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Chapter 15

Climatic Factors

15. Climatic Factors

Summary

15.1 This chapter provides an updated assessment of the effects of the Proposed Development on climate change and of the effects of climate change on the proposed development. It builds on the chapter on climatic factors included in the September 2023 ES addendum, which concluded that the Proposed Development would be appropriately designed and constructed to adapt to impacts arising from climate change and there are no significant residual effects, so that the Proposed Development was considered to be resilient to the effects of climate change, and that the EfW Facility would provide a reduction in greenhouse gas emissions compared to the baseline scenario, supporting the UK's Net Zero trajectory

15.2 The carbon assessment prepared as part of the September 2023 ES addendum has been updated to include an alternative baseline, under which some of the waste to be delivered to the EfW Facility is sent to alternative EfW plants on the island of Ireland and further afield. This is intended to reflect the current waste management approach.

15.3 The updated carbon assessment concludes, as before, that the EfW Facility will lead to a reduction in greenhouse gas emissions compared to current waste management practices.

15.4 The Proposed Development is considered to be appropriately designed and constructed to adapt to impacts arising from climate change and there are no significant residual effects.

15.5 Therefore, the Proposed Development is considered to be resilient to the effects of climate change and the EfW Facility will provide a reduction in greenhouse gas emissions compared to the baseline scenario, supporting the UK's Net Zero trajectory.

15.6 Further, the Proposed Development will be a platform for the deployment of a range of decarbonising and circular economy technologies as they become technically and economically feasible.

Introduction

15.7 This section of the Environmental Statement (ES) provides further information on the likely significant effects of the Proposed Development on climate change, primarily focussing on greenhouse gas (GHG) emissions from the EfW Facility but also considering the other three elements of the Proposed Development – the MBT plant, the IBA plant and the Visitors Centre. It updates but should be read in conjunction with the original March 2014 ES chapter and appendices and subsequent ES addendums issued to the Department in March 2019, October 2020 and September 2023. The chapter also considers the resilience of the Proposed Development to the effects of climate change. This chapter is supported by the following technical appendices.

- Appendix 15.1 – Revised Carbon Assessment
- Appendix 15.2 – Climate Baseline

- Appendix 15.3 – Climate Change Resilience Detailed Results
- Appendix 15.4 – Response to noarc21 objection 21 June 2024

Statement of Authority

15.8 This section of the ES and supporting technical appendix have been prepared by Stephen Othen and reviewed by Rosalind Flavell of Fichtner Consulting Engineers Ltd. Stephen (MA MEng CEng MIChemE) is a chartered chemical engineer with over twenty-five years of professional experience and has previous experience undertaking carbon and climate change assessments for planning applications for EfW Facilities, including provided expert evidence on the subject at public inquiries. Rosalind (CEnv CSci MIAQM MIEnvSc PIEMA) has an MSc in Applied Meteorology and has over fifteen years of experience of project management and undertaking air quality and carbon and climate assessments for planning and permitting purposes for a wide range and scale of developments including EfW facilities across the UK.

Policy and Guidance

15.9 There is extensive international, national and local policy which supports the need to reduce emissions of GHGs and the need to assess the impact of the changing climate on developments.

15.10 The Institute of Environmental Management and Assessment (IEMA), the largest professional body for environmental practitioners, has published guidance on the approach to Environmental Impact Assessment (EIA) for carbon emissions, titled 'Assessing Greenhouse Gas Emissions and Evaluating their Significance'. The guidance sets out areas for consideration at all stages of the assessment to assist EIA practitioners in taking an informed approach to the treatment of GHG emissions within an EIA. The guidance was updated in February 2022 to reflect changes in the climate change 'agenda' since the original publication in 2017. The guidance is herein referred to as the 'IEMA 2022 Guidance'. Key updates include mitigation taking a more prominent role and requiring consideration from the offset, and the provision of significance descriptions based on the relative contribution towards achieving net zero.

15.11 The guidance mentions the legally binding GHG reduction targets and states that an EIA must give due consideration to how a project will contribute to the achievement of these targets.

15.12 The guidance also gives detail on how to assess the significance of GHG emissions. The crux of significance is not whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050 (science-based 1.5°C trajectory). This is consistent with the targetsin section 1 of the Climate Change (Northern Ireland) 2022.

15.13 IEMA has also produced guidance titled 'Environmental Impact Assessment Guide to Climate Change and Resilience and Adaption' (2020), referred to herein as the IEMA 2020 Guidance. This provides guidance on how to consider the impacts of climate change resilience within project design and guidance on the assessment of significance of climate change impacts on a project.

Methodology

GHG Emissions

15.14 The assessment of GHG emissions has been undertaken in line with the IEMA 2022 Guidance, as in the previous assessment and as explained below, and the detailed methodology was set out in the original carbon assessment for the EfW Facility, including the IBA plant. There are two modifications to the carbon assessment methodology.

15.15 The Visitor's Centre is expected to attract up to 3,000 visitors in a year, which would be a mixture of individuals and organised mainly school/educational groups. The GHG emissions from the additional transport would be very small, of the order of 10-20 tCO2e per annum, and so this has been excluded from the quantitative assessment.

15.16 The MBT plant will lead to a number of benefits which are likely to lead to a reduction in overall GHG emissions. However, these are difficult to quantify accurately as they will depend on a large number of factors which are not under the Applicant's control and so, as a conservative assumption, the following benefits have been excluded from the quantitative assessment.

- The introduction of a single integrated waste management site is highly likely to reduce transport emissions. This is particularly the case for waste from Belfast. At present, this waste is collected from households and delivered to a transfer station, before being transported again to an EfW plant. Once the Proposed Development is operational, the waste can be delivered directly to it, reducing double handing and transport distances. There may be a similar reduction for waste from other councils.
- The introduction of a single site may allow for increased efficiencies in the separation processes and so lead to additional recycling. This is not yet clear, as it depends on the details of all of the possible interim solutions.
- The Proposed Development provides a long term secure solution, which is likely to lead to benefits compared to a sequence of interim solutions.

15.17 The assessment of GHG emissions has been undertaken in line with the IEMA 2022 Guidance. This acknowledges that there are many different methods available for measuring and quantifying GHG emissions. However, the guidance provides a framework of six steps that an assessment should incorporate, as follows:

- **Set the scope and boundaries of the assessment**. These include system boundaries and temporal boundaries.
- **Develop the baseline**. This includes the current, future and alternative baselines.
- **Decide upon the assessment methodologies**. The methodology should result in a relevant, complete, consistent, transparent and accurate assessment of the reasonable worst case.
- **Data collection**. Project activity data and GHG emissions factors should be collated.
- **Calculate the GHG emissions inventory**. Although the quantification of GHG emissions for an EIA may vary in methodology and approach between projects, it is expected that in almost all cases, a calculated (not measured) approach is taken because these are

completed in advance of a project commencing development. It is recommended that the following structure should be used to calculate GHG emissions: GHG emission / removal = GHG emission factor × activity data. Both annual and lifetime GHG emissions should be calculated and reported. In addition, as part of this inventory compilation, uncertainty should be considered.

- **Mitigation opportunities**. Once the magnitude of emissions has been determined, mitigation measures should be proposed.

15.18 The IEMA 2022 Guidance requires the scope and boundaries (system and temporal) of the assessment to be set. The guidance goes on to acknowledge that GHG emissions are not geographically limited. GHG emissions have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The receptor for GHG emissions is the global atmosphere, which has a high sensitivity considering the severe consequences of climate change.

15.19 The IEMA 2022 Guidance describes a logical modular approach for identifying life cycle stages to define system boundaries for the assessment. The life cycle stages are broadly set out as follows:

- Before use stage;
- Use stage;
- End-of-life stage; and
- Beyond asset life cycle.

15.20 The guidance acknowledges that, as projects vary in size, so does the scale of the assessment needed to deliver a proportionate EIA. Certain life cycle modules / stages can be excluded when justified. The guidance goes on to state that activities that do not significantly change the result of the assessment can be excluded where expected emissions are less than 1% of total emissions.

15.21 Assessments on comparable facilities show the emissions during construction, when annualised over the lifetime of 25 years, are estimated to be less than 1% of the direct emissions from the EfW Facility. In addition, the construction of a landfill, or combined cycle gas turbine (CCGT) (or any form of energy generation including renewables) will result in associated carbon emissions but they would be difficult to determine for comparison. Therefore, the contribution of emissions from construction has not been considered any further with reference to GHG emissions.

15.22 Similarly, end-of-life and beyond asset life cycle stages are not considered in this assessment, as any GHG emissions from this stage will also be minor when compared to the GHG emissions over the lifetime of the project.

15.23 As such, the assessment focuses on the operational emissions only (use stage). It considers the direct emissions from combustion of waste and auxiliary fuel and indirect emissions associated with the transport of waste, reagents and residues. It also considers the downstream indirect benefits (scope 3) associated with exporting electricity to the grid (and so displacing other forms of electricity generation) and with the use of residues as aggregate (displacing other forms of aggregates).

15.24 In terms of temporal boundaries, both the annual impacts and lifetime impacts of the Proposed Development are considered in the assessment.

15.25 In terms of significance, the IEMA 2022 Guidance states that:

"When evaluating significance, all new GHG emissions contribute to a negative environmental impact; however; some projects will replace existing development or baseline activity that has a higher GHG profile. The significance of a project's emissions should therefore be based on its net impact over its life time, which may be positive, negative or negligible".

15.26 When GHG emissions cannot be avoided, the goal of the EIA process should be to reduce the project's residual emissions at all stages. Where GHG emissions remain significant, but cannot be further reduced, approaches to compensate the project's remaining emissions should be considered. The aim of EIA is to protect the environment by ensuring that a local planning authority when deciding whether to grant planning permission for a project, which is likely to have significant effects on the environment, does so in the full knowledge of the likely significant effects, and takes this into account in the decision making process.. Therefore, it is essential to provide context for the magnitude of GHG emissions.

15.27 The crux of significance is not whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a science-based 1.5°C transition towards net zero which the UK government has committed to achieve by 2050. The IEMA 2022 Guidance sets out the significance criteria as 'major adverse', 'moderate adverse', 'minor adverse', 'negligible', and 'beneficial', with examples to distinguish significance listed as follows:

- **Major adverse**: the project's GHG impacts are not mitigated or are only compliant with do-minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type. A project with major adverse effects is locking in emissions and does not make a meaningful contribution to the UK's trajectory towards net zero.
- **Moderate adverse**: the project's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type. A project with moderate adverse effects falls short of fully contributing to the UK's trajectory towards net zero.
- **Minor adverse**: the project's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. A project with minor adverse effects is fully in line with measures necessary to achieve the UK's trajectory towards net zero.
- **Negligible**: the project's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such

that radical decarbonisation or net zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards net zero and has minimal residual emissions.

- **Beneficial**: the project's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline. A project with beneficial effects substantially exceeds net zero requirements with a positive climate impact.

15.28 Major or moderate adverse effects and beneficial effects are considered to be significant. Minor adverse and negligible effects are not considered to be significant. The IEMA 2022 Guidance lists some examples of projects in the context of these significance criteria, summarised as follows:

- A project that follows a 'business-as-usual' or 'do minimum' approach and is not compatible with the UK's net zero trajectory, or accepted aligned practice or area based transition targets, results in a significant adverse effect. It is down to the practitioner to differentiate between the 'level' of significant adverse effects e.g. 'moderate' or 'major' adverse effects.
- A project that is compatible with the budgeted, science based (in terms of rate of emissions reduction) and which complies with up-to-date policy and 'good practice' reduction measures to achieve that has a minor adverse effect that is not significant. I.e., it is acknowledged that the project may have residual emissions, but is doing enough to align with / contribute to the net zero by 2050 goal (including at least a 78% reduction by 2035).
- A project that achieves emissions mitigation that goes substantially beyond the reduction trajectory, and has minimal residual emissions, is assessed as having a negligible effect that is not significant. This project plays a key part in achieving the net zero by 2050 / 78% reduction by 2035 goals.
- A project which results in the avoidance or removal of GHG emissions from the atmosphere (such as CCUS projects) have a beneficial effect that is significant. Only projects that actively reverse (rather than only reduce) the risk of severe climate change can be judged as having a beneficial effect.

15.29 Accordingly, an assessment of the contribution of the project towards the net zero trajectory (in accordance with the budgeted, science based 1.5°C trajectory) and the significance of the contribution has been undertaken and presented within this chapter.

15.30 A modification to this approach is required for the very largest-scale developments, those that in themselves have magnitudes of GHG emissions that materially affect the UK’s or a devolved administration’s total carbon budget. An indicative threshold of 5% of the UK or devolved administration carbon budget in the applicable time period is proposed in the IEMA 2022 Guidance, at which the magnitude of GHG emissions irrespective of any reductions is likely to be significant. This approach has also been assessed within this chapter, in addition to the approach above.

15.31 The IEMA 2022 Guidance sets out ‘good practice’ approaches to contextualising a project’s carbon emissions by comparing to sector-based, local, and / or national carbon budgets, policy goals and / or performance standards. This comparison has been undertaken whereby the net impact of emissions has been assessed in relation to local carbon emissions and sector carbon emissions. The data is sourced from UK local authority and regional GHG emissions from national statistics for the latest available data, 2021, which also includes a waste management category. This sector has been looked at on a national and local scale.

15.32 The emissions associated with the EfW Facility have also been compared to the UK carbon budgets for the periods 2023-2027, 2028-2032 and 2033-2037. It is noted that the Sixth Carbon Budget only reaches 2037. Future continuation in the reduction of these budgets is expected in order to reach net zero by 2050.

Climate Change Resilience

15.33 The assessment of the resilience of the Proposed Development to climate change has been undertaken in line with the IEMA 2020 Guidance. This includes quantifying the future baseline climate, identification of receptors sensitive to the projected changes to climate and their level of sensitivity, determining the magnitude of impacts, and the significance of any effects.

15.34 In order to determine the existing baseline climate, climate averages from the period 1991-2020 have been sourced from the nearest meteorological site to the Proposed Development, as published on the Met Office website.

15.35 The future baseline has been defined using UK Climate Projections 2018 (UKCP18). UKCP18 are a set of climate projections and tools to access climate data. The data used within this assessment has been extracted from the UKCP18 key results spreadsheet for the scenarios as detailed in Appendix 15.2. The identified changes have then been applied to the current baseline climate conditions to give a prediction of the local future climate conditions.

15.36 The resilience to climate change has been assessed for the following vulnerable receptors:

- Plant buildings and operational equipment;
- Vehicular access to site (for workers and waste);
- Grid connection and local users;
- On-site workers; and
- Soft landscaping.

15.37 The impacts of climate change that have been considered within the assessment for each receptor are:

- Increase in precipitation;
- Decrease in summer precipitation;
- Increase in summer temperatures; and
- Extreme events.

15.38 The following climate change impacts have been scoped out of the assessment, as justified below.

- **Sea level rise**- the site location is not in proximity to coastlines or tidal rivers and so will not be impacted by sea level rise.
- **Snow and ice** - the latest UK Climate Predictions (UKCP) (UKCP18) anticipate less snow and ice than the current baseline and as such, the risk from snow and ice is not anticipated to increase due to climate change.
- **Increased winter temperatures** - increases in winter temperatures do not exceed the current baseline for other times of the year and so the proposals would not be vulnerable to this effect.
- **Relative humidi**ty - changes in humidity are not included in the UKCP18 predictions and it is not likely to have a significant effect on the Proposed Development as it is designed to allow for a range of ambient conditions.
- **Water quality and soils** - water availability has the potential to cause changes to the mobilisation of pollutants. More acidic soils and / or water can increase the deterioration of building materials. Soil stability may be altered by a change in water availability. However, the design has accounted for a range of conditions.

15.39 For each receptor, the significance of each predicted effect of climate change has been assessed. This has considered the sensitivity of the receptor and the magnitude of impact.

15.40 IEMA state that the sensitivity of a receptor is "*the degree of response of a receiver to a change and its capacity to accommodate and recover from a change if it were to be affected".* This should account the susceptibility, vulnerability, and the value / importance of the receptor.

- **susceptibility** is defined as "*the ability of the receptor to be affected by a change";* and
- **vulnerability** is defined as "*the potential exposure of the receptor to a change and sensitivity is the degree of response of a receiver to change and a function of its capacity to accommodate and recover from a change if it is affected*".

15.41 The scale of the susceptibility and vulnerability has been determined using the IEMA 2020 Guidance as set out in Table 15.1.

Table 15.1 – Susceptibility and Vulnerability Scale

Scale	Susceptibility	Vulnerability
High	Receptor has no ability to withstand / not be substantially altered by the projected changes to the existing / prevailing climatic factors (e.g. lose much of its original function and form).	Receptor is directly dependent on existing / prevailing climatic factors and reliant on these specific existing climate conditions continuing in future (e.g. river flows and groundwater level) or only able to tolerate a very limited variation in climate conditions
Moderate	Receptor has some limited ability to withstand / not be altered by the projected changes to the existing / prevailing climatic conditions (e.g. retain elements of its original function and form).	Receptor is dependent on some climatic factors but able to tolerate a range of conditions (e.g. a species which has a wide geographic range across the entire UK but is not found in southern Spain).

Scale	Susceptibility	Vulnerability
Low	Receptor has the ability to withstand / not be altered much by the projected changes to the existing/prevailing climatic factors (e.g. retain much of its original function and form).	Climatic factors have little influence on the receptors (consider whether it is justifiable to assess such receptors further within the context of EIA – i.e. it is likely that such issues should have been excluded through the EIA scoping process).

15.42 In addition to the susceptibility and vulnerability, the value / importance of the receptor has been used to reach a reasoned conclusion on sensitivity using professional judgement. The greater the susceptibility, and / or vulnerability of the receptor, the greater the likelihood that the receptor would also be of higher sensitivity. For instance, a high-value receptor that has very little resilience to change in climate is considered to be more likely to have a higher sensitivity than a high-value receptor that is very resilient to changes in climate. The sensitivity of the receptor to the effect of climate change has been deemed to be low, medium or high. These descriptors have been determined based on professional judgement and are in line with the following examples:

- The sensitivity of a receptor to the impacts of fluvial flooding could be described as ‘low’ under the following scenario:
  - The value of the receptor is low - such an unused low grade farmers field;
  - The vulnerability is low - as it does not lie within the flood plain so is unlikely to be impacted by fluvial flooding associated with increased rainfall as a result of climate change; and
  - The susceptibility is low - as the receptor would have the ability to return to its previous use as the event would only cause temporary loss of use of the field, and damages would be limited.
- The sensitivity of a receptor to the impacts of fluvial flooding could be described as ‘high’ under the following scenario:
  - The value of the receptor is high - such a residential property;
  - The vulnerability is high - as it lies within the flood plain and is likely to be impacted by fluvial flooding associated with increased rainfall as a result of climate change; and
  - The susceptibility is high - as there are no flood defences or on site mitigation measures and therefore no ability to withstand fluvial flooding.
- The sensitivity of a receptor to the impacts of fluvial flooding could be described as ‘medium’ under the following scenario:
  - The value of the receptor is high - such a residential property;
  - The vulnerability is high - as it lies within the flood plain and is likely to be impacted by fluvial flooding associated with increased rainfall as a result of climate change; and

- The susceptibility is low - as there are effective mitigation measures in place such as flood defences which would allow the property to withstand the projected increases in rainfall and associated fluvial flooding events.

15.43 For each receptor and each identified change in climate, the magnitude of effect has been determined. The magnitude is “the degree of a change from the relevant baseline conditions which derives from the construction and operation of a development”. This is based on a combination of:

- Probability, which would take into account the chance of the effect occurring over the lifespan of the development, if the risk is not mitigated; and
- Consequence, which would reflect the scale or complexity of the effect, considering degree of harm, duration, frequency and reversibility of effect.

15.44 A combination of probability and consequence has been used to reach a reasoned conclusion on the magnitude of effect using professional judgement. Where a probability and / or consequence of the effect is high then the magnitude of effect would also be high. Descriptors of negligible, small, medium and large have been used to define the magnitude of impact in line with the following examples in relation to fluvial flooding:

- A negligible magnitude of change may be used to describe a scenario where there is a low probability of a fluvial flooding occurring, if the receptor is not within or close to a flood zone, and the consequence of flooding would be low, for example the damage caused by fluvial flooding of a low grade farm field is minimal and reversible;
- A small magnitude of change may be used to describe a scenario where there is a low probability of a fluvial flood occurring, i.e. the receptor is not within a flood zone, but there is a higher consequence of risk, for example a residential property may undergo a small amount of damage. A small magnitude of change could also be used to describe a scenario where there is a high probability of fluvial flooding, but the consequence is low, for example the damage caused by flooding of a low grade farm field is minimal and reversible;
- A medium magnitude of change may be used to describe a scenario where there is some probability of a fluvial flood event occurring, if the receptor is within a flood zone, and there is some consequence to a flood, for example a residential property may undergo some amount of damage; and
- A large magnitude of change may be used to describe a scenario where there is a high probability of a fluvial flood event occurring, if the receptor is within a flood zone particularly close to a river, and there is a likely consequence to a flood, for example a residential property may undergo significant damage.

15.45 The significance of effect has then been determined, taking into account the sensitivity for each receptor and the magnitude for each climate change effect using professional judgement. The following matrix provides an example of how the sensitivity of receptor and magnitude of effect can be used to determine the significance of the effect.

Table 15.2 – Climate Change Resilience – Significance of Effect Matrix

Sensitivity of receptor	Magnitude of effect descriptors			
	Negligible	**Small**	**Medium**	**Large**
Low	Negligible	Negligible	Negligible	Slight
Medium	Slight	Slight	Moderate	Substantial
High	Moderate	Moderate	Substantial	Substantial

15.46 An effect of negligible or slight significance is considered to be 'not significant'. A moderate or substantial effect is considered 'significant'.

Explanation of Baseline Conditions

GHG Emissions

15.47 The IEMA 2022 Guidance defines the baseline as a reference point against which the impact of a project can be compared against (sometimes referred to 'business as usual' or 'BaU', where assumptions are made on current and future GHG emissions). The baseline can be in the form of:

- "GHG emissions within the boundary of the GHG quantification but without the proposed project; or
- GHG emissions arising from an alternative project design and/or BaU for a project of this type".

15.48 The ultimate goal of establishing a baseline is being able to assess and report the net GHG impact of the proposed project.

15.49 As the impact of GHG emissions from the EfW Facility will be worldwide, a physical boundary to their impact cannot be defined. Therefore, the second option has been chosen to establish the baseline for the purposes of the main assessment. Notwithstanding this, the change in impacts of the EfW Facility have also been determined, in line with the first option.

15.50 For the main assessment, the principal 'alternative project design and/or BaU for a project of this type' (i.e. the baseline) will be 1) sending the waste to landfill, as this is currently the most likely alternative destination for the waste, and 2) generating electricity via gas-fired power stations, as this is the current 'marginal' technology. These choices for the baseline scenario are discussed in Appendix 15.1.

15.51 It has been suggested by an objector (letter to DfI from noarc21 dated 21 June 2024) that some of the waste which would be processed at the EfW Facility is currently being processed at other EfW facilities and so comparing with landfill is incorrect. We consider that the result of building a new EfW facility will be that less waste goes to landfill somewhere. If waste is processed at Hightown Quarry rather than at an EfW facility in Sweden, for example, then the operator of that EfW facility would source waste from elsewhere and, given that millions of tonnes of waste are being sent to landfill across Europe, that other waste would be displaced from landfill.

15.52 Despite this, an alternative baseline has been set out in the updated carbon assessment, which does not allow for these second order effects. While most of the residual waste continues to be processed in landfill, some is sent to the Full Circle Generation plant in Belfast, EfW plants in Scandinavia and the Indaver Meath EfW plant. These choices are explained in Appendix 15.1.

15.53 A summary of the baseline figures of local and sector carbon emissions, used for the assessment of significance, is provided in Table 15.3. The local area has been selected as Northern Ireland, as this is the area where the Site is located and the area from which the waste will be collected.

Table 15.3 – Baseline Figures – Local and Sector GHG Emissions Summary

Source	Units	Value
UK Waste Management Sector 2021	kt CO_2e/a	18,814
NI Total – 2021	kt CO_2e/a	20,233
NI Total – Waste Management Sector 2021	kt CO_2e/a	988

Climate Change Resilience

15.54 The information on current climate has been sourced from historical climate averages data from the period 1991-2020, as set out on the Met Office website. Trends are as described in the Met Office regional profile for Northern Ireland, which is appropriate for the site, and data taken from the closest long-term meteorological station with historical data, Belfast Newforge, which is approximately 11 km to the south-south-east of the site. Full details of the baseline climate have been provided in Appendix 15.2 and summarised in Table 15.4.

15.55 As described in the methodology section, the future baseline has been calculated by taking the current climate data from Belfast Newforge and applying the predicted changes as set out in UKCP18. This assessment has used the UKCP18 predictions, based on the predictions for Northern Ireland. The predicted changes to baseline climate have been detailed within Appendix 11.2.

15.56 In summary, the current baseline and future baselines used for the purpose of this assessment have been provided in Table 15.4. It has also been qualitatively assumed that there will be increases in both the intensity of rainfall and speeds of winds in winter.

Table 15.4 – Future Baseline Climate Conditions Summary

Item	Units	Baseline - Belfast Newforge (1991-2020)	Predicted change (UKCP18)	Future Baseline (at Belfast Newforge 2040-2059)
Central (50th percentile) Estimate				
Mean annual temperatures	°C	10.0	1.50	11.5
Mean winter temperatures	°C	5.3	1.40	6.7
Mean summer temperatures	°C	15.0	1.70	16.7
Mean in winter precipitation	mm	84.0	5.0%	88.0
Mean summer precipitation	mm	76.0	-14.0%	65.0
High (90th percentile) estimate				
Mean summer precipitation	mm	76.0	1.0%	77.0
Low (10th percentile) Estimate				
Mean winter precipitation	mm	84.0	-6.0%	79.0

Predicted Environmental Impacts (Construction and Operation)

Embedded Mitigation

GHG Emissions

15.57 The Proposed Development will go through a detailed design process prior to construction, which considers measures to minimise the impact of GHG emissions. These are described further below.

- The Proposed Development will need a Permit issued under The Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013 to operate. In accordance with the Permit requirements, the Applicant will be required to ensure that the Proposed Development is operated efficiently, and that energy and water are used efficiently, including maintaining records of utilities consumption.
- The Proposed Development will be operated to ISO 14001 certification. This is the international standard for environmental management systems (EMS) and provides the operator with a framework for making policy and process changes that help improve the environmental performance. The EMS requires the setting of objectives and targets to

reduce the environmental impacts associated with operation of the Proposed Development.

- The development is to be built on an undeveloped brownfield site. Therefore, there are no onsite structures to be repurposed or recycled.
- The Proposed Development would be constructed in line with appropriate building standards, keeping pollution and waste to a minimum and ensuring the potential effect from its construction do not compromise its surroundings.

Climate Resilience

15.58 In terms of designing the building to be resilient to the impacts of climate change, the following mitigation measures will be incorporated into the design, to help improve the resilience of the Proposed Development to climate change.

- The flood risk and any subsequent mitigation measures have been calculated taking climate change into account.
- The surface water drainage system will include attenuation storage to restrict surface water runoff generated across roofs and hardstanding, with a capacity designed to take into account of changes due to climate change.
- The water supply will be provided by Northern Ireland Water, who have a range of mitigation measures and improvements in place to improve climate resilience and ensure reliable water source to their customers.
- Buildings materials will be resilient to expected climatic extremes with British Standards applicable for most materials to ensure that extreme climatic conditions are accounted for. For example, movement joints will allow for expansion and contraction of building materials under changing temperatures and building wind loading studies have been carried out including a safety factor sufficient to allow for stronger winds due to climate change.
- A contingency plan will be in place to account for any halt in feedstock availability (such as during bank holiday periods). The site has capacity for a few weeks worth of waste feedstock, taking account of the MBT plant and baled storage, and storage capacity for residues. Therefore, the Proposed Development is able to continue operations for a few weeks in the event of a halt in feedstock availability.
- Cables associated with the grid connection would be underground. This protects them from any above ground damage from storm or wind events and the cables are designed to be resilient to water and so would not be impacted by any flooding events.
- There will be a Risk Assessment Method Statements (RAMS) in place to account for the impact of any climate induced hazards to on-site workers. On-site workers are fitted with the correct Personal Protective Equipment (PPE) and must adhere to site health and safety rules and procedures in place for their protection.
- The buildings will be regularly inspected for any damage potentially caused by winds or weather conditions, and preventative maintenance carried out.
- The site operational procedures will include monitoring of weather conditions and warnings provided to workers should any adverse weather occur.

- The soft landscaping scheme for the Attenuation Lagoons includes the planting of native marginal and aquatic species. It is proposed that the variation of species and native species will increase the resilience of the soft landscaping to the impacts of climate change.

Construction

15.59 As noted above, impacts of construction have been scoped out of the assessment.

Operational Phase – GHG Emissions

15.60 A detailed updated carbon assessment has been included in Appendix 15.1. A summary of the key results from the assessment is provided in Table 15.5.

Table 15.5 – Summary of Key Results from the GHG Assessment

Parameter	GHG Emissions (t CO_2e per annum)	
	Base Case	**Alternative Baseline**
Releases from LFG	94,176	56,584
Transport of waste and outputs to landfill	485	292
Offset of grid electricity from LFG engines	-14,313	-8,600
Total baseline landfill emissions	**80,348**	**48,276**
Emissions from the baseline EfW facilities	0	33,872
Transport of waste to and outputs from the baseline EfW facilities	0	1,049
Offset of grid electricity with generation from the baseline EfW facilities	0	-16,122
Offset of boiler natural gas usage with heat from the baseline EfW facilities	0	-2,393
Total baseline EfW facilities emissions	**0**	**16,683**
Total Baseline Emissions	**80,348**	**64,958**
Transport of waste to and outputs from the EfW Facility	84,870	84,870
Offset of grid electricity with the generation from the EfW Facility	878	878
Offset of material outputs	-450	-450
Emissions from the EfW Facility	-48,766	-48,766

Parameter	GHG Emissions (t CO_2e per annum)	
Total Emissions – EfW Facility	**36,532**	**36,532**
Difference between baseline and EfW Facility	**43,815**	**28,464**

15.61 The net benefit of the EfW Facility (with the IBA plant) has been calculated as the difference between the baseline (assuming the 211,000 tpa of waste are deposited in landfill) or the alternative baseline (with some of the residual waste going to alternative EfW plants) and the EfW Facility. As shown, the EfW Facility is predicted to produce 43,815 fewer tonnes of CO_2e per annum than the landfill baseline or 28,464 fewer tonnes of CO_2e per annum than the alternative baseline. As such, the EfW Facility at Hightown has a carbon benefit.

15.62 The above results have been based on assumptions on the waste composition, landfill gas capture rate and the grid displacement factor. To show the effect of using different assumptions on calculated GHG emissions, the sensitivity of using different assumptions has been considered in Appendix 15.1. If a different waste composition is used, with some of the food waste removed from residual waste, then the net benefit is predicted to be 35,045 tonnes of CO_2e per annum compared to landfill. A range of assumptions for landfill gas capture rate and the grid displacement factor have been considered, giving a predicted benefit of between 1,631 and 92,111 tCO_2e per annum compared to landfill or between 7,154 and 57,482 tCO_2e per annum compared to the alternative baseline.

15.63 The cumulative lifetime impact associated with the Proposed Development has been assessed in Section 6 of Appendix 15.1. The estimated date of operation of the EfW Facility (and the IBA plant) is 2030. From this point, the lifetime assessment has been undertaken for a period of 25 years. Although it is acknowledged that the lifetime of the EfW Facility (with the IBA plant) may be longer than this, it is difficult to predict the baseline parameters this far into the future, and it is common practice to assess the lifetime benefit for Carbon Assessments for 25 years. Therefore, within the lifetime analysis below, it is assumed that the EfW Facility and the IBA plant operation spans between 2030 and 2054. During the lifetime, the grid displacement factor, landfill gas recovery rate and waste composition will vary, so this has been taken into account.

15.64 The results show that the EfW Facility (with the IBA plant) would have a benefit over landfill until 2045, although the benefit decreases over time. This is because the decrease in the electricity grid displacement factor means that the offset from displacement of power generated by the EfW Facility decreases. In addition, landfill becomes less of a carbon burden as LFG capture rates improve, so the difference between the EfW Facility and the baseline decreases. The changes to the waste composition will have an impact on the total carbon in the waste, which also influences the results. The lifetime cumulative benefit of the EfW Facility (with the IBA plant) is 107,075 t CO_2e over 25 years until 2054. These results are further detailed and displayed graphically within Appendix 15.1.

15.65 For completeness, the annual net benefit of emissions of the EfW Facility (with the IBA plant) compared to the alternative baseline are shown in Appendix 15.1 up to 2054, using the same changes in waste composition, landfill gas collection rates and grid displacement factors as for the main lifetime assessment. This assumes that the rest of Europe will decarbonise its electricity grid at the same rate as the UK, which may not be realistic, and it assumes that it will remain acceptable to export waste from Northern Ireland to other countries indefinitely, which may not be politically acceptable as it conflicts with the principle of dealing with waste locally so that Northern Ireland is self-sufficient. Compared to the alternative baseline, the carbon impact of the EfW Facility is a carbon benefit annually until 2042. The lifetime cumulative net benefit of the EfW Facility (with the IBA plant) is 40,512 tCO2e over 25 years until 2054.

15.66 In accordance with the IEMA 2022 Guidance, both the significance of the project against national and local carbon emissions and carbon budgets, and the significance of the project against the net zero trajectory, have been assessed. The original assessment is repeated below and expanded to consider the alternative baseline.

15.67 To determine the significance of the calculated annual carbon emissions associated with the Proposed Development against local and national carbon emissions, these have been compared to the current baseline and the alternative baseline, with the results displayed in Table 15.6.

Table 15.6 – Summary of the Key Results from the GHG Assessment

Source	Value (tCO_2e/a)	As % of Background				
		Total Baseline	Total Alt Baseline	Total EfW Facility	Net Benefit	Net Alt. Benefit
UK Waste Management Sector 2021	18,813,600	0.43%	0.35%	0.19%	0.24%	0.16%
Northern Ireland Total – 2021	20,233,100	0.40%	0.32%	0.18%	0.21%	0.14%
Northern Ireland – Waste Management Sector 2021	987,600	8.14%	6.58%	3.70%	4.44%	2.88%

15.68 The contribution of emissions from the EfW Facility (with the IBA plant) are below 5% of the UK Waste Management sector total and therefore are not considered a significant contribution on a national scale. Furthermore, as there is a net benefit compared to the baseline and the alternative baseline, this reduces the contribution of carbon emissions to the UK and NI Waste Management sector.

15.69 Although the EfW Facility would be considered a project of national (and international) importance (as the impact of GHG emissions are worldwide and a physical boundary to their impact cannot be defined), the carbon emissions have also been compared to the local baseline emissions in

Northern Ireland. The carbon contributions associated with the EfW Facility are 0.18% of Northern Ireland's emissions. As this is less than 5%, in accordance with the IEMA 2022 Guidance, this is considered to be not significant.

15.70 The carbon emissions have also been compared to the Waste Management sector for Northern Ireland; the carbon contributions associated with the EfW Facility (with the IBA plant), without consideration of the baseline, are 3.70% of the 2021 Northern Ireland Total Waste Management sector emissions. As this is less than 5%, in accordance with the IEMA 2022 Guidance, this is considered to be not significant. In addition, the EfW Facility (with the IBA plant) results in a reduction in the contribution to the Northern Ireland Waste Management emissions of 4.44% compared to the baseline or 2.88% compared to the alternative baseline. Therefore, this emissions reduction is a benefit to the Northern Ireland waste management sector emissions, although as the benefit is less than 5%, it is therefore not significant.

15.71 Although the IEMA guidance quotes the 5% significance criteria for comparing sector emissions, it is recognised that emissions from the Proposed Development will contribute to the total carbon emissions of the region and UK. The IEMA 2022 Guidance recognises that it is important to consider the net impact of the project over its lifetime, when compared against the likely alternative.

"When evaluating significance, all new GHG emissions contribute to a negative environmental impact; however; some projects will replace existing development or baseline activity that has a higher GHG profile. The significance of a project's emissions should therefore be based on its net impact over its lifetime, which may be positive, negative or negligible".

15.72 The total emissions associated with the EfW Facility (with the IBA plant) have been calculated for each 5-year period corresponding to the carbon budgets. These values have used the annual values taken from the lifetime assessment, totalled for each 5 year period. As the first carbon budget only goes up to 2027 and the first operational year is expected to be 2030, there is no effect on the first carbon budget. The values for the second and third budgets are displayed against the UK carbon budgets for each period, with the percentage contribution towards the budget also displayed.

Table 15.7 – Summary of the Key Results from the GHG Assessment

Item	2023-2027 Carbon Budget: 1,950 $MtCO_2e$		2028-2032 Carbon Budget: 1,725 $MtCO_2e$		2033-2037 Carbon Budget: 965 $MtCO_2e$	
	Value (t CO_2e)	As % of Budget	Value (t CO_2e)	As % of Budget	Value (t CO_2e)	As % of Budget
EfW Facility Emissions	-	-	203,541	0.012%	383,546	0.040%
Baseline emissions	-	-	266,343	0.015%	442,037	0.046%

Item	2023-2027 Carbon Budget: 1,950 $MtCO_2e$		2028-2032 Carbon Budget: 1,725 $MtCO_2e$		2033-2037 Carbon Budget: 965 $MtCO_2e$	
	Value (t CO_2e)	As % of Budget	Value (t CO_2e)	As % of Budget	Value (t CO_2e)	As % of Budget
Difference (Benefit)	-	-	62,802	0.004%	58,491	0.006%
Alternative Baseline emissions	-	-	241,123	0.014%	414,978	0.043%
Difference (Benefit) vs Alternative	-	-	37,582	0.002%	31,432	0.003%

15.73 For each carbon budget period, the net emissions from the EfW Facility (with the IBA plant) are well below 5% of the carbon budget and therefore the contribution is considered to be ***not significant***.

15.74 To determine whether the project contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050, the project's emissions should be based on its net impact over its lifetime according to the IEMA 2022 Guidance as, although all new GHG emissions contribute to a negative environmental impact, some projects will replace existing development or baseline activities that have a higher GHG profile.

15.75 The Proposed Development results in the avoidance of GHG emissions to the atmosphere, compared to the baseline and the alternative baseline, in each budget period. This can be described in accordance with the IEMA 2022 Guidance as having a ***beneficial*** effect that is ***significant***. However, the IEMA 2022 Guidance continues to state that "*only projects that actively reverse (rather than only reduce) the risk of severe climate change can be judged as having a beneficial effect*."

15.76 In accordance with the IEMA 2022 Guidance:

- a beneficial project can be described as "*the project's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline. A project with beneficial effects substantially exceeds net zero requirements with a positive climate impact*": and
- a negligible project can be described as "*the project's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards net zero and has minimal residual emissions*."

15.77 Therefore, the significance would be described as ***beneficial***, because the change in carbon emissions compared to the baseline is negative. However, as the EfW Facility does not actively reverse the risk of climate change, as it does not remove carbon from the atmosphere (such as CCUS technology would), as a conservative measure, it has been concluded that the EfW Facility (with the IBA plant) is of ***negligible*** significance, with reference to the Net Zero trajectory.

Operational Phase Climate Resilience

15.78 The climate change resilience has been assessed for the following vulnerable receptors:

- Plant buildings and operational equipment;
- Vehicular access to site (for workers and waste);
- Grid connection;
- On-site workers; and
- Soft landscaping.

15.79 For each receptor, the impact of each predicted climatic effect has been assessed. This has taken into account the design mitigation measures embedded into the Proposed Development. The susceptibility and vulnerability to climate change have been considered to determine the resulting sensitivity to the impacts of climate change. Magnitude has been determined taking into account the probability and consequence. The sensitivity of the receptor and magnitude of effect has been used to determine the overall significance of effects. Full details of the assessment can be found in Appendix 15.3.

15.80 To summarise, the overall significance of effects of climate change on the buildings and operational equipment has been assessed to be negligible to slight; the overall significance of effects of climate change on vehicular access to site has been assessed to be slight; the overall significance of effects climate change on the grid connection and local users has been assessed to be negligible; the overall significance of effects of climate change on on-site workers has been assessed to be slight and the overall significance of effects on soft landscaping has been assessed to be slight. None of these are considered to be significant impacts. Therefore, overall it is predicted that the impact of climate change on the Proposed Development is not significant - i.e. the Proposed Development is resilient to climate change.

Other Matters

Objection

15.81 Colin Buick, on behalf of the group NoArc21, made a submission on 21 June 2024 in which he made a number of comments on the carbon assessment included in the September 2023 ES addendum. Fichtner has responded to these comments in Appendix 15.4 of this April 2025 ES addendum, in which we have explained that his comments are incorrect.

Finch Judgement

15.82 On 20 June 2024, the UK Supreme Court gave a judgement on the case of *Finch v Surrey County Council & Others*. This case concerns the correct application of the Environmental

Impact Assessment (EIA) process to assessing the ‘downstream’ greenhouse gas emissions from new oil development, specifically the emissions associated with the use of the product (oil) once it has been refined. The equivalent emissions for the Proposed Development, i.e. the benefits of exporting electricity and material products, have been considered in the carbon assessment.

15.83 In conducting our assessment, and in light of the *Finch* judgment, we have considered the following three questions::

- Would the development give rise to inevitable indirect upstream or downstream effects i.e. would there be inevitable causation?
- Is it possible to undertake evidence based meaningful assessment of the effects?
- Will an assessment reasonably conclude likely significant effect(s)?

15.84 GHG emissions can be categorised into the following three scopes for company reporting purposes:

- Scope 1 covers direct emissions from owned or controlled sources.
- Scope 2 covers indirect emissions from the purchase and use of electricity, steam, heating and cooling. By using the energy, an organisation is indirectly responsible for the release of these GHG emissions.
- Scope 3 includes all other indirect emissions that occur in the upstream and downstream activities of an organisation.

15.85 The GHG emissions associated with the Proposed Development were not specifically reported within these categories. The carbon assessment specifically calculated:

15.85.1 Direct GHG emissions from the combustion of waste in the EfW Facility (scope 1).

15.85.2 Indirect GHG emissions associated with the transport of waste and outputs from the EfW Facility (scope 3).

15.85.3 Indirect GHGs associated with the offset of material output from the EfW Facility namely Incinerator Bottom Ash Aggregate (IBAA) and Air Pollution Control residues (APCr) which would displace other forms of aggregate. This has a carbon benefit and is scope 3.

15.85.4 Indirect GHGs associated with the offset of electricity generated by the EfW Facility compared to the counterfactual case. This has a carbon benefit and is considered either scope 2 (as being effectively negative consumption of electricity) or scope 3.

15.86 The following additional upstream and downstream emissions, all of which are scope 3, were not specifically included in the carbon assessment:

15.86.1 Indirect GHG emissions associated with the transportation of construction workers to the Site.

15.86.2 Indirect GHG emissions associated with the transport of operational phase workers to the Site.

15.86.3 Indirect GHG emissions associated with the production of flue gas treatment reagents and auxiliary fuel for start up and safe shutdown of the EfW Facility.

15.87 However, the first two of these would not lead to inevitable effects, as the workers would commute to other places of work, and the third of these cannot be quantified as it is not known where the reagents or oil would be produced. In addition, the contribution from production of reagents and auxiliary fuel would be minor and so would not lead to significant effects. Therefore, it is reasonable for these to be excluded.

Description of Proposed Mitigation Measures (Construction and Operation)

Construction

15.88 No additional mitigation measures are proposed beyond those embedded in the design of the Proposed Development. Mitigation measures relevant to the construction phase of the development have been previously set out in Chapter 15 of the original ES (March 2014) which includes the preparation of a Construction Environmental Management Plan. This will, for example, encourage the careful use of resources and material, a reduction in waste and encourage materials to be procured from sustainable sources. This is in addition to the standard construction mitigation measures outlined in the relevant technical chapters such as noise and air quality.

Operation

15.89 No additional mitigation measures are proposed beyond those embedded in the design of the Proposed Development.

GHG Emissions

15.90 In relation to GHG emissions, the IEMA 2022 Guidance states that "*where the initial assessment identifies significant adverse effects, additional mitigation should be considered to reduce these effects to an acceptable and non-significant level where feasible".* The GHG assessment has established that there will be no significant effects on climate as a result of GHG emissions from the EfW Facility (with the IBA plant), and no further mitigation measures are recommended.

15.91 Notwithstanding this, there are some potential further enhancements to the Proposed Development which are not currently considered appropriate (e.g. due to technical or commercial constraints) but may become feasible within the lifetime of the Proposed Development, which would help to offset residual GHG emissions. For example, whilst carbon capture and district heating are not part of the current application, the Proposed Development has been "future proof" designed to accommodate such developments in the future.

15.92 The UK Government report 'Ten Point Plan for a Green Revolution' stated that a consultation on the phase out of new diesel HGVs would be launched in 2021. The Ten Point Plan also stated there will be £20 million invested in freight trials to pioneer hydrogen and other zero emission lorries, to support industry to develop cost-effective, zero-emission HGVs in the UK. The consultation on the phase-out of new diesel HGVs was subsequently held between July - September 2021, the outcome being that the government announced a phase-out date for the sale of new, non-zero emission HGVs less than or equal to 26 tonnes from 2035 and, from 2040, all new HGVs sold in the UK must be zero emission. A further call for evidence ran between May - July 2022 under the previous government to try to determine possible exemptions to the 2035 phase-out date. At the time of writing, feedback from the call of evidence is being analysed and is not yet published on the UK Government's website. Taking this into consideration, there is the potential for decarbonisation of the fleet of waste delivery vehicles for the Proposed Development.

15.93 In addition to the above, current mitigation measures will be constantly under review; the Permit issued under The Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013 will require that records of energy and water consumption are maintained, that there will be periodic reviews of heat export viability; and the EMS requires objectives and targets to be set (and tracked) to reduce the environmental impacts associated with operation of the Proposed Development.

Climate Change Resilience

15.94 No additional mitigation measures are deemed necessary. The impact of climate change on the Proposed Development will be monitored in future years and if any adaptations are required, they can be considered in due course. However, in line with the assessment, the embedded mitigation measures are expected to be resilient to climate change so that there are no significant impacts of climate change on the Proposed Development.

Statement of Significance of Residual Effects

15.95 The impacts of the EfW Facility (with the IBA plant) in relation to GHG emissions have been assessed in line with the IEMA 2022 Guidance, using a reasoned set of assumptions where definitive parameter values were not available. It has been concluded that there will be a net carbon benefit (and as such a positive effect in reducing carbon emissions) of the EfW Facility (with the IBA plant), compared to the baseline scenario and the alternative baseline scenario.

15.96 The effect of GHG emissions associated with the EfW Facility (with the IBA plant), under the reasonable tonnage case, is determined to be not significant when compared to 2021 total Northern Ireland emissions, or the 2021 national waste management sector emissions and the change in emissions compared to the baseline is determined to be not significant when compared to Northern Ireland Waste Sector emissions. When compared to future national carbon budgets, both the net emissions and the net benefit of the EfW Facility (with the IBA plant) during the carbon budget time frames are considered to be not significant.

15.97 In line with the IEMA guidance 'Environmental Impact Assessment Guide to Climate Change and Resilience and Adaption' (2020), it has been concluded that the projected climate change effects over the lifetime of the Proposed Development will have a negligible to slight effect, and as such, there will be no significant effects on vulnerable receptors.

15.98 The measures to avoid, prevent, reduce or offset any significant adverse effects on climate change and the vulnerability of the Proposed Development are already included in its design. As such, the Proposed Development is considered to be appropriately designed and constructed to adapt to impacts arising from climate change and there are no significant residual effects.

15.99 In conclusion, the Proposed Development has been considered to be resilient to the effects of climate change and the EfW Facility (with the IBA plant) will provide a reduction in GHG emissions compared to the baseline scenario and the alternative baseline, supporting the UK's Net Zero trajectory.

Clyde Shanks

Appendix 15.1

Revised Carbon Assessment

FICHTNER

Consulting Engineers Limited

Hightown Quarry

arc21

Appendix 15-1 Carbon Assessment

ENGINEERING + CONSULTING

Document approval

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Prepared by:	Stephen Othen		Technical Director	09/04/2025
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Revision no	Date	Details of revisions	Prepared by	Checked by
00	09/04/25	Draft for client	SMO	HKL

Contents

1 Introduction

1.1 Background

Fichtner Consulting Engineers Limited (Fichtner) has been appointed by the applicant to provide a carbon assessment for the Energy from Waste Facility (EfW Facility) which is planned to be developed at Hightown Quarry by arc21 as part of an integrated waste management facility.

The original ES (from 2014) included a carbon assessment as part of a WRATE model, which predicted that the integrated waste management facility would reduce carbon emissions, compared to landfill, by 57,474 tonnes of CO_2-equivalent per annum (tCO_2e p.a.). The WRATE assessment was updated in 2019, giving a benefit compared to landfill of 54,033 tCO_2e p.a.

The EfW Facility has been designed to generate 18.7 MWe at the design point and export 16.7 MWe, when operating in power-only mode. At the design point, which is a thermal input of 72 MWth, the plant is designed to process 26.8 tonnes per hour of waste at a net calorific value (NCV) of 9.67 MJ/kg, which gives an annual waste throughput of approximately 211,000 tonnes per annum (tpa).

The integrated waste management facility includes a bottom ash treatment facility, which produces an incinerator bottom ash (IBA) Aggregate to displace virgin aggregate.

1.2 Objective

The purpose of this carbon assessment is to determine the relative carbon impact of processing waste in the EfW Facility, compared to disposal in a landfill, as this is the most likely alternative destination for the waste in Northern Ireland. This is consistent with the baseline comparison used in the previous WRATE assessments and further reflects the Department for Agriculture, Environment and Rural Affairs' (DAERA's) proposed direction of travel regarding phasing out of exports by 2030. The sensitivity of the results to changes in grid displacement factors, landfill gas recovery rates and waste composition, as well as the export of heat, has also been assessed.

As some of the assumptions will change over time, the cumulative impact of the EfW Facility over its lifetime has also been assessed.

The report has been revised to include an alternative baseline, in which some of the waste which would be processed in the EfW Facility is instead processed in other EfW facilities on the island of Ireland or in Sweden, with some being sent to landfill.

The assessment focuses on the operational emissions only (use stage). It considers the direct emissions from combustion of waste and auxiliary fuel and indirect emissions associated with the transport of waste, reagents and residues. It also considers the downsteam indirect benefits (scope 3) associated with exporting electricity to the grid (and so displacing other forms of electricity generation) and with the use of residues as aggregate (displacing other forms of aggregates).

2 Conclusions

1. The following scenarios have been assessed to determine the change in carbon impacts associated with the development of the EfW Facility:
   a. **Baseline**: The management of 211,000 tpa of waste in landfill facilities within the region.
   b. **Proposal:** The management of 211,000 tpa of waste at the EfW Facility.
2. The carbon impacts associated with the operation of the EfW Facility take account of:
   a. carbon dioxide released from the combustion of fossil-fuel derived carbon in the EfW Facility;
   b. releases of other greenhouse gases from the combustion of waste;
   c. combustion of gas oil in auxiliary burners;
   d. carbon dioxide emissions from the transport of waste and residues;
   e. emissions offset from the use of residues; and
   f. emissions offset from the export of electricity from the EfW Facility.
3. The carbon impacts associated with the baseline landfill scenario take account of:
   a. the release of methane in the fraction of landfill gas (LFG) which is not captured; and
   b. emissions offset from the generation of electricity from LFG.
4. The baseline is predicted to lead to carbon impacts of **80,348 tCO_2e p.a**. The EfW Facility is predicted to lead to carbon impacts of **36,532 tCO_2e p.a.** Therefore, the EfW Facility is predicted to lead to a reduction in carbon impacts of **43,815 tCO_2e p.a.** compared to the baseline.
5. The sensitivity of the carbon assessment results to a different waste composition, with additional food waste removed at source, has been considered. The net benefit of the EfW Facility in this case is **35,045 tCO_2e p.a.** compared to the baseline.
6. The sensitivity of the carbon assessment results to different LFG recovery rates and different grid displacement factors has also been assessed. The results of the LFG and grid displacement sensitivities show a range of carbon benefits of the Proposed Development compared to landfill of between 1,631 and 92,111 tCO_2e per annum.
7. An alternative baseline, in which some of the existing waste is sent to alternative EfW facilities in the UK and Europe, has also been considered. The EfW Facility continues to have a net benefit, with a net reduction of greenhouse gas emissions of **28,464 tCO_2e p.a**.
8. To assess the lifetime impact of the EfW Facility, the carbon impact has been assessed for the first 25 years of operation, up to 2054. Taking into account conservative changes in grid displacement factors, improvements in LFG capture efficiencies and changes to waste compositions (assuming a reduction in food and plastic wastes over time) over the lifetime of the EfW Facility, it is predicted that the EfW Facility will have an annual carbon benefit each year up to 2043, and that the total cumulative carbon benefit of the EfW Facility compared to landfill will be **107,075 tCO_2e** over 25 years until 2054.
9. The sensitivity of the lifetime assessment results to changes to grid displacement factors, LFG capture rates and waste composition has been assessed. Sensitivity results show a range in the cumulative benefit of the EfW Facility over landfill over 25 years to 2054 between **40,512 t CO_2e** and **354,386 t CO_2e**.

3 Main parameters

3.1 Design case

The following parameters have been used for the EfW Facility. This is based on a reasonable tonnage expected at the EfW Facility, as presented in the ES.

- The annual throughput is 211,000 tpa;
- The NCV of the waste is 9.67 MJ/kg; and
- The annual availability is nearly 90%, or 7,871 hours.

3.2 Waste composition

The integrated waste management facility would receive residual waste from the arc21 councils. This would be processed through the mechanical and biological treatment plant to extract recyclable materials, with the remaining waste being sent to the EfW Facility. Depending on capacity, some commercial and industrial waste could also be sent directly to the EfW Facility.

At this stage of design, the composition of the residual waste and the equipment to process that waste have not been determined. Therefore, the waste composition for the carbon assessment has been derived from public data and reasonable assumptions, in order to give waste with the design NCV mentioned above.

There are two sources of waste composition data in Northern Ireland.

- WRAP: "UK Waste Composition Estimates", January 2020. This report, prepared by Eunomia on behalf of WRAP, gives an estimate for residual waste collected from households at the kerbside and from Household Waste Recycling Centres in calendar year 2017. This data is presented for the whole of the UK and for the constituent parts, including Northern Ireland, and so gives a total composition for all household residual waste.
- WRAP: "Northern Ireland Kerbside Waste Composition 2017", March 2018. This report, prepared by RPS on behalf of WRAP (NI), gives an estimate for kerbside collected residual waste only for the financial year 2016/17.

As the first report gives composition data for all residual waste, rather than just kerbside collected waste, the data for Northern Ireland from this report has been used as the baseline case.

Given that waste management policies have changed since 2017, the compositions have been adjusted by removing 90% of plastic bags, as well as removing 90% of WEEE, as this would be removed before coming to the integrated waste management facility. This data has then been adjusted to remove 5% of cardboard, 95% of metals and 57% of plastics, to represent the performance of the mechanical separation and to achieve a NCV of 9.67 MJ/kg.

It is recognised that UK waste policy supports the increased collection of food waste. In order to model the impact of this, an alternative waste composition has been considered, in which 50% of food waste is removed before the waste reaches the integrated waste management facility. As this gives a higher NCV, the waste throughput has been reduced to maintain the same thermal capacity.

Table 1 below shows the characteristics of the assumed waste composition for the baseline case and the low food case.

Table 1: Nominal waste characteristics

Waste Mix	Carbon content (% mass)	Biocarbon (% carbon)	NCV (MJ/kg)	Nominal waste throughput (tpa)
Base Case	26.14	60.45	9.67	211,000
Low Food	27.82	57.92	9.85	207,171

3.3 Baseline

The baseline scenario should represent the situation should the EfW Facility not be built. In this assessment, it has been assumed that waste would otherwise be sent to landfill. It is recognised that this is a simplification, as the EfW Facility forms part of the overall integrated waste management facility, but it is appropriate for determining the benefit of the EfW Facility alone. It also means that the assessment does not take account of the other benefits of the integrated waste management facility, such as the increase in recycling rates, and so it is conservative.

The approach to use landfill as a baseline is supported by national UK guidance, specifically "*Energy from Waste: A Guide to the Debate*" and "*Energy recovery for residual waste – A carbon based modelling approach*", both published by DEFRA in 2014.

Taking this into consideration, landfill is considered to be appropriate to form the baseline scenario. That is, without the EfW Facility, it has been assumed that the 211,000 tpa of waste would otherwise go to landfill.

3.4 Grid offset

Sending electricity to the grid offsets the carbon burden of producing electricity using other methods. Therefore, it is important to consider the type of power station which would be displaced.

Data on electricity generation in Northern Ireland is published by the Department for the Economy. According to the Energy in Northern Ireland 2022 report[1], which is the most recently published report, electricity generation in Northern Ireland in 2020 was 42.5% from gas, 10.8% from coal and 45.6% from renewables, with over 80% of the renewables being from wind. A shorter report for the period April 2022 to March 2023[2] states that the renewables share of electricity consumption had increased to 48.5%, of which 84.7% was generated from wind. This report does not, however, have any data on the split of non-renewable electricity. The electricity markets in Northern Ireland and Ireland are linked together in the All-Ireland electricity market. Therefore, the sources of electricity in Ireland are also relevant. According to the Sustainable Energy Authority of Ireland (SEAI)'s 2022 report on Energy in Ireland[3], about 60% of electricity in Ireland in 2021 was generated from fossil fuels, split into gas (45.7%), coal (8.2%), oil (4.4%) and peat (1%). Renewables provided 35% (29.5% wind, with biomass, waste, hydro and solar contributing the rest), with the balance made up with imports. 2021 was unusual in that there was a significant increase in coal-generation due to reduced wind generation and some outages on the gas-fired plants.

It is considered that the construction of the EfW Facility will have little or no effect on how much electricity is generated from wind. Wind plants have very low operating costs and renewable plants are favoured in the electricity market, so wind plants will always operate when they can. Therefore,

[1] https://www.economy-ni.gov.uk/publications/energy-northern-ireland-2022

[2] https://www.economy-ni.gov.uk/publications/issue-27-electricity-consumption-and-renewable-generation-northern-ireland-april-2022-march-2023

[3] https://www.seai.ie/publications/Energy-in-Ireland-2022.pdf

the marginal electricity source is likely to be a combined-cycle gas turbine (CCGT). It is also possible that the EfW Facility will displace power generated by an open-cycle gas turbine or gas engines, both of which are more carbon intensive than CCGT. Therefore, it is more conservative to assume that CCGT's will be displaced. The displacement factor for CCGTs is 0.371 t CO_2e/MWh[4].

Notwithstanding the above, the effect of changing the grid offset displacement factor has been considered as a sensitivity in Section 5.2.

3.5 Material offset

The EfW Facility and bottom ash treatment facility will produce two types of residues – IBA Aggregate (IBAA) and Air Pollution Control residues (APCr).

IBAA will be used in construction to displace other forms of aggregate. The APCr will be used on salt mines, again displacing the use of virgin aggregate. According to DESNZ "Greenhouse gas reporting: conversion factors 2023", the greenhouse gas emissions associated with the use of aggregates from primary material production are 7.75 kgCO_2e per tonne.

3.6 Parameters summary

The following scenarios have been assessed to determine the change in carbon impacts associated with the EfW Facility:

- **Baseline**: The management of 211,000 tpa of waste via landfill.
- **Proposal**: The management of 211,000 tpa of waste via the EfW Facility.

[4] DEFRA – Fuel Mix Disclosure Table – 01/04/2022 – 31/03/3023

4 Calculations

4.1 Energy from Waste

The combustion of waste generates direct emissions of carbon dioxide. It also produces emissions of nitrous oxide, which is a potent greenhouse gas. Methane may arise in minimal extents from decomposition of waste remaining in the waste bunker. However, decomposition will be reduced by the use of biodrying in the MBT Facility and actively managed by ensuring that waste does not remain in the bunker for a long period. As such, methane is not regarded to have relevant climate impacts in quantitative terms. In addition, combustion air will be drawn from the bunker area. This means that any methane which is generated by the decomposition of the waste will be drawn into the combustion chamber and burnt. As the methane would have arisen from biodegradable waste, any carbon dioxide produced by burning that methane will also be derived from biodegradable waste and so can be excluded from the assessment.

Exporting energy to the grid offsets greenhouse gas emissions from the generation of power in other ways. In the case of the EfW Facility, the displaced electricity will be the marginal source which is currently gas-fired power stations. As explained in further detail in section 3.4, it is considered that the construction of the EfW Facility will not significantly affect how wind or solar plants operate. Therefore, the use of a gas-fired power station is considered a reasonable comparator when assessing the grid offset of the EfW Facility.

The following sections provide detail of the calculation of the carbon burdens and benefits associated with the EfW Facility. Unless otherwise specified, all values presented are on an annual basis.

4.1.1 Direct emissions

The combustion of waste generates direct emissions of carbon dioxide, with the tonnage determined using the carbon content of the waste.

For the carbon assessment, only carbon dioxide emissions from fossil sources (e.g. plastics) need to be considered, as carbon from biogenic sources (e.g. paper and wood) has a neutral carbon burden. The biogenic material in the residual waste processed in the EfW Facility is biogenic material already found within wastes. This means that there is no requirement to consider, for example, any land use implications in producing the biogenic material as, unlike energy crops which are grown for combustion, biogenic waste already exists.

The UK Government's document "Energy from Waste: A Guide to the Debate" states, in paragraph 40:

"Considering the energy from waste route, if our black bag of waste were to go to a typical combustion-based energy from waste plant, nearly all of the carbon in the waste would be converted to carbon dioxide and be released immediately into the atmosphere. Conventionally the biogenic carbon dioxide released is ignored in this type of carbon comparison as it is considered 'short cycle', i.e. it was only relatively recently absorbed by growing matter. In contrast, the carbon dioxide released by fossil-carbon containing waste was absorbed millions of years ago and would be newly released into the atmosphere if combusted in an energy from waste plant." For landfill, paragraph 42 states *"Burning landfill gas produces biogenic carbon dioxide which, as for energy from waste, is considered short cycle."*

Therefore, the carbon assessment is in line with government guidance for exactly this type of facility.

It has been assumed that all of the carbon in the waste fuel is converted to carbon dioxide in the combustion process as, according to Volume 5 of the Intergovernmental Panel on Climate Change (IPCC) Guidelines for Greenhouse Gas Inventories, it can be assumed that waste incinerators have combustion efficiencies of close to 100%. The mass of fossil derived carbon dioxide produced is determined by multiplying the mass of fossil carbon in the fuel by the ratio of the molecular weights of carbon dioxide (44) and carbon (12) respectively as shown in the equation below:

$$Mass\ of\ CO_2\ out = Mass\ of\ C\ in\ \times \frac{Mr\ CO_2}{Mr\ C}$$

Where Mr = molecular weight. The total fossil derived carbon emissions are presented in Table 2.

Table 2: Fossil CO_2 emissions

Item	Unit	Base case	Low Food Case
Fossil carbon in input waste	t C	21,818	24,255
Fossil derived carbon dioxide emissions	**t CO_2**	**79,999**	**88,933**

The process of recovering energy from waste may lead to releases of small amounts of nitrous oxide and methane, which contribute to climate change. The impact of these emissions is reported as CO_2e emissions and is calculated using the Global Warming Potential (GWP) multiplier. In this assessment the GWP for 100 years has been used.

Emissions of nitrous oxide and methane depend on combustion conditions. Nitrous oxide emissions also depend on flue gas treatment. These details are based on the final design of the EfW Facility, which is not available at this stage. Therefore, at this stage, default emission factors from the IPCC have been used to determine the emissions of these gases, as shown in Table 3.

Table 3: N_2O and CH_4 assumptions

Item	Unit	Value	Source
N_2O default emissions factor	kg N_2O/TJ	4	IPCC Guidelines for Greenhouse Gas Inventories, Vol 2, Table 2.2 Default Emissions Factors for Stationary Combustion in the Energy Industries, Municipal Wastes (non-biomass) and Other Primary Solid Biomass,
CH_4 default emissions factor	kg CH_4/TJ	30	
GWP – N_2O to CO_2	kg CO_2e/kg N_2O	298	IPCC Fourth Assessment Report (AR4) 2007 (consistent with government guidance)
GWP – CH_4 to CO_2	kg CO_2e/kg CH_4	25	

Nitrous oxide and methane emissions from both the biogenic and non-biogenic fractions are considered as a carbon burden. Both the biogenic and non-biogenic fractions of waste have the same default emissions factor. Table 5 shows the emissions of nitrous oxide and methane and the equivalent carbon dioxide emissions.

Table 4: N_2O and CH_4 emissions

Item	Unit	Base case	Low food case
N_2O emissions	t N_2O	8.16	8.01
Equivalent CO_2 emissions	**t CO_2e**	**2,432**	**2,388**
CH_4 emissions	t CH_4	61.21	60.10
Equivalent CO_2 emissions	**t CO_2e**	**1,530**	**1,503**

The EfW Facility would be equipped with auxiliary burners which would burn fossil fuel-derived gasoil or its synthetic fuel replacement (i.e. fuel derived from green hydrogen and green carbon dioxide) when this becomes available, and would have a capacity of about 65% of the boiler capacity, 46.8 MWth. These would only be used for start-up and shutdown. It is assumed that there would be 4 start-ups/shutdowns a year, and that the burners would operate for 18 hours total for start-up and shut down. Hence, the approximate total fuel consumption would be:

$$46.8 \times 4 \times 18 = 3{,}370\ MWh$$

Each MWh of gasoil releases 0.26978 tonnes of carbon dioxide[5], so the emissions associated with auxiliary firing would be 3,370 x 0.26978 = 909 t CO_2e.

Table 5 shows the total direct equivalent carbon dioxide emissions for the combustion of waste in the EfW Facility.

Table 5: Total equivalent CO_2 emissions from the combustion of waste

Item	Unit	Base case	Updated case
CO_2 emissions	t CO_2	79,999	88,933
N_2O emissions	t CO_2e	2,432	2,388
CH_4 emissions	t CO_2e	1,530	1,503
Burner emissions	t CO_2e	909	909
Total emissions	**t CO_2e**	**84,870**	**93,733**

4.1.2 Grid offset

The amount of carbon dioxide offset by the electricity generated by the EfW Facility is calculated by multiplying the net electricity generated by the grid displacement factor. The EfW Facility will also be capable of exporting heat to local users, subject to technical and economic considerations. If heat is exported, less electricity will be exported but the carbon benefits of the EfW Facility will be higher. At this stage of design there are currently no formal heat offtake agreements in place, but the potential heat export is considered as a sensitivity case.

The carbon dioxide offset by electricity generation is counted as a carbon benefit and is shown in Table 6 below.

Table 6: EfW Facility electricity offset

Item	Unit	Both cases
Net electricity export	MW	16.70
Net electricity exported	MWh p.a.	131,446
Total CO_2 offset through export of electricity	**tCO_2e p.a.**	**48,766**

4.1.3 Material offset

According to the ES, it is anticipated that around 13,000 tpa of APCr and 45,000 tpa of IBAA will be produced per annum. This gives an offset of 58,000 x 0.00775 = 449.50 tCO_2e p.a.

[5] DEFRA – Greenhouse gas reporting: Conversion factors 2022

4.2 Landfill baseline

When waste is disposed of in landfill, the biogenic carbon degrades and produces landfill gas (LFG). LFG is comprised of methane and carbon dioxide, so has a significant carbon burden. Some of the methane in the LFG can be recovered and combusted in a gas engine to produce electricity.

4.2.1 Emissions

The emissions associated with LFG can be split into:

1. carbon dioxide released in LFG;
2. methane released in LFG; and
3. methane captured and combusted in LFG engines and flares, producing carbon dioxide as a result of the combustion.

Since 1 and 3 result in the release of carbon dioxide derived from biogenic carbon in the waste, these should both be excluded from the calculation. Therefore, the focus of this calculation is the methane which is released to atmosphere, alongside the electricity displaced by generation in LFG engines. This is calculated as follows:

1. The biogenic carbon in the waste comes from the waste composition, discussed in Section 3.2.
2. 50% of the degraded biogenic carbon is released and converted into LFG. The released carbon is known as the dissimilable decomposable organic carbon (DDOC) content.
   a. This assumes a sequestration rate of 50%, which is considered to be a conservative assumption and is in accordance with DEFRAs *'Energy from Waste – A Guide to the Debate'*.
   b. There is considerable uncertainty in literature surrounding the amount of biogenic carbon that is sequestered in landfill. The high sequestration used in this assessment (i.e. 50%), combined with the use of high LFG capture rates (assumed 68% capture) is considered to be conservative. Therefore, it is not considered appropriate to give additional credit for sequestered carbon as this would result in an overly-conservative assessment.
      i. Although the DEFRA report "*Energy recovery for residual waste - A carbon based modelling approach*" considers the impact of sequestration on the carbon model, the report notes that there was considerable uncertainty surrounding the calculation and that further work is required.
      ii. Changing the level of sequestration impacts on both the amount of biogenic carbon that needs to be counted on the EfW side of the model, and the amount of methane emitted on the landfill side. The calculations are described as being "*particularly sensitive to sequestration levels, with any drop in assumed sequestration significantly favouring Energy from Waste over landfill*".
      iii. In addition, the report describes an additional complicating factor regarding the effect of sequestration assumptions on the LFG capture rate. The report indicates that the assumed LFG capture rates are based on a high sequestration rate, which may not be correct, and which are based on the higher end of the rates in literature. Should the sequestration rates be lower in reality, more LFG is generated than expected, resulting in lower capture rates and making the impact of landfill considerably worse. The approach used within the report (i.e. high sequestration percentage, high LFG capture rates and no additional credit for sequestered carbon), and also within this carbon assessment, is considered to be conservative, in that it will tend to favour landfill over EfW.

iv. Therefore, it is considered that the report does not support the inclusion of credit for sequestered carbon within the assessment and that this uncertainty is addressed with the conservative assumptions mentioned above.

3. LFG is made up of 57% methane and 43% carbon dioxide, based on a detailed report carried out by Golder Associates for DEFRA[6].
   a. Opinion is divided as to whether to use an assumption of 50% or 57% for the methane content of LFG. The Golder Associates report reviewed an extensive dataset from UK landfill sites and calculated that a figure of 57% should be used, stating that this figure "is based on a substantive and representative data set, and is considered to be a very reliable calculation". This figure is then used throughout the Golder Associates report to derive the other figures. It is therefore considered that 57% is the appropriate proportion to use within this carbon assessment. However, it is acknowledged by Golders that further review of published studies may be required to explain why 50% is more commonly used as an assumption in accordance with the IPCC (2006) default values.
4. Based on the same report, the analysis assumes 68% of the LFG is captured and that 10% of the remaining 32% is oxidised to carbon dioxide as it passes through the landfill cover layer. The unoxidized LFG is then released to atmosphere.
   a. The Golder Associates report states the estimated LFG collection efficiency for a subset of 43 large modern landfills as 68%. For all UK landfills, the figure would be 52%. Taking this into consideration, 68% has been used as the central figure: the landfill site in the comparison scenario is considered to represent a typical modern large UK landfill site. Nevertheless, a more conservative figure of 75% has been considered for sensitivity purposes within section 5.2.
5. Based on the same report, 90.9% of the captured LFG is used in gas engines to generate electricity, although 1.5% of this captured LFG passes through uncombusted and is released to atmosphere. The remainder is combusted in a flare. It has been assumed that the flares fully combust the methane.
   a. The DEFRA report "*Energy recovery for residual waste - A carbon based modelling approach*" assumes that, over the life of a landfill site, about 50% of the LFG collected is used to generate electricity, with the remainder flared. In contrast to this, the Golder Associates report estimates that around 90.9% of the LFG would be used to generate electricity. This does not take account of sites which do not have gas engines, but should be representative of the 43 large, modern landfills for which the collection efficiency figure was derived. The Golder Associates report was produced after the DEFRA report and is more detailed, with a clearer evidence base. Therefore, Fichtner considers that the Golder Associates report supersedes the DEFRA report, and the assumption made for the amount of LFG used to generate electricity within the assessment is more conservative.
   b. In addition to the above, the DEFRA report uses an engine efficiency of 41%, based on the gross generation efficiency of new LFG engines. The Golder Associates report agrees with this figure for new engines, but takes account of parasitic loads and other losses to estimate a net export efficiency of 36%. Given that the assessment of the EfW Facility has used net electricity exported, it is reasonable to use the same type of efficiency for LFG engines.

Table 7 outlines the LFG assumptions and Table 8 shows the equivalent carbon emissions associated with the baseline scenario.

[6] Review of Landfill Methane Emissions Modelling (WR1908), Golder Associates, November 2014

Table 7: LFG assumptions

Item	Value	Source
Calorific value of methane	50 MJ/kg	DESNZ "Greenhouse gas reporting: conversion factors 2023"
DDOC content *(dissimilable decomposable carbon content, i.e. biogenic carbon which is converted to LFG)*	50%	Review of Landfill Methane Emissions Modelling (WR1908), Golder Associates (2014)
Carbon dioxide percentage of LFG	43%	
Methane percentage of LFG	57%	
LFG recovery efficiency	68%	
Oxidisation of LFG in cap	10%	
Fraction of recovered landfill gas used in engines	92%	
Methane slippage through LFG engine	1.5%	
LFG engine efficiency	36%	
Molecular ratio of methane to carbon	1.33	Standard Values
Molecular ratio of carbon dioxide to methane	2.75	
Molecular ratio of carbon dioxide to carbon	3.67	
Global Warming Potential – methane to carbon dioxide	25	IPCC Fourth Assessment report (2007) - consistent with Gov guidance

Table 8: LFG emissions – landfill baseline scenario

Item	Unit	Base case	Low Food Case
Biogenic carbon	t	33,347	33,386
Total DDOC content	t	16,674	16,693
Methane in LFG, of which:	t	12,672	12,687
-Methane captured	t	8,617	8,627
-Methane oxidised in landfill cap	t	406	406
-Methane released to atmosphere directly	t	3,650	3,654
Methane leakage through gas engines	t	118	118
Total methane released to atmosphere	t	3,767	3,771
CO_2e released to atmosphere	**tCO_2e**	**94,176**	**94,284**

The value for biogenic carbon in Table 8 above is calculated by multiplying the annual tonnage of waste by the carbon content percentage of the waste, and then again by the percentage of that carbon which is derived from biogenic sources.

4.2.2 Grid offset

The methane in the LFG that has been recovered can be used to produce electricity. This electricity will offset grid production, and results in a carbon benefit of sending waste to landfill as per section 3.4. The assumptions for the amount of LFG methane captured and used in a typical LFG engine are shown in Table 9.

Table 9: LFG grid offset assumptions

Item	Value	Source
LFG recovery efficiency	68%	DEFRA Review of Landfill Methane Emissions Modelling (Nov 2014)
Methane captured used in gas engines	90.9%	
Methane leakage through gas engines	1.5%	
LFG engine efficiency	36%	
Methane net calorific value	50 MJ/kg	DESNZ "Greenhouse gas reporting: conversion factors 2023"

The power produced by the LFG engines is based on the amount of methane, the heat content of methane and the engine efficiency, as per the assumptions in Table 9. The power generated by the LFG engines and the carbon dioxide offset are shown in Table 10.

Table 10: LFG grid offset – landfill baseline scenario

Item	Unit	Base case	Low Food Case
Methane captured, of which:	t	8,617	8,627
-Methane flared	*t*	783	784
-Methane leakage through gas engines	*t*	118	118
-Methane used in gas engines	*t*	7,716	7,725
Fuel input to gas engines	GJ	385,803,959	386,249,278
Power generated	MWh	38,580	38,625
Total CO_2e offset through grid displacement	**t CO_2e**	**14,313**	**14,330**

4.3 Transport

There are carbon emissions associated with the transport of waste and reagents to the EfW Facility, and the transport of residues (i.e. Incinerator Bottom Ash (IBA) and APCr) from the process to their respective treatment facilities. The assumptions for determining these emissions are presented in Table 11.

Table 11: Transport assumptions

Parameter	Unit	Value	Source
Average payload – Waste to landfill	tonnes	20	Project-specific assumption.
Average payload – Waste to EfW Facility	tonnes	20	
Payload – Export of APCr	tonnes	18	
Payload – Export of IBA	tonnes	20	

Parameter	Unit	Value	Source
Payload – Export of Oversize ash	tonnes	20	
Payload - Export of Ferrous ash	tonnes	20	
Payload – Import of lime	tonnes	27.5	Standard assumption
Payload – Import of PAC	tonnes	21	
Payload – Import of Ammonium hydroxide	tonnes	10	
Payload – Import of Diesel	tonnes	32	
Articulated lorry CO_2 factor - 100% loaded	kg CO_2/km	0.91733	DESNZ "Greenhouse gas reporting: conversion factors 2023" HGV (all diesel) Articulated (>3.5- 33t)
Articulated lorry CO_2 factor - 0% loaded	kg CO_2/km	0.61562	
Waste distance to landfill (one way)	km	30	Assumption for typical transport in Arc21 area.
Waste distance to EfW Facility (one way)	km	30	
IBA distance to recovery	km	50	IBAA transport within NI
Oversize and ferrous ash distance to disposal	km	2.5	Project-specific assumption
APCr distance to disposal	km	32	To Islandmagee Salt Mines
Lime distance to EfW Facility	km	280	Typical assumption
PAC distance to EfW Facility	km	200	Typical assumption
Ammonia distance to EfW Facility	km	400	Typical assumption
Diesel distance to EfW Facility	km	160	Typical assumption
Mass of waste	tonnes	211,000	Project-specific assumption
Mass of IBA (excluding Oversize and Ferrous ash)	tonnes	45,000	Project-specific assumption
Mass of Oversize ash	tonnes	2,250	Approximately 5% of IBA
Mass of Ferrous ash	tonnes	4,050	Approximately 9% of IBA
Mass of APCr	tonnes	13,000	Project-specific assumption
Mass of lime	tonnes	6,253	Scaled from other projects
Mass of activated carbon	tonnes	98	
Mass of ammonia	tonnes	1,318	
Mass of fuel oil	tonnes	370	

The carbon burden of transporting the waste is determined by calculating the total number of loads required and multiplying it by the transport distance to generate an annual one-way vehicle distance. This is multiplied by the respective empty and full carbon dioxide factor for HGVs to determine the overall burden of transport. It is recognised that this is conservative, as it may be possible to coordinate HGV movements to reduce the number of trips.

The calculations for the base case are shown in Table 12, covering transport for the baseline (all waste to landfill) and the EfW scenario. The results for the low food case are very similar.

Table 12: Transport emissions – Base Case

Parameter	Unit	Landfill Case	EfW Facility Case			
		Waste to landfill	Waste to EfW Facility	IBA to disposal/ recovery	APCr to disposal/ recovery	Other transport
Number of loads required	p.a.	10,550	10,550	2,250	723	693
One-way distance	km	30	30	50	32	Various
One-way total vehicle distance per year	km	316,500	316,500	112,500	23,136	120,350
Total CO_2 emissions	**t CO_2**	**485**	**485**	**172**	**35**	**184**

5 Results

5.1 Base case results

The results of the assessment are shown below. It can be seen that there is a net carbon benefit of between **35,000 and 43,800 tCO_2e p.a.** for the EfW Facility.

Table 13: Summary – base case

Parameter	Units	Base case	Low food case
Releases from landfill gas	t CO_2e	94,176	94,284
Transport of waste and outputs to landfill	t CO_2e	485	476
Offset of grid electricity from landfill gas engines	t CO_2e	-14,313	-14,330
Total landfill emissions	**t CO_2e**	**80,348**	**80,431**
Emissions from the EfW Facility	t CO_2e	84,870	93,733
Transport of waste to and outputs from the EfW Facility	t CO_2e	878	869
Offset of material outputs	t CO_2e	-450	-450
Offset of grid electricity with EfW Facility generation	t CO_2e	-48,766	-48,766
Total EfW Facility Emissions	**t CO_2e**	**36,532**	**45,386**
Net Benefit of the EfW Facility	**t CO_2e**	**43,815**	**35,045**

Another way of expressing the benefit of the EfW Facility is to consider the additional power generated by recovering energy rather than sending the waste to landfill and calculating the effective net carbon emissions per MWh of additional electricity exported.

The effective net carbon emissions per MWh of additional electricity exported for the EfW Facility is calculated as follows, for the base case:

1. Additional power exported = 131,446 –38,580= 92,865 MWh
2. Net Carbon released = (84,870 + 781) – (94,176 + 485) = -9,010 tCO_2e
3. Effective carbon intensity = -9,010 ÷ 92,865 = -0.0970 t CO_2e/MWh

For the low food case, a similar calculation gives an effective carbon intensity of -0.0027 t CO_2e/MWh.

Hence, it can be seen that the additional power generated by the EfW Facility compared to landfill would effectively be generated at zero net carbon emissions.

5.2 Sensitivities

5.2.1 Heat export

The EfW Facility has the capability to export heat to adjacent users. We have considered the benefits of exporting 10 MWth of heat. We have assumed that this would be produced by extracting steam at 2.4 bar-a from the turbine, which would reduce the power generated by around

1.52 MWe, and that this heat would displace heat produced by natural gas with an emissions factor of 0.20188 $kgCO_2e/kWh$[7].

The results of this case are shown in Table 14 below. This shows that the benefit increases by **13,231 t CO_2e per annum.**

Table 14: Summary – heat export case

Parameter	Units	Base case	Low food case
Releases from landfill gas	t CO_2e	94,176	94,284
Transport of waste and outputs to landfill	t CO_2e	485	476
Offset of grid electricity from landfill gas engines	t CO_2e	-14,313	-14,330
Total landfill emissions	**t CO_2e**	**80,348**	**80,431**
Emissions from the EfW Facility	t CO_2e	84,870	93,733
Transport of waste to and outputs from the EfW Facility	t CO_2e	878	869
Offset of material outputs	t CO_2e	-450	-450
Offset of grid electricity with EfW Facility generation	t CO_2e	-44,342	-44,342
Offset of heat with EfW	t CO_2e	-17,656	-17,656
Total EfW Facility Emissions	**t CO_2e**	**23,301**	**32,155**
Net Benefit of the EfW Facility	**t CO_2e**	**57,046**	**48,276**

5.2.2 Landfill gas and grid displacement factor

The two key assumptions in the carbon assessment are the grid displacement factor for electricity and the landfill gas capture rate.

- There is some debate over the type of power which would be displaced and so the effect of using lower figures has been considered, which would only be relevant if the EfW Facility were to displace other renewable sources of electricity.
- The Golders Associates report for DEFRA states that the collection efficiency for large, modern landfill sites was estimated to be 68% and the collection efficiency for the UK as a whole was estimated to be 52%. There have been suggestions in other guidance that a conservative figure of 75% should be used. The sensitivity of the results to this assumption has also been assessed below.

Table 15 below shows the estimated net benefit of the EfW Facility, in tonnes of carbon dioxide equivalent emissions per annum, for different combinations of grid displacement factor and landfill gas capture rate.

It can be seen that there is a benefit for all LFG capture rate and grid displacement factor combinations.

[7] DEFRA – Greenhouse gas reporting: Conversion factors 2022

Table 15: Sensitivity analysis

Grid Displacement Factor (t CO_2e/MWh)	**LFG Capture Rate**			
	75%	**68%**	**60%**	**52%**
Base Case Waste				
0.371	22,686	**43,815**	67,963	92,111
0.320	18,152	39,079	62,996	86,912
0.233	10,419	31,000	54,522	78,043
Low Food Case Waste				
0.371	13,891	**35,045**	59,221	83,396
0.320	9,360	30,311	54,255	78,199
0.233	1,631	22,236	45,784	69,333

5.3 Alternative baseline

5.3.1 Introduction

The purpose of this assessment has been to compare the carbon emissions from the EfW Facility with the carbon emissions from sending the same waste to landfill. This is because the effect of building the EfW Facility will be to reduce the amount of waste going to landfill, given that there is residual waste going to landfill at the moment.

It has been suggested by consultees that some of the waste which would be processed at the EfW Facility is currently being processed at other EfW facilities and so comparing with landfill is incorrect. We consider that the result of building a new EfW facility will be that less waste goes to landfill somewhere. If waste is processed at Hightown Quarry rather than at an EfW facility in Sweden, for example, then the operator of that EfW facility would source waste from elsewhere and, given that millions of tonnes of waste are being sent to landfill across Europe, that other waste would be displace from landfill. Despite this, in this document we have set out an alternative baseline for the residual waste to be processed at Hightown Quarry, which does not allow for these second order effects.

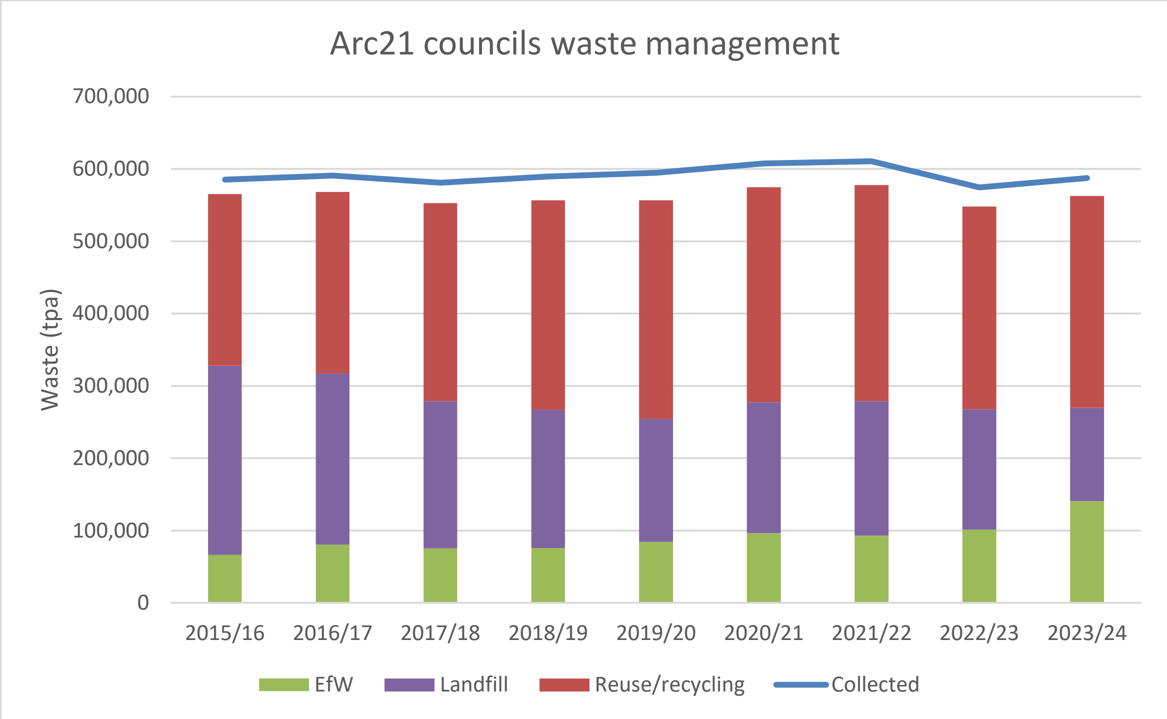
5.3.2 Current position

The EfW Facility would take residual waste.

DAERA publishes data on local authority collected municipal waste. The latest report was published on 28 November 2024[8] and includes data up to the 2023/24 financial year. As shown in the graph below, the amount of residual waste being sent to landfill or exported to other EfW facilities has been consistently above 265,000 tpa, except in 2019/20.

8 Northern Ireland local authority collected municipal waste management statistics 2023/24 annual report

Figure 1: Municipal waste management routes, 2015/16 to 2023/24



Source: Northern Ireland local authority collected municipal waste management statistics 2022/23 annual report

Arc21 has provided data on the destinations of waste sent to EfW facilities from the Arc21 area in 2022/23. Waste was sent to the Full Circle Generation (FCG) plant in Belfast, Indaver's facility in Meath and various plants in Sweden, Norway and Latvia, as well as to landfill. This data has been used to develop a realistic alternative baseline. For simplicity, the different routes have been grouped into four specific routes.

1. **FCG, Belfast (31,600 tpa)**

   Some waste from the areas around Belfast is sent to transfer stations at Coleraine or Portadown to be bulked up before being shipped to the FCG plant. This means that waste is transported twice, increasing the distance travelled by around 30 km to 60 km.

   Information from the 2023 performance report shows that the net efficiency of the plant in 2023 was 14.69%.

2. **Scandinavian EfW plants (44,100 tpa)**

   35,000 tonnes of waste was sent to Sweden in 2022/23, with smaller amounts going to Norway and Latvia. As that waste would travel further, we have assumed that all of the waste sent to Europe is specifically sent to Gothenburg. This requires 40 km of road travel (20 km at each end). According to ports.com, the sailing distance between Belfast Port and Gothenburg port is 878 nautical miles, or 1,598 km.

   We have assumed that the plant in Sweden is as efficient as the proposed EfW Facility, but that it will also export heat as most plants in Sweden are connected to district heating schemes. We have assumed that the heat efficiency will be 10%, which would reduce the electrical efficiency to 21.68%.

Sweden generates most electricity from renewables but exports electricity to other European countries. This means that generation of electricity from waste is likely to lead to a reduction in fossil fuel generation elsewhere in Europe, so we have assumed that this would displace gas-fired power stations.

3. **Meath EfW Facility (8,500 tpa)**

   Some waste is sent to Indaver's facility at Meath and to other EfW facilities. We have assumed that all of this waste actually goes to Meath, rather than further afield, travelling 131 km by road.

   We have assumed that the Meath plant has the same electrical efficiency as the proposed EfW Facility.

4. **Landfill (126,776 tpa)**

   This uses the same assumptions as in the main baseline case.

The results of this alternative baseline case are shown below and compared with the Updated Base Case. It can be seen that the emissions from the alternative baseline are lower than for landfill, because it incorporates some EfW plants, but the EfW Facility continues to have a net benefit of **28,464 tCO_2e.a.**

Table 16: Summary of Alternative Baseline

Parameter	Units	Base Case	Alternative Baseline
Baseline			
Releases from landfill gas	t CO_2e	94,176	56,584
Transport of waste and outputs to landfill	t CO_2e	485	292
Offset of grid electricity from landfill gas engines	t CO_2e	-14,313	-8,600
Total baseline landfill emissions	**t CO_2e**	**80,348**	**48,276**
Emissions from the baseline EfW facilities	t CO_2e		33,872
Transport of waste to and outputs from the baseline EfW facilities	t CO_2e		1,049
Offset of grid electricity with generation from the baseline EfW facilities	t CO_2e		-16,122
Offset of boiler natural gas usage with heat from the baseline EfW facilities	t CO_2e		-2,393
Total Baseline EfW facilities emissions	**t CO_2e**	**0**	**16,683**
Total Baseline Emissions	**t CO_2e**	**80,348**	**64,958**
EfW Facility			
Emissions from the EfW Facility	t CO_2e	84,870	84,870
Transport of waste to and outputs from the EfW Facility	t CO_2e	878	878
Offset of material outputs	t CO_2e	-450	-450
Offset of grid electricity with EfW Facility generation	t CO_2e	-48,766	-48,766
Total EfW Facility Emissions	**t CO_2e**	**36,532**	**36,532**
Net Benefit of the EfW Facility	**t CO_2e**	**43,815**	**28,464**

The sensitivity of the alternative baseline case to changes in landfill gas capture rates and grid displacement factors has also been considered and the results are shown below. It can be seen that the EfW Facility has a net benefit in all cases.

Table 17: Sensitivity of alternative baseline scenario to changes in assumptions

Grid Displacement Factor (t CO_2e/MWh)	LFG Capture Rate			
	75%	68%	60%	52%
0.371	15,769	**28,464**	42,973	57,482
0.320	12,585	25,159	39,528	53,898
0.233	7,154	19,520	33,653	47,785

6 Lifetime carbon assessment

The benefits discussed within the main body of the assessment mostly relate to those within a single year. The carbon benefits will accumulate over time; however, the annual benefits will also vary over time as a number of key assumptions will vary.

The estimated date of operation of the EfW Facility is 2030. From this point, the lifetime assessment has been undertaken for a period of 25 years. Although it is acknowledged that the EfW Facility's lifetime may be longer than 25 years, it is difficult to predict the baseline parameters this far into the future, and it is common practice to assess the lifetime benefit for carbon assessments for 25 years. Therefore, within the lifetime analysis below, it is assumed that the EfW Facility operation spans between 2030 and 2054. In this section, the 'lifetime' benefits of the EfW Facility have been considered and compared to the baseline scenario, landfill.

6.1 Future assumptions

The lifetime assessment has incorporated predicted changes to key carbon assessment assumptions with time. These are described as follows.

1. The UK government's policy is to decarbonise grid electricity. The UK government has set a target to bring all greenhouse gas emissions to net zero by 2050. This means that the benefit of displacing grid electricity will reduce. As explained in section 3.4, it is considered that the correct comparator at present is CCGTs and that this will remain the case for some time. However, the UK government has published a set of UK long run marginal generation-based emission factors[9] for each year until 2010. These start at 0.091 kg CO_2e/kWh in 2028 and drop to 0.002kg CO_2e/kWh by 2052.

   However, these are only relevant if the EfW Facility were to displace other renewable sources of electricity (which we do not consider to be the case as justified in section 3.4) and as such are considerably more conservative than the grid displacement factor used in the main assessment. In addition, as noted earlier, the generation mix in Ireland as of 2021 includes around 10% coal, whereas the overall UK generation mix includes only 2% coal and 17% nuclear, so the overall carbon intensity of power in Ireland is likely to be higher than in the UK.

   Taking this into consideration, it is not considered that the DESNZ long-run generation-based factors are representative of the types of power station which would be displaced by the EfW Facility in the short to medium term. The current grid displacement factor is 0.371 tCO_2e/MWh. Comparatively, the DESNZ long-run generation grid factor for 2025 is 0.195 tCO_2e/MWh. As this is lower than the current grid situation, in order to update the DESNZ long-run generation grid factors but continue to recognise the UK Government targets to Net Zero (and 0.002 tCO_2e/MWh grid displacement factor) by 2054, the factors have been adjusted to start from 0.371 tCO_2e/MWh in 2025 and follow the same rate of change to 2054 as the original DESNZ factors. Although this should provide a more accurate reflection of the near future, it is recognised that it remains difficult to accurately predict the exact rate of grid decarbonisation into the longer term.
2. For the baseline scenario, the emissions associated with landfill are influenced by the LFG capture rate. For the lifetime assessment, it has been assumed that the LFG capture rate increases incrementally over time, due to improvements to the LFG capture technology efficiency.

[9] Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, DESNZ, 2023

3. Waste composition will vary over time. The new Waste Strategy for Northern Ireland is currently under development, but similar documents in other parts of the UK have focused on the reduction of plastic wastes and the separate collection of food waste.

   The lifetime scenario therefore takes into account reductions in food and plastics within residual waste; it has been assumed that plastics will be removed from the waste stream at a rate of 2% per annum, to a maximum of 30% reduction and food waste will be removed from the waste stream at a rate of 2% per annum, to a maximum of 50% reduction. These changes result in minor changes to the waste NCV, reaching a peak of 10.11 MJ/kg.

   These changes to waste compositions are generally incremental assumptions and it is probable that waste compositions will change differently to these assumptions. However, it is not possible to accurately predict what waste composition will be into the future and so this lifetime assessment should be seen as an example of what could happen in the future rather than a prediction.

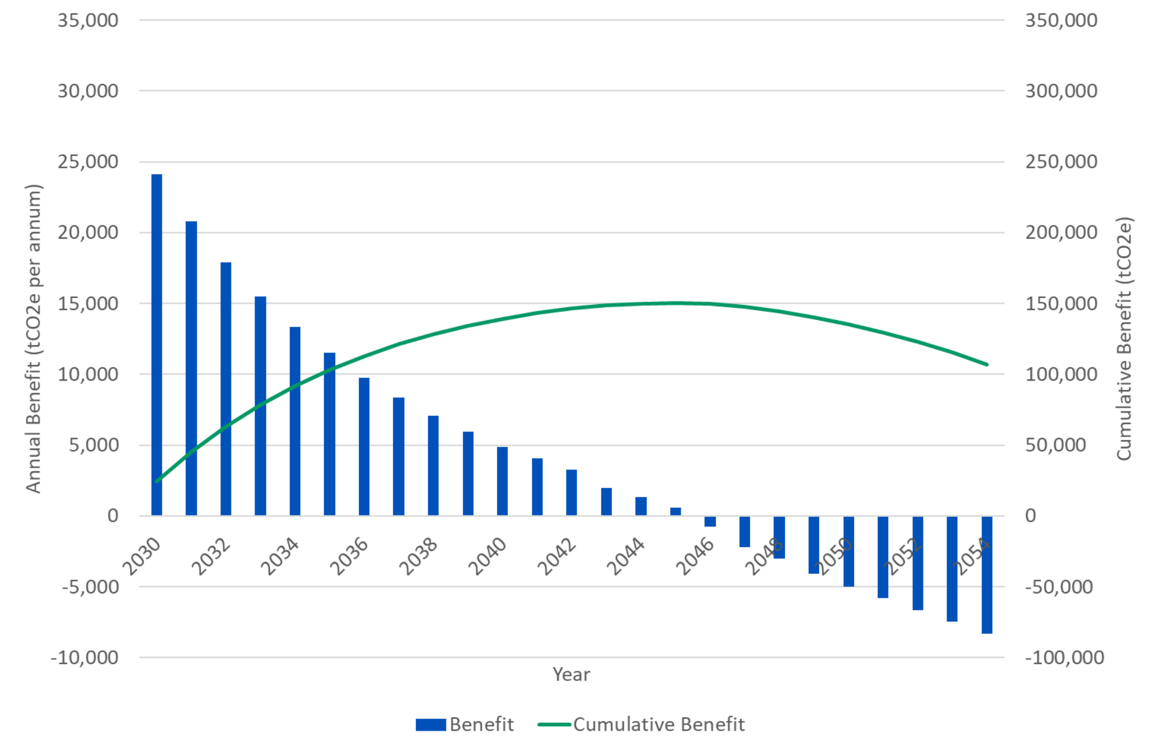
   For carbon assessment purposes, this scenario results in a conservative, high carbon waste with an NCV above the design value. Other scenarios are possible. An energy recovery facility using fuel derived from residual municipal solid waste operating up to the year 2050 needs to be able to thermally treat waste with a wide range of NCVs. If the UK and Northern Ireland government policy measures aimed at removing plastics from the residual waste stream prior to thermal treatment are implemented successfully - and any substitute sustainable materials have a lower energy content - then the ability to process waste with low NCVs will likely be the limiting factor in designing the EfW facility.

It is recognised that it is difficult to predict what the most appropriate assumptions to use are into the future, as there is a large level of uncertainties to the decarbonisation of the grid, landfill gas recovery improvements and waste composition. Therefore, we have included sensitivity lifetime assessments (section 6.3) to demonstrate the range in potential lifetime emissions of the EfW Facility, dependent on the future assumptions used.

6.2 Lifetime assessment results

The annual net benefit of emissions of the EfW Facility compared to the baseline are shown in Figure 2 up to 2055. The carbon impact of the EfW Facility is a carbon benefit annually until 2045, although the benefit decreases with time. This is caused because the decrease in the electricity grid displacement factor which means that the offset from displacement of power generated by the EfW Facility decreases. In addition, landfill becomes less of a carbon burden as LFG capture rates improve, so the difference between the EfW Facility and the baseline decreases. The changes to the waste composition will have an impact on the total carbon in the waste, which also influences the results, as shown by the non-linear trend in the graph. The lifetime cumulative benefit of the EfW Facility is **107,075 tCO_2e** over 25 years until 2054.

Figure 2: Lifetime Carbon Benefit



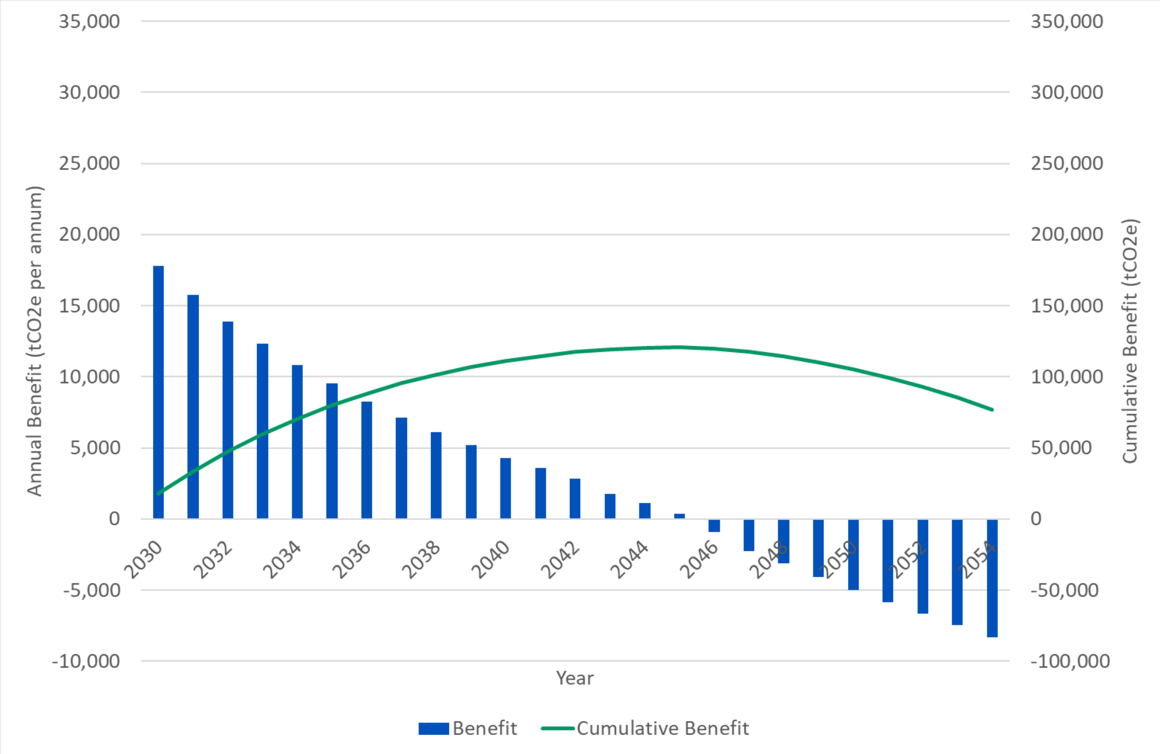
6.3 Lifetime assessment sensitivities

6.3.1 Grid displacement factor

As detailed above and in section 6.1, it is not considered that the DESNZ long-run generation-based factors are representative of the type of power station which would be displaced by the EfW Facility in the short to medium term. However, given that these factors are published by the government, the sensitivity of the lifetime assessment to using these factors has been considered.

The lifetime assessment of the EfW Facility using the standard DESNZ long-run marginal factors is presented in Figure 3.

Figure 3: Lifetime assessment results – grid displacement factor sensitivity

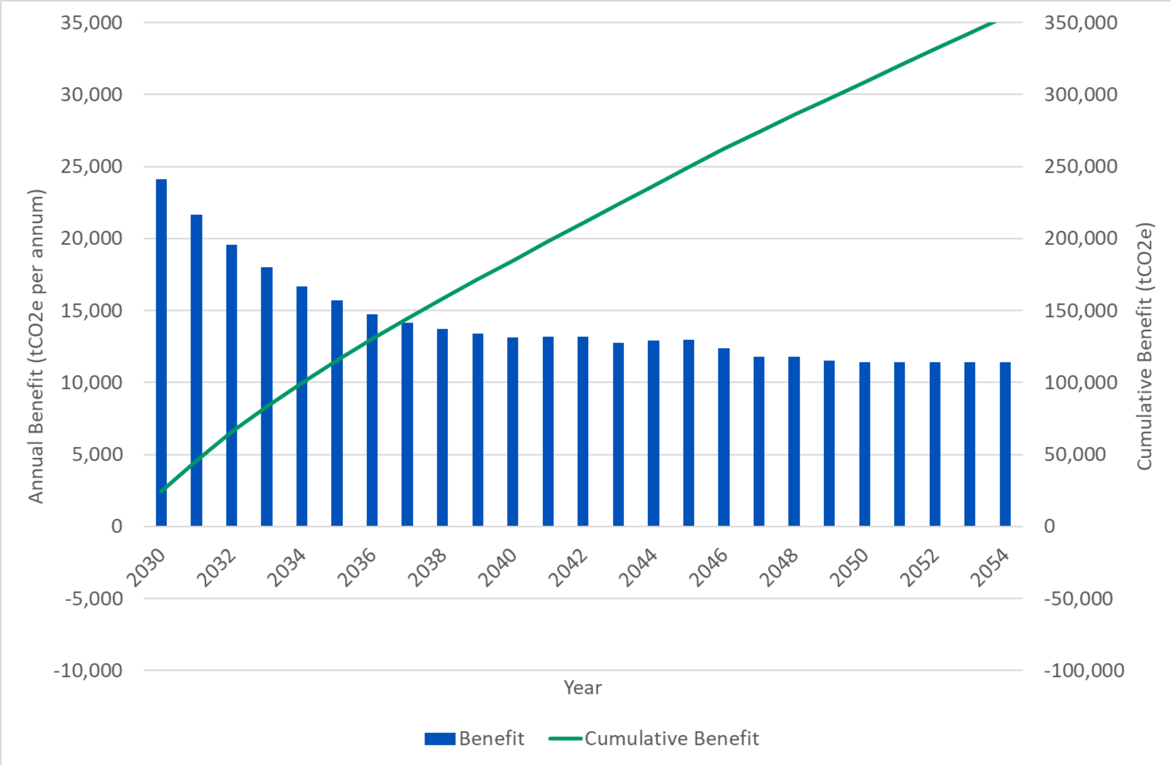


As shown, the graph shows a carbon benefit annually until 2045, as in the main assessment, but the benefit is lower in the earlier years than in the main lifetime assessment. Under this sensitivity scenario the lifetime cumulative benefit of the EfW Facility is **76,890 t CO_2e** over 25 years until 2054.

6.3.2 LFG capture rate

The lifetime assessment has assumed that the improvement to LFG capture rates occur incrementally, from a base LFG capture rate in the starting year of operation of 68%, to be representative of the collection efficiency for large, modern landfill sites (Golders Associates report for DEFRA). Therefore, as the assumed landfill comparator sites are already modern landfill sites, the assumption that the LFG capture rate increases incrementally each year from this point is conservative. A sensitivity of the lifetime assessment which maintains an LFG capture rate of 68% for the lifetime of the EfW Facility until 2054 is presented in Figure 4.

Figure 4: Lifetime assessment results – LFG sensitivity

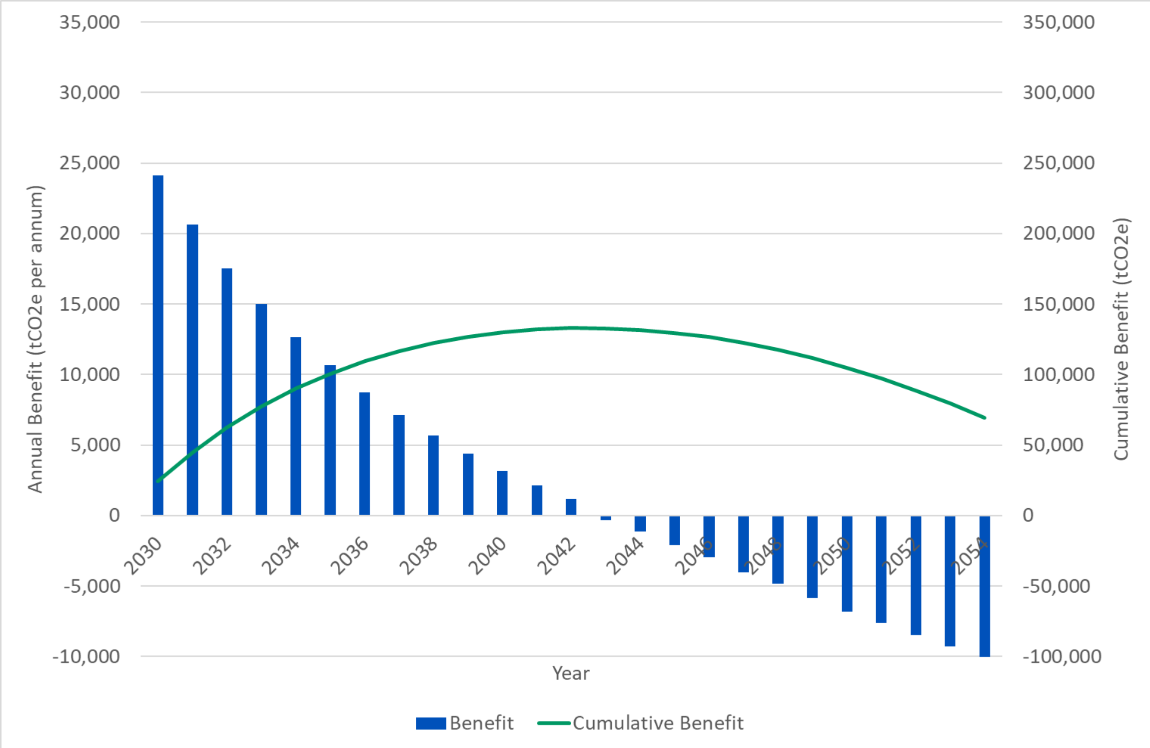


As shown, if it is assumed that the LFG capture rate remains constant over the 25 year lifetime of the EfW Facility, there is an annual carbon benefit each year. Although the overall trend is a decrease in the carbon benefit with time, the change is not linear due to the changes in the waste composition. Under this sensitivity scenario the lifetime cumulative benefit of the EfW Facility is **354,386 t CO_2e** over 25 years until 2054.

6.3.3 Waste composition

As described in section 6.1, the main lifetime assessment has assumed incremental reductions to both plastic and food waste within the waste composition, to reflect UK Government targets to reduce both of these types of waste. However, as also explained in section 6.1, this is difficult to predict and quantify into the future. Therefore, this sensitivity assessment shows the lifetime assessment results based on no changes to waste composition. This is shown in Figure 5.

Figure 5: Lifetime assessment results – waste composition sensitivity



As shown, assuming no change to the waste composition results in a similar carbon benefit to the main lifetime assessment in the first few years of the EfW Facility's lifetime. However, the benefit decreases slightly more rapidly each year, up to 2043, when the annual carbon impact becomes a carbon burden. This is because, with no change to waste composition, the direct emissions from the EfW Facility remain the same, but the grid offset decreases, and the emissions from the landfill comparator decrease within improvements to LFG capture rates, so that the EfW facility is similar to landfill by 2043.

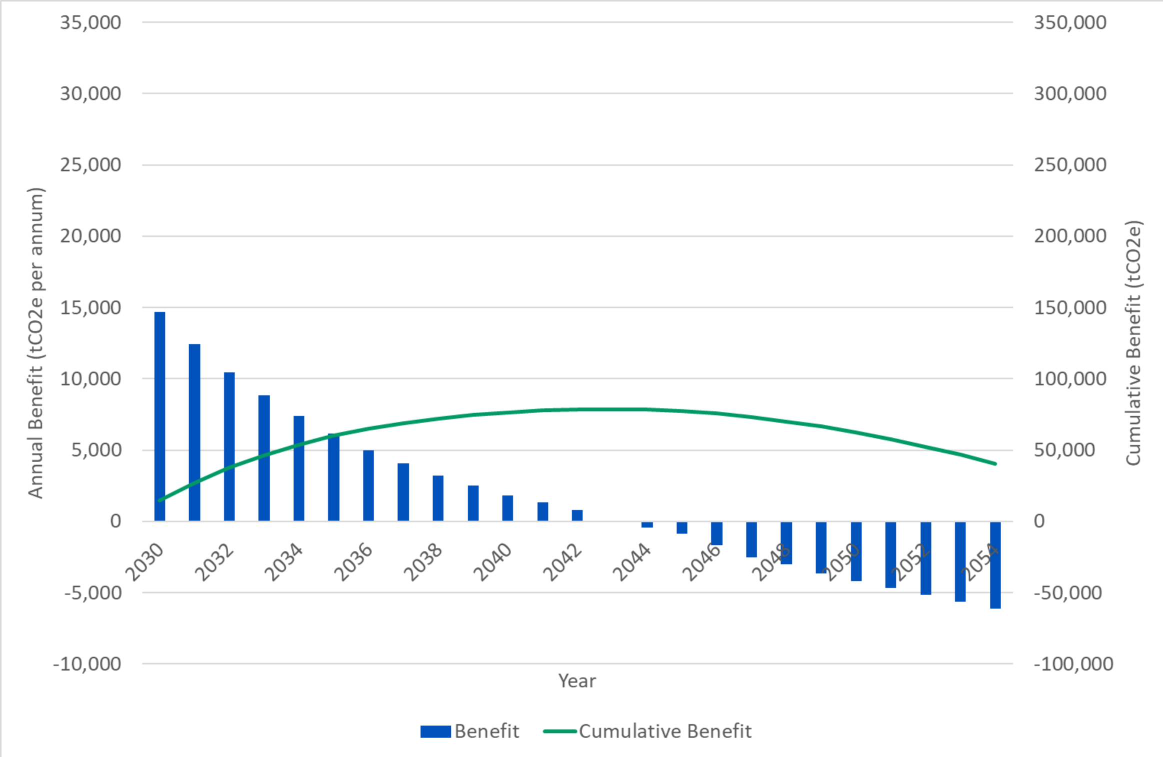
However, the cumulative carbon impact of the EfW Facility remains a benefit throughout its lifetime; the lifetime cumulative benefit of the EfW Facility is **69,468 t CO_2e** over 25 years until 2054.

6.3.4 Alternative baseline

For completeness, the annual net benefit of emissions of the EfW Facility compared to the alternative baseline are shown in up to 2054, using the same changes in waste composition, landfill gas collection rates and grid displacement factors as for the main lifetime assessment. This assumes that the rest of Europe will decarbonise its electricity grid at the same rate as the UK, which may not be realistic, and it assumes that it will remain acceptable to export waste from Northern Ireland to other countries indefinitely, which may not be politically acceptable.

Compared to the alternative baseline, the carbon impact of the EfW Facility is a carbon benefit annually until 2042, although the benefit decreases with time. The lifetime cumulative benefit of the EfW Facility is **40,512 tCO_2e** over 25 years until 2054.

Figure 6: Lifetime assessment results – alternative baseline sensitivity



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Appendix 15.2

Climate Baseline

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Environmental Statement

Appendix 15.2 – Climate Change Baseline

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Document approval

	Name	Signature	Position	Date
Prepared by:	Rosalind Flavell		Senior Environmental Consultant	24/08/2023
Checked by:	Stephen Othen		Technical Director	24/08/2023

Document revision record

Revision no	Date	Details of revisions	Prepared by	Checked by
00	24/08/2023	First Issue	RSF	SMO

Contents

1 Introduction

This appendix has been written in support of Chapter 15 – Climate Change of the Environmental Statement.

This appendix provides detail of the climate baseline in the vicinity of the Proposed Development, based on UK Meteorological Office (Met Office) historical climate averages and regional profile descriptions. In addition, the future climate baseline for the area has been quantified based on the latest UK Climate Projections (UKCP).

2 Baseline Climate

The current climate at the site has been determined based on Met Office historical climate averages data from the period 1991-2020, from the closest meteorological station with this historical data, Belfast Newforge[1] (approximately 11 km to the south-south-east of the site) and Met Office UK regional climate summary for Northern Ireland[2]. The regional climate summaries focus on the 30 year averaging period 1981-2010.

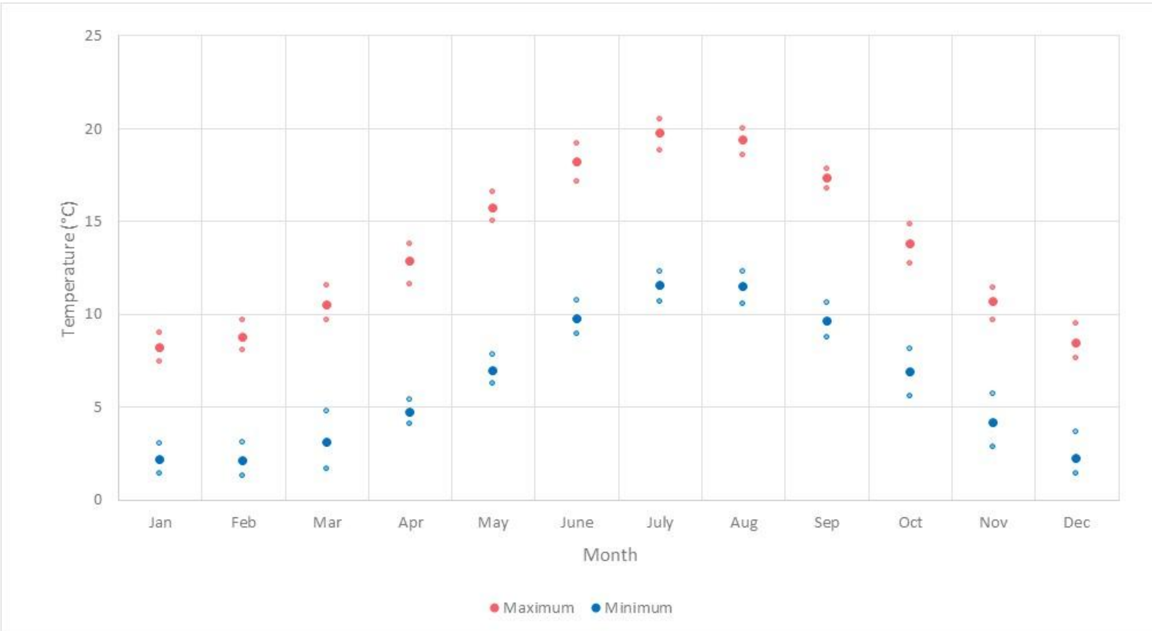
Within this analysis, winter refers to the months of December, January and February, and summer refers to the months of June, July and August.

2.1 Temperature

The long term annual mean at Belfast Newforge is 10.0°C. Temperature shows both a seasonal and a diurnal variation, with January being the coldest month and July being the warmest month.

The long term mean winter temperature recorded at Belfast Newforge is 5.3°C and the mean summer temperature is 15.0°C. The mean maximum temperature in winter is 8.5 °C and the mean maximum temperature in summer is 19.1°C. Note that these are means, and that there are individual days which will be greater than this each year. Figure 1 graphically shows the monthly mean temperature profile over the year for Belfast Newforge.

Figure 1: Mean monthly minimum and maximum temperature: Blackpool Belfast Newforge 1991-2020



Source: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcey2u2yw

[1] Met Office UK climate averages, [available at https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcey2u2yw {Accessed 23/08/2023}]

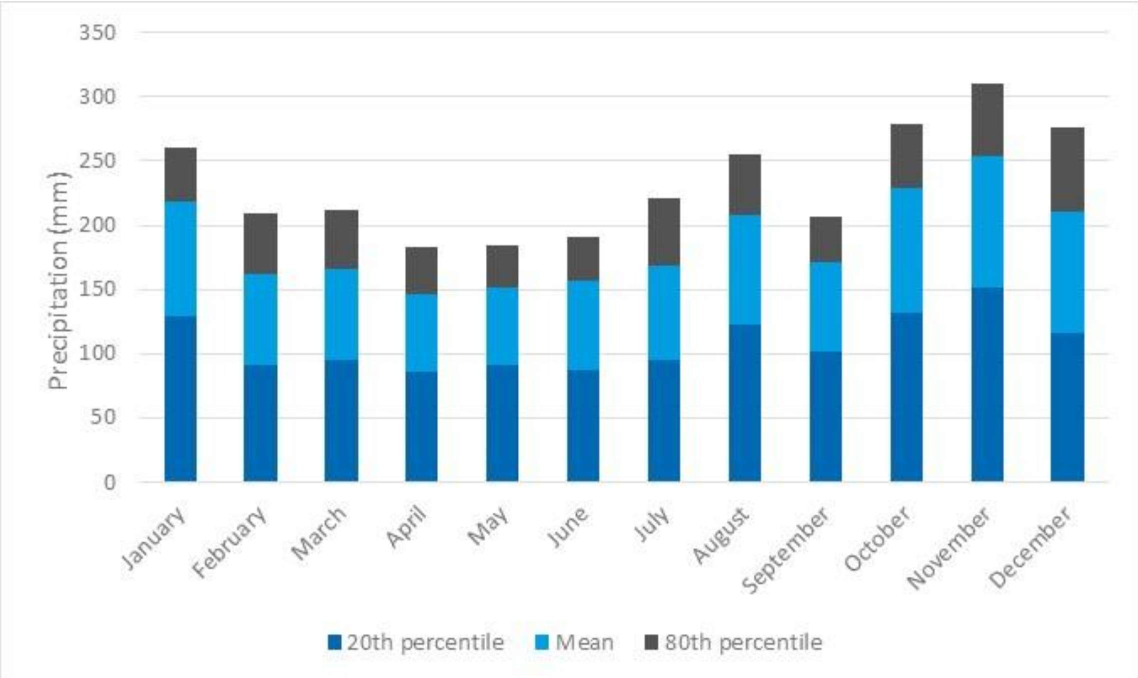
[2] Met office (2016) Northern Ireland: climate [available at https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/regional-climates/northern-ireland_-climate---met-office.pdf [Accessed 21/10/2022}]

2.2 Precipitation

Across the UK, rainfall tends to be associated with Atlantic depressions or with convection. The Atlantic lows are more vigorous in autumn and winter and bring most of the rain that falls in these seasons. In summer, convection caused by solar surface heating sometimes forms shower clouds and a large proportion of rain falls from showers and thunderstorms. A further factor that greatly affects the rainfall distribution is altitude. Moist air that is forced to ascend hills may be cooled below the dew point to produce cloud and rain.

Rainfall in Northern Ireland varies widely. The annual mean rainfall at Belfast Newforge is 934 mm. Rainfall is generally well distributed though the year, and in area of the Proposed Development and Belfast Newforge seasonal variations are less marked than the wetter areas. Long term seasonal means recorded at Belfast Newforge are 75 mm per month in summer and 84 mm per month in winter.

Figure 2: Long term precipitation trend recorded at Belfast Newforge 1991-2020



Source: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcey2u2yw

The occurrence of snow is linked closely with temperature, with falls rarely occurring if the temperature is higher than 4 °C. For snow to lie for any length of time, the temperature normally has to be lower than this. Snowfall is not included within the data from Belfast Newforge, but the regional profile for Northern Ireland states that at lower-lying areas to the east like Belfast Newforge and the Proposed Development have about 15 days with snow falling a year.

2.3 Wind

Northern Ireland is one of the windier parts of the UK. The strongest winds are associated with the passage of deep areas of low pressure close to or across the UK. The frequency and strength of these depressions is greatest in the winter half of the year, especially from November to January, and this is when mean speeds and gusts (short duration peak values) are strongest.

The long term annual mean wind speed is not reported for Belfast Newforge on the Met Office summary data. However, for Northern Ireland the long term annual mean wind speed, recorded at

10 m height, is 8.62 knots, with some annual variation showing higher wind speeds in October through to March and the lowest wind speeds in July and August. Wind speed is also sensitive to local topographic effects, with places sheltered by hills or wooded/urban areas having lower wind speeds. Belfast Newforge and the Proposed Development location are expected to be subject to lower windspeeds as they away from the coast and not on elevated land.

Wind direction tends to blow from the south or south-west, as Atlantic depressions pass the UK, and later comes from the west or north-west as the depression moves away. The range of directions between south and north-west accounts for the majority of occasions and the strongest winds nearly always blow from this range of directions.

A day of gale is defined as a day on which the wind speed attains a mean value of 34 knots or more over any period of 10 minutes. At low altitudes in Northen Ireland gales most frequently occur on the coasts of Antrim and Down with about 15 days of gales on average each year.

2.4 Summary

A summary of the baseline has been included in Table 1.

Table 1: Existing baseline climate conditions

Item	Units	Baseline (Belfast Newforge 1991-2020)
Mean annual temperatures	°C	10.0
Mean winter temperatures	°C	5.3
Mean summer temperatures	°C	15.0
Mean in winter precipitation	mm	84.0
Mean summer precipitation	mm	75.8

3 Future Climate

The future climate at the site has been defined using the latest UKCP which provide the most up-to-date assessment of how the UK climate may change in the future. The latest version is UKCP18.

UKCP18 has predictions based on different emissions scenarios. These are determined by the Representative Concentration Pathways (RCPs), which specify concentrations of greenhouse gases that will result in total radiative forcing (the difference between the incoming and outgoing radiation at the top of the atmosphere). Radiative forcing scenarios for 2100 have been set at 2.6, 4.5, 6.0 and 8.5 watts per square metre (w/m^2) to span a wide range of plausible future emissions scenarios. Each scenario includes many assumptions regarding population growth, economic development, technological innovation and attitudes to social and environmental sustainability.

This assessment has used the data produced by using the high emissions scenario (RCP8.5). This is the worst-case scenario but is plausible and realistic should the societal behaviour reflect the assumptions up to 2100 as set out in RCP8.5. In UKCP18, the probabilistic projections provide local low, central, and high changes across the UK, corresponding to 10%, 50% and 90% probability levels. This assessment has used the central estimate, which is considered to be the level at which as much evidence points to a lower outcome as a higher one. The 10th and 90th percentiles reflect the lowest and highest 10% of the model runs – the value at which 10% of the model runs fall at or below (10th percentile) or at and above (90th percentile) fall at or above. These have been considered where the direction of change is predicted to vary at each level. The predictions also cover a range of spatial resolutions. The scenario from which the future climate has been calculated in summarised in Table 2.

The UKCP18 predictions are based on different regions to the Met office regional profiles. The site and Belfast Newforge meteorological station fall within the Northern Ireland administrative region. Therefore, this has been used for the future climate predictions.

Table 2: Future climate change data scenario summary

Projection	Emissions scenario	Percentile	Area	Baseline time period	Time horizon
UKCP18	RCP8.5	50th, 10th and 90th (where appropriate)	Northern Ireland	1981-2000	2040-2059

The identified changes have then been incorporated to the current baseline from Belfast Newforge to give a local prediction of future climate.

The baseline from which the predicted changes are based (1981-2000) is not the same as the baseline climate data from Belfast Newforge (1991-2020). Therefore, some of the results may be slight over or under estimations. Nevertheless, they offer an estimate sufficient for this assessment in order to determine likely significant effects.

3.1 Temperature

Climate change is projected to lead to hotter summers and warmer winters. Probabilistic projections show that there is more warming in summer than winter, and a more pronounced north-south contrast in summer. This trend is projected in the low, central and high estimates. The projected changes in mean temperature as a central estimate are an overall annual increase of 1.5°C, an increase of 1.4°C in winter and an increase of 1.7°C in summer.

3.2 Precipitation

Over land, projections show a move towards wetter winters and drier summers as a central estimate. However, there is some variation in the projections. The change in winter precipitation for the low estimate is projected to decrease, but, for the central and high estimate this is projected to increase. The change in summer precipitation for the low and central estimate is projected to decrease, but, for the high estimate no change is projected. Projections also show that it is likely that more rain will fall during intense or extreme events.

The projected change in mean winter precipitation is an increase of 5% as a central estimate, however, the 10th percentile shows a decrease of 6%. Projected change in mean summer precipitation is a decrease of 14% as a central estimate, but the 90th percentile shows an increase of 1%.

3.3 Wind

There is large uncertainty in projected changes in wind and air circulation across the UK and it is difficult to represent regional extreme winds for the future. However, projections indicate there will be an increase in near surface wind speeds over the UK and more significant impacts of wind will be experienced in the winter months, including an increase in frequency of winter storms. However, projections have not been quantified.

3.4 Summary

3.4.1 Projections

Table 3 shows the variations in projections at the low, medium and high estimates.

Table 3: Future baseline climate conditions variables

Item	Units	Low estimate – 10th %ile	Central estimate – 50th %ile	High estimate – 90th %ile
Mean annual temperatures	°C	+0.8	+1.5	+2.4
Mean winter temperatures	°C	+0.4	+1.4	+2.6
Mean summer temperatures	°C	+0.6	+1.7	+2.9
Mean in winter precipitation	%	-6	+5	+17
Mean summer precipitation	%	-31	-14	+1

It should be noted that predictions are a general trend. Due to natural variations, there will still be cold winters, dry winters, cooler summers and wetter summers.

3.4.2 Summary

Table 4: Future baseline climate conditions

Item	Units	Baseline (Belfast Newforge 1991-2020)	Predicted change (UKCP18)	Future baseline (At Belfast Newforge 2040-2059)
Central (50th percentile) estimate				
Mean annual temperatures	°C	10.0	1.50	11.5
Mean winter temperatures	°C	5.3	1.40	6.7
Mean summer temperatures	°C	15.0	1.70	16.7
Mean in winter precipitation	mm	84.0	5.0%	88.0
Mean summer precipitation	mm	76.0	-14.0%	65.0
High (90th percentile) estimate				
Mean summer precipitation	mm	76.0	1.0%	77.0
Low (10th percentile) estimate				
Mean winter precipitation	mm	84.0	-6.0%	79.0

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Appendix 15.3

Climate Change Resilience
Detailed Results

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Arc 21

Environmental Statement

Appendix 15.3 – Climate Change Resilience Assessment – Detailed Results

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Document approval

	Name	Signature	Position	Date
Prepared by:	Rosalind Flavell		Senior Environmental Consultant	24/08/2023
Checked by:	Stephen Othen		Technical Director	24/08/2023

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00	24/08/2023	First Issue	RSF	SMO
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Contents

1 Introduction

This technical appendix supports Chapter 15 – Climate Change of the Environmental Statement (ES) and provides the detailed results of the climate change resilience assessment.

The climate change resilience has been assessed for the following vulnerable receptors:

- plant buildings and operational equipment;
- vehicular access to site (for workers and feedstock);
- Grid connection;
- on-site workers and;
- soft landscaping.

For each receptor, an overview has been provided on how climate change may affect the receptor. Then the impact of each predicted climatic effect has been assessed including identification of measures within the design to mitigate any adverse impacts, in line with the methodology set out in Chapter 15 of the ES. For each receptor the following have been considered:

- the sensitivity of the receptor, which considers the value of the receptor and the susceptibility and vulnerability of the receptor to climate change;
- the magnitude of impact, which considers the probability of the event occurring and the consequence given the embedded mitigation in the design of the Facility; and
- significance of effect, taking into account the sensitivity of the receptor and magnitude of impact.

The climate changes which have the potential to impact upon the Proposed Development and which have been considered within this assessment are:

- Increase in precipitation;
- Decrease in precipitation;
- Increase in summer temperatures; and
- Extreme events.

The following effects of climate change are not considered as they are not anticipated to impact the Proposed Development.

- Sea level rise– the site location is not in proximity to coastlines or tidal rivers and so will not be impacted by sea level rise.
- Snow and ice - the latest UK Climate Predictions (UKCP) (UKCP18) predictions anticipate less snow and ice than the current baseline and as such, the risk from snow and ice is not anticipated to increase due to climate change.
- Increased winter temperatures - increases in winter temperatures do not exceed the current baseline for other times of the year and so the Proposed Development would not be vulnerable to this effect.
- Relative humidity - changes in humidity are not included in the UKCP18 predictions and it is not likely to have a significant effect on the Proposed Development as it is designed to allow for a range of ambient conditions.
- Water quality and soils - water availability has the potential to cause changes to the mobilisation of pollutants. More acidic soils and / or water can increase the deterioration of building materials. Soil stability may be altered by a change in water availability. However, the design materials have be chosen to be appropriate for existing ground conditions and would be able to withstand changes in soil acidity as a result of changes in water availability.

A summary table of the steps considered and the resulting significance has been provided for all of the vulnerable receptors in section 7.

2 Plant buildings and operational equipment

Changes in climate can affect the plant building and operational equipment in a number of ways including:

- Increased flooding can result in damage to buildings resulting in the need for emergency repairs and possible disruption to the operations on the site.
- The operation of the Proposed Development could be impacted by a depletion of water resources as it is a net user of water.
- Increased summer temperatures could cause the buildings to be heated up to higher temperature than currently, leading to additional resources to ensure buildings are maintained at an appropriate temperature.
- Increased extreme events including flooding and high wind speeds resulting in structural damage to buildings and the need for emergency repairs and possible disruption to the operations on the site.

The following section identifies the anticipated change in climate conditions, the effect this would have upon the receptor and the significance.

2.1 Climatic effect – increase in precipitation

The predicted increase in precipitation due to climate change could increase the risk of flooding at the site. If flooding of the site were to be severe, there would be a risk of flood damage to buildings, resulting in maintenance and possible generation disruption.

A review of the Flood Maps (Northern Ireland)[1] shows that:

- The Proposed Development is not located in an area susceptible to fluvial/sea flooding either in present day of allowing for climate change.
- There are small areas of the site susceptible to surface water flooding in the present day and when allowing for the effects of climate change.

The Proposed Development will include Sustainable Urban Drainage Systems (SuDS) with associated attenuation ponds which limits the flows from the site to greenfield run-off rate. Therefore, the Proposed Development will not increase the flood risk elsewhere. The pipes and storm water attenuation have been sized to accommodate a 1 in 30 year storm event directing surface water away from operational areas.

The assessment of significance of the potential for increased precipitation and associated increased flooding risk as a result of climate change, on the plant buildings and operational equipment is as follows:

<u>Sensitivity</u>

The sensitivity of the plant buildings and operational equipment to flooding is deemed to be <u>medium</u> for the following reasons:

- The value of the receptor is <u>high</u>.
- The susceptibility of the plant building and operational equipment to flooding is deemed to be <u>low</u> because there are effective mitigation measures in place (hard wearing materials and surface water drainage) which would allow the property to withstand the projected changes.

[1] https://dfi-ni.maps.arcgis.com/apps/webappviewer/index.html?id=fd6c0a01b07840269a50a2f596b3daf6, accessed 23/08/2023

- The vulnerability of the plant building and operational equipment to surface water flooding is considered to be low, as the risk of flooding is of low significance and climate change has been considered within this assessment.

Magnitude

The overall magnitude of impact is negligible for the following reasons:

- The probability of increased rainfall is high, but the probability of increased flood risk is low, as the flood risk assessment has already taken into account climate change.
- The consequence is low because should flooding occur, there are effective mitigation measures in place (hard wearing materials and surface water drainage) which would allow the property to withstand the projected changes.

Significance

As a result, it is considered that the predicted increase in precipitation leading to the increased potential for surface water flooding would be of slight significance to the plant buildings and operational equipment.

2.2 Climatic effect – decrease in precipitation

Decrease in precipitation gives the increased possibility of drought, particularly during summer months, which is further detailed in Appendix 15-2. As the Proposed Development uses water within the process, it may be impacted by depletion of water resources in the UK caused by changes to climate.

Water is supplied by Northern Ireland Water. Northern Ireland Water has a Water Resource and Supply Resilience Plan[2] with a planning horizon up to 2042/43. The strategic aim of the plan is to improve the resilience of Northern Ireland's water supply system. The plan considers the whole of Northern Ireland and seven Water Resource Zones, of which the Proposed Development is within the East Water Resource Zone (WRZ). This shows the East WRZ is predicted to have a surplus of water supply based on a 1:40 year drought, during summer critical peak demand and during the winter critical period. Northern Ireland Water also has a target to achieve operational net zero by 2030 and are committed to improving and protecting biodiversity.

Although the risk of drought from climate change cannot be directly controlled, Northern Ireland Water is aware of the risk and are taking measures to ensure climate resilience and reliable supply to their customers, and the WRSRP shows that even in a 1:40 year drought event there is predicted to be a surplus of water supply in the region.

Furthermore, any wastewater at the Proposed Development will be re-circulated, which reduces the reliance of the Proposed Development on water from Northen Ireland Water.

The assessment of significance of the potential for the increased risk of drought as a result of climate change, on the plant buildings and operational equipment is as follows:

Sensitivity

The sensitivity of the plant buildings and operational equipment to a decrease in precipitation is deemed to be medium for the following reasons:

- The value of the receptor is high.

[2] https://seswater.co.uk/-/media/files/seswater/your-environment/wrmp-2022/ses-water-draft-wrmp22.pdf

- The susceptibility of the plant building and operational equipment to drought would be low as the water supplier has mitigation measures in place to ensure reliable supply, and the impacts of no supply would be temporary. There will also be water re-use within the process to reduce reliance of the water supplier.
- The vulnerability of the plant building and operational equipment to drought is high because the area may be impacted by drought and the receptor requires water to operate.

Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased drought within the area is moderate, but due to the mitigation measures committed to by the water supplier, the probability of reduced water supply at the site is low.
- The consequence is moderate because a disruption in water supply would cause the process to be temporarily halted, although it is likely that the impacts would be short term.

Significance

As a result, it has been considered that the predicted decrease in precipitation leading to the increased potential for drought and lack of water supply to the Proposed Development would be of slight significance to the plant buildings and operational equipment.

2.3 Climatic effect - increase in summer temperatures

The potential for an increase in mean summer temperatures has the possibility to cause buildings to be heated up to higher temperatures than at current. However, measures to allow for temperature change have been incorporated into the design of the Proposed Development. These embedded mitigation measures include:

- The building materials are resilient to expected climatic extremes with British Standards applicable for most materials to ensure that extreme climatic conditions are accounted for.
- The building includes movement joints to allow for expansion and contraction of the materials.
- Any heating systems or cooling systems within the buildings are powered by electricity from the ERF, unless it is offline, in which case auxiliary power is used.
- The ventilation systems for the electrical systems are designed to within stand a range of temperatures greater than the currently experienced temperatures to account for climate change.

The assessment of significance of the potential for increased temperatures as a result of climate change, on the plant buildings and operational equipment is as follows:

Sensitivity

The sensitivity of the plant buildings and operational equipment to increased temperatures is deemed to be low for the following reasons:

- The value of the receptor is high.
- The susceptibility of the plant building and operational equipment to increased temperatures is low as the buildings have been designed to tolerate a range of temperatures.
- The vulnerability of the plant building and operational equipment to increased temperatures is low because it will likely experience higher ambient temperatures but is already tolerant to higher temperatures from the process.

Magnitude

As such the overall magnitude of impact is small for the following reasons:

- The probability of increased temperatures is high.
- The consequence is low because an increase in temperature will not cause significant damage to the buildings or operation of the Facility.

Significance

As a result, it has been considered that the predicted increase in temperatures leading to the increase in building temperatures would be of negligible significance to the plant buildings and operational equipment.

2.4 Climatic effect – extreme events

The predicted increase in rain caused by storms and extreme events is covered in the flooding sections. Surges in wind may have an impact on the wind loading of buildings, the potential impact being structural damage to the buildings, for example wind gusts could cause damage or shifting to cladding or bolts causing a risk of cladding or external parts of the building coming loose. The UKCP18 projections predict that wind speeds will increase, but do not quantify what the increase will be.

A standard part of the structural design for buildings and building materials includes wind loading studies, which includes a safety factor to allow for these strong winds and associated wind loading. In addition, preventative measures such as preventative maintenance and inspections of the cladding and building materials are carried out at regular intervals.

The assessment of significance of the potential for surges in wind caused by more frequent and intense extreme events as a result of climate change, to impact on the plant buildings and operational equipment is as follows:

Sensitivity

The sensitivity of the plant buildings and operational equipment to increased temperatures is deemed to be medium for the following reasons:

- The value of the receptor is high.
- The susceptibility of the plant building and operational equipment to increased wind damage is moderate as the buildings have been built to tolerate a range of wind gusts, but are susceptible to some level of damage.
- The vulnerability of the plant building to increased wind damage is high because they will likely experience higher winds, however the operational equipment has a low vulnerability to wind damage as it is not exposed to increased winds because it is within the shelter of the buildings.

Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased extreme events and wind damage to the buildings is high but to the operational equipment is low.
- The consequence is low, because should extreme events occur, the buildings may undergo a small amount of damage, but this would be repairable at the operators cost and impacts would be short term. The operational equipment is sheltered within the buildings, so will not undergo any damage from wind.

Significance

As a result, it has been considered that the predicted increase in extreme events leading to the potential increase in wind damage would be of slight significance to the plant buildings and operational equipment.

2.5 Summary

The assessment of the effect of changes to climate on plant buildings and operation is summarised in Table 1 in section 7.

In summary, the overall significance of effects of changes to climate on the buildings and operational equipment has been assessed to be negligible to slight. This is not a significant effect.

3 Vehicular access to the site (for workers and waste)

Events linked to climate change can affect vehicular access to the site. If the waste feedstock cannot access the site, there is a risk of supply disruption and potential shut down of the Proposed Development. If staff cannot access the site, there may be an impact to shift patterns and the potential for partial or complete shut down if there are not enough staff to maintain safe plant operation.

In the case that vehicles are restricted from accessing the site, the site, including the MBT plant and the baled storage area, has capacity for a few weeks' worth of waste feedstock, and storage capacity for residues generated. Therefore, general operation of the Proposed Development can continue normal operations for a few weeks, by which time it is expected that any road restrictions would have been removed or alternative routes created.

The highways network is designed for resilience to extreme events and it is the local councils' and the Highways Authority's responsibility to maintain the roads. For A roads and trunk roads, their clearance or the creation of alternative routes created would be priority for the Highway Authority.

The value of vehicular access to the site is high because the Proposed Development relies on deliveries of waste and raw materials and collection of the residues and the access of the site staff to undertake operations.

3.1 Climatic effect –increase in precipitation

Anticipated potential impacts to vehicular access to the site from an increase in precipitation are increased surface run off and associated surface water flooding of access routes, or other flooding of access routes.

The assessment of significance of the potential for vehicular access blockages a result of the effects of changes in climate is as follows:

Sensitivity

The sensitivity of the vehicular access to the site to flooding is deemed to be medium for the following reasons:

- The value of the receptor is high.
- The susceptibility is deemed to be low as there are effective mitigation measures in place to clear any flooding of access routes or provide alternative routes, and there is a contingency plan in place to enable operations to continue for a few weeks.
- The vulnerability is medium because although the risk of surface water flooding at the is low due to mitigation measures, there is the potential for the local access routes to have higher risk levels.

Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased rainfall is high, but the probability of increased flooding to vehicular access routes is medium as most roads are designed to be tolerant to flooding.
- The consequence is low because should flooding of the access routes occur, there may be disruption to the site access, but the contingency plan in place would allow the Proposed

Development to continue operations for a few weeks, by which time it would be expected for road blockages to be cleared or alternative routes provided.

Significance

As a result, it is considered that the predicted increase in precipitation leading to the increased potential for access route flooding would be of slight significance to the vehicular access to the site.

3.2 Climatic effect – decrease in summer precipitation

Decrease in summer rainfall of gives the increased possibility of drought. This is not expected to impact the vehicular access to the site.

3.3 Climatic effect - increase in summer temperatures

The potential for an increase in mean summer temperatures has the possibility to cause drought and warmer conditions for driving. This is not expected to impact the vehicular access to the site.

3.4 Climatic effect – extreme events

The predicted increase in rain caused by storms and extreme events is covered in the flooding sections. Surges in wind may have an impact on the vehicular access to site where they cause branches to be blown off or trees to be blown over, resulting in a road blockage.

The assessment of significance of the potential for vehicular access blockages a result of extreme events as a result of changes to climate is as follows:

Sensitivity

The sensitivity of the vehicular access to the site to road blockages caused by fallen trees is assessed to be medium for the following reasons:

- The value of the receptor is high.
- The susceptibility is deemed to be low as there are effective mitigation measures in place to clear any blockages or provide alternative route and there is a contingency plan in place to enable operations to continue for a few weeks.
- The vulnerability is moderate, as it is possible that part of the vehicular access route could be impacted by fallen trees or branches in an extreme event.

Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased extreme events is high, but the probability of this impacting the vehicular access routes is moderate, as the highways agency are responsible for clearing road blockages quickly.
- The consequence is low because should a blockage occur, there may be disruption to the site access, but the contingency plan in place would allow the Proposed Development to continue operations for a few weeks, by which time it would be expected for road blockages to be cleared or alternative routes provided.

Significance

As a result, it is considered that the predicted increase in extreme events as a result of changes to climate leading to the increased potential access route blockage by fallen trees or branches would be of slight significance to the vehicular access to the site.

3.5 Summary

The assessment of the effect of changes to climate on vehicular access to the site is summarised in Table 1 in section 7.

In summary, the overall significance of effects of changes to climate on vehicular access to the site has been assessed to be slight. This is not a significant effect.

4 Grid connection and local users

4.1 Climatic effect –increase in precipitation

Anticipated potential impacts to grid connection and local electricity or gas users from an increase in precipitation are flooding events which could cause water damage to the grid connection and electricity or gas supply. Any flooding damage to the grid connection and electricity or gas supply could result in no output of power from the Proposed Development, which would impact the users of the local electricity distribution network.

However, the design is such that the grid connection and associated electricity cables will be underground. This protects them from any above ground damage from storm or wind events and the electricity cables are designed to be resilient to water and so would not be impacted by any flooding events.

The assessment of significance of the potential for damage to grid connection and local users as result of increased precipitation associated with projected changes to climate is as follows:

Sensitivity

The sensitivity of the grid connection and local users to the site to flooding is deemed to be low for the following reasons:

- The value of the receptor is high.
- The susceptibility is deemed to be low as there are effective mitigation measures, that the electricity cables will be underground and designed to be resilient to water, which reduce risks of flooding to damaging them.
- The vulnerability is low as risk the electricity cables will be underground and designed to be resilient to water so are tolerant to flooding.

Magnitude

The overall magnitude of impact is medium for the following reasons:

- The probability of increased rainfall is high, but the probability of increased flooding damaging the grid connection to local users is low, as the electricity cables are designed to be resilient to water so are tolerant to flooding.
- The consequence is high because should damage to the electricity cables from flooding occur, the Proposed Development would not be able to output power to the grid or and/or local users may be impacted. The water damage caused would be fixable but impacts may be longer term.

Significance

As a result, it has been considered that the predicted increase in precipitation leading to the increased potential of water damage to the grid connection and electricity supply would be of negligible significance to the grid connection and local users.

4.2 Climatic effect - decreased summer precipitation

Decrease in summer rainfall gives the increased possibility of drought. This is not expected to impact the electricity connection and local users.

4.3 Climatic effect - increase in summer temperatures

The potential for an increase in mean summer temperatures is not expected to impact the electricity connection and local users.

4.4 Climatic effect - extreme events

The predicted increase in rain caused by storms and extreme events is covered in the flooding sections. Surges in wind are not expected to impact the electricity connection or local users, given that the connections would be via an underground cable.

4.5 Summary

The assessment of the effect of changes to climate on grid connection and local users is summarised in Table 1 in section 7.

In summary, the overall significance of effects changes to climate on the grid connection and local users has been assessed to be negligible. This is not a significant effect.

5 On-site workers

Events linked to climate change can affect on-site workers by resulting in dangerous working conditions or closure of the site. This may include working in uncomfortable temperatures causing dehydration or heat stroke, increased risk of wind exposure, and increased risk to hazards of cladding or building parts being shifted by wind gusts, coming loose and falling on workers. The UKCP18 projections do not quantify the increase in wind speeds but predict they will increase.

There are mitigation measures built into the design including the use of Risk Assessment Method Statements (RAMS). This includes measures such as ensuring that prior to any workers climbing the buildings or stack, wind speeds are checked to ensure they are not at dangerous levels. There is air-conditioning and/or sufficient ventilation in indoor areas where staff could be expected to be present for prolonged periods of time. Staff are equipped with the correct personal protective equipment (PPE), trained in site health and safety and informed about protecting themselves from the dehydration and the sun.

The risk of wind damage to on-site workers caused by damage to buildings is reduced by measures such as preventative maintenance and regular inspections of the cladding and building materials. Furthermore, monitoring of weather conditions is a part of the operating procedures, so on-site workers are warned or informed of any adverse weather.

This embedded mitigation has been considered within the following assessment.

The on-site workers are high value receptors.

5.1 Climatic effect –increased in precipitation

The risk of on-site workers working in flooding conditions has not been assessed because, as assessed in section 2.1, the risk of flooding is of no or low significance and any flooding would be of shallow depths and last for a short period, which is not expected to impact workers.

5.2 Climatic effect – decrease in summer precipitation

Decrease in summer rainfall gives the increased possibility of drought. This is not expected to impact the on-site workers.

5.3 Climatic effect - increase in summer temperatures

The potential for an increase in mean summer temperatures has the possibility to cause warmer conditions for on-site workers, bringing with it an increased risk of uncomfortable conditions and potential for heatstroke.

The assessment of significance of the potential for warmer conditions to on-site workers as result of increases in summer temperatures is as follows:

Sensitivity

The sensitivity of the on-site workers to increased temperatures is deemed to be medium for the following reasons:

- The value of the receptor is high.
- The susceptibility is deemed to be moderate, as mitigation measures would be in place such as access to appropriate PPE, education and appropriate ventilation. However, they may still be impacted by the increase in temperatures.

- The vulnerability is considered to be moderate as it is likely that temperatures will increase.

Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased temperatures is high, however this will not just be specific to the site but to all ambient air which on-site workers would be exposed to in their everyday life. The probability of regular negative impact to the on-site workers from high temperatures is low.
- The consequence is moderate because if on-site workers suffer heatstroke, there may be shortage of workers. However, high heat occasions would only occur in summer and for a few days at a time.

Significance

As a result, it has been considered that the predicted increased temperatures leading to the increased potential for uncomfortable working conditions for the on-site workers would be of slight significance.

5.4 Climatic effect - extreme events

The predicted increase in rain caused by storms and extreme events is covered in the flooding sections. Gusts of wind may have an impact on the safety of on-site workers around the buildings.

The assessment of significance of the potential for on-site workers safety conditions as result of extreme events associated with changes in climate is as follows:

Sensitivity

The sensitivity of the on-site workers to increased safety risks from wind gusts is deemed to be medium for the following reasons:

- The value of the receptor is high.
- The susceptibility is deemed to be low, as the on-site workers have access to appropriate PPE and education. Preventative maintenance and regular inspections and RAMS are in place to ensure on-site worker safety.
- The vulnerability is considered to be moderate as it is likely that wind gusts will increase.

Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased extreme events is high, however the probability of this impacting on-site workers in low due to the imbedded mitigation measures.
- The consequence of injury caused by increased wind gusts is high.

Significance

As a result, it has been considered that the predicted increase in extreme events leading to increased risk to on-site workers from wind gusts would be of slight significance.

5.5 Summary

The assessment of the effect of changes to climate on on-site workers is summarised in Table 1 in section 7.

In summary, the overall significance of effects of changes to climate on on-site workers has been assessed to be slight. This is not a significant effect.

6 Soft landscaping

A Balancing Lagoon will be created as part of the site's SuDS. This will enhance bio-diversity at the site. The area will be planted with native marginal and other aquatic planting. A range of species and use of native species increases the resilience of the soft landscaping to the impacts of climate change.

6.1 Climatic effect

The soft landscaping could be impacted by all the climatic effects assessed in this appendix:

1. Increased precipitation, especially in heavy downpours, could damage plant species and significant changes in levels within the Balancing Lagoons could cause plants to drown. However, the Balancing Lagoons are designed to fluctuate and marginal and aquatic planting will be used which are resilient to changes in water levels.
2. Decrease in precipitation and an increase in occurrence of high temperatures could cause drought which would cause plant species to wilt and potentially die. However, native species with established root systems are reasonably hardy and resilient to drought. Potential mitigation could include watering of the soft landscaping should it be required until the species have established.
3. Extreme events could cause heavy downpours of rain (see point 1) and wind damage to plants. In the case of larger trees, wind gusts could cause tree branches to break off or tree trunks to fall. In these cases the trees would be permanently damaged. However, it would be possible to replace any severely damaged trees and it is expected for the other plants, grassland species and marginal planting, to be more resilient to wind gusts.

The value of soft landscaping is medium. Although the soft landscaping is not integral to the operation or working of the Proposed Development, it is important for the biodiversity and pleasantness of the area and thus would be of high value. However, any damages to the soft landscaping can be easily remedied with further planting and maintenance and hence the value is medium.

The assessment of significance of the potential changes to climatic on the soft landscaping has been combined, as the assessment is similar for all projected changes. The assessment of significance is at follows.

Sensitivity

The sensitivity of the soft landscaping to climatic changes is deemed to be medium for the following reasons:

- The value of the receptor is medium.
- The susceptibility is deemed to be low, as although there is some potential for plants to be damaged, native plants are reasonably hardy and resilient to the projected climatic changes, and any damages will be limited and temporary.
- The vulnerability is considered to be moderate as it is likely that soft landscaping will be subject to the projected changes in climate.

Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of the projected changes to climate is high, however the probability of them impacting the soft landscaping is deemed to be moderate due to the natural resistance of plants to varied conditions.

- The consequence of damage to the soft landscaping is low. Although, the soft landscaping is important for the biodiversity on the Site, damage to it would be temporary and fixable.

6.2 Summary

The assessment of changes to climate on soft landscaping is summarised in Table 1 in section 7.

In summary, the overall significance of effects of changes to climate on soft landscaping has been assessed to be slight. This is not a significant effect.

7 Summary

The assessment of climate change impacts on the receptors has been summarised in Table 1.

Table 1: Summary of climate change assessment

Predicted change in climate	Impact of change in climate	Effect	Sensitivity				Magnitude of effect considering embedded mitigation			Overall significance
			Value	Susceptibility	Vulnerability	Sensitivity	Probability	Consequence	Magnitude of Effect	
Plant buildings and operational equipment										
Increase in precipitation	Surface water flooding	Flood damage to buildings and operational equipment	High	Low	Low	Medium	Low	Low	Negligible	Slight
Decrease in precipitation	Drought	Loss of water supply for process	High	Low	High	Medium	Low	Moderate	Small	Slight
Increase in temperatures	Increases in summer maximum temperatures	Over -heating of buildings and equipment	High	Low	Low	Low	High	Low	Small	Negligible
Extreme events	Increases in wind gusts	Building damage from high winds	High	Moderate	High/Low	Medium	High/Low	Low	Small	Slight
Vehicular access to site										
Increase in precipitation	Flooding of access roads	Restricted access of workers and raw materials to site.	High	Low	Medium	Medium	Medium	Low	Small	Slight
Extreme events	Trees and branches blocking access roads	Restricted access of workers and raw materials to site.	High	Low	Moderate	Medium	Moderate	Low	Small	Slight
Grid connection and local users										
Increase in precipitation	Flooding causing damage to cable and grid connection	EfW facility unable to export power	High	Low	Low	Low	Low	High	Medium	Negligible
On-site workers										
Increase in summer temperatures	Uncomfortable working conditions and heatstroke	Ill workers and shortage of workers	High	Moderate	Moderate	Medium	Low	Moderate	Small	Slight

Predicted change in climate	Impact of change in climate	Effect	Sensitivity				Magnitude of effect considering embedded mitigation			Overall significance
			Value	Susceptibility	Vulnerability	Sensitivity	Probability	Consequence	Magnitude of Effect	
Extreme events	Surges in wind and effects on worker safety	Hazard to workers.	High	Low	Moderate	Medium	Low	High	Small	Slight
Soft landscaping										
All climatic impacts	Damage to soft landscaping plants	Loss of biodiversity	Medium	Low	Moderate	Medium	Moderate	Low	Small	Slight

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Appendix 15.4

Response to Objection

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Hightown Quarry

Arc21

Appendix 15-4 Response to objection

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Document approval

	Name	Signature	Position	Date
Prepared by:	Stephen Othen		Technical Director	09/04/2025
Checked by:	Rosalind Flavell		Senior Consultant	09/04/2025

Document revision record

Revision no	Date	Details of revisions	Prepared by	Checked by
0	09/04/2025	Final	SMO	RSF

1 Introduction

Fichtner Consulting Engineers Ltd prepared the updated climate change assessment for the planning application for the proposed Hightown Quarry residual waste treatment project (the Proposal). The applicant has asked Fichtner to respond to representations made by a third party on this subject.

2 Colin Buick

2.1 Introduction

Mr Colin Buick wrote to DfI on 21 June 2024 on behalf of Noarc21.

His letter refers to a Good Practice Guidance but it does not clarify what this document is or who it was prepared by. The reference is a document prepared by a grouping called UK Without Incineration Network (UKWIN), a national group which campaigns against energy from waste (EfW) plants.

It is notable that many of the points made by Mr Buick have been made by other local objection groups and UKWIN at planning inquiries into other EfW plants. We have responded to these points in previous Inquiries across the UK. On each occasion the decision maker has accepted Fichtner's position over the UKWIN position.

2.2 Response

Each of the points made by Mr Buick in his 21 June 2024 objection correspondence is identified below in *italics* together with a responding comment from Fichtner.

1. *The claimed net climate benefit cannot be ascertained with any great certainty, given it is highly sensitive to the assumptions applied, and as such the claimed climate benefits should carry little if any weight in the assessment.*

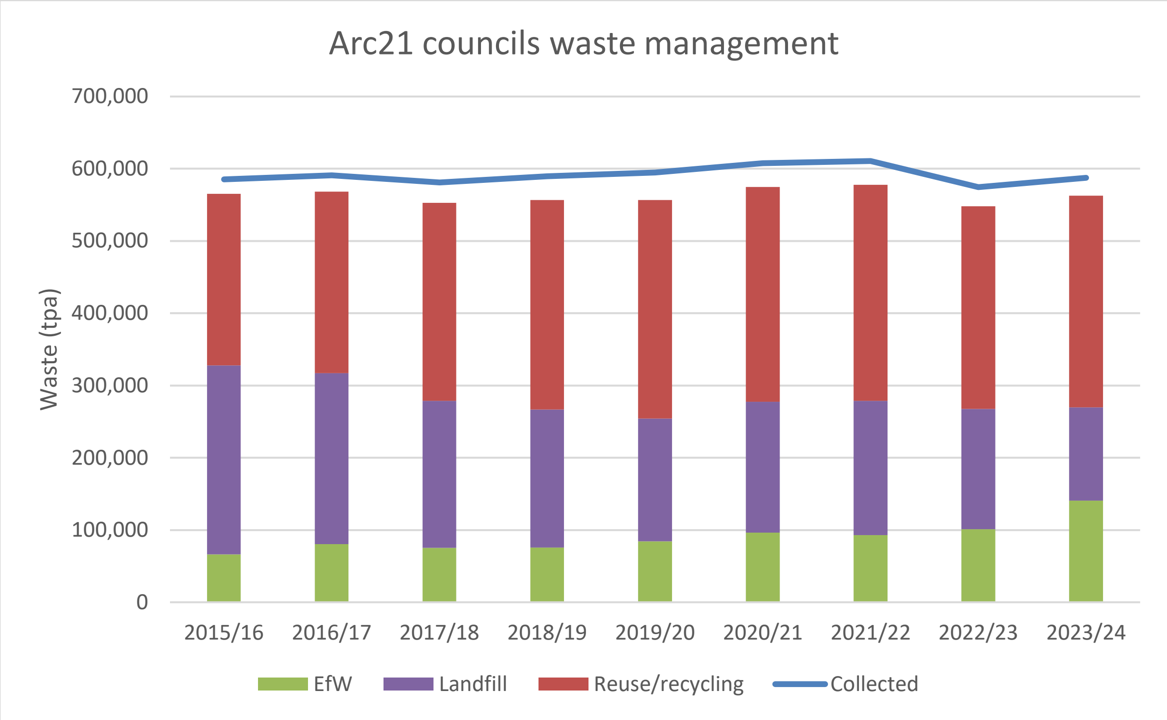
   It is agreed that the precise benefit will depend on the future composition of waste, the type of power displaced and the performance of landfill sites. This is why the assessment that has been made by the applicant includes a range of sensitivities to demonstrate that there is a clear benefit over landfill under all circumstances.

2. *The assessment is premised on the assumption that the incinerator would only be displacing waste sent directly (untreated) to landfill. It might actually be the case that during the lifetime of the facility it would end up displacing an amount of reduction, re-use and recycling/composting which would have occurred. Given that those top tiers of the waste hierarchy have far lower impacts than incineration, this uncertainty regarding the alternative fate of the feedstock over its operational lifetime adds inherent uncertainty to the conclusions of the assessment.*

   The Hightown Quarry plant would take residual waste, that is waste which remains after reduction, reuse, source segregation at home and recycling. This is essentially the material that remains in the black bin. DAERA publishes data on local authority collected municipal waste. The latest report was published on 28 November 2024 and includes data up to the 2023/24 financial year. As shown in the graph below, the amount of residual waste being sent to landfill or exported to other EfW plants has been consistently above 265,000 tpa, except in 2019/20.

It is misleading to claim that residual waste other than that in the black bin will be displaced by the proposed facility. Arc21 has separate contracts with recycling and organic processing operators to ensure that the recycling and organic bins are processed to contribute to recycling targets.

Figure 1: Municipal waste management routes, 2015/16 to 2023/24



Source: Northern Ireland local authority collected municipal waste management statistics

3. *If credit is given for biogenic carbon sequestration based on the Applicant's assumptions then this would flip the claimed net benefit (of 34,692 to 43,463 tCO2e) to a net disbenefit of between 17,673 to 26,516 tCO2e (see Appendix 1 spreadsheet for calculations). Even in the heat export case the claimed benefits would turn negative, resulting in a disbenefit of between 4,442 tCO2e/year and 13,276 tCO2e/year.*

   As addressed in response to the next point, it is not accepted that credit should be given for biogenic carbon sequestration and so the calculations above are not accepted.

4. *In relation to the landfill baseline, it is stated by Fichtner that "it is not considered appropriate to give additional credit for sequestered carbon [in landfill] as this would result in an overly-conservative assessment" on the basis that they are conservative in relation to their Landfill Gas Capture Rate assumption (68%) and their level of assumes sequestration rate (50%). Not only are these assumptions not particularly conservative, but even if they were their degree of conservatism would be insufficient to compensate for not giving additional credit for sequestered biogenic carbon. If you look at the corrected version of the Applicant's sensitivity analysis (see spreadsheet) you will see that if a grid displacement factor of 0.233 is assumed then across nearly all scenarios the plant would be worse than landfill. This shows that assuming 68% LFG capture rate even if it were conservative would be insufficient to justify failing to credit biogenic carbon sequestration in landfill.*

The reasons for our approach to this issue are set out clearly in section 4.2.1 of Appendix 15.1.

The key conclusion was as follows:

> "The [DEFRA] report indicates that the assumed LFG capture rates are based on a high sequestration rate, which may not be correct, and which are based on the higher end of the rates in literature. Should the sequestration rates be lower in reality, more LFG is generated than expected, resulting in lower capture rates and making the impact of landfill considerably worse. The approach used within the report (i.e. high sequestration percentage, high LFG capture rates and no additional credit for sequestered carbon), and also within this carbon assessment, is considered to be conservative, in that it will tend to favour landfill over EfW."

It is important to expand on the final point. The LFG capture rates used in the assessment come from a Golders Associates report for the Department for Environment Food and Rural Affairs (DEFRA) – "Review of Landfill Methane Emissions Modelling (WR1908)". In this report, the amount of LFG captured is known, as this is measured, but the amount of LFG which is not captured is not known, for obvious reasons, and so is derived from modelling. This uses DDOC assumptions from Melmod, which the two DEFRA reports say lead to sequestration rates which are at the higher end of rates in the literature.

If the correct sequestration rate is lower, then the amount of LFG which has been generated is higher and the LFG capture rates would be lower.

This can be illustrated with a simple example.

The base assumptions in the carbon assessment are that 50% of biogenic carbon is sequestered and 68% of the released landfill gas is captured. This means that, for every 200 tonnes of biogenic carbon in the waste, 100 tonnes is sequestered, 68 tonnes is used to generate power and 32 tonnes is released as landfill gas.

If, instead, only 45% of the biogenic carbon is sequestered, then 90 tonnes of the biogenic carbon would be sequestered and 110 tonnes would form LFG. In this example it is known, from measurements, that 68 tonnes is used to generate power and so the LFG capture rate would be 68/110 = 61.8%. At a sequestration rate of 29.5% (which is the sensitivity figure used in the DEFRA report "Energy recovery for residual waste - A carbon based modelling approach"), only 59 tonnes of the biogenic carbon would be sequestered and so the landfill gas capture rate would be 68/141 = 48.2%.

Fichtner has done some sensitivity calculations to show the impact of this assumption, based on sequestration rates of 50%, 47.5%, 45%, and 29.5% and allowing for the changes in LFG capture rates which are implied. It can be seen that the results are very sensitive to the sequestration rate and that only a slight reduction in sequestration rate is sufficient to mean that the Proposal has a net benefit compared to landfill, even allowing for a sequestration credit, and even excluding district heating. With district heating, the benefits are larger.

Table 1: Sequestration sensitivity

Sequestration Rate	50%	47.5%	45%	29.5%
Base Case				
Benefit of Proposal (no sequestration credit)	43,815	58,071	72,327	160,714
Benefit of Proposal (with sequestration credit)	-17,321	-8	17,304	124,644
Benefit of Proposal (with sequestration credit and district heating	-4,090	13,223	30,535	137,875

Sequestration Rate	50%	47.5%	45%	29.5%
Low Food Case				
Benefit of Proposal (no sequestration credit)	35,045	49,317	63,590	152,079
Benefit of Proposal (with sequestration credit)	-26,162	-8,830	8,503	115,967
Benefit of Proposal (with sequestration credit and district heating	-12,931	4,402	21,734	129,198

In addition, it is not certain that carbon will remain sequestered in landfill over the long term. The Environmental Services Association (ESA), in its Net Zero Strategy, notes that "landfill science does not yet provide a dataset to support the concept that materials are sequestered in them within a long-term timeframe."

5. *Fichtner states that "For the lifetime assessment, it has been assumed that the LFG capture rate increases incrementally over time, due to improvements to the LFG capture technology efficiency" (see page 21), but the main assessment is based on 68% without taking into account any such improvement. This indicates that 68% is an overly pro-incineration assumption to make rather than a conservative assumption that justifies ignoring biogenic CO2. Also, they do not demonstrate that the sequestration rate for the proposed feedstock is likely to be significantly below 50%.*

   The lifetime assessment was, again, intended to be conservative by assuming improvements in LFG capture rates, which may not happen, and by starting at a figure which is already representative of well-run UK landfill sites.

6. *It is important to fully take into account the decarbonisation of the electricity grid, so even the 0.233 assumed grid displacement factor is overly pro-incineration. Fichtner state that they take into account grid decarbonisation in their lifetime sensitivity analysis and sensitivity analysis, but not in their central analysis. We don't think they take it into account enough even in their sensitivity analysis, but it at the very least calls into question their central analysis. They state "it remains difficult to accurately predict the exact rate of grid decarbonisation into the longer term" on page 21, and the fact their sensitivity analysis is a world apart from current BEIS figures means that they could have significantly understated the impact of decarbonisation in their sensitivity analysis. This highlights the inherent uncertainty in their claimed benefit which are highly reliant on the assumed (but uncertain) grid displacement counterfactual.*

   The revised carbon assessment explains in detail why using the UK long run marginal generation-based emission factors is not reasonable. This is because the EfW facility would not displace renewable forms of electricity, as these would continue to operate and generate power whenever possible.

   This is supported by the latest power generation data. In 2022, 44.6% of Northern Ireland's electricity was generated by natural gas and 10.9% by coal, although the generation from coal is expected to cease now that the coal generation at Kilroot has ended. In the 12-month period to December 2024, 43.5% of electricity was generated from renewables sources; this level has fluctuated between about 40% and 50% since 2019 but there has not been an upward trend. (See Electricity Consumption and Renewable Generation in Northern Ireland, published by NISRA).

7. *The Applicant's carbon assessment is based on a throughput of 211,000 per year. I understood from https://www.northernirelandworld.com/news/people/mallusk-incinerator-refusal-of-planning-permission-for-project-quashed-4163995 that at some point this was increased to 300,000 tpa. The assessment above is based on the applicant's 211,000 tonnes of throughput.*

   The revised carbon assessment which Mr Buick is commenting on (Appendix 11 ES addendum, September 2023) and the carbon assessment included in Appendix 15.1 of this April 2025 ES addendum have only considered the EfW facility, which is expected to process approximately 211,000 tonnes of waste per annum.

   The broader integrated waste management facility would receive more waste than this and has a planning capacity of 300,000 tonnes per annum. As explained in paragraph 15.16 of the climate chapter, the MBT plant will lead to a number of benefits which are likely to lead to a reduction in overall GHG emissions. However, these are difficult to quantify accurately as they will depend on a large number of factors which are not under the Applicant's control and so, as a conservative assumption, these benefits have been excluded from the quantitative assessment.

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