13 CLIMATE CHANGE

13.1 Introduction

13.1.1 This Chapter reports the likely significant effects of the Proposed Development in terms of Climate Change in the context of the Site, surrounding area, and wider environment, recognising that climate change is a global issue.

13.1.2 This climate change chapter will cover the following topics:

- **Assessment of Impacts:** A conventional impact assessment that will focus on the potential effects of the Proposed Development (i.e. greenhouse gas (GHG) emissions on the climate). This will include an overview of how the proposed development aids in the mitigation of climate change; and
- **Assessment of Climate Resilience:** A review of the resilience of the Proposed Development to the potential effects arising from projected changes in future climate. This will include a qualitative discussion of the vulnerability and sensitivity of the proposed development to climate change impacts, with an assessment of the magnitude of effects.

13.1.3 The chapter describes the methods used to assess the impacts, the baseline conditions currently existing at the Site and surroundings, the potential direct and indirect impacts of the development arising from Climate Change, the mitigation measures required to prevent, reduce, or offset the impacts and the residual effects. It has been written by Wardell Armstrong.

13.1.4 This chapter is not intended to be read as a standalone assessment and reference should be made to the front end of this Environmental Impact Assessment Report (EIAR) (Chapters 1 – 5), as well as the final chapters, 'Summary of Residual and Cumulative Effects' and 'Summary and Conclusions' (Chapters 16 and 17).

13.2 Legislation, Policy and Guidance

13.2.1 The relevant legislation, policy and guidance are listed below.

Legislative Framework

13.2.2 The applicable legislative framework is summarised as follows:

- Climate Change Act 2008 (2050 Target Amendment) Order 2019;
- The Town and Country Planning (EIA) (Scotland)Regulations 2017;

Planning Policy

13.2.3 The applicable planning policy is summarised as follows:

- Scottish Planning Policy (2014);
- East Ayrshire Local Development Plan (2017);
- SEPA Thermal Treatment of Waste Guidelines (2014)

13.2.4 Policy ENV 14 – Low and Zero Carbon Buildings within the East Ayrshire Local Development Plan (2017)[i] suggests that new buildings will have a 15% reduction in carbon emissions when compared to the Scottish Buildings Standards (2010).

13.2.5 Following the Draft release of NPF4, policy 20(i) requires that any proposals for new energy recovery plants should be supported by a decarbonisation strategy in line with Scottish Government decarbonisation goals. Such goals require the proposed development (Killoch ERP) to be net zero by 2045. In line with this policy, a net zero strategy for Killoch ERP development has been prepared (Appendix 13.1) and should be referred to in conjunction with this Climate Change Chapter.

Guidance

13.2.6 Due to the relatively recent incorporation of climate change within EIA regulations, there is currently little guidance on best practise techniques and methodologies to use in the assessment of effects.

13.2.7 The applicable guidance is summarised as follows:

- The Institute of Environmental Management and Assessment (IEMA), 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' (2022)[ii];
- IEMA and European Commission, 'Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment' (2013)[iii];
- European Investment Bank (EIB) (2020)[iv];
- IEMA, 'Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation' (2020)[v]; and
- Royal Institute of Charted Surveyors (RICS), 'Whole Life Carbon Assessment for the Built Environment' (2017)[vi].

13.2.8 Although not specifically designed for EIA purposes, the European Investment Bank (2020) guidance sets out a credible and viable definition for the baseline scenario in terms of climate change, as this assessment differs to the definition of a baseline scenario in other sections of the ES. The EIB methodological approach is given additional validity as it is recommended by the European Commission in its guidance document; Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (2013).

13.2.9 In summary, the EIB baseline scenario does not consider a “do nothing scenario”. It assumes that there is demand for this form of waste disposal. Therefore, the assessment baseline scenario can be considered to be a ‘typical’ development which:

- Delivers the same outputs as the proposed development; and
- Is built to standard building regulations using normal construction practices; and
- Is constructed in a nominal location.

13.2.10 A 2019 technical note from European Bank for Reconstruction and Development (EBRD)[vii] states that this type of baseline is appropriate since “*it is recognised that ‘something’ must be done*” and allows for a comparison of relative effect.

13.3 Assessment Methodology and Significance Criteria

Scope of the Assessment

13.3.1 The assessment considers the construction and operational CO_2 emissions, over a 25-year period, as a sensible estimate of project life based upon changes to technology and waste management practices moving forwards. It is not possible to fully understand, at this time, how energy use and the subsequent emissions produced, will change during this period. As such, it has been assumed that energy use will remain the same, year on year, throughout the assessment period.

13.3.2 The assessment will use the emission factors produced in the Zero Waste Scotland (ZWS) report entitled ‘*The climate change impacts of burning municipal waste in Scotland*’ [viii]. This report considers the potential emissions that will be generated from the disposal of waste from both Energy from Waste (EfW) facilities as well as landfills.

13.3.3 The greenhouse gas emissions associated with the proposed development have been reported in tonnes of CO_2 equivalent (tCO_2e). This approach accounts for the varying global warming potential of different greenhouse gases, which is a measure of the amount of infrared radiation captured by a gas in comparison to an equivalent mass of CO_2 over a fixed lifetime.

13.3.4 Greenhouse Gas (GHG) emissions are calculated by the following formulae:

GHG Emissions = Activity Data x Emission Factor

13.3.5 The scoping opinion required the construction and decommissioning emissions to be considered (please refer to Chapter 2 for further details on the development phases). The construction emissions include those related to producing the materials as well as those emitted onsite during the building process. The emissions from decommissioning are difficult to predict, as whilst a 25-year lifespan is used for assessment purposes, the application is for a permanent facility, and it is likely the decarbonisation of the national grid and the electrification of machinery will lead to reduced emissions, particularly given the UK's goals to be carbon neutral by 2025.

Extent of the Study Area

13.3.6 The assessment focuses on the impact of an external factor (climate change) on the scheme, as well as the global impact of the scheme on climate change through carbon emissions. This is very different to impacts arising from other EIA topics which generally consider spatially defined receptors within a limited geographical location.

Emissions

13.3.7 The emissions produced by waste disposal are based on a number of things, including the composition of the waste. The same composition of waste will be assumed for both the baseline scenario and the absolute scenario.

13.3.8 As this GHG assessment makes use of emission factors from the ZWS[viii] report, the waste composition used in this assessment must be the same as that used in that report; this has been reproduced in **Error! Reference source not found.**. The r eport uses a composition that was estimated for 2018, however this is unlikely to have changed. There will likely be changes in waste composition before 2025 and beyond. However, it is not possible predict these changes. The report states that there is a high uncertainty around the waste composition due to lack of published information and how the type of waste can vary.

Table 13.1: The estimated composition and carbon content of municipal waste in Scotland in 2018.

Waste Material Type	Proportion of Waste	Proportion of waste which contains carbon (%)	Proportion of carbon which is biogenic (%)	Proportion of carbon which is fossil (%)
Animal and mixed food waste	26%	14%	100%	0%
Discarded equipment (excluding discarded vehicles, batteries and accumulators wastes)	2%	0%	0%	0%
Glass wastes	6%	0%	0%	0%
Health care and biological wastes	9%	19%	79%	21%
Household and similar wastes (refuse and furniture)	6%	45%	50%	50%
Metallic wastes, mixed ferrous and non-ferrous	4%	0%	0%	0%
Mineral waste and construction and demolition	3%	7%	50%	50%
Paper and cardboard wastes	14%	32%	100%	0%
Plastic wastes	15%	52%	0%	100%
Rubber wastes	0%	0%	0%	100%
Textile wastes	6%	40%	50%	50%
Vegetal wastes	5%	24%	100%	0%
Wood wastes	3%	44%	100%	0%

Total	100%	25.6%	14.7%	10.9%

13.3.9 The Energy Recovery Park (ERP) is likely to export only electricity at first, however the SEPA Thermal Treatment Guidelines (2014) state that heat has to be exported after 7 years of operation[ix]. Therefore, the operational scenario will use the emission factor for electricity export only but will also consider reduction in emissions that exporting the heat as well could provide.

Baseline Scenario

Construction Emissions

13.3.10 For construction emissions, the RICS '*Whole life carbon assessment for the built environment'* 2017 guidance will be used. The approach to assessing construction emissions is different to how operational emissions are calculated, and a high-level assessment based on project costs, in line with the RICs guidance, is used to determine construction emissions. RICs Guidance provides an average of 1.4 tonnes of CO_2e/£100k of project value (based on 2015 data which has not been updated to reflect inflation) as an estimate for emissions arising from construction-related activities.

Operational Emissions

13.3.11 For the purpose of the climate change assessment, in contrast to other impact assessments in this ES, the baseline is not assumed to be 'no development' but rather it is considered to be an equivalent 'typical' development. The justification follows the EIB methodology; "*the baseline scenario is the expected alternative means to meet the output supplied by the proposed development*". A 2019 technical note from European Bank for Reconstruction and Development (ERBD) states that this type of baseline is appropriate since "*it is recognised that 'something' must be done*" and allows for a comparison of relative effect.

13.3.12 Using a baseline that is representative of '*business as usual'* is also supported by IEMA (2022) guidance which states that "*baselines can take the form of… GHG emissions arising from an alternative project design and/or BAU for a project of this type.*"

13.3.13 In accordance with both the EIB and IEMA guidance, the methodology will utilise a baseline that is representative of emissions associated with landfill waste disposal as the primary purpose of the Proposed Development is to dispose of waste generated by the public and not to generate low carbon energy. This method of waste disposal is currently '*business as usual*' and therefore is the expected alternative method of waste disposal, that would exist without the development of the ERP, as it is assumed there is an underlying need for the disposal of waste.

13.3.1 The carbon emission factor of landfill waste disposal, from the ZWS technical report[viii], is considered with an estimated amount of waste in tonnes, for the calculation of the baseline emissions. The annual emissions of 'landfill waste disposal' is scaled up to the project lifetime of 25 years to determine the lifetime baseline emissions.

13.3.1 The baseline emissions are not considered within the assessment of significance but are used to provide a comparison to the absolute scenario through the calculation of the *Relative Emissions*. In simple terms is the proposed development better or worse than the business as usual case in terms of carbon emissions.

Absolute Scenario

13.3.2 As proposed within The Scottish Government Net Zero Climate Change Plan, there is a landfill ban set to be put into force in Scotland in 2025. This ban will mean that residential municipal waste cannot be sent to landfill and an alternative solution will need to be found. In replacement, it is assumed that over the 25 years, waste will be disposed of at the EfW plant.

13.3.3 The absolute scenario resembles the total emissions, over the 25 years, associated with disposing of waste via an Energy from Waste (EfW) Plant with consideration of the beneficial effect of the mitigation measures proposed with the Net Zero Strategy (See appendix 13.1).

Relative Emissions

13.3.4 The emissions associated with the operations of the ERP are assessed for its "relative emissions (Re)", which is expressed as the difference between absolute emissions generated by the proposed development and the baseline emissions.

$$\boldsymbol{Relative\ Emissions\ (Re) = Absolute\ Emissions\ (Ab) - Baseline\ Emissions\ (Be)}$$

13.3.5 The relative emissions are used to provide a comparison between the absolute and baseline emission scenario. Relative emissions may be positive or negative:

where negative, the project is expected to result in a savings in GHG emissions relative to the baseline and vice versa (subject to the general caveats surrounding the carbon footprint methodologies). As stated within the EIB methodology, calculating relative emissions "*is one way of evaluating the impact of a project in emissions terms since it provides a context to the absolute emissions of the project, i.e. whether the project reduces or increases GHG emissions overall. This can then be used as an indicator, along with others, of the environmental performance of the project.*"

13.3.6 The relative emissions are not used to define significance of effect. The significance of the climate change effect will be measured according to whether the absolute scenario will create emissions or not. The significance criteria are discussed below.

Sensitive Receptors

13.3.7 When considering the effects of the Proposed Development on climate change, unlike other technical areas, assessment of individual receptors is not strictly applicable. Climate change is a global phenomenon and highly localised climate change impacts as a direct result of emissions associated with this development are extremely unlikely. It is understood that certain regions, populations, and species are more sensitive to climate change than others, but it would not be reasonable to provide an assessment of the Proposed Development's potential impact on all these receptors. This is because any single development would have an infinitesimal impact on global climate change overall. However, it is still important to undertake the assessment to ensure the Proposed Development does not emit unacceptable levels of emissions not only in an effort to reduce future climate change impacts, but to contribute towards local and national emission targets.

Limitations

13.3.8 The ZWS technical report[viii] which has provided the emission factors for the baseline and operational scenarios has a number of limitations.

13.3.9 This emissions assessment assumes a constant waste composition and is based on a waste composition from 2018. The composition of this is likely to change before 2025 when the Proposed Development becomes operational and may have significantly changed by the end of the Proposed Development's lifetime.

This change may lead to less plastic being sent to the ERP which would reduce the emissions produced from the combustion process. There have been assumptions made regarding the composition of the current waste being sent to an EfW (such as the proposed ERP) or landfill.

13.3.10 The energy outputs for the waste disposal techniques are based on PPC permits not the annual exports. The report assumes that the overall emissions from an EfW or landfill are related linearly with the amount of waste being disposed of. Therefore, variables such as building size may not be reflected accurately.

Design Solutions and Assumptions

13.3.11 The assessment considers the operational CO_2e emissions over a 25-year period, which is representative of the development's 'lifetime' taking into account changes in technology and waste management techniques. It is not possible to fully understand, at this time, how energy use and emissions will vary during this period, but it has been assumed that energy use will remain the same, year on year, throughout the assessment period.

13.3.12 The emission factor for the Proposed Development is taken from the ZWS technical report[viii]. The emission factor resembles a weighted average of emission factors for '*Electric only incinerators'* that were considered in the ZWS report. The emission factor also includes emissions associated with those from transportation, burning the waste, and those saved from sending the waste to be recycled or exporting electricity.

13.3.13 It has been assumed that the Proposed Development will export electricity only for the first seven years and thereafter it will export both heat and electricity. This is because the Thermal Treatment of Waste Guidelines 2014**Error! Bookmark not defined.** i ndicates that heat should be exported within the first seven years of commissioning.

13.3.14 The ERP will use the electricity generated by burning waste to cover its own parasitic load, exporting the remaining electricity generated. The parasitic load has been calculated to be 13,760MWh per year, with a further 503MWh per year of electricity being imported for start-up and shut down processes as well as consumption during non-operational hours. This emission factor will decrease over time as the grid decarbonises. The emission factor from the ZWS report includes the energy demand from the parasitic load.

13.3.15 There are a number of elements that may not be best represented by the emission factors used. It has therefore been decided to quantify the emissions generated and saved as a result of the certain elements of the Proposed Development. These are detailed below.

13.3.16 The emission savings associated with heat export are not considered within the ZWS emission factor. This impact of exporting heat, which is proposed to occur after year 7 (between year 8 and 25) will be considered in addition to the yearly exportation of electricity from the EfW. The amount of heat exported by the ERP will depend on the demand from the nearby developments. An assessment of heat users within 15km of the Proposed Development shows an overall heat demand of 779,980 MWh per year. There is one large heat load identified with a demand of around 30MWh per year. For the purposes of this assessment the amount of heat being exported each year (from year 8 of operation) is assumed to be 53,412MWh per year.

13.3.17 The Proposed Development will use diesel within the auxiliary burners, the annual consumption of this is expected to be 160 tonnes of diesel per year.

13.3.18 The additional increase or decrease in emissions outside of the scope within the ZWS technical report will be noted within the results section of the operational phase.

Significance Criteria

13.3.19 Effects that are deemed to be significant for the purposes of this assessment are different to those associated with other technical chapters. The IEMA guidance (2022) states that the significance of impact with regard to GHG emissions is binary, i.e., all emissions are significant as "*all projects create GHG emissions that contribute to climate change*". It is therefore determined that any absolute emissions arising, after consideration of the mitigation measures proposed within the Net Zero Strategy (Appendix 13.1), will be determined as Adverse and therefore Significant.

13.3.20 A 'Not Significant' outcome may be achieved if mitigation measures are in place that remove or offset emissions, that derive from the absolute scenario, to achieve net zero. As stated within the IEMA Guidance (2022), Net Zero is defined as;

"When anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period."

13.3.21 The IEMA Guidance (2022) expands on this further and states that "*Net zero is achieved where emissions are first reduced in line with a 'science-based' trajectory with any residual emissions neutralised through offsets*".

13.3.22 It is likely that a Not Significant outcome will only be achieved in 2045 following the development a Carbon Capture and Storage (CCS) facility, as stated by the Net Zero Strategy (Appendix 13.1), which will allow the ERP development to be net zero.

13.3.23 The criteria listed in **Error! Reference source not found.** has been used to assess t he significance of the impacts of the Proposed Development on climate through the generation of GHG emissions.

Table 13.2: Significance Criteria for Absolute Emissions

Absolute Emissions	Effect	Significance
No mitigation proposed and the project is only compliant with do-minimum standards. Absolute emissions **do not** make a meaningful contribution to UK's trajectory towards net zero.	Major	Significant
Mitigation measures result in absolute emissions to partially meet applicable existing policy. Absolute emissions **fall short** of fully contributing to the UK's trajectory towards net zero.	Moderate	Significant

Emissions are partially mitigated and partially meet current policy targets. Absolute emissions **fall short** of contributing to UK's trajectory towards net zero.	Minor	Significant
Mitigation measures go beyond existing and emerging policy and design standards, such that decarbonisation or net zero is achieved before 2050. Absolute emissions are **well ahead** of UK's trajectory towards net zero.	Negligible	Not Significant
Emissions are below zero and result in a reduction in atmospheric GHG concentration.	Beneficial	Significant

13.3.24 With this methodology, it is likely many developments would deliver significant adverse impacts. However, if there is evidence to show that the developer was making a genuine attempt to remove all emissions, in accordance with the IEMA GHG Management Hierarchy[1], then a not significant outcome would be achieved.

13.3.25 With consideration of the net zero strategy (Appendix 13.1), this report will outline when the development achieves net zero in emissions and therefore result in Not Significant effects on climate change.

13.4 Baseline Conditions

13.4.1 For the baseline scenario the emission factor for the disposal of waste by landfill will be used and multiplied by the amount of waste that will be sent to Proposed Development throughout its lifespan. The emission factor for sending municipal waste to a landfill was calculated to be 257 kgCO_2e per tonne using Lifecycle Analysis. The ZWS technical report takes into many aspects involved in sending waste to landfill including;

- Calculating the proportion of biogenic carbon embedded in waste which escapes as methane;
- Sorting and recycling of waste, including avoided production;
- Process emissions (transport and auxiliary inputs to landfill); and

[1] IEMA - Pathways to Net Zero: Using the IEMA GHG Management Hierarchy November 2020

- Emissions avoided from energy displacement

13.4.2 The amount of waste expected to be sent to the Proposed Development on an annual basis is expected to be 166,000 tonnes per year, this will be used as the amount of waste being disposed of on a yearly basis in the baseline scenario. Therefore, over an estimated 25-year lifetime of the technology, 4,150,000 tonnes of waste would be sent to landfill in the baseline scenario.

13.4.3 Table 13.3 below shows the amount of emissions produced by the baseline scenario.

Table 13.3: Estimated emissions within the Landfill baseline scenario

	Waste (tonnes)	Greenhouse gas emissions in (tCO2e)
Annual (Baseline Scenario)	166,000	42,662
Total across 25-year lifetime (Baseline Scenario)	4,150,000	1,066,550

Assessment of Effects

Construction Emissions

13.4.4 The construction emissions have been estimated to be 1400 tonnes of CO_2e. This is based on an emission factor of 1400 kgCO_2e/£100k of project value[x]. The value of the Proposed Development is estimated to be £100 million.

Operational Emissions

13.4.5 The projected total energy use and CO_2e emissions for the development's 25-year operational lifespan can be seen in **Error! Reference source not found.**. The l ifetime emissions (**Error! Reference source not found.**) consider that the Proposed Development will export electricity for the first 7 years of operation and thereafter, for years 8 to 25, it will export heat and electricity.

Table 13.4: Annual and Lifetime Operational Emissions of Absolute Scenario

Emission Type	Emissions (tCO_2e)
Annual Absolute Scenario	

EfW emissions with exportation of Electricity only	37,682
Emissions from imported electricity	117
Emissions from burning diesel	513
Lifetime Absolute Scenario	
EfW emissions with exportation of Electric only (25 years)	942,050
Emissions from imported electric (25 years)	2,932
Emissions from burning diesel (25 years)	12,826
Total emissions across 25-year lifetime (Absolute Scenario)	**957,808**
Emission savings	
Emission savings from exporting heat (18 years: year 8 – 25)	256,698
Converting HGV/RCVs to EV alternatives	44,540
2040 – Carbon Capture and Storage (CC&S) technology	**Net Zero**

13.4.6 The above calculations have been used as an estimation of the operational emissions to allow for a comparison between the baseline and absolute (operational) scenarios. The total lifetime operational emissions are 1.07 million tCO_2e. Over the 25 year project lifetime, the relative emissions of the proposed development are negative, with the absolute emissions being 34% less, with a total of 701,110 tCO_2e, than the emissions from the baseline scenario.

Emissions from other Operational Activities

13.4.7 The emissions from the 160 tonnes of diesel being used equate to 513 tonnes of CO_2e per year, which equals a total of 2,932 tCO_2e over the 25 years, assuming the same tonnage of diesel is used every year.

13.4.8 The emissions from the imported electricity, which have been calculated using the current emission factor of grid electricity, equates to 117 tonnes of CO_2e per year. This amounts to 12,827 $tcCO_2e$ over the 25 years, assuming the total of imported electricity remains at 503 MWh per year over the project lifetime.

Assessment of Effects with consideration of the Net Zero Strategy

Emission savings from heat exportation

13.4.9 As previously mentioned, the Proposed Development will look to export both electricity and power after 7 years at the latest. As this heat would have not been put to use in an electricity only strategy it will lead to emission reduction as it removes the need to generate heat through burning fuels or using electricity. This reduces the emissions per tonne of waste. If the facility exported 53,412MWh of heat it will offset the need to generate this heat though other energy sources. Therefore, the ERP would displace 14,261 tonnes of CO_2e per year, assuming the UK marginal heat average is 0.267 $kgCO_2e/kWh$. This totals to 256,698 tCO_2e emissions saved over the project lifetime (Table 13.4).

The Net Zero Strategy

13.4.10 The Decarbonisation strategy, also referred to as the Net Zero Strategy (Appendix 13.1) outlines how the development will achieve zero emissions by 2040 which is in line with the Scottish Government Climate Change Plan[2] target of net zero by 2045.

13.4.11 The strategy outlines various measures that can be adopted to achieve a net zero status by 2040. This climate change chapter quantifies the impact of two mitigation measures that are proposed to be adopted during the operational phase of the development. These measures were quantified based on the data available and viability of adopting the measure for the proposed development. These measures include the electrification of HGV/RCV fleet from 2025 and the development of Carbon Capture and Storage (CCS) technology for use in 2040. Carbon Capture and Storage (CCS) processes remove carbon dioxide (CO_2) that would otherwise be emitted from fossil fuel power stations and other industrial processes and transport it for permanent underground storage. Developing CCS will allow the EfW to be net zero in 2040 which is in line with the Scottish Government Climate Change Plan.

13.4.12 The EfW emission factor used from the ZWS Report considers transport emissions associated with waste deliveries and collections to proposed site. This was based on BEIS carbon conversion factors for 2018 and Zero Waste Scotland Carbon Metric distances for transporting municipal waste. However, to calculate the

[2] Update to the Climate Change Plan 2018 - 2032: Securing a Green Recovery on a Path to Net Zero (www.gov.scot)

emissions saved from the conversion of the HGV/RCV fleet to electric vehicle (EV) equivalents, bespoke transport emissions associated with the Killoch ERP were calculated. These transport emissions were calculated using activity data provided within the transport chapter (Chapter 7). The GHG Protocol was then followed to determine the lifetime emissions.

13.4.13 The net zero strategy (Appendix 13.1) proposes that by 2025, following the completion of the construction phase, EVs will replace the current HGV/RCVs. The transport chapter (chapter 7) provided the following details (Table 13.5) with regard to HGV/RCV movements.

Table 13.5: Annual transport movements for HGVs and RCVs

	Annual Vehicle Movements	Average total vehicle movements per day (sum of departing and arriving movements)	Tonnes per Vehicle
HGVs	11,533	49	23
RCVs	8,289	35	8

13.4.14 It was understood that the average daily movements represent waste collected from five counties that comprise of all waste to be processed at the Killoch ERP. The locations and relevant distances, from the proposed site location, are displayed in Figure 13.1.

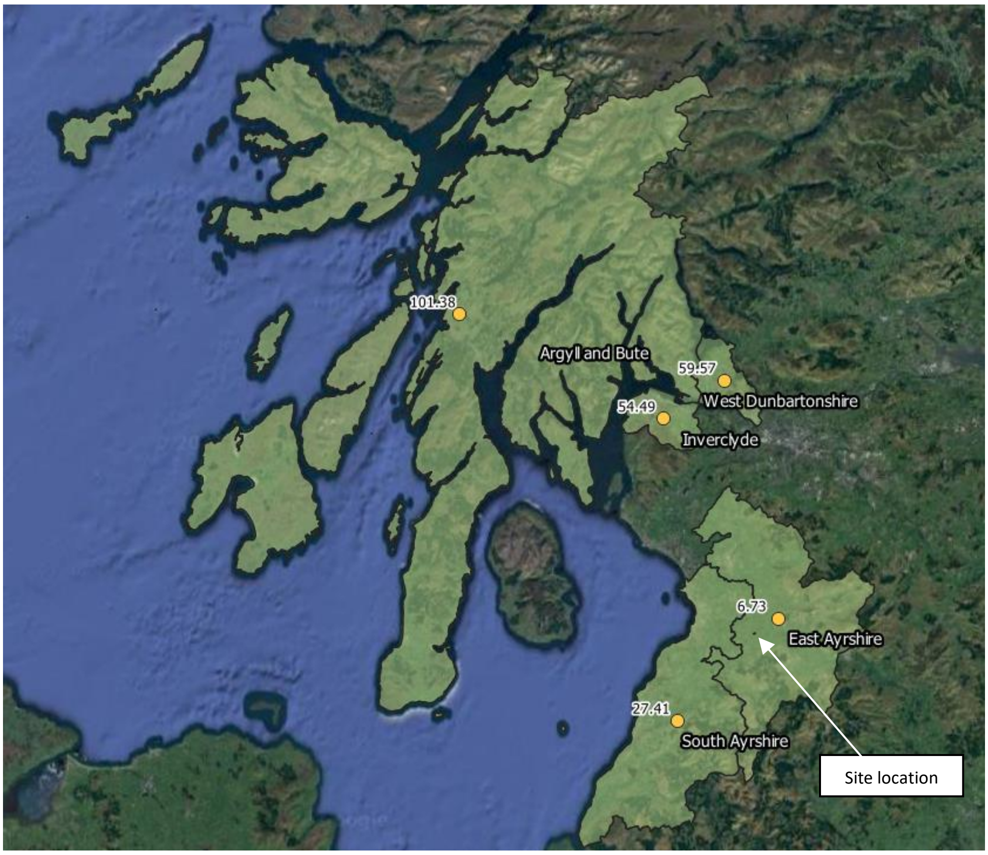

Figure 13.1: Central locations of 5 counties where waste is collected for the EfW

13.4.15 The distances from the 5 counties were used to determine emissions associated with HGV and RCV movements, assuming the movements were equally divided across the five sites (9.8 HGV and 7 RCV movements per county) and all vehicles met the tonnage provided in Table 13.5.

13.4.16 The lifetime emissions (tCO_2e) associated with combined HGV and RCV movement equated to 44,540 tCO_2e. Table 13.6 breaks this down further into annual and daily emission totals.

Table 13.6: Emission savings associated with HGV/RCV movements

	Daily Emissions (tCO2e)	Annual Emissions (tCO2e)	Lifetime Emissions (tCO2e)
HGVs	6.05	1427.07	35677
RCVs	1.50	354.55	8864
Total	**7.55**	**1781.62**	**44540**

13.4.17 The lifetime emission savings associated with exportation of heat (after year 7) and replacement of diesel HGV/RCVs, with EV alternatives, are listed in Table 13.7.

13.4.18 To achieve the net zero target by 2040, it is proposed that a CCS facility is developed on site to remove the remaining 656,570 tCO_2e, following the savings associated with the exportation of heat and EV HGV/RCVs (Table 13.7).

Table 13.7: Lifetime emissions and emission savings (tCO_2e)

Lifetime Emissions	
Waste	942050
Emissions from imported electricity (grid)	2932
Emissions from burning diesel	12826
Total Emissions	**957, 808**
Lifetime Emission Savings	
Exporting heat	256698
Converting HGV/RCVs to EV alternative	44540
Carbon Capture and Storage	**656570**
Net Zero by 2040	

13.4.19 The graph below demonstrates the decline in the development's emissions following the exportation of heat, the replacement of HGV/RCVs to EV alternatives, and implementation of CCS in 2040.

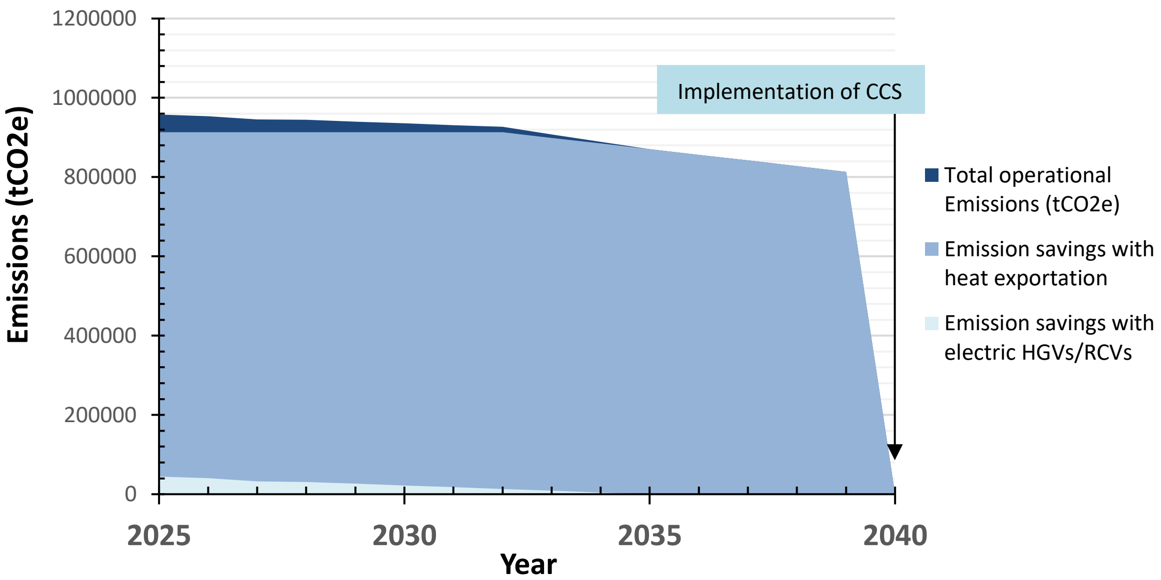

Figure 13.2: Emission savings associated with heat exportation and electrification of HGVS

13.4.20 By 2040, the development is determined as Not Significant with regard to its impact on climate change. This is due a net zero outcome being achieved with the deployment of a CCS facility.

13.4.21 In line with the IEMA Guidance (2022), a project that achieves emissions mitigation beyond national policy targets and the UK's emission reduction trajectory, with the aim to be net zero by 2050, is assessed as having a ***Negligible*** effect on climate change that is ***Not Significant***.

13.5 Mitigation

13.5.1 The impact has been assessed as Negligible and Not significant and as such mitigation is not required.

13.5.2 Another opportunity to reduce the overall emissions generated by the ERP would be to install rooftop solar at the Proposed Development, this could either be exported to the grid or used to cover the parasitic load and reduce the amount of electricity being imported.

13.6 Residual Effects

13.6.1 If CCS is not developed into the design of the ERP for use by 2040, the development will continue to result in emissions. Although these will annually decline by 2050 (end of the project lifetime), the emissions remain at 656,570 tCO_2e (Figure 13.3).

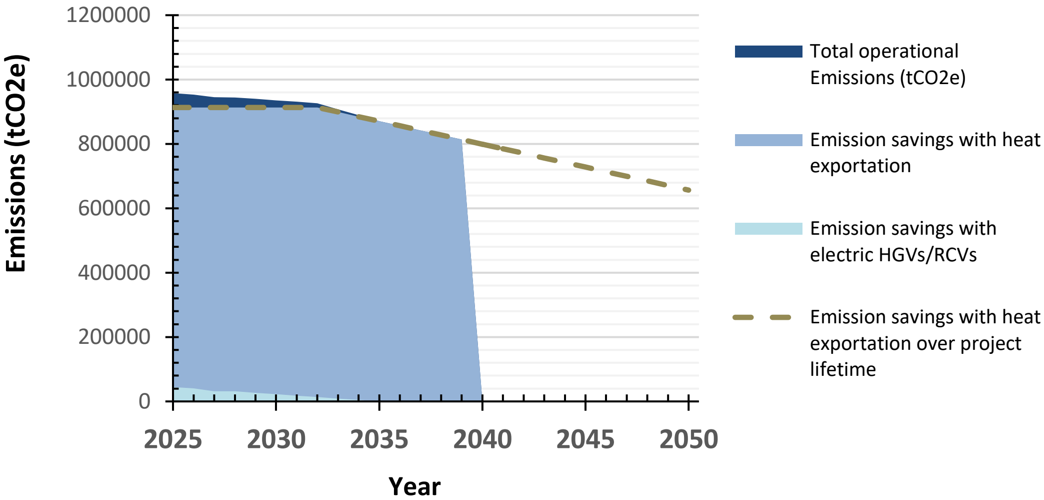

Figure 13.3: Emissions from exportation of heat and electricity over the project lifetime

13.6.2 Nonetheless the residual effects are classed as negligible and ***Not Significant.***

13.7 Assessment of Cumulative Effects

13.7.1 In terms of Climate Change, which is a global issue, comprehensive consideration of inter-cumulative effects (i.e. effects of this Proposed Development in combination with other developments) would need to account for every other development and activity that generates carbon emissions or releases other greenhouse gas effects. As this encompasses, to varying degrees, most of the activity on the globe it is not practical to consider inter-cumulative effects, beyond recognising that it is necessary to reduce carbon emissions across the board and each and every development has a duty to minimise its own emissions as far as technically viable.

13.7.2 Intra-cumulative effects (i.e. climate change effects in combination with other environmental effects on a common receptor) are also unrealistic to appraise. Climate change effects manifest as effects considered within other environmental disciplines, for example air quality and flood risk, but do not really have a quantifiable direct effect on local receptors. The effects act on a global receptor but the individual contribution from a single development of this scale is almost indistinguishable. It is the additive effects from all the other development going on around the world that poses the potential catastrophic threat.

13.8 Climate Resilience Risk Assessment

Approach

13.8.1 The update to the EIA regulations not only requires an assessment of the potential impacts of a proposed development on climate change but also its vulnerability to climate change itself. In context of the proposed development, the spirit of the regulations is to ensure that the risk of climate change effects are identified and mitigated if required (adaptation).

13.8.2 Assessing the impacts of climate change on a scheme is fundamentally different to the assessment of impacts arising from the scheme in other EIA topics, since it focusses on the impact of an external factor (climate change) on the scheme, rather than the impact of the scheme on receptors. The resilience of the proposed development to climate change is assessed based on the susceptibility and vulnerability of a range on different receptors. The magnitude of the effects is deemed to be significant based on a matrix of likelihood and consequence.

Assessment Methodology

13.8.3 The IEMA guidance 'Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation' (2020)[v] explains how our climate is changing but uncertainties remain in the magnitude, frequency and spatial occurrence, either as changes to average conditions or extreme conditions, which generally makes it difficult to assess the impacts of climate change in relation to a specific project. Therefore, scientific assumptions must be made in order to assess the resilience of new developments to any future changes in climate.

13.8.4 Climate Change projections for the UK (UKCP18)[xi] are based on global climate simulation models to explore regional responses to climate change. UKCP18 considers the effects arising from a series of emissions scenarios and Representative Concentration Pathways (RCP) which project how future climatic conditions in the UK are likely to change at a regional level, taking account of naturally occurring climate variations. Probabilistic projections provide a range of possible climate change outcomes and their relative likelihoods (ranging across 10th to 90th percentiles).

Climate Change Projections

Climate Scenarios and Timelines Considered

13.8.5 Climate Change projections for the UK (UKCP18) are based on global climate simulation models to explore regional responses to climate change. UKCP18 considers the effects arising from a series of emissions scenarios and Representative Concentration Pathways (RCP) which project how future climatic conditions in the UK are likely to change at a regional level, taking account of naturally occurring climate variations.

13.8.6 The UKCP18 dataset provides future climate change projections for land and marine regions as well as observed climate data for the UK. Analysing time series plume data from UKCP18 provides an indication of climate projections for the regional 25km grid that encompasses the site. The RCP's show how the climate could change up to the year 2100, compared to a 1982 – 2000 baseline. RCPs are probabilistic projections and provide a range of possible climate change outcomes and their relative likelihoods (ranging across 10th to 90th percentiles).

Future Climate Baseline

13.8.7 When determining the future baseline, the conservative approach recommended as best practice by the IEMA guidance (2020)[v] is to use the central estimate (50th percentile) for the high emissions scenario (RCP8.5) to establish the likely worst-case changes to climatic conditions. This assessment considers the regional variations in north-west England during these periods. A reference range is provided in each case, using the 10% probability level as a lower limit and the 90% probability level as an upper limit. These scenarios and probability levels were used to provide credible projected changes including an indicative level of uncertainty.

Sensitivity

Climate Vulnerability and Sensitivity of Receptors

13.8.8 The resilience of the proposed development to climate change is assessed based on the susceptibility and vulnerability of a range on different receptors.

13.8.9 Potential receptors within elements of the project relevant to the location, nature and scale of the development have been identified and receptor groups include:

- Buildings and infrastructure receptors (including equipment and building operations);
- Human health receptors (e.g. construction workers, occupants and site users);

- Environmental receptors (e.g. habitats and species); and
- Climatic systems.

13.8.10 The IEMA guidance (2020)[v] describes the sensitivity of the receptor/receiving environment as *"the degree of response of a receiver to a change and a function of its capacity to accommodate and recover from a change if it is affected."* Therefore, in line with the IEMA guidance, the following factors have been considered to ascribe the sensitivity of receptors in relation to potential climate change effects:

- Value or importance of receptor;
- Susceptibility of the receptor (e.g. ability to be affected by a change); and
- Vulnerability of the receptor (e.g. potential exposure to a change).

13.8.11 The susceptibility and vulnerability of the receptor is determined using the following scales listed in Table 13.8 and Table 13.9. The tables outline the definitions of susceptibility and vulnerability for the measure of the receptor's resilience to climate change.

13.8.12 Table 13.8 details the scale used to determine the susceptibility of the receptor.

Table 13.8: Measure of receptor susceptibility to climatic impact

Susceptibility	
Low	Receptor has the ability to withstand or not be altered much by the projected changes to the existing/prevailing climatic factors.
Medium	Receptor has some limited ability to withstand or not be altered by the projected changes to the existing/prevailing climatic conditions.
High	Receptor has no ability to withstand or not be substantially altered by the projected changes to the existing/prevailing climatic factors.

13.8.13 Table 13.9 details the scale used to determine the vulnerability of the receptor.

Table 13.9: Measure of receptor vulnerability to climatic impact

Vulnerability	
Low	Climatic factors have little influence on the receptors.

Medium	Receptor is dependent on some climatic factors but able to tolerate a range of conditions.
High	Receptor is directly dependent on existing/prevailing climatic factors and reliant on these specific existing climate conditions continuing in future or only able to tolerate a very limited variation in climate conditions.

Significance Criteria

Magnitude of Effects

13.8.14 The magnitude assigned to the effect will also consider control mechanisms that may be in place (e.g., due to legislation and commonly occurring standards) which would reduce the probability or the consequence of the effect and therefore the overall magnitude.

13.8.15 The IEMA guidance uses a combination of probability and consequence to reach a reasoned conclusion on the magnitude of the effect of Climate Change on the proposed development. Probability and Consequence are defined by the IEMA guidance as:

- Probability: takes into account the chance of the effect occurring over the lifespan of the development if the risk is not mitigated; and
- Consequence: reflects the geographical extent of the effect, or the number of receptors affected (e.g., scale), the complexity of the effect, degree of harm to those affected and the duration, frequency and reversibility of effect.

13.8.16 Definitions of likelihood and magnitude will vary between schemes and are tailored to the specific project. Project lifetime is considered to include construction and operational stages and is taken to be 80 years for this assessment of climate risk.

13.8.17 The guidance indicates that the greater the probability of an effect, the more likely it is to occur, meaning the magnitude of the effect, on the proposed development, will be greater if these projected changes in climate are not considered at the outset of the project.

13.8.18 Likelihood categories are detailed in Table 13.10 and are based on the probability of the regional climate effect identified using the future climate baseline (Table 13.4). From this the consequence of impact is determined as indicated in Table 13.11 below.

Table 13.10: Criteria for Assessing Likelihood of Impact	
Likelihood Category	**Description (Probability and Frequency of Occurrence)**
Very High	The event occurs multiple times during the lifetime of the project (assumed 25 years), e.g. approximately annually, typically 25 events.
High	The event occurs several times during the lifetime of the project (25 years), e.g. approximately once every five years, typically 5 events.
Medium	The event occurs limited times during the lifetime of the project (25 years), e.g. approximately once every 12 years, typically 2 events.
Low	The event occurs during the lifetime of the project (25 years), e.g. once in 25 years.
Very Low	The event may occur once during the lifetime of the project (25 years).

Table 13.11: Criteria for Assessing Consequence of Impact	
Consequence of Impact	**Description of Impact**
Extreme Adverse	National-level (or greater) disruption lasting more than 1 week.
Major Adverse	National-level disruption lasting more than 1 day but less than 1 week. *OR* Regional-level disruption lasting more than 1 week.
Moderate Adverse	Regional-level disruption lasting more than 1 day but less than 1 week.
Minor Adverse	Regional-level disruption lasting less than 1 day.
Negligible	Isolated disruption to the immediate locality lasting less than 1 day.

13.8.19 The significance of this impact on the proposed development will be determined using the Significance Matrix for Climate Resilience in **Error! Reference source not found.** below and assessed in conjunction with the Significance Criteria for determining the impact of the proposed development on Climate Change.

Table 13.12: Significance Matrix for Assessing Climate Resilience						
Significance Matrix for Assessing Climate Resilience		**Measure of Likelihood**				
		Very Low	**Low**	**Medium**	**High**	**Very High**
Measure of Consequence	**Negligible**	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
	Minor	Not Significant	Not Significant	Not Significant	Significant	Significant
	Moderate	Not Significant	Not Significant	Significant	Significant	Significant
	Major	Not Significant	Significant	Significant	Significant	Significant
	Extreme	Not Significant	Significant	Significant	Significant	Significant

Assumptions/Limitations

13.8.20 The IEMA guidance (2020) references datasets that predict how our climate is changing but there remain uncertainties in the magnitude, frequency and spatial occurrence. These can be either as changes to average conditions or extreme conditions, which generally makes it difficult to assess the impacts of climate change in relation to a specific project. Using data provided by UKCP18, the RCP8.5 scenario is used to characterise changes to climate factors such as temperature and precipitation are projected and assumed to occur over the next 80 years.

13.8.21 The Applicant can implement measures to reduce the significance of the climatic impacts and increase climate resilience according to global and regional climate projections with relevance to the scale of the proposed development. However, the uncertainties associated with probabilistic climate projections are outside of the Applicant's control and cannot be fully mitigated against.

13.8.22 This Statement relies on data provided by third parties with other technical disciplines providing information regarding the embedded mitigation to determine the development's resilience to climate change. Therefore, WA accepts no responsibility for inaccuracies carried forward from third party information.

13.9 Baseline Conditions

13.9.1 Scotland is classified under Köppen Geiger climate classification system as having a 'Cfb' climate, more commonly known as a temperate oceanic climate. These are typically mid latitude climates with warm summers and mild winters. The average temperature in all months will be below 22°C and there is not an identifiable dry/wet season i.e. precipitation rates are similar year-round. The average temperature in Kilmarnock, approximately 20km north of the Site, is 8.2°C and the average annual rainfall is 1148mm[xii].

Global Climate Change Projections

13.9.2 Table 13.13 highlights the main projected global climate change issues.

Table 13.13: Projected global impacts of climate change

Climate Change Issue	Projected Global Impacts
Solar Radiation	Long term projected changes in surface solar radiation, as a result of global warming, would suggest a decrease in available solar power due to a decrease in downwelling shortwave radiation, likely linked to the increase of water vapour[xiii]. This is considered to be anthropogenic strengthening of "natural" decadal variability in irradiance, known as global dimming and brightening, which is influenced by synoptic weather patterns, cloud variations and atmospheric aerosols[xiv].
Heat Waves	The IPCC[xv] predict that temperature extremes will increase more rapidly than global mean surface temperature, with the number of hot days projected to increase in most land regions. In the 1.5°C warming scenario heat waves in mid latitudes could warm by up to 3°C.
Extreme Rainfall and Flooding	IPCC and Met Office[xvi] both suggest a general uncertainty in the projection of changes in heavy precipitation for the UK due to position in the transition zone between north and south Europe's contrasting projected changes. It is generally agreed the northern parts of the UK will experience overall increases of up to 10%. Overall, the UK is expected to see a general increase in precipitation trends up to 2100.
Rising Sea Levels	The most recent modelling indicates global sea level rise of 0.26-0.77m by 2100, under a 1.5°C warming scenario[xv]. Risk is amplified on small islands and in low lying coastal areas and deltas.

Storms and Winds	Atmospheric circulations have large variability across interannual through to decadal time scales, which makes forming projections with any reasonable confidence very difficult. There is more robust evidence in the Northern Hemisphere that since the 1970s there has been a general poleward shift of storm tracks and jet streams and near-surface terrestrial wind speeds have been declining by approximately 0.1-0.14 m s^{-1} per decade across land[xvii].
Cold Spells and Snow	It has been observed the spring snow cover has been continuing to decrease in extent in the Northern Hemisphere and that cold temperature extremes are projected to decrease along with the number of frost days[xviii].

Regional Climate Change Projections

13.9.3 The UKCP18 projections make use of new standardised emissions scenarios called Representative Concentration Pathways (RCP) which are used in the IPCCs latest 5th assessment report and specify the time-dependant greenhouse gas concentrations to 2100.

13.9.4 The following graphs are based on the four Representative Concentration Pathways (RCP) and show how the climate in London could change up to the year 2100, compared to a 1982-2000 baseline. The RCPs themselves are based on several social and economic assumptions, as well as the degree to which countries choose to reduce their GHGs in the future. The RCPs are used to analyse how different emission scenarios could affect climate projections. These range from RCP2.6 where atmospheric emission concentrations are strongly reduced through to the worst-case scenario, RCP8.5, where emission concentrations continue to rise unmitigated.

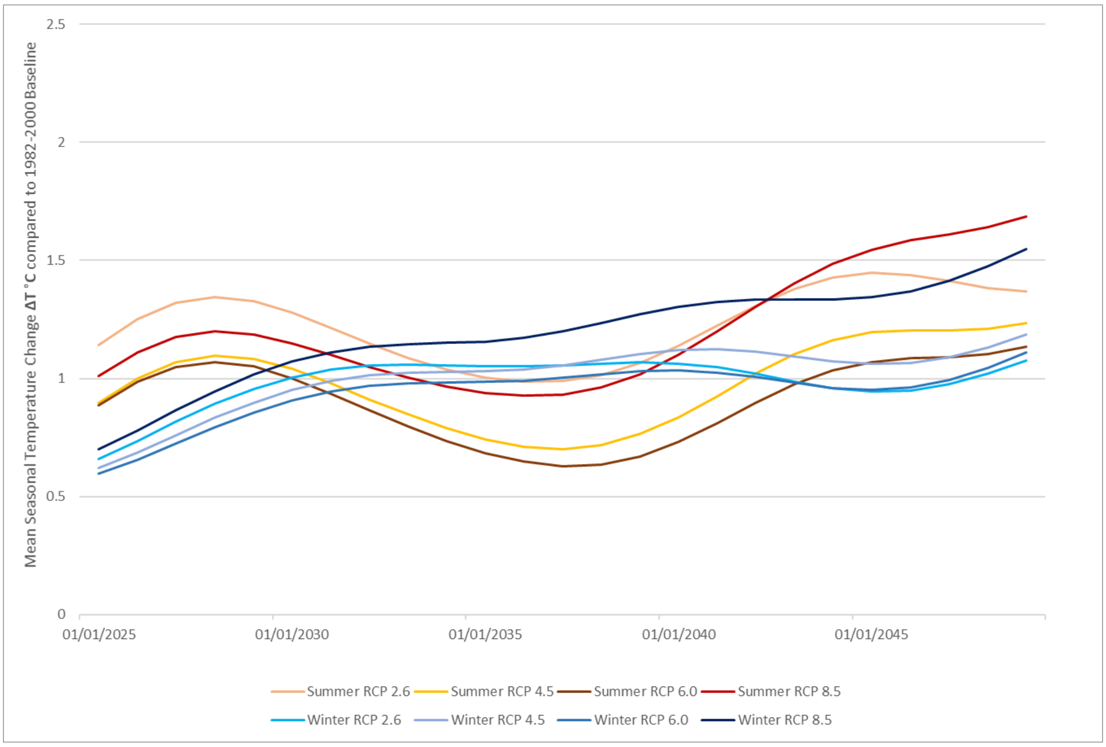

Figure 13.4: Projected changes in seasonal mean air temperature across four RCP scenarios, from 2025-2049 compared to the 1981-2000 baseline, using the probabilistic projections (50th percentile).

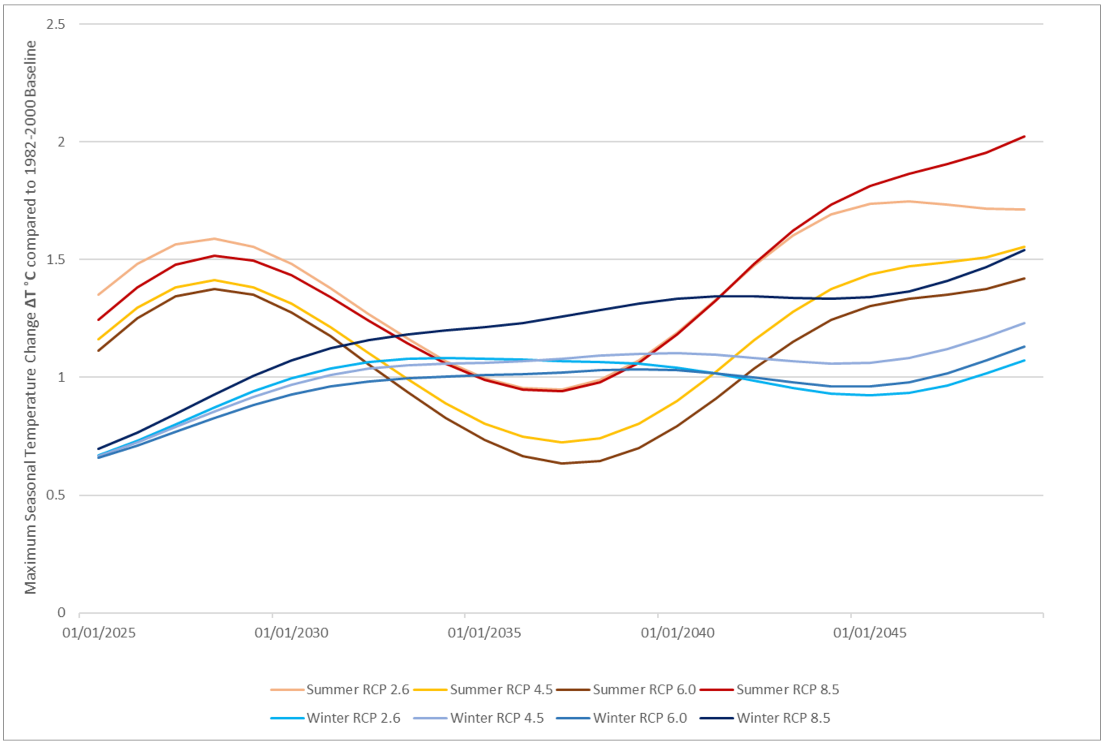

Figure 13.5: Projected changes in seasonal maximum air temperature across four RCP scenarios, from 2025-2049 compared to the 1981-2000 baseline, using the probabilistic projections (50th percentile).

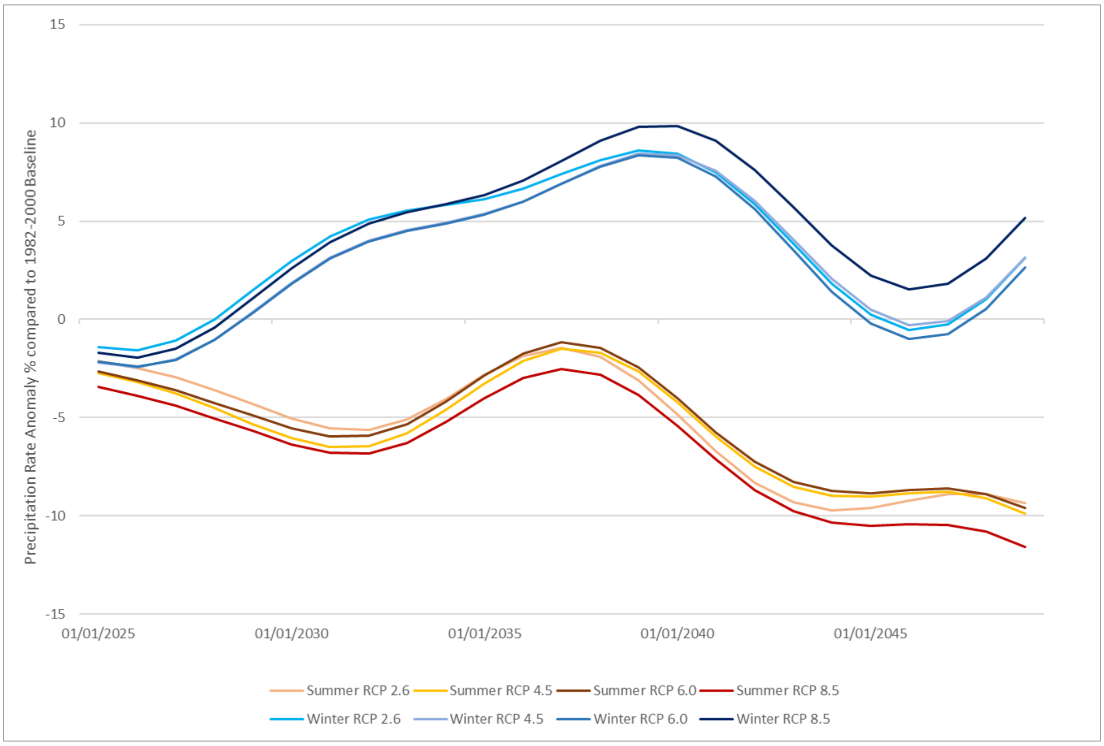

Figure 13.6: Seasonal average precipitation rate anomaly (%) for 2025-2049 compared to the 1981-2000 baseline for all RCP scenarios using probabilistic projections (50th percentile).

13.9.5 Climate change projections for the site generally show a warming trend over both summer and winter months across all RCP scenarios indicated by progressive temporal increases in both mean and maximum seasonal temperatures to 2049. Both the mean and maximum summer temperature increase until the late 2020s and then fall during the first half of 2030s, they then both increase during the 2040s. The winter scenarios do not show this same trend, as they increase more gradually over time without any reducing in 2030s. The pattern of change is broadly consistent with the UK average projections.

13.9.6 Long term seasonal changes in precipitation patterns are also projected for the site. Across all RCP scenarios, albeit to varying degrees, summer precipitation levels are projected to decrease, and winter precipitation levels are projected to increase. For the middle emissions scenarios (RCP 4.5 and RCP 6.0), winter precipitation anomalies are projected to increase by approximately 4.5% by 2045. Summertime precipitation rate anomalies are projected to decrease by approximately 7% by 2045. The seasonal changes projected are broadly consistent with the average changes projected for the UK as a whole.

13.10 Future Climate Baseline

13.10.1 A summary of a range of projected changes to climate variables is provided in Table 13.14 which can be used to build up a holistic view of future climate and assess potential impacts to determine a future climate baseline, using RCP8.5 as a conservative approach.

13.10.2 Table 13.14 shows that the temperature at the Site is unlikely to change dramatically during the proposed developments lifetime. With certain points, such as the 2030s having a lower average summer temperature than 2025-2029. Although the overall trend of the precipitation is clear there are peaks and troughs which again would lead to increased or decreased risk associated with climate change impacts.

Table 13.14: Quantitative summary of the future baseline for key climatic variables at the Site

Season	Variable	Time Period	Lower Probability		Median	Higher Probability	
			5th percentile	10th percentile	50th percentile	90th percentile	95th percentile
Winter	Mean Temperature (°C)	2025-2029	-1.19	-0.74	0.86	2.44	2.89
		2030-2034	-0.94	-0.49	1.12	2.73	3.20
		2035-2039	-0.92	-0.46	1.21	2.88	3.39
		2040-2044	-0.88	-0.40	1.33	3.07	3.57
		2045-2049	-0.83	-0.33	1.43	3.21	3.71
	Mean Precipitation (%)	2025-2029	-36.2	-28.8	-0.9	35.2	45.2
		2030-2034	-31.2	-23.6	4.5	42.3	52.4

		2035-2039	-32.0	-24.1	8.1	46.1	57.4
		2040-2044	-33.2	-25.4	7.2	45.0	55.8
		2045-2049	-36.9	-28.6	2.8	41.2	52.1
Summer	Mean Temperature (°C)	2025-2029	-0.67	-0.27	1.14	2.57	2.97
		2030-2034	-0.79	-0.38	1.05	2.51	2.92
		2035-2039	-0.96	-0.53	0.96	2.45	2.87
		2040-2044	-0.73	-0.28	1.30	2.89	3.34
		2045-2049	-0.55	-0.08	1.61	3.34	3.82
	Mean Precipitation (%)	2025-2029	-49.8	-38.8	-4.5	30.4	38.6
		2030-2034	-50.1	-39.2	-6.3	28.2	37.5
		2035-2039	-40.6	-32.9	-3.2	30.1	40.6
		2040-2044	-45.8	-38.1	-8.3	28.2	40.0
		2045-2049	-48.9	-40.3	-10.8	26.1	38.7

13.11 Potential Effects

13.11.1 There are three broad risk categories to buildings from future climate change in the UK:

- **Risk to comfort and energy performance:** warmer winters will reduce heating requirements, however the increased use of cooling systems in the summer will present a challenge to energy consumption and carbon emissions;
- **Risk to construction:** resistance to extreme conditions, detailing, and the behaviour of materials; and
- **Risk to water management:** management of water during both flooding and drought events, and changes in soil composition.

13.11.2 Combined, these categories can be considered climate change threats that could result in increased energy demands, economic losses and loss of life.

13.11.3 Climate change may result in variations in approach to general building design and construction in order to offer a higher degree of protection against the identified perils. Many of these improvements will be brought about using existing off-the shelf components that are in common use in other places around the world but may not previously have been considered necessary in parts of the UK.

13.11.4 As well as seeking improvements in the construction techniques for buildings there will also be a need to improve various aspects of their operational performance to provide more resilience against climate change.

13.11.5 At more localised levels the effects themselves can manifest in different ways and therefore the most appropriate strategies should be selected on a site-specific basis. A coastal village may be at most risk from sea-level rises and storm surges, while at inland locations the threat of heat waves or high winds might be more significant. Adaptation involves developing a resilience and a preparedness to deal with the likely consequences of climate change.

13.11.6 Table 13.15 indicates the impact on the Proposed Development that could arise from climatic effects, reproduced from data in the National House Building Council and European Commission reports[xix] [xx] and the UK Climate Change Risk Assessment Report.

Table 13.15: Potential Impacts

Climatic Factor	General Impact	Component/Sub Structure Impact

Soil Drying	Increase will affect water tables and could affect foundations in clay soils.	Increased risk of basement heave or subsidence, water ingress, consequential damage to finishes and stored items. Ground shrinkage can lead to failure of electrical, gas and water pipes, foundations and sub-structures.
Temperature	Maximum and minimum changes will affect heating, cooling and air conditioning costs. Frequency of cycling through freezing point will affect durability. Daily maximum and minimum temperature will affect thermal air movement.	Air conditioning/ heating/ cooling systems due to increased cooling/ decreased heating requirements. Overheating of mechanical and electrical equipment effecting lifespan, reliability and potential health and safety issues. Plastic materials will have a reduced lifespan. Structure/cladding/roofing membranes, sealants, pavements and roads have increased risk of cracking. Reduced capacity of overheated power lines. Building overheating (due to increased fabric efficiency and incorrect implementation). Solar PV modules work slightly less efficiently at high temperatures and some studies[xxi] have shown that high temperatures can age at a faster rate. Decreased labour productivity.
Relative Humidity	Increase will affect condensation and associated damage or mould growth.	Timber framed construction. Internal walls, finishes and stored items.
Precipitation	Increase and decrease will affect water tables; cleaning costs will be increased in winter, with associated redecoration requirements; durability and risk of water ingress will be affected by combination of precipitation increase and gales.	Increased damage to roofing and higher risk of failure, increased chances of flooding. Structure/cladding/roofing membranes and sealants have increased risk of cracking due to different moisture movements. Damage to foundations and basements. Delays in construction and

		increased costs. Increased risk of subsistence.
Gales	Increase will affect need for weather tightness, risk of water ingress, effectiveness of air conditioning, energy use, risk of roof failures.	Increased damage to roofing and higher risk of failure.
Radiation	Increase may affect need for solar glare control.	Window specification and glare control requirement.
Cloud	Increase/decrease in seasonal lighting needs.	Changes in lighting systems and glare control requirement.

Sensitivity of receptors

13.11.7 The sensitivity of receptors has been determined through an assessment of the susceptibility and vulnerability of the proposed development to future climate changes. The future baseline shows that at certain points in the Proposed Developments lifetime certain impacts are more likely than others.

Table 13.16: Assessment of Susceptibility and Vulnerability of the Proposed Development to Future Climate Baseline

Climate Change Issue	Receptors Impacted	Susceptibility	Vulnerability	Likelihood
Soil Drying	Building Structures, Species and Habitats	Low	Low	Medium
Temperature	Workers, Building Structures, Species and Habitats	Low	Low	Medium
Relative Humidity	Workers and Building Structures	Low	Medium	Medium
Precipitation	Workers, Building Structures, Species and Habitats	Medium	Medium	High
Gales	Building Structures, Species and Habitats	Low	Medium	High
Radiation	Workers and Building Structures	Low	Medium	Medium

Cloud	Workers	Low	Low	Low

Magnitude of Effects

13.11.8 A qualitative assessment has been undertaken based on the data from UKCP18 identified in Table 13.11 to assess the magnitude of the effects of climate change. In line with the IEMA guidance, a combination of probability and consequence is used to reach a reasoned conclusion on the magnitude of the effect of Climate Change on the proposed development.

13.11.9 The IEMA guidance (2020) indicates that the greater the probability of an effect, the more likely it is to occur, and the higher significance effect it will have on the proposed development if these projected changes in climate are not considered at the outset of the project.

Table 13.17: Assessment of Magnitude of Effects on Proposed Development from Future Climate Baseline

Climate Change Issue	Likelihood	Consequence	Magnitude of Effects
Soil Drying	Medium	Minor Adverse	Minor Adverse
Temperature	Medium	Moderate Adverse	Moderate Adverse
Relative Humidity	Medium	Moderate Adverse	Moderate Adverse
Precipitation	High	Moderate Adverse	Moderate Adverse
Gales	High	Major Adverse	Major Adverse
Radiation	Medium	Minor Adverse	Minor Adverse
Cloud	Low	Minor Adverse	Minor Adverse

13.11.10 The impact of changes to the future climate baseline for the Proposed Development have a range of likelihoods and levels of adversity for effects. Taking into account the control mechanisms and mitigation measures in place including building regulations the overall magnitude of effects is likely to be ***Minor Adverse*** and ***Not Significant***.

Significance Assessment

13.11.11 The impact of future climate change on the proposed development without mitigation is deemed to be significant.

Table 13.18: Assessment of Significance

Climate Change Issue	Magnitude of Impact	Significance
Soil Drying	Minor Adverse	Not Significant
Temperature	Moderate Adverse	Significant
Relative Humidity	Moderate Adverse	Significant
Precipitation	Moderate Adverse	Significant
Gales	Major Adverse	Significant
Radiation	Minor Adverse	Not Significant
Cloud	Minor Adverse	Not Significant

13.12 Mitigation Measures

Temperature

13.12.1 As the temperature changes within the 25 year lifespan of the development are approximately 2°C for the maximum temperature, see Figure 13.5, the impacts are likely to be less adverse than other areas within the United Kingdom. The maximum temperatures recorded in are averages and the peak temperatures on a daily basis may be much higher, this could be an issue for workers who may suffer from overheating in some conditions.

13.12.2 Increased temperatures, particularly in winter, may lead to reduce heating demand and could therefore impact the amount of heat that the ERP could export, this may have financial implications if it is not considered. The electricity consumption may also fluctuate with temperature, with less demand during winter months and increased demand in the summer from a need for air conditioning.

Precipitation

13.12.3 As shown Figure 13.6 increased precipitation is expected during the winter months. Increased precipitation is likely to lead to greater chance of flooding and potentially more repair work being needed over the lifetime of the proposed development.

13.12.4 The majority of the site is at low risk from surface water and river flooding. A Flood Risk Assessment for the Proposed Development has been undertaken by Wardell Armstrong (Appendix 11.4), taking into consideration climate change projections of increased rainfall and flooding. The findings of this chapter state that the proposed development may be permitted in terms of flood risk.

Extreme Weather

13.12.5 It is difficult to attribute human induced climate change to any particular extreme weather event. There is little evidence that climate change is affecting storms. However, UKCP18 projects an increase in near surface wind speed in the second half of the 21st century during winter, although the increase in wind speed is modest compared to monthly and seasonal variability[xxii].

13.12.6 The Proposed Development has a 75m tall stack as well as a roof that is 45m in height, if wind speeds increased and extreme weather became more common then the building will have to be designed to cope with these increased loads.

13.12.7 In all cases, within the loading calculations a suitable margin of error will be used to ensure the roof materials remain fixed in position during extremely severe wind conditions although it is not possible to quantify precisely future impacts of climate change vulnerability as insufficient data is available.

13.12.8 Although projections suggest an overall decrease in cold spells, it is still important to consider risk mitigation in the event of adverse extreme weather. The roof at the Proposed Development is large and the possibility of increased load from snowfall should be considered during the design process.

Limiting Impacts on Biodiversity

13.12.9 Impacts on biodiversity can include but are not limited to mortality, biome shifts, ecosystem change, water scarcity/flooding, pest exacerbation and ecosystem feedback capabilities, including carbon sequestration.

13.12.10 In the establishment of landscapes and ecological habitats as part of detailed design the proposed development will need to consider the climate resilience of enhancements that are used.

13.12.11 Key aspects suggested for consideration when designing climate resilient landscaping are:

- Species selection: Drought tolerant species e.g. enzymic resilience to warmer temperatures;
- Sensitivity to watering e.g. induced root hypoxia and rot from oversaturation;
- Growth inhibition e.g. pollution tolerance;
- Wind tolerance e.g. strong, deep root structures;
- Year-round ecosystem services e.g. forage and shelter capability during difficult seasons to continually support ecology and human needs;
- Avoiding fragmentation of green spaces, landscapes and ecological habitats where possible; and,
- Control use and ongoing spread of invasive and alien species that may impede native species ability to adapt or be in competition for resources during times of decreased availability e.g. as a response of extreme weather.

Air Quality and Transport

13.12.12 The relationship between air quality and climate change is highly complex but is an important consideration due to the direct risk to human health. For example, when atmospheric pressure increases, pollutants are concentrated to the ground, resulting in increased respiratory health issues.

13.12.13 Climate variations across regions will affect air quality differently. Increased precipitation aids the clearing of pollutants from air, whilst warmer, drier conditions stalls air that is saturated in pollutants e.g. smog.

13.12.14 The Air Quality Assessment undertaken by Fichtner (Chapter 8) has concluded that there will not be significant adverse effects on air quality, odour or human health. This is due to the mitigation and control measures that have been included within the Proposed Development.

Residual Effects

Table 13.19: Residual Effects of Future Climate Change on Proposed Development

Description of Effect	Potential impact including significance	Mitigation	Residual Effect including significance

Construction			
Not assessed at outline due to lack of data			
Completed Development			
Soil Drying	Minor Adverse – Not Significant	Good Design	Minor Adverse – Not Significant
Temperature	Moderate Adverse – Significant	Good Design	Minor Adverse – Not Significant
Relative Humidity	Moderate Adverse – Significant	Good Design	Minor Adverse – Not Significant
Precipitation	Moderate Adverse – Significant	Good Design	Minor Adverse – Not Significant
Gales	Major Adverse – Significant	Good Design	Minor Adverse – Not Significant
Radiation	Minor Adverse – Not Significant	Good Design	Minor Adverse – Not Significant
Cloud	Minor Adverse – Not Significant	Good Design	Minor Adverse – Not Significant

13.13 Cumulative Impacts

13.13.1 Cumulative effects come in two forms. The first relate to the impacts of the proposed development in conjunction with other developments in the area. These developments should be existing, consented or reasonably foreseeable in terms of delivery and should be located within a realistic geographical scope where environmental effects could combine to create a more significant effect on a particular sensitive receptor. These are hereafter referred to as cumulative effects.

13.13.2 In terms of Climate Change, which is a global issue, comprehensive consideration of inter-cumulative effects (i.e. effects in combination with other developments) would need to account for every other development and activity that generates carbon emissions or releases other greenhouse gases. As this encompasses, to varying degrees, most of the activity on the globe it is not practical nor helpful, to consider inter-cumulative effects, beyond recognising that it is necessary to reduce carbon emissions across the board and that all development has a duty to reduce its own emissions.

13.13.3 The second type of cumulative effect is that of the combination of the various types of impacts from the proposed development. These are hereafter referred to as synergistic effects. Technical chapters that can be associated directly include traffic and transport, as well as the indirect impacts of climate change such as air quality, flood risk and ecology. The mitigation of synergistic effects is possible through thoughtful and informed design that will act to minimise the proposed development or surrounding receptors vulnerability to effects.

13.13.4 Intra-cumulative effects (i.e. climate change effects in combination with other environmental effects on a common receptor) are also unrealistic to appraise. Climate change effects manifest as effects considered within other environmental disciplines, for example air quality and flood risk, but do not have a quantifiable direct effect on local receptors. The effects act on a global receptor but the individual contribution from a single development of this scale is almost indistinguishable. It is the additive effects from all the other development globally that poses the potential catastrophic threat.

13.14 Differences between the Consented and Proposed Development

13.14.1 The EIA undertaken for the previous application did not include a climate change assessment, beyond the impacts considered within the Flood Risk Assessment and Air Quality Chapters.

13.15 Conclusions

Assessment of Impacts from Emissions

13.15.1 There will be emissions from the construction process, which are estimated to be 1400 tonnes of CO_2e. It is noted that the methodology has some limitations that could both increase and decrease the amount of emissions produced from the Proposed Development.

13.15.2 The proposed development's operational absolute emissions were modelled to be Not Significant with a Negligible impact on climate change. The implementation of CCS in 2040 will result in a net zero emission total 5 years before the Scottish government target.

Assessment of Climate Resilience

13.15.3 It will not be possible to eliminate every risk associated with climate change but through intelligent design, preparation and responsible construction, these risks will be minimised. Discussion and recommendations have detailed reducing these risks in key areas such as overheating, flooding and extreme weather, which has taken into consideration not only the health and safety of the users of the proposed development, but the resilience of the proposed development itself.

---

[i] East Ayrshire Council (2017). Local Development Plan – Volume 1: Strategy and Policy
[ii] The Institute of Environmental Management & Assessment (IEMA) (2022). Assessing Greenhouse Gas Emissions and Evaluating their Significance.
[iii] European Commission (2013). Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment.
[iv] European Investment Bank (2020). EIB Project Carbon Footprint Methodologies – Methodologies for the Assessment of Project GHG Emissions and Emission Variations.
[v] Institution of Environmental Management & Assessment (2020). Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation.

[vii] European Bank for Reconstruction and Development (EBRD) (2019). Technical note: Methodology for the economic assessment of EBRD projects with high greenhouse gas emissions.
[viii] Zero Waste Scotland (2020). The Climate Change Impacts of Burning Municipal Waste in Scotland.
[ix] Scottish Environment Protection Agency (2014). Thermal Treatment of Waste Guidelines 2014.
[x] RICS (2017). Whole life carbon assessment for the built environment 1st edition.
[xi] Department for Environmental and Rural Affairs (DEFRA), Department for Business, Energy and Industrial Strategy (DBEIS), Met Office and Environment Agency (2018). UK Climate Projections. Available at: https://ukclimateprojections-ui.metoffice.gov.uk/ui/home
[xii] Climate-Data.org. Kilmarnock Climate Summary. Available at: https://en.climate-data.org/europe/united-kingdom/scotland/kilmarnock-8438/#climate-graph
[xiii] Bartok et al. (2016). Projected changes in surface solar radiation in CMIP5 global climate models and in EURO-CORDEX regional climate models for Europe. Climate Dynamics
[xiv] Parding et al. (2016). Influence of Synoptic Weather Patterns on Solar Irradiance Variability in Northern Europe. American Meteorological Society 29.
[xv] IPCC (2018). Special Report on Global Warming of 1.5°C (SR15). Summary for Policy Makers.
[xvi] Met Office (Undated). UK Climate: Observations, projections and Impacts. Met Office, Exeter
[xvii] Vautard et al. (2010). Northern Hemisphere atmospheric stilling partly attributed to an increase in surface roughness. Nat. Geosci., 3 and McVicar et al. 2012. Global review and synthesis of trends in observed terrestrial near-surface wind speed: Implications for evaporation, J. Hydrol. (within IPCC, 2014. Fifth Assessment Report: Chapter 2.)
[xviii] Intergovernmental Panel on Climate Change (IPCC) (2014). Fifth Assessment Report: The Physical Science Basis
[xix] National House Building Council Foundation (NHBC) (2007). Climate change and innovation in house building: designing out risk (NF3)
[xx] European Commission (2013). Adapting infrastructure to climate change
[xxi] Patt, A., Pfenninger, S. and Lilliestam, J., (2013). Vulnerability of solar energy infrastructure and output to climate change. Climate Change 121 pp93-102
[xxii] Met Office (Undated). UK extreme events - Wind storms. Available at: https://www.metoffice.gov.uk/research/climate/understanding-climate/uk-extreme-events_wind-storms.