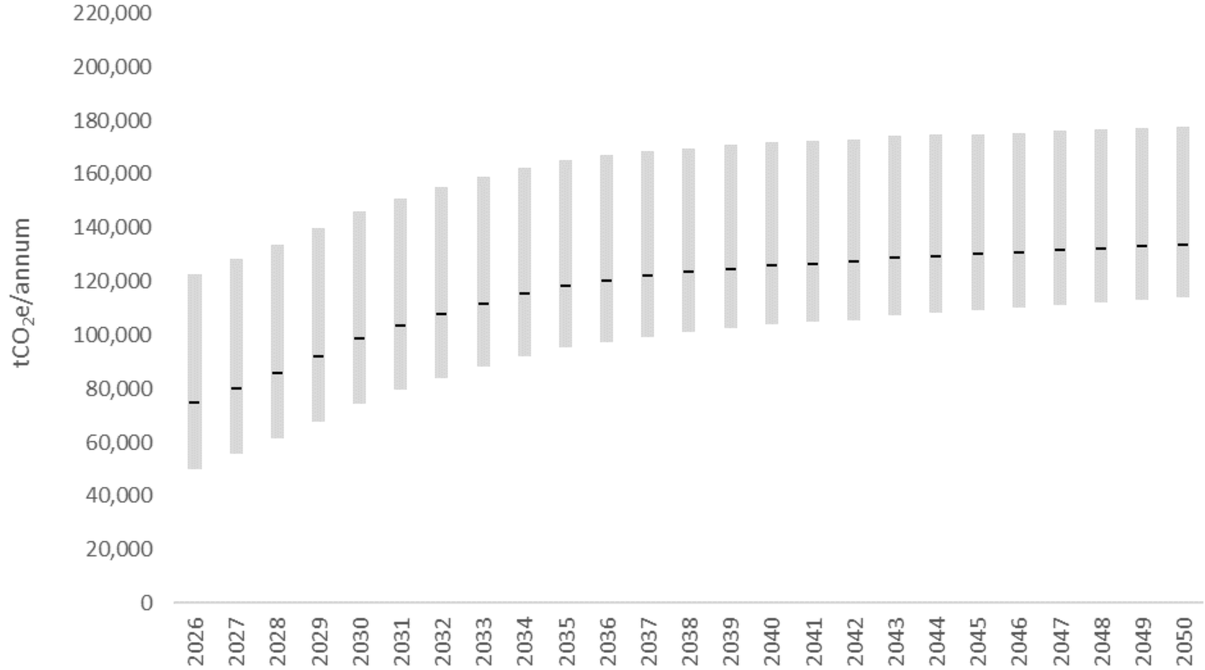
### Graph 7-1: Net GHG emissions with 50:50 biogenic:fossil carbon ratio



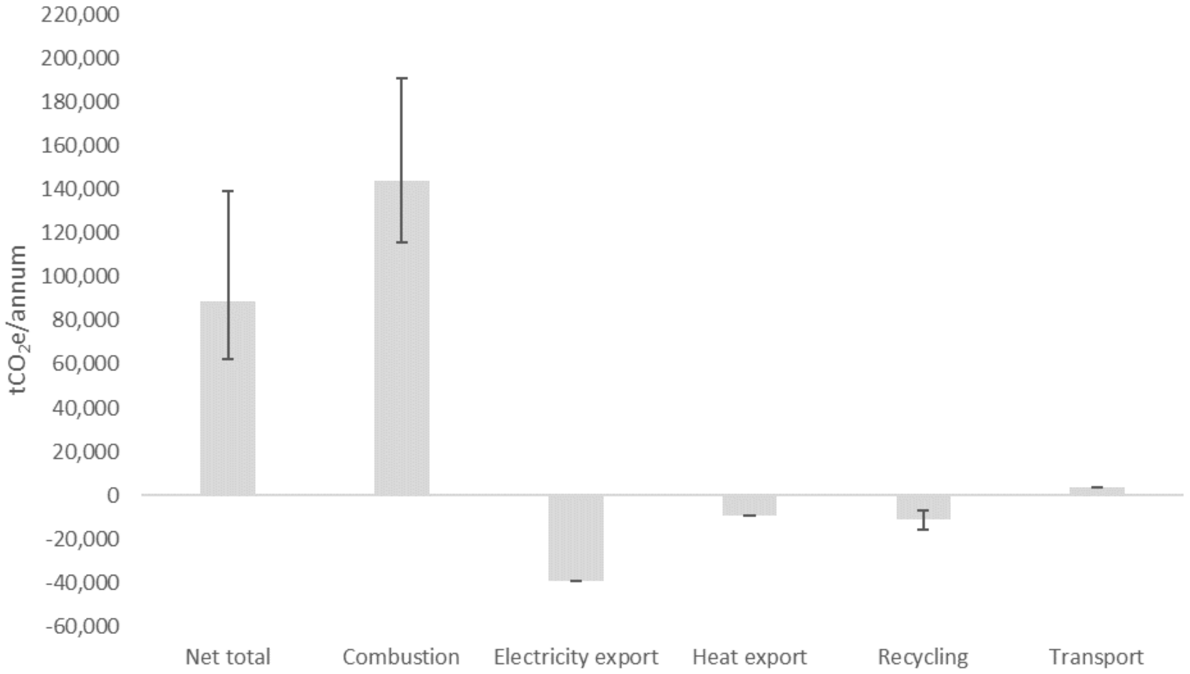
## Graph 7-2: Net GHG emissions with 45:55 biogenic:fossil carbon ratio



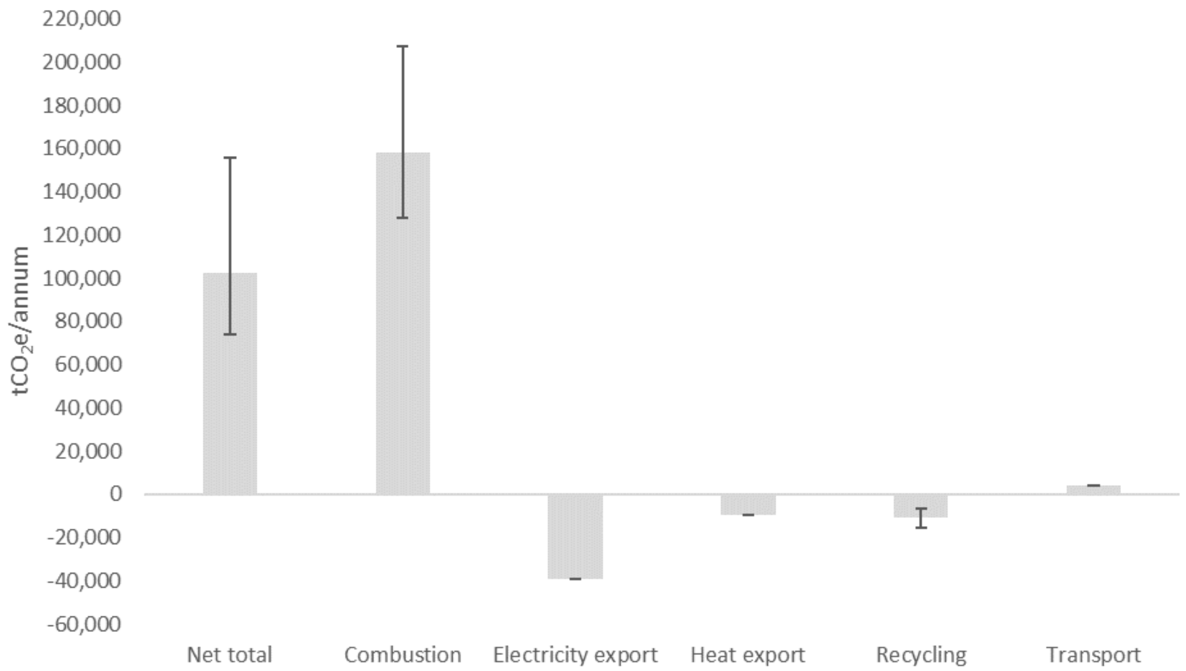

## Graph 7-3: Net GHG emissions with 55:45 biogenic:fossil carbon ratio



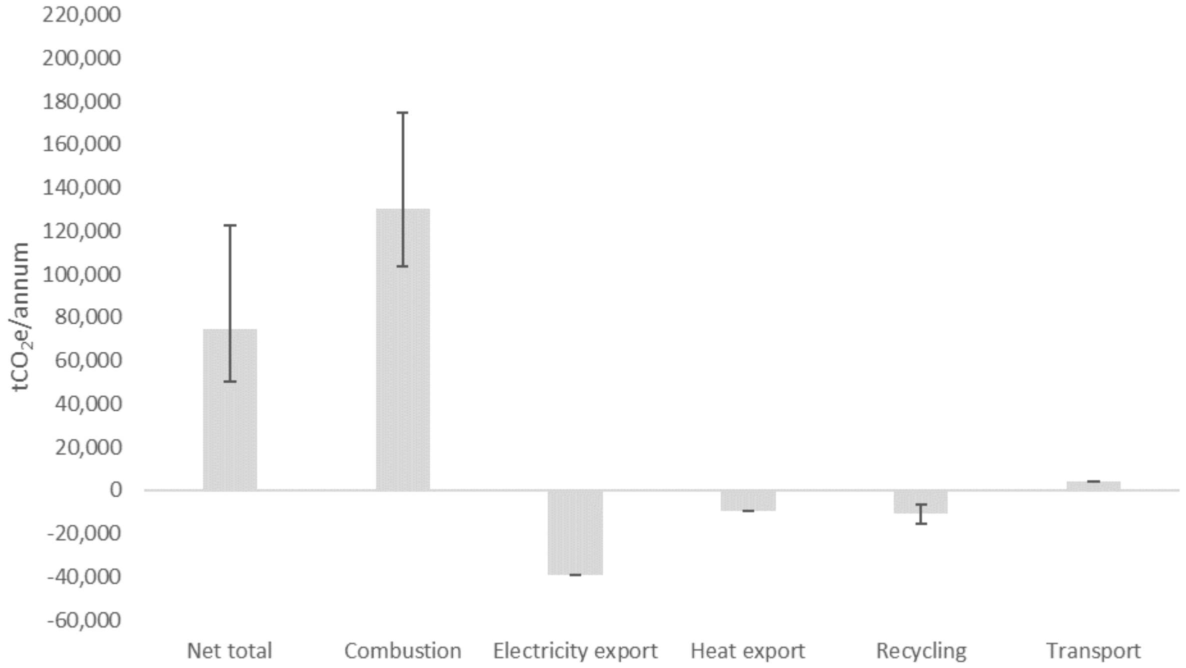
**Graph 7-4: Year one GHG emissions breakdown with 50:50 biogenic:fossil carbon ratio**




**Graph 7-5: Year one GHG emissions breakdown with 45:55 biogenic:fossil carbon ratio**



## Graph 7-6: Year one GHG emissions breakdown with 55:45 biogenic:fossil carbon ratio




## Table 7-1: GHG emissions breakdown with 50:50 biogenic:fossil carbon ratio

| Item | High | Central | Low |
|---|---|---|---|
| **Year 1 ($tCO_2e$/annum)** | | | |
| **Combustion** | 190,789 | 144,200 | 122,620 |
| **Displaced electricity** | -39,388 | -39,388 | -39,388 |
| **Displaced heat** | -9,316 | -9,316 | -9,316 |
| **Recycling** | -6,736 | -10,797 | -15,614 |
| **Transport** | 3,795 | 3,795 | 3,795 |
| **Net total** | 139,144 | 88,495 | 62,097 |
| **Year 10 ($tCO_2e$/annum)** | | | |
| **Combustion** | 190,789 | 144,200 | 122,620 |
| **Displaced electricity** | -8,159 | -8,159 | -8,159 |
| **Displaced heat** | -258 | -258 | -258 |
| **Recycling** | -4,622 | -7,408 | -10,714 |
| **Transport** | 3,795 | 3,795 | 3,795 |
| **Net total** | 181,545 | 132,170 | 107,285 |

### Table 7-2: GHG emissions breakdown with 45:55 biogenic:fossil carbon ratio

| Item | High | Central | Low |
|---|---|---|---|
| **Year 1 ($tCO_2e$/annum)** | | | |
| **Combustion** | 207,126 | 157,890 | 134,535 |
| **Displaced electricity** | -39,388 | -39,388 | -39,388 |
| **Displaced heat** | -9,316 | -9,316 | -9,316 |
| **Recycling** | -6,736 | -10,797 | -15,614 |
| **Transport** | 3,795 | 3,795 | 3,795 |
| **Net total** | 155,482 | 102,184 | 74,011 |
| **Year 10 ($tCO_2e$/annum)** | | | |
| **Combustion** | 207,126 | 157,890 | 134,535 |
| **Displaced electricity** | -8,159 | -8,159 | -8,159 |
| **Displaced heat** | -258 | -258 | -258 |
| **Recycling** | -4,622 | -7,408 | -10,714 |
| **Transport** | 3,795 | 3,795 | 3,795 |
| **Net total** | 197,883 | 145,860 | 119,199 |

### Table 7-3: GHG emissions breakdown with 55:45 biogenic:fossil carbon ratio

| Item | High | Central | Low |
|---|---|---|---|
| **Year 1 ($tCO_2e$/annum)** | | | |
| **Combustion** | 174,451 | 130,511 | 110,706 |
| **Displaced electricity** | -39,388 | -39,388 | -39,388 |
| **Displaced heat** | -9,316 | -9,316 | -9,316 |
| **Recycling** | -6,736 | -10,797 | -15,614 |
| **Transport** | 3,795 | 3,795 | 3,795 |
| **Net total** | 122,807 | 74,805 | 50,183 |
| **Year 10 ($tCO_2e$/annum)** | | | |
| **Combustion** | 174,451 | 130,511 | 110,706 |
| **Displaced electricity** | -8,159 | -8,159 | -8,159 |
| **Displaced heat** | -258 | -258 | -258 |

| Item | High | Central | Low |
|---|---|---|---|
| **Recycling** | -4,622 | -7,408 | -10,714 |
| **Transport** | 3,795 | 3,795 | 3,795 |
| **Net total** | 165,208 | 118,481 | 95,371 |

# References

BEIS (2023) Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book. [Online] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal [accessed 08/06/23]

BEIS (2023) UK Government GHG Conversion Factors for Company Reporting. [Online] https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting [accessed 19/06/23]

Defra (2014) Energy recovery for residual waste. A carbon based modelling approach. Defra, London.

Defra (2018) Digest of Waste and Resource Statistics – 2018 Edition. Defra, London.

EC Joint Research Centre (2019) Best Available Techniques Reference Document (BREF) for Waste Incineration. [Online] https://eippcb.jrc.ec.europa.eu/sites/default/files/2020-01/JRC118637_WI_Bref_2019_published_0.pdf [accessed 03/04/19]

Element Energy (2021) Development of trajectories for residential heat decarbonisation to inform the Sixth Carbon Budget. A study for the Committee on Climate Change. [Online] https://www.theccc.org.uk/wp-content/uploads/2020/12/Full-Report-Development-of-trajectories-for-residential-heat-decarbonisation-to-inform-the-Sixth-Carbon-Budget-Element-Energy.pdf [accessed 02/06/23]

ERM and Golder Associates (2006) WRT237 Carbon Balances and Energy Impacts of the Management of UK Wastes. Defra, London.

European Aluminium Association (2018) Environmental Profile Report. Life-cycle inventory data for aluminium production and transformation processes in Europe. European Aluminium Association, Brussels.

Golder Associates (2005) Report on UK Landfill Methane Emissions: Evaluation and Appraisal of Waste Policies and Projections to 2050. Defra, London.

Golder Associates (2014) WR1908 Review of Landfill Methane Emissions Modelling. Defra, London.

Hammond, G. and Jones, C. (2019) Inventory of Carbon and Energy (ICE) Version 3.0. University of Bath, Bath.

IPCC (2006) IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Waste. IGES, Japan.

IPCC (2021) Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2391 pp.

N. Nolan, pers. comm. (2012)

Resource Futures (2012) WR1003 Biodegradability of Municipal Solid Waste. Defra, London.

WRAP (2017) UK Waste Composition Estimates V3.0 Final. England table.

World Steel Association, pers. comm. (2022) LCI Data for Steel Products.

WRI and WBCSD (2004) The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. Revised edition. WRI and WBCSD, Washington and Geneva.