Exeter City Council's Costed Organisational Carbon Footprint Projections to 2030

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1.3	DL, IB, EF, RR	27/11/24	Draft including ECC comments
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3.0	DL	19/12/24	Intermediate version
4.0	DL	7/1/25	Final version
5.0	DL	22/1/25	Minor edits and updates to numbers (social housing costings and Riverside PV exports)
6.0	DL	29/5/25	Very minor changes to Table 1

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Cover image: Decarbonising Riverside leisure centre will considerably reduce ECC's organisational footprint (Photo courtesy of Exeter Leisure)

Management Summary

Exeter City Council (ECC) declared a Climate Emergency in 2019 and as part of this commitment aims to achieve 'net zero' greenhouse gas (GHG) emissions for its own activities by 2030. The definition of 'net zero' in this context includes all greenhouse gas (GHG) emissions arising from ECC's direct activities (termed Scope 1 and 2) and from other indirect activities including its supply chains (termed Scope 3), which together result in the Council's total GHG emissions. The Centre for Energy and the Environment (CEE) at the University of Exeter has produced ECC's GHG inventory for each of the past 6 years. The inventory is updated here for the 2023/24 financial year.

Additionally, in 2022, the CEE assessed the potential to achieve net zero by reducing emissions across five sectors: council-owned housing, non-domestic buildings, transport, renewable energy and land use change/afforestation. This work also updates and extends that analysis to include costs and considers three scenarios:

- Business as Usual (BAU): The level of activity that is already planned for and/or committed to by ECC.
- Mid Case (Mid): An agreed escalation of ambition beyond the BAU scenario i.e., a 'stretch target' that could be contingent for example, on securing additional government grant funding.
- Net Zero (Max): A theoretical maximum level of uptake for measures with less consideration of potential constraints (e.g., cost, skills, supply chain capacity etc.).

The focus of this analysis is on the costs to be borne by ECC in decarbonising its direct Scope 1 and 2 activities. It does not include the costs of decarbonising ECC's supply chains (Scope 3). Assessment of Scope 3 emissions themselves is currently data poor and there is no published methodology or data to extend this to costed Scope 3 emissions reduction projections.

The assessment of Scope 1 and 2 carbon reduction potential within each sector includes the appraisal of central government policy, input from discussions with ECC service leads and other officers in relevant departments, and consultation with key ECC documents and data sources. Source based estimates of capital (CAPEX) and operational (OPEX) costs associated with measures are estimated over the period 2024/25 to 2030/31. Where applicable, OPEX costs have been calculated from projected energy consumption and prices, with additional expenditure included for transport leases or tree planting maintenance.

The sector assessments are desk based, as there was no scope for detailed site visits or audits. Each sector assessment provides a number of potential measures to reduce emissions ranging from straightforward energy efficiency to far more challenging and potentially contentious solutions. It is important to note that these are not pre-determined trajectories, but a range of different scenarios for reducing GHG emissions for demonstration purposes.

ECC's organisational GHG emission in 2023/24 for all scopes are 39,340 tCO_2e, a 0.7% increase over the 39,072 tCO_2e in 2022/23. Emissions for the reduced costed emissions Scope 1 & 2 total 20,094 tCO_2e. In both cases emissions have not changed significantly since 2018/19 and do not exhibit a downward trend consistent with achieving net zero by 2030.

2023/24 Scope 1 & 2 emissions from social housing are 17,270 tCO_2e. Under the BAU scenario, social housing emissions will decrease by 26% (to 12,818 tCO_2e) by 2030/31 and cost a total of £19.9m in CAPEX. The Mid scenario sees accelerated insulation and PV rollout and the electrification of heat. These measures will cost an extra £14.1m compared to BAU and reduce emissions by 71% (to 5,094 tCO_2e). The Max scenario costs an additional £37.9m on top of the Mid CAPEX, or £52m on top of BAU but will see a reduction of 86% (to 2,337 tCO_2e).

The ECC's non-domestic stock emitted an estimated 2,740 tCO_2e of Scope 1 & 2 emissions in 2023/24. BAU measures such as insulation works at the Corn Exchange and heat pump installation at Riverside will reduce these emissions by 57% (to 1,170 tCO_2e) by 2030/31. These measures are estimated to cost a total of £5.2m in CAPEX on top of £14.1m in OPEX (the total energy costs from 2024/25 to 2030/31). Under the Mid scenario, three of ECC's leisure centres: Riverside, Northbrook and Wonford receive thorough insulation works and air source heat pumps. PV is installed at the ISCA centre and RAMM, electric heating is also installed in the latter. These upgrades will cost a further £3.5 million in CAPEX, with minimal operational cost changes and see total emissions decrease by 68% (to 884 tCO_2e). Installing air source heat pumps throughout ECC's corporate estate and leisure centres results in the Max scenario costing a further £8.1m in CAPEX. Total OPEX reduces by £0.7m from BAU. Max case reductions in emissions are estimated at 78% (to 590 tCO_2e) in 2030/31.

The majority of ECC's 2023/24 transport emissions stem from the council's own vehicles (Scope 1 & 2) of 856 tCO_2e. Refuse vehicles contribute 524 tCO_2e (61%) meaning that the overall emissions reduction pathways are strongly influenced by the decarbonisation trajectory for these vehicles. Under BAU, Scope 1 & 2 transport emissions fall slightly from 856 tCO_2e in 2024/25 to 766 tCO_2e in 2030/31. BAU is unable to accelerate electrification despite ECC's own dedicated renewable charging supply for electric refuse vehicles (eRCVs) due to the high vehicle lease costs. Under the Mid scenario, the introduction of biofuel (HVO) combined with gradual electrification leads emissions to fall steadily to 79 tCO_2e in 2030/31. Under the Max scenario emissions quickly fall to 79 tCO_2e in 2025/26 due to the full early electrification of the vehicle fleet then slowly decreases to 77 tCO_2e in 2030/31 as electricity decarbonises further. The predominance of vehicle leasing means that most costs are classified as OPEX. BAU total OPEX to 2030/31 of £16.3m increases by £1.5m in the Mid scenario and by a further £3.5m in the Max scenario.

Exporting renewable energy simultaneously offsets ECC's gross footprint and generates financial revenue. In 2023/24, ECC's solar photovoltaic (PV) portfolio exported 2,989 MWh of the total 4,576 MWh generated, with the balance being self-consumed, offsetting -619 tCO_2e. Additional deployment on homes, non-domestic buildings and, in the Max scenario, on ground mounted arrays increase PV exports in 2030/31 to 4,298 MWh, 4,965 MWh and 10,475 MWh in the BAU, Mid and Max scenarios, respectively. However, by 2030 decarbonisation of the electricity grid reduces the grid electricity emission factor, diminishing potential offsets from exporting renewable energy. As a result, despite increasing generation, offset emissions from additional domestic and non-domestic PV installation in 2030/31 will be -268 tCO_2e in the BAU scenario, -309 tCO_2e in the Mid scenario, and -652 tCO_2e in the Max scenario. Selling renewable energy exports from non-domestic buildings from 2024/25 to 2030/31 generates revenue of £1.1m in the BAU scenario, £1.1m in the Mid scenario, and £1.9m in the Max scenario. The Max scenario also includes ground mounted array CAPEX of £2.3m.

The Council owns 409 ha of greenspaces which currently has 24% (98 ha) canopy cover and offsets its footprint by sequestering -155 tCO_2e annually. Under the BAU scenario, annual offsets in 2030/31 will increase to -161 tCO_2e, costing a total of £1m in OPEX to 2030/31. Increasing canopy cover to 30% in a Mid scenario increases annual offsets in 2030/31 to -309 tCO_2e, with £0.3m of additional costs of which £0.2m is CAPEX. Increasing the canopy cover to 100% in a Max scenario would offset -2,032 tCO_2e in 2030/31, costing a further £4m on top of the Mid scenario of which £2.3m is CAPEX.

Overall, Scope 1 and 2 emissions reductions for the three scenarios and the estimated costs associated with delivering each are summarised in the table below.

Scenario	2023/24	2030/31	Change % or from BAU
BAU			
Emissions tCO2e	20,094	14,322	-29%
Total CAPEX £m		£25.1m	
Total OPEX £m		£30.4m	
Total cost £m		£55.5m	
Mid			
Emissions tCO2e	20,094	5,424	-73%
Total CAPEX £m		£42.9m	£17.8m
Total OPEX £m		£31.8m	£1.4m
Total cost £m		£74.7m	£19.2m
Max			
Emissions tCO2e	20,094	266	-99%
Total CAPEX £m		£93.7m	£68.6m
Total OPEX £m		£35.5m	£5.1m
Total cost £m		£129m	£73.5m

The Max scenario, although theoretically, possible is beset with challenges. Costs aside, there are likely to be significant practical constraints on the skills and supply chains needed to provide the measures required particularly, for example, in the retrofit of social housing. The Mid scenario illustrates that a more moderate level of additional spending may have the potential to achieve significant emissions reduction at a more practical pace. This said, aspects of the Mid scenario remain ambitious for example the extensive decarbonisation of heat in the City Council's housing. Business as usual sees more modest reductions in emissions. However, it should be recognised that the BAU emission reductions modelled still considerably exceed the trajectory of emission reduction seen over recent years.

Delivering the scenarios will require the engagement of each service in the Council and particularly those involved with housing, building and transport. Investment, at least in part, needs to be driven by service led emission reduction objectives and appropriate prioritisation metrics which look for effective GHG emissions reduction per £ spent and maximise co-benefits.

Contents

1 Introduction

Exeter City Council (ECC) declared a Climate Emergency in 2019 and as part of this commitment aims to achieve 'net zero' greenhouse gas (GHG) emissions for its own activities by 2030. The definition of 'net zero' in this context includes all greenhouse gas (GHG) emissions arising from ECC's direct activities (termed Scope 1 and 2) and from other indirect activities including its supply chains (termed Scope 3), which together result in the Council's total GHG emissions. The aim is to achieve GHG emissions as close to zero as practicable by 2030. Netting the remaining emissions would require the purchase of carbon offsets but there is a desire to achieve net zero with as little reliance on offsets as possible.

Following an initial decarbonisation pathway projection by the Centre for Energy and the Environment (CEE) at the University of Exeter in 2022 [1], the CEE was commissioned by ECC to reassess the potential to achieve the 2030 commitment with the addition of information on the costs involved. The focus of the analysis is on the costs to be borne by ECC in decarbonising its direct Scope 1 and 2 activities (plus the additional Scope 3 emissions associated with these activities, for example Well to Tank (WTT) emissions associated with gas use in a boiler). The analysis does not include the costs of decarbonising ECC's supply chains (other Scope 3 emissions). Assessment of Scope 3 emissions themselves is currently data poor and there is no published methodology or data to extend this to a costed emissions reduction trajectory.

The CEE has produced ECC's carbon footprint annually since 2018/19. This work updates the footprint for the 2023/24 financial year and assesses the potential to reduce emissions across five sectors: council-owned housing, non-domestic buildings, transport, renewable energy and land use change/afforestation. The 2022 report included separate sections for f-gases, waste and procurement. Here, f-gases are included in buildings, the de minimis emissions from waste are not included and procurement is excluded as it is purely Scope 3.

The assessment of carbon reduction potential within each sector includes the appraisal of central government policy, input from discussions with ECC service leads and other officers in relevant departments, and consultation with key ECC documents and data sources. This process enables the identification of both passive (e.g., the general reduction in carbon intensity of the national electricity grid) and active (e.g., fitting insulation to council-owned buildings) carbon reduction measures. The CEE's 2022 report [1] sought to understand the level of carbon reduction possible for each measure with very aggressive levels of uptake. In many cases, it is likely that this will not be possible due to technical, economic and political factors. The analysis uses three 2030 scenarios as follows:

- Business as Usual Scenario (BAU): The level of activity within a measure that is already planned for and/or committed to by ECC.
- Mid Case Scenario (Mid): An agreed escalation of ambition beyond the BAU scenario i.e., a 'stretch target'. Such a scenario could be contingent for example, on securing additional government grant funding.
- Net Zero Scenario (Max): A theoretical maximum level of uptake for a measure with less consideration of potential constraints (e.g., cost, skills, supply chain capacity etc.).

For each measure within a sector, the level of implementation for each of the three scenarios includes discussions with ECC officers and source-based estimates of capital (CAPEX) and operational (OPEX) costs associated with each measure. Outdated cost figures are adjusted for inflation to 2024 using the Consumer Price Index (CPI) [2]. The sector assessments are desk based, as there was no scope for detailed site visits or audits. Each sector assessment provides a number of potential measures to reduce emissions ranging from straightforward energy efficiency to far more challenging and potentially contentious solutions. It is important to note that these are not pre-determined trajectories, but a range of different scenarios for reducing GHG emissions for demonstration purposes.

2 ECC's Current Organisational Footprint

ECC's organisational GHG emissions in 2023/24 for all scopes totalled 39,340 tCO_2e (see Table 1). Categories that fall outside the projections in this analysis are show in red italics. Table 2 summarises those categories which are included i.e. omitting Scope 3 emissions except WTT emissions associated Scope 1 and 2 activities. The resulting footprint of 20,081 tCO_2e is approximately half the total footprint.

Emission from all Scopes have increased by 268 tCO_2e (0.7%) from 2022/23. Trends in emissions for the total footprint from 2018/19 to 2023/24 are shown in Figure 1 by Scope, and in Figure 2 by emissions category. Trends in emissions included in the scope of this study (i.e. Table 2) are shown in Figure 3. Emissions have not changed significantly over the period, and do not show a downward trend consistent with achieving net zero by 2030. The reduction of over 7,000 tCO_2e reduction from last year's published inventory is due to more accurate data on leased assets provided by ECC [3] which have been applied across the restated timeseries in the figures below.

Table 1: ECC total GHG Inventory results 2023/24. Scope 3 categories denoted in red.

Category	Scope 1	Scope 2	Scope 3	Offset	Total
1. Buildings (exc. housing)	**1,049**	**1,146**	**5,551**		**7,746**
1.1 Corporate Estate	366	307	159		832
1.2 Leisure Centres	684	405	244		1,333
1.3 Other Non-Domestic		434	142		576
1.4 Waste from Buildings			*3*		*3*
1.5 Homeworking Energy			*173*		*173*
1.6 Construction and Maintenance			*897*		*897*
1.7 Leased Out			*3,933*		*3,933*
2. Social Housing	**11,467**	**2,946**	**8,816**		**23,229**
2.1 Operational emissions	11,467	2,946	2,858		17,270
2.2 Construction and Maintenance			*5,958*		*5,958*
3. Transport	**688**		**612**		**1,300**
3.1 Own Vehicles	688		168		856
3.2 Grey Fleet			*16*		*16*
3.3 Business Travel			*10*		*10*
3.4 Commuting			*417*		*417*
4. Procurement			**7,839**		**7,839**
4.1 Goods			*3,444*		*3,444*
4.2 Services			*4,394*		*4,394*
5. Offsets	**-155**			**-619**	**-774**
5.1 Exported Renewable Energy				-619	-619
5.2 Land Use Change	-155				-155
Total (entire footprint)	**13,050**	**4,092**	**22,817**	**-619**	**39,340**

Table 2: ECC GHG inventory results 2023/24 for the scope of this study (Scopes 1 and 2, and associated WTT emissions)

Category	Scope 1	Scope 2	Scope 3	Offset	Total
1. Buildings (exc. housing)	**1,049**	**1,146**	**545**		**2,740**
1.1 Corporate Estate	366	307	159		832
1.2 Leisure Centres	684	405	244		1,333
1.3 Other Non-Domestic		434	142		576
2. Social Housing	**11,467**	**2,946**	**2,858**		**17,270**
2.1 Operational emissions	11,467	2,946	2,858		17,270
3. Transport	**688**		**168**		**856**
3.1 Own Vehicles	688		168		856
5. Offsets	**-155**			**-619**	**-774**
5.1 Exported Renewable Energy				-619	-619
5.2 Land Use Change	-155				-155
Total (scope of this study)	**13,050**	**4,092**	**3,571**	**-631**	**20,094**

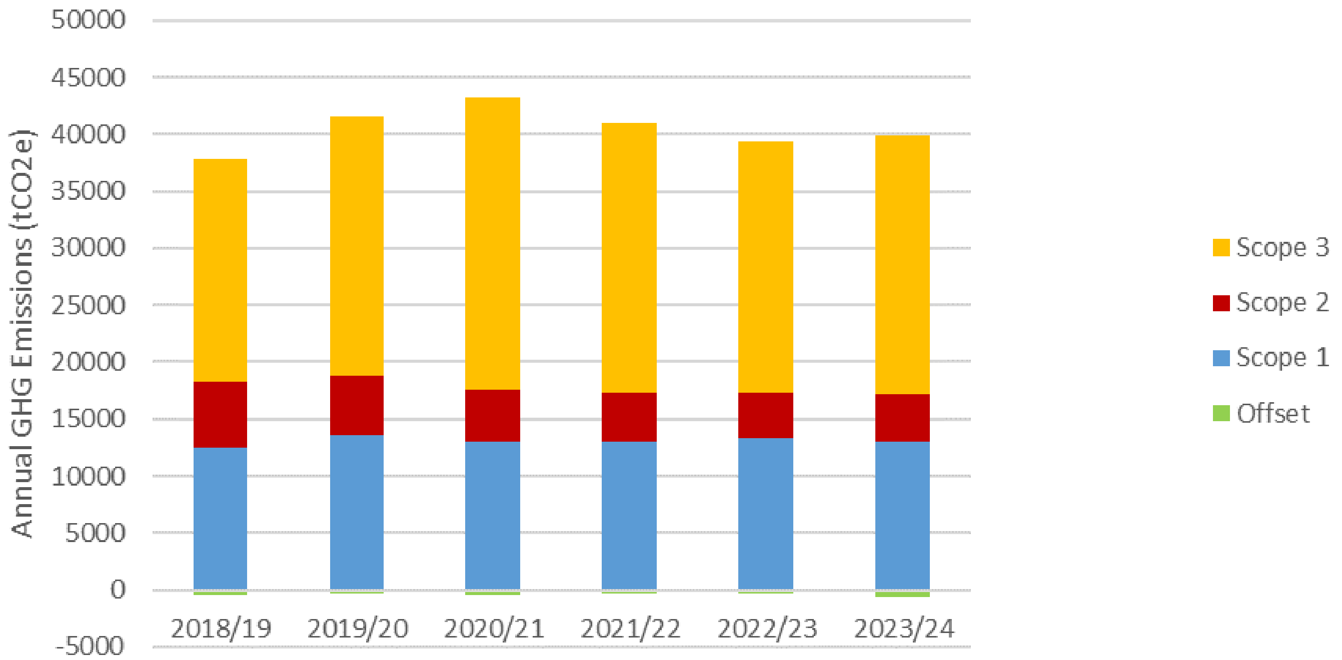

Figure 1: ECC total footprint by scope

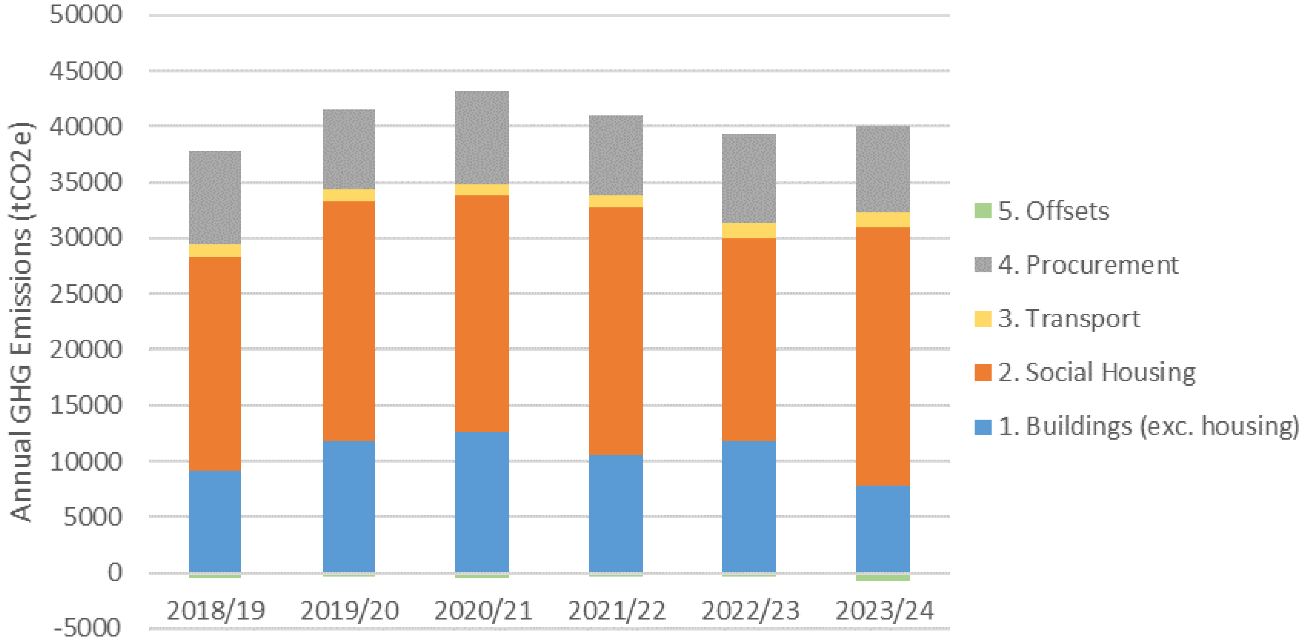

Figure 2: ECC total footprint by category

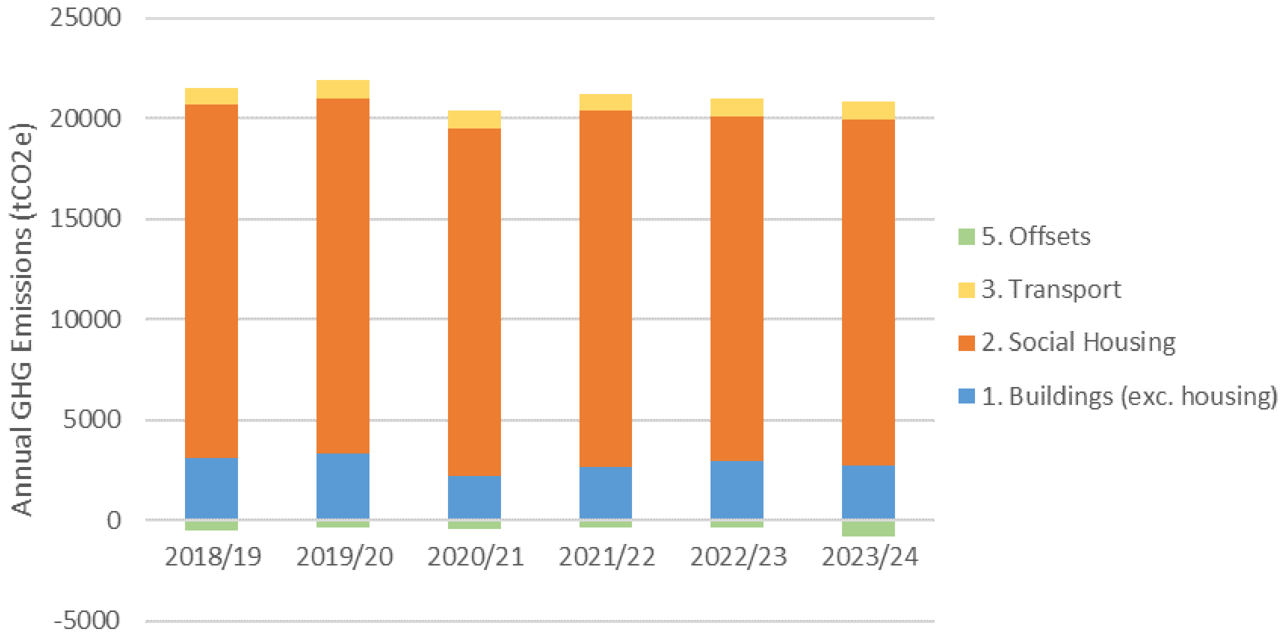

Figure 3: ECC footprint by category for the scope of this study (Scopes 1 and 2 and associated WTT emissions)

3 Housing

3.1 Current sector summary

2023/24 emissions from ECC's social housing (all scopes) are estimated at 23.2 ktCO_2e, an increase of 5.0 ktCO_2e from 2022/23. ECC's social housing emissions have two major contributors: operational emissions (Scope 1 & 2) and construction emissions (Scope 3). Operational emissions arise from the consumption of fuel, either directly or indirectly, and leakage from Refrigeration, Air Conditioning, and Heat Pump (RACHP) equipment to meet domestic energy demand. Construction emissions are the embodied emissions associated with materials used in the construction and maintenance of homes.

Figure 4 shows the change in housing emissions over time. In 2023/24, 74% (17,270 tCO_2e) of emissions are due to domestic energy consumption. This value has remained constant over time (< 5% change), largely due to the modelling methodology used in lieu of reliable data. Domestic energy consumption was modelled in the 2022 report using EPC data [1]. This has been adjusted to account for the change in housing stock and the method altered slightly to account for PV installations which partially reduce electricity consumption. The remaining 26% (5,958 tCO_2e) is due to construction and maintenance emissions, which have been estimated here using a high-level spend-based method. The lower construction emissions in 2022/23 are due to less expenditure being assigned to housing costs in that year.

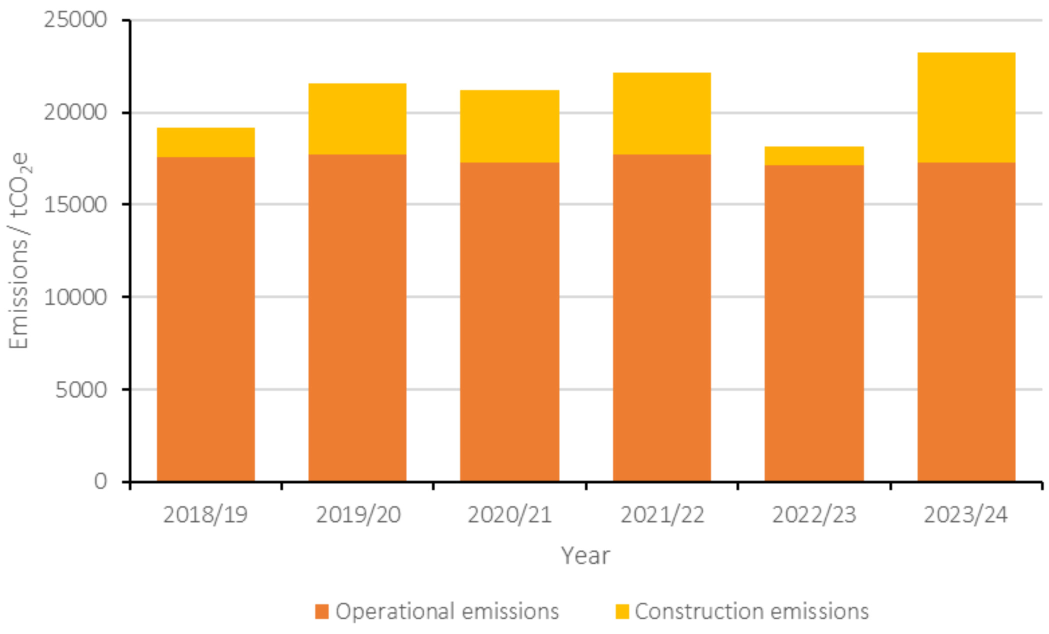

Figure 4: Emissions from social housing (tCO_2e) over time for operational and construction & maintenance.

3.2 Disposal of stock

Disposal of social housing stock occurs through either demolition or Right-to-Buy, a scheme that allows eligible tenants in social housing to purchase their home. Stock disposal to 2030 is assumed to be the same under all three scenarios. To model future energy demand, the 11 worst EPC rated homes are scheduled for demolition. Statistics produced by the Ministry of Housing, Communities and Local Government, show that around 33 homes are purchased through the scheme in Exeter each year[a] [4]. To model this, 33 homes, not scheduled for demolition, are randomly selected and their energy demand removed from the ECC housing stock each year. Therefore, each year, ECC's 'existing stock' (before new construction is accounted for) decreases by 44 homes. The term 'existing stock' will be used to refer to the currently built homes not scheduled for demolition or purchased in a given year.

In the scenarios, the existing stock list is used when determining the number of homes available for potential future energy efficiency measures. It is assumed that ECC would not install PV or a heat pump, for example, on houses scheduled for demolition or being purchased and that no new homes constructed (see Section 3.3) will see energy efficiency measures retrofitted.

No costs or income are associated with demolition or Right-to-Buy, respectively, as these are not energy or carbon-specific measures.

3.3 Construction of new stock

ECC has committed to constructing 500 new Passivhaus homes between 2020 and 2030 [5]. 100 are currently built, and under all scenarios it is assumed that the remaining 400 are constructed at a linear rate across the remaining seven years to 2030. The Passivhaus standard ensures that a home must have a specific primary energy consumption of ≤ 46.2 $kWhm^{-2}yr^{-1}$ [6][b]. The floor area of the new stock was taken as the median floor area of the current social housing stock (66 m^2). Each home was assumed to be electric only, thus, the electricity consumption of ECC's social housing stock increased by ~174,000 $kWhyr^{-1}$ each year, as shown below. After completion, the total increase in electricity consumption is estimated at 1,220 $MWhyr^{-1}$.

The cost uplift to meet Passivhaus standard for a new residential property is 8% [7]. According to a report by the Passivhaus Trust, it costs approximately £1,400 m^{-2} to build Passivhaus properties in Exeter [6], a cost uplift on a normal residential construction of £112 m^{-2}. Multiplying by the median floor area (66 m^2) provides an estimate of the Passivhaus quality uplift at £7,400 per property. At 57 homes per year, the total cost uplift to meet Passivhaus standard for all would require an additional £422,000 per year.

3.4 Insulating existing stock

To promote maximum efficiency (for example to undertake several jobs at a time to extract maximum value from scaffolding, or to make use of a dwelling whilst it is decanted), ECC looks to implement energy efficiency measures with other maintenance measures using a 'whole-house approach'.

[a] Based on a five-year rolling average.

[b] Determined by dividing the Passivhaus primary energy demand of 120 $kWhm^{-2}yr^{1}$ by a primary energy factor of 2.6.

In conversation with ECC, only two insulation measures are chosen for the energy modelling in this analysis, namely cavity wall insulation (CWI) and loft insulation (LI). Whilst other associated interventions such as replacing doors and windows do save energy, the amount they save relative to their cost mean they are generally not economic for that reason alone (although they do provide a wide range of other co-benefits). Some other measures, e.g. improvements to rainwater goods, do not impact energy performance at all. The costs of these associated measures and their benefits have therefore not been included as they would disproportionately skew the results.

Cost and energy savings for heating controls are assumed to occur alongside heat decarbonisation measures in Section 3.6 and PV is discussed in Section 3.7.

The energy savings from the individual measures must be treated carefully as they will interact. For example, the energy savings arising from installing a heat pump in Section 3.6 and improving the insulation of a dwelling is not simply the sum of each measure's independent contribution. The savings for insulating (Section 3.4), appliance efficiency improvements (Section 3.5), and heat decarbonisation (Section 3.6) are calculated together. It is therefore not possible to dissect individual savings for each measure, so their respective components are discussed in each section with the final result given in Section 3.6.

The 2023/24 ECC retrofit schedule shows 181 homes are planned for insulation works; all three scenarios assume that this rate continues each year. The 2020 NEED Framework statistics determine a median relative energy saving from the combined installation of CWI and LI at 13.8% [8].

Homes to be retrofitted have a general survey and a loft survey that cost on average £324 and £109 per home, respectively. Each home also requires cavity extraction, costing £1,835, before new insulation can be installed. The average cost of installation is £1,092 for CWI £459 for LI. Therefore, the total average cost of retrofitting a home with CWI and LI is £3,820[c]. The 181 homes retrofitted per year will cost an estimated £691,000 a year, or £4.8 million to 2030.

In conversation with ECC, it is understood that it costs an average of £40,000 per home improved. In this analysis, only loft insulation, cavity wall insulation and PV (Section 3.7) measures are costed, but the additional expenditure required to provide the other measures accompanying retrofit works is discussed in Section 3.9.

3.5 Improvement in appliance efficiency

The Climate Change Committee (CCC) reports that electricity consumption fell by 12% in 10 years from 2008-2018, despite a 7% increase in population, the CCC predicts this to continue [9]. In this analysis, the electricity saving is calculated with Eq. 1.

$$\text{Saving\%} = 100 - \left(\sqrt[10]{100-12}\right)^{Y} \qquad \textit{Eq. 1}$$

[c] Cost data from ECC retrofit schedule

Where Y is the number of years from the current reported year (2023/24), e.g. $Y = 1$ for 2024/25 projections. This produces an approximate 1.2% increase in electricity saved every year.

No capital expenditure from ECC is associated with these efficiency increases as they arise due to tenant behaviour.

3.6 Decarbonising heat

Gas consumption accounts for 76% of the current social housing emissions, a large proportion of which is for heating and hot water demand. Heat decarbonisation represents the greatest potential for reaching net zero emissions but also the greatest challenge.

In the BAU scenario, all gas boilers (assumed 85% efficiency) are replaced with 90% efficient boilers at end of life. Assuming an average 12-year boiler lifespan means that, in the existing stock list, around 400 boilers are replaced each year. Accounting for all relevant interventions, gas consumption is modelled to reduce by an average of 587 MWh each year, 4,110 MWh by 2030/31. Improvements to appliance efficiency are the only electrical measure modelled in this scenario, saving an average of 170 MWh of electricity a year, 1,190 MWh by 2030/31.

In the Mid case scenario, electric heating is installed into all homes on the existing stock list. For the purposes of modelling, only well-insulated homes receive electric heating; installing electric heating without insulating thoroughly can lead to high electricity bills. There are around 4,500 homes modelled, 94% of which have gas heating. Therefore, in the Mid scenario 609 homes per year will need electric heating installed. When combined with insulation measures, this is modelled to save around 8,420 MWh a year of gas each year with an increase in electricity consumption by 6,680 MWh each year. Decarbonisation of grid electricity will result in this swap producing reduced emissions over time.

In the Max scenario, air source heat pumps (ASHPs) are installed into every home on the existing stock list (609 per year). The amount of electricity required by the heat pump to produce the necessary heat demand depends on its coefficient of performance (CoP), the ratio of heat supplied to the electricity consumed. The CoP is influenced by many factors, including the temperature differential, but with improvements in heat pump technology, the CCC predicts the CoP to reach 3.5 in 2030 [10]. This analysis assumes a linear increase from the current UK average of 2.8 to 3.5 in 2030 [11]. Therefore, installing 609 ASHPs per year will save 8,420 MWh of gas each year but will result in only an approximate 1,790 MWh per year increase in electricity consumption.

The installation of ASHPs to provide low carbon heating to homes will have knock-on effects on emissions from F-gases. ASHPs hold charges of refrigerants, and leakages increase atmospheric concentrations of these greenhouse gases. The resulting F-gas emissions from different ASHP installation scenarios in ECC's domestic estate has been included in the projections.

Leakage was estimated assuming a 16 kW ASHP with a charge of 2.2kg of R32 is installed[d]. The analysis assumes a linear uptake of ASHPs every year and uses a standard 3% leakage rate.

Table 3 summarises the modelling assumptions used to estimate annual leakages and emissions from domestic ASHP installation from 2023/24 to 2030/31.

Table 3: Domestic ASHP number of installations, refrigerant type, refrigerant charge, and annual leakage from 2023/24 to 2030/31 under the Max scenario

Financial year	N° of ASHPs installed	Annual leak rate	Refrigerant type	Refrigerant charge per ASHP (kg)	Annual leakage (kg yr^{-1})
2023/24	0	3%	R32	2.2	0
2024/25	609	3%	R32	2.2	33.13
2025/26	1217	3%	R32	2.2	65.80
2026/27	1826	3%	R32	2.2	98.01
2027/28	2434	3%	R32	2.2	129.69
2028/29	3043	3%	R32	2.2	161.04
2029/30	3651	3%	R32	2.2	191.86
2030/31	4260	3%	R32	2.2	222.22

Cost data for the BAU and Mid case scenario are inflation adjusted values from a 2018 Delta-ee report commissioned by BEIS, which interviewed various installers to gain insight into installation prices [12]. For installing a new gas boiler, the report details different types of installation depending on installer or desired heating system. For BAU, the most appropriate installation scenario is the "24kW combi for combi direct swap by regional installer (including labour and fittings but excluding controls and heat distribution system)" costing £3,300 [12]. Replacing 400 boilers every year would cost £1.3 million, a total of £8.8 million over the seven years.

The Delta-ee report also gives average costs based on different scenarios for electric heating. Notably, "Install a new system with high-end electric radiators (which have a small storage capacity), including controls" in a one- or three-bedroom house [12]. Analysis of EPC data shows that the median social home in Exeter has two bedrooms. The cost of the two scenarios is averaged to give an estimated cost of £4,900 per installation. To meet the Mid scenario of 609 installations a year would cost around £3.0 million, a total of £20.9 million after seven years.

For the Max scenario, MCS data on the average cost of an ASHP installation in Devon is used [13]. A three-year average is calculated at £12,100. To install 609 ASHPs per year would approximately cost £7.3 million, totalling £51.3 million after seven years. Despite the high CAPEX, the greater efficiency of ASHPs reduces the electricity bills of tenants compared to direct electric heating, although the cost is likely to be similar to gas heating.

3.7 PV installation

The BAU, Mid and Max scenarios assume PV is installed on all suitable homes by 2050, 2040 and 2030 respectively. The electricity saving from a PV array depends on a multitude of factors,

[d] See https://www.jouleuk.co.uk/products/16kw-r32-air-source-heat-pump/

such as the number of panels, the capacity of each panel, the solar resource, intrinsic panel properties and the self-consumption factor.

The PV potential of ECC's social housing stock was modelled by the CEE in 2021 [1]. The number of panels that can be installed was modelled from the roof area, estimated using EPC data of floor areas and property types. This study concluded that 25,700 panels can be installed across a total of 2,700 suitable homes – an average of 9.6 panels per home.

Further data provided by the ECC shows that 799 homes already have PV arrays, giving an estimated 7,700 panels installed already. To install PV arrays on the remainder 1,900 homes would require rates of 70 homes, 110 homes and 270 homes per year, respectively.

The panel capacity is assumed at 0.4 kWp[e]. When estimating generation, using data from ECC on the installation years of social housing PV arrays, any panels installed from 2014 onwards are given a 0.4 kWp capacity. To account for improvements in PV capacity over time, any installations prior to this are given a 0.18 kWp capacity based on product specifications from PV manufactures (see Section 6.1).

The solar resource, the amount of sunlight available at a location, is modelled with PVGIS v5.3 [14]. This models the solar intensity at a location and combines this information with some intrinsic properties of the solar panel to produce an estimate of the energy a panel at that location will generate within a year. Due to the wide variation in the location, angle and facing direction of the ECC's social housing roofs an average value is determined and used in analysis. The settings used in PVGIS are listed below. With these settings, PVGIS models an average annual energy generation of 826 $kWhyr^{-1}kWp^{-1}$, this is 330 $kWhyr^{-1}$ for a 0.4 kWp panel.

- Location: 50.718, -3.522 – a central point within the Exeter.
- Solar radiation database: PVGIS-SARAH3 – works well with European destinations.
- PV technology: Crystalline Silicon – most common type of panel used.
- Installed peak PV power (kWp): 1 kWp – allows the yearly generation output to be independent of kWp.
- System loss (%): 14% – default value used by PVGIS for the module efficiency of a monocrystalline silicon PV cell [15].
- Mounting position: Roof added / Building integrated
- Azimuth (°): 90° – west-facing, balanced option for determining an average value.
- Slope (°): 30° – good compromise for an average value when using a west-facing azimuth [16].

Energy generated by a solar array is either consumed directly by the household (self-consumption) or exported to the grid; exports are covered in Section 6.2. To determine the electricity saving from a PV array requires the self-consumption ratio, the proportion of

[e] In-line with values used by Currie & Brown in their reports on decarbonising two of ECC's leisure centres – (see Section 4.2.4) [18,19].

electricity generated that is consumed directly. This was modelled as part of the 2021 footprint and the median value, of the eligible homes, is calculated at 35%.

Combining all this information together gives a yearly electricity saving increase of 76 MWh, 120 MWh and 300 MWh for the BAU, Mid and Max scenarios, respectively. Over seven years to 2030, accounting for the decay of the PV cells[f], the arrays will reduce electricity consumption by 531 MWh, 843 MWh and 2,050 MWh under the three scenarios.

This analysis has not modelled the effect of installing PV alongside electric heating as there is no reliable way of determining if a home can have retrofitting, heat decarbonisation and PV measures implemented. This is important to note as when electric heating is installed into a home with PV, the self-consumption ratio will increase.

The ECC retrofit schedule suggests that the average cost of installing PV is £6,740 per house, including £204 for a PV survey and £339 for scaffolding. To meet each scenario would require a yearly spend of £470,000 yr^{-1}, £750,000 yr^{-1} and £1.8 million yr^{-1} for the BAU, Mid and Max scenarios, respectively. Over seven years this accumulates to £3.3 million, £5.2 million and £12.7 million respectively.

The main financial incentives for PV are reduced energy bills through self-consumption and income generated through exporting excess energy, both of which would reduce annual OPEX. However, no financial savings are modelled here as ECC are not responsible for social housing bills and data limitations makes estimating export payments impractical (see Section 6.2).

3.8 Summary of Modelling Assumptions

The full range of assumptions made for each combination of measure and scenario as discussed in the previous sections is shown in Table 4.

Table 4: Modelled assumptions for housing

Measure	BAU Scenario	Mid Scenario	Max Scenario
Disposal of stock	**11 homes demolished a year** – least energy efficient **33 homes lost a year through Right-to-Buy** – randomly allocated	Same as BAU	Same as BAU
Construction of new homes – operational targets	**500 new homes to Passivhaus standard till 2030** – 120 $kWhm^{-2}$.	Same as BAU	Same as BAU
Insulation	**Current nature and rate of insulation continues** – 181 homes a year with CWI and LI	Same as BAU	Same as BAU

[f] Most manufacturers provide a guarantee that a panel will retain 80% of its generation capacity after 20 years. This means that year the output decreases by $(1 - \sqrt[20]{0.80}) \times 100 = 1.1\%$ each year.

Measure	BAU Scenario	Mid Scenario	Max Scenario
Decarbonising heat	Replace gas boilers like for like at end of life – ~400 replacements a year	Linear installation rate of direct electric heating to all gas homes by 2030 – 609 installations a year	Linear installation rate of ASHPs to all gas homes by 2030 – 609 installations a year
Increasing appliance efficiency	12% reduction in electricity consumption from increased appliance efficiency – ~1.2% a year	Same as BAU	Same as BAU
PV installation	Install PV on all suitable homes by 2050 – 70 homes a year	Install PV on all suitable homes by 2040 – 111 homes a year	Install PV on all suitable homes by 2030 – 269 homes a year

3.9 Projected Emissions to 2030/31

Historical and projected operational emissions under the three scenarios are shown in Figure 5. The shaded areas show the projected emission ranges under the three scenarios, purple between BAU and Mid, and orange between Mid and Max. The BAU trajectory represents the upper limit, the Max scenario represents the lower limit, and the middle trajectory represents the Mid scenario.

Under the BAU scenario, the 2030/31 operational emissions are estimated at 12,818 tCO_2e, primarily due to grid decarbonisation. Thus, with heat electrification, the energy demand of social housing in the Mid scenario would produce an estimated 5,094 tCO_2e of emissions for the 2030/31 inventory. The enhanced electrical efficiency of ASHPs compared to electric heaters and accelerated PV rollout means that far less grid electricity is consumed in the Max scenario. This results in 2030/31 operational emissions of 2,297 tCO_2e. This includes the exponential increase in F-gas emissions from < 1 tCO_2e in the current footprint to 191 tCO_2e in 2030/31 and illustrates how the carbon saving achieved from transitioning to low carbon heating significantly outweighs the negative feedback from increased F-gas emissions. It should be mentioned that the BAU scenario is predicted to have fewer emissions in 2024/25 than the Mid scenario as the electrification of heat in the Mid scenario produces more emissions than gas heating due to electricity having a greater emission factor in that year.

Over the seven years to 2030/31, total operational emissions from social housing are modelled as 103,112 tCO_2e, 81,374 tCO_2e and 63,553 tCO_2e under the BAU, Mid and Max scenarios, respectively.

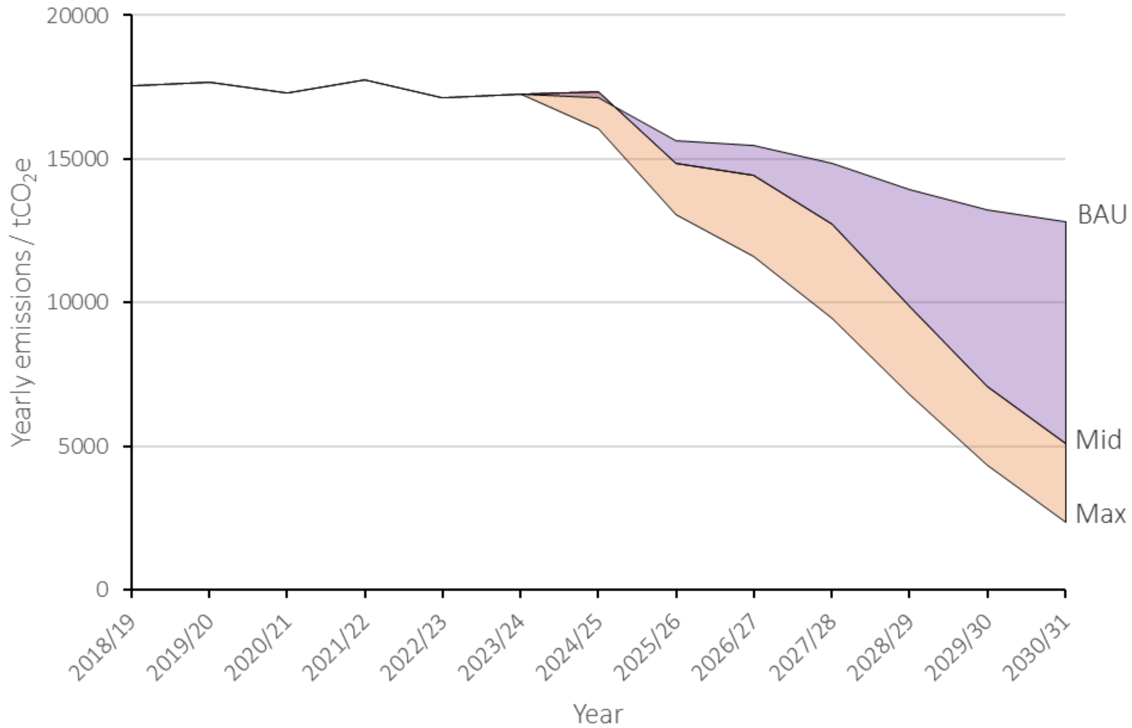

Figure 5: Projected operational emissions (tCO_2e) from social housing under the three scenarios.

The capital costs associated with implementing the measures under the three scenarios are shown in Figure 6 and Table 5. In Figure 6 each bar represents the capital expenditure (CAPEX) needed every year to meet each scenario's requirements. There are no operational costs (OPEX) for social housing as tenants are financially liable for their energy consumption. The constant or linear implementation trajectories for the measures means the annual upfront costs have remained largely constant at £2.91 million, £4.85 million and £10.3 million for the BAU, Mid and Max scenarios, respectively.

As mentioned in Section 3.4, ECC's whole-house approach has social homes receiving maintenance and retrofitting works concurrently at an average cost of £40,000 per home. Only a quarter of this (£10,600) is assigned to energy efficiency-specific interventions in this analysis. As such, a further £29,400 is required per property to deliver these measures alongside the other works. At 181 homes per year for each scenario, this additional cost is calculated at £5.33 million per year, a total of £37.3 million by 2030/31.

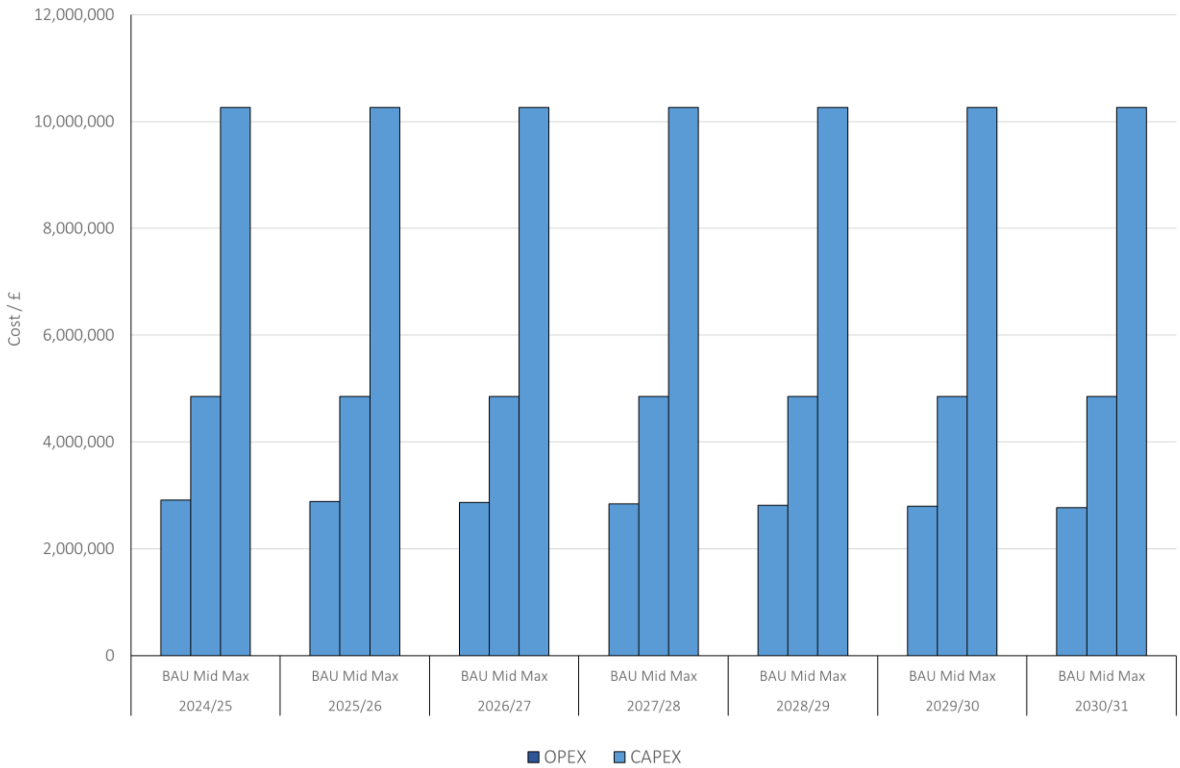

Figure 6: Annual CAPEX of decarbonising ECC's social housing under the three scenarios.

*Table 5: Cost breakdown of social housing emission reduction scenarios. Only measures with costs associated with them are shown. * Denotes that these costs are provided as part of a £40,000 per house maintenance and retrofit package. Totals may not sum due to rounding.*

Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
BAU Scenario								
CAPEX	£2,910,000	£2,890,000	£2,860,000	£2,840,000	£2,820,000	£2,790,000	£2,770,000	£19,900,000
of which…								
Construction of new stock	£422,000	£422,000	£422,000	£422,000	£422,000	£422,000	£422,000	£2,960,000
Insulating existing stock*	£691,000	£691,000	£691,000	£691,000	£691,000	£691,000	£691,000	£4,840,000
Decarbonising heat	£1,330,000	£1,300,000	£1,280,000	£1,260,000	£1,230,000	£1,210,000	£1,180,000	£8,790,000
PV installation*	£470,000	£470,000	£470,000	£470,000	£470,000	£470,000	£470,000	£3,290,000
OPEX	£0	£0	£0	£0	£0	£0	£0	£0
Total	£2,910,000	£2,890,000	£2,860,000	£2,840,000	£2,820,000	£2,790,000	£2,770,000	£19,900,000
Mid Scenario								
CAPEX	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£34,000,000
of which…								
Construction of new stock	£422,000	£422,000	£422,000	£422,000	£422,000	£422,000	£422,000	£2,960,000
Insulating existing stock*	£691,000	£691,000	£691,000	£691,000	£691,000	£691,000	£691,000	£4,840,000
Decarbonising heat	£2,990,000	£2,990,000	£2,990,000	£2,990,000	£2,990,000	£2,990,000	£2,990,000	£20,900,000
PV installation*	£747,000	£747,000	£747,000	£747,000	£747,000	£747,000	£747,000	£5,230,000
OPEX	£0	£0	£0	£0	£0	£0	£0	£0
Total	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£34,000,000
Difference from BAU	£1,940,000	£1,960,000	£1,990,000	£2,010,000	£2,040,000	£2,060,000	£2,080,000	£14,100,000
Max Scenario								
CAPEX	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£71,800,000
of which…								
Construction of new stock	£422,000	£422,000	£422,000	£422,000	£422,000	£422,000	£422,000	£2,960,000
Insulating existing stock*	£691,000	£691,000	£691,000	£691,000	£691,000	£691,000	£691,000	£4,840,000
Decarbonising heat	£7,330,000	£7,330,000	£7,330,000	£7,330,000	£7,330,000	£7,330,000	£7,330,000	£51,300,000
PV installation*	£1,810,000	£1,810,000	£1,810,000	£1,810,000	£1,810,000	£1,810,000	£1,810,000	£12,700,000
OPEX	£0	£0	£0	£0	£0	£0	£0	£0
Total	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£71,800,000
Difference from BAU	£7,350,000	£7,370,000	£7,400,000	£7,420,000	£7,450,000	£7,470,000	£7,490,000	£52,000,000
Difference from Mid	£5,410,000	£5,410,000	£5,410,000	£5,410,000	£5,410,000	£5,410,000	£5,410,000	£37,900,000

4 Non-domestic Buildings

4.1 Current sector summary

2023/24 emissions from ECC's non-domestic building stock (all scopes) are estimated at 7.7 $ktCO_2e$, a reduction of 4.1 $ktCO_2e$ from 2022/23. The change is predominantly due to the fewer emissions associated with Scope 3 construction and maintenance due to completion of St Sidwell's Point in April 2022. A breakdown of non-domestic building emissions by type is shown in Figure 7.

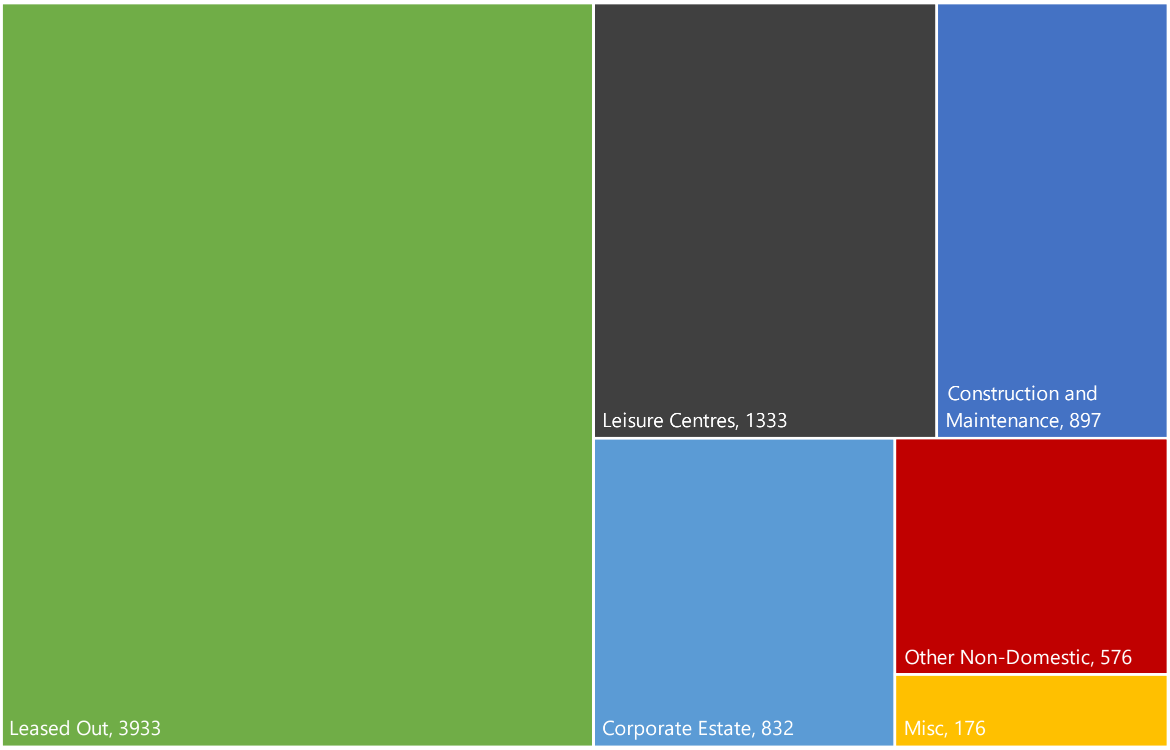

Figure 7: Breakdown of ECC's 2023/24 non-domestic emissions for all scopes (tCO_2e).

Just over half (51%) of emissions, 3,933 tCO_2e, arise from the energy demand of ECC's Scope 3 downstream leased assets. This is a reduction of two thirds from the value reported in the 2022/23 inventory due to better data allowing ground lease emissions to be removed [3]. ECC is not financially responsible for the utility bills of leased assets so there is limited financial incentive for implementing energy efficiency measures. Without meter readings, the emissions are calculated using energy benchmarks from CIBSE TM46 [17]. These comprise consumption values per unit floor area for gas and electricity depending on property type. For each leased asset, the property type is determined through visual inspection. The emissions are estimated by multiplying the corresponding energy benchmark for gas and electricity by the total floor area, adjusting according to the EPC score[g] and multiplying by a corresponding emission factor. This methodology has enabled historic emission figures to be updated slightly from the previous inventory.

[g] An EPC score of 71 would have its energy use data multiplied by 0.71 as an EPC rating of 100 is theoretically an average building.

17% of non-domestic emissions, 1,333 tCO_2e, are produced to meet the energy demand for ECC's six leisure centres: Riverside Leisure Centre, Northbrook Swimming Pool, Wonford Sports Centre, ISCA Centre, Exeter Arena and St Sidwell's Point Leisure Centre. This is a 163 tCO_2e reduction on last year, despite increased usage of backup gas use at St Sidwell's Point. The reduction is mostly due to the lower emissions factor of grid electricity. Leisure centres represent the greatest potential for decarbonisation across ECC's estate.

ECC's corporate buildings are responsible for 832 tCO_2e (11%) and comprising a wide range of ECC uses including council offices, cultural buildings and waste management centres. Some of the buildings are listed making fabric changes difficult and/or show minimal decarbonisation potential.

Scope 3 construction and maintenance conducted by the ECC emitted 897 tCO_2e (12%), occurring due to the carbon associated with materials purchased by ECC for various projects. This is down from 4,761 tCO_2e the year before due to completion of St Sidwell's Point in April 2022.

The remaining 9%, 752 tCO_2e, of non-domestic emissions is comprised of emissions from car park energy use (referred to as "Other Non-Domestic"), as well as waste treatment and the energy associated with remote working (collectively referred to as "Misc"). There is not a substantial difference in these emissions compared to last year.

2023/24 Scope 1 and 2 emissions total 2,740 tCO_2e with 49% emitted from leisure centres, 30% from corporate buildings and 21% from other non-domestic properties.

4.2 Leisure Centres

2023/24 emissions from ECC's leisure centres (all scopes) are estimated at 1,333 tCO_2e, a reduction of 163 tCO_2e from 2022/23. A breakdown of ECC's 1,333 tCO_2e Scope 1 and 2 leisure centre emissions is given in Figure 8. Just under half (47%) of all leisure centre emissions are due to the energy demand of Riverside leisure centre, producing 624 tCO_2e. This is a down from 882 tCO_2e last year, a reduction of 29%, likely due to better building management including refinement of heating controls. As the ECC's most carbon intensive leisure centre, Riverside has been chosen as a priority for decarbonisation, with potential retrofitting measures beginning in 2025.

The new Passivhaus St Sidwell's Point is responsible for 30% of leisure centre emissions (398 tCO_2e). Despite high levels of energy efficiency, its large size results in high electricity consumption. A quarter of emissions are due to a gas boiler temporarily supplementing the installed heat pumps for longer periods than normal due to commissioning faults and repair delays. St Sidwell's Point opened in 2022 and no energy saving measures are modelled beyond transitioning away from the gas backup and PV installation.

The other swimming pool operated by ECC, Northbrook, makes up 9% of leisure centre emissions (122 tCO_2e). The non-swimming pool leisure centres, ISCA centre, Wonford, and Exeter Arena collectively comprise 14% of total emissions at 103 tCO_2e, 46 tCO_2e and 39 tCO_2e, respectively. None of these have seen any considerable change from the previous inventory.

Finally, fluorinated gas (F-gas) leakage from 28 Refrigeration, Air Conditioning, and Heat Pump (RACHP) units accounts for 9 tCO_2e.

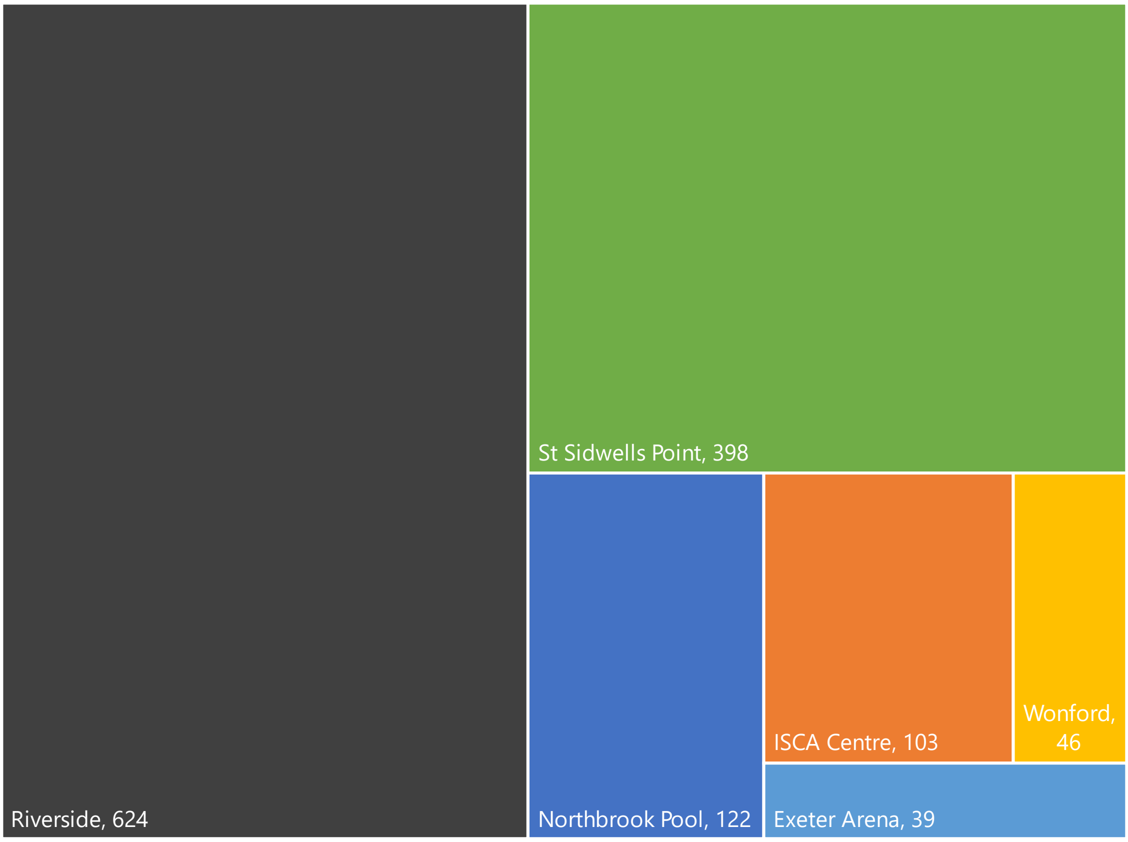

Figure 8: Breakdown of 2023/24 Scope 1 & 2 leisure centre emissions (tCO_2e).

Projections include energy saving measures being installed into a different leisure centre each year with the priority determined by current gas consumption. Energy savings are modelled from the installation year.

1. Riverside, 2025
2. Northbrook, 2026
3. ISCA Centre, 2027
4. Wonford, 2028
5. Exeter Arena, 2029

The priority order above does not apply to PV installations (see Section 6.3).

4.2.1 Change in stock

The only change in stock modelled in the leisure centre analysis is the hypothetical closure of Northbrook in 2025 in the Max scenario. No cost is associated with the closure as it is not an energy saving-specific measure.

4.2.2 Efficiency improvements

A range of thermal and electrical efficiency measures have been modelled for ECC's leisure centres based on conversations with ECC service leads. Where possible, costs and savings data have been adapted from two decarbonisation reports by Currie & Brown (C&B) on Riverside

[18] and Northbrook [19]. Using these reports, relative savings are determined for each measure. Future gas and electricity consumption is modelled by finding the product of the relevant savings and multiplying by the current consumption values. CWI for Riverside, Northbrook and Wonford is assumed for the Mid scenario in their respective upgrade years, costing approximately £44,000.

It should be noted that roof upgrades proposed in the Mid scenario for Northbrook, Wonford and the ISCA centre are not included in this analysis. These works are not energy efficiency-specific measures but rather to replace roofs at their end-of-life or to allow for a PV array. The total cost for all three roofs is estimated at £1,450,000 using data from the C&B report and roof areas from Google Maps [19]. Thus, the large CAPEX required for minimal energy savings would produce a misleading conclusion about necessary maintenance works.

Glazing upgrades and draught-proof external doors are also modelled for the Mid case scenario for Riverside and Northbrook as per Currie & Brown. C&B propose triple glazing for the pool halls of both leisure centres and the curtain walling of Northbrook. Double glazing is suggested for the rooflights of both centres, the curtain walling of Riverside and the remaining windows of Northbrook. Currie & Brown also calculate additional thermal savings due to draught-proofing in addition to these works and these have been apportioned to each of the measures based on their initial efficiency savings. The total capital cost associated with these upgrades is £1.7 million. Note that under the Max scenario, Northbrook is projected to close so upgrades to its fabric are only modelled in the Mid scenario.

Increasing the electrical efficiency of Riverside and Northbrook is achieved by upgrading all fluorescent lighting fixtures to LEDs (costing £100,000) and is modelled in the BAU scenario for Riverside and the Mid scenario for Northbrook. Energy efficient LEDs have recently been installed into the ISCA centre, but current energy data does not reflect this. Future annual electricity consumption for the ISCA centre has been reduced to account for this with no costs associated.

4.2.3 Decarbonising heat

Decarbonising heat in leisure centres is more expensive than other non-domestic buildings due to the increased hot water demand. ASHP installation will remove all future gas consumption but increase electricity consumption. Data provided by Currie & Brown is used to model costs and energy impacts [18,19]. C&B assume a gas boiler efficiency of 85% and an ASHP coefficient of performance (CoP) of 2.6. These figures are used with the modelled gas consumption data following efficiency measures to estimate the increase in electricity demand for each leisure centre. ASHP installation was modelled for the BAU scenario of Riverside, Mid scenario for Wonford and Northbrook and Max scenario for Exeter Arena and ISCA centre.

The effects on F-gas emissions from different ASHP installation scenarios in ECC's non-domestic estates is also modelled. The heating capacity, refrigerant type, refrigerant charge, and installation year for each building in each scenario are shown in Table 6. To estimate F-gas emissions, all ASHPs are given a standard 3% leakage rate and assumed to be charged with R32 refrigerant with a global warming potential of 677 $kgCO_2e\ kg^{-1}$. Refrigerant charges for each building were estimated using a generic refrigerant charge rate derived from a standard commercial heat pump. A standard 100 kW R32 commercial heat pump has a refrigerant charge of 25 kg[h], resulting in a refrigerant charge rate of 0.25 kgR32 kW^{-1}.

Table 6: ASHP heating capacity, refrigerant type, refrigerant charge, installation year, and scenario for each building in ECC's non-domestic estate

Building	Scenario	Capacity (kW)	Refrigerant type	Refrigerant charge (kg)	Annual leak rate	Annual leakage (kg yr^{-1})	Installation year
Riverside	BAU	1500	R32	375	3%	11.25	2024/25
Northbrook	Mid	200	R32	50	3%	1.50	2025/26
ISCA	Max	750	R32	188	3%	5.63	2026/27
Wonford	Mid	400	R32	100	3%	3.00	2027/28
Exeter Arena	Max	200	R32	50	3%	1.5	2028/29

Costs for the ASHPs at Riverside and Northbrook are taken from the Currie & Brown reports and are apportioned on a per kW basis for other sites [18,19]. However, determining the capacity of a potential ASHP requires an assessment of the building's peak heat demand, which is beyond the scope of this report. An estimate is calculated using data from a CEE report analysing the heat load of buildings on the University of Exeter's Streatham campus [20]. The average demand of the ECC's leisure centres is determined from metered data and multiplied by a peak demand to average demand ratio from an analogous University of Exeter building rounded up to produce an estimate for the ASHP capacity needed for the ECC building. The total CAPEX calculated is £8 million. The installation of an ASHP at Riverside, funded through the Public Sector Decarbonisation Scheme (PSDS), accounts for half of this [21].

For St. Sidwell's Point, the BAU scenario assumes a transition away from the temporary gas backup boiler as the ASHP is reconfigured, saving an estimated 450 MWh of gas with a corresponding 150 MWh increase in electricity consumption. No costs are associated with this measure. The building also has a connection point for a potential future heat network which is not modelled as it is assumed that no ECC capital costs would be directly associated with the change and there would be no additional carbon or energy benefits on top of the current BAU scenario.

4.2.4 PV installation

This section covers the impact of a PV installation on each leisure centre's electricity consumption. Section 6.3 models the potential for offsetting provided by the export of excess non-domestic PV generation to the grid.

Five leisure centres are potential sites for new PV arrays. Information on the size of each array is sourced from ECC representatives. For the BAU case, a 72 kWp, 49 kWp and 146 kWp PV array is modelled for Exeter Arena, Wonford and St Sidwell's Point respectively. For the Mid case scenario, 21.6 kWp and 158 kWp arrays are also installed at Northbrook and ISCA Centre.

Self-consumption from these sites is modelled as part of Section 6.3, using data on load factors and self-consumption ratios from current ECC PV sites. The output from each site is decreased

[h] Available at: https://library.mitsubishielectric.co.uk/pdf/book/MECH_MEHP#page-1

by 1.1% each year to account for gradual cell deterioration. This analysis calculates an annual electricity saving of 66 MWh for the BAU scenario – a total of 332 MWh over the five years from installation to 2030. With two additional sites, the Mid scenario has a larger average annual electricity saving at 111 MWh, a total saving of 555 MWh.

Costs are derived from the C&B reports and applied on a per kWp basis [18,19]. Meeting the requirements of the BAU scenario would cost £272,000. The Mid scenario would cost ECC £457,000 to implement. Only the financial saving arising from self-consumption is detailed in this section and manifests itself as lower OPEX each year. Income generated by selling exported energy is included in Section 6.3.

4.2.5 Leisure Centre Summary

Figure 9 shows the projected emissions from leisure centres under the three scenarios. In 2030/31 emissions from ECC's six leisure centres total 471 tCO_2e for BAU, 343 tCO_2e for Mid and 250 tCO_2e for Max. The cumulative emissions from 2024/25 to 2030/31 are estimated as 5,130 tCO_2e, 4,530 tCO_2e and 4,148 tCO_2e in the BAU, Mid and Max scenarios, respectively.

Figure 10 and Table 7 show the costs (CAPEX and OPEX) associated with the measures identified across the ECC's six leisure centres. Operating costs are determined by multiplying the consumption of each fuel type by future fuel prices estimated by DESNZ in Annex M of the energy and emissions projections [2].

The large CAPEX in 2025/26 is to decarbonise the energy intensive Riverside leisure centre. The £1,110,000 difference between the BAU and Mid scenarios is due to fabric and glazing improvements in the Mid scenario which will ensure lower electricity consumption. Additionally, in 2026/27, the main contributors to the £1.3 million CAPEX in the Mid scenario are energy efficiency upgrades for Northbrook. In the Max scenario, this site is closed so the only costs are for four PV installations at other sites.

Under the Max scenario, all six sites are disconnected from gas, relying on electric ASHPs. Whilst electrification has a significant effect on emissions reduction, there is only a minimal difference in OPEX because while an ASHP is around 300% efficient[i], electricity typically costs about three times more than gas. The reduction in OPEX from £1.2 million in 2024/25 to £408,000 in 2030/31 in the Max scenario is predominantly due to the fuel price reductions projected by DESNZ [2].

[i] Uses three times less kWh of electricity than kWh of gas needed by a gas boiler to produce the same heat demand.

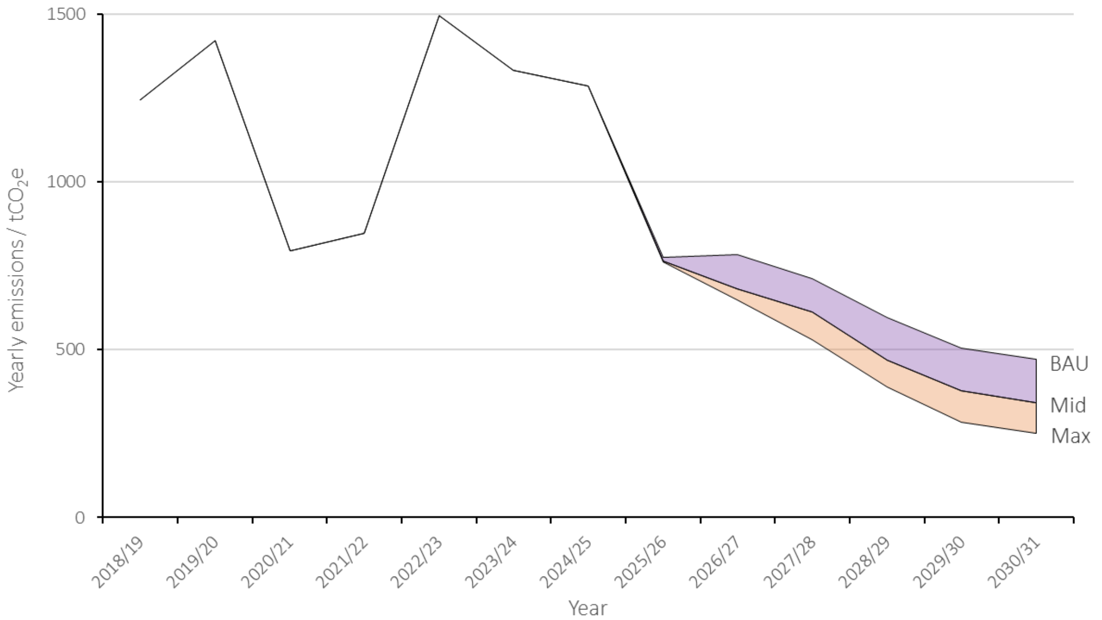

Figure 9: Projected leisure centre emissions (tCO_2e) under the three different scenarios.

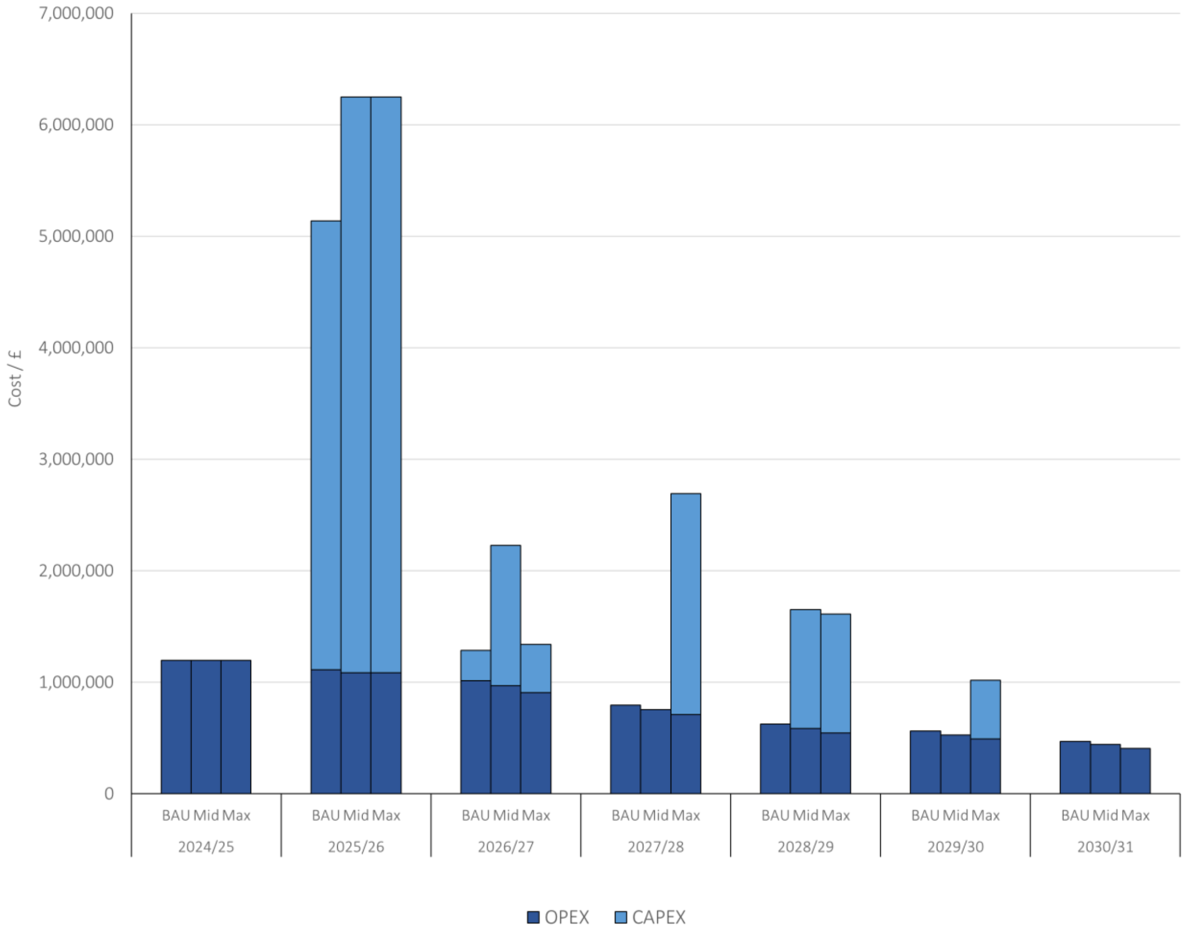

Figure 10: Annual capital and operating costs associated with decarbonising ECC's leisure centres under the three different scenarios.

Table 7: Cost breakdown of leisure centre emission reduction scenarios. Only measures with costs associated with them are shown. Totals may not sum due to rounding

Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
BAU Scenario								
CAPEX	£0	£4,020,000	£272,000	£0	£0	£0	£0	£4,300,000
of which…								
Efficiency improvements	£0	£85,400	£0	£0	£0	£0	£0	£85,000
Decarbonising heat	£0	£3,940,000	£0	£0	£0	£0	£0	£3,940,000
PV installation	£0	£0	£272,000	£0	£0	£0	£0	£272,000
OPEX	£1,200,000	£1,110,000	£1,010,000	£797,000	£624,000	£562,000	£471,000	£5,780,000
Total	£1,200,000	£5,140,000	£1,290,000	£797,000	£624,000	£562,000	£471,000	£10,100,000
Mid Scenario								
CAPEX	£0	£5,160,000	£1,260,000	£0	£1,070,000	£0	£0	£7,480,000
of which…								
Efficiency improvements	£0	£1,620,000	£216,000	£0	£8,600	£0	£0	£1,840,000
Decarbonising heat	£0	£3,550,000	£585,000	£0	£1,060,000	£0	£0	£5,190,000
PV installation	£0	£0	£457,000	£0	£0	£0	£0	£457,000
OPEX	£1,200,000	£1,090,000	£970,000	£757,000	£586,000	£528,000	£441,000	£5,560,000
Total	£1,200,000	£6,250,000	£2,230,000	£757,000	£1,650,000	£528,000	£441,000	£13,000,000
Difference from BAU	£0	£1,110,000	£942,000	-£40,000	£1,030,000	-£34,300	-£30,500	£2,970,000
Max Scenario								
CAPEX	£0	£5,160,000	£433,000	£1,980,000	£1,070,000	£529,000	£0	£9,170,000
of which…								
Efficiency improvements	£0	£1,620,000	£0	£0	£8,600	£0	£0	£1,620,000
Decarbonising heat	£0	£3,550,000	£0	£1,980,000	£1,060,000	£529,000	£0	£7,110,000
PV installation	£0	£0	£433,000	£0	£0	£0	£0	£433,000
OPEX	£1,200,000	£1,090,000	£908,000	£710,000	£546,000	£491,000	£408,000	£5,350,000
Total	£1,200,000	£6,250,000	£1,340,000	£2,690,000	£1,610,000	£1,020,000	£408,000	£14,500,000
Difference from BAU	£0	£1,110,000	£56,100	£1,900,000	£988,000	£457,000	-£62,900	£4,440,000
Difference from Mid	£0	£0	-£885,000	£1,940,000	-£40,200	£492,000	-£32,300	£1,470,000

4.3 Corporate Estate

2023/24 emissions from ECC's leisure centres (all scopes) are estimated at 832 tCO_2e, a reduction of 151 tCO_2e from 2022/23. A breakdown of the 832 tCO_2e of Scope 1 & 2 emissions associated with ECC's corporate estate is given in Figure 11. The largest greenhouse gas emitter across the estate is the Royal Albert Memorial Museum (RAMM) at 457 tCO_2e, 55% of ECC's corporate estate emissions. The 66 tCO_2e reduction from last year's inventory is due to better controls of the heating and cooling system as well as reprogramming of the building management system which has resulted in lower fuel consumption. However, the RAMM's Grade II listed status limits the scope for future works [22].

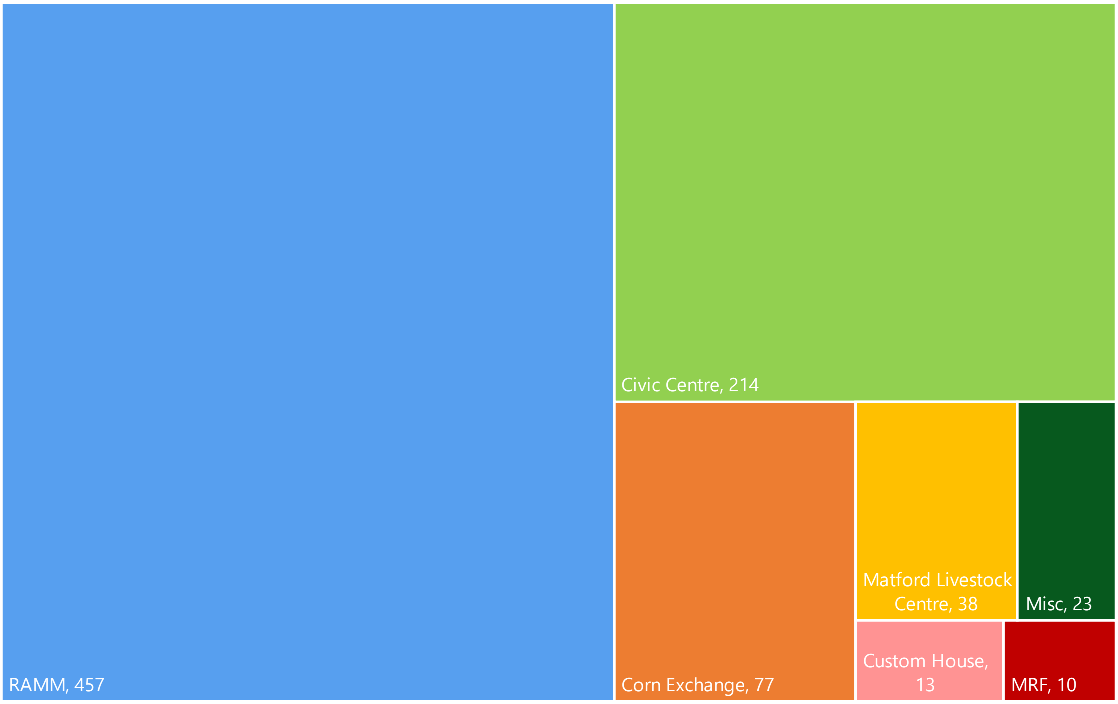

Figure 11: Breakdown of 2023/24 corporate estate emissions (tCO_2e).

26% of ECC's Corporate Estate emissions (214 tCO_2e) arise from its offices at the Civic Centre. Plans to potentially move ECC offices to alternative sites and sell the Civic Centre means that no retrofitting interventions are modelled for this building [23]. Energy use at the Corn Exchange is responsible for 9% of corporate estate emissions (77 tCO_2e). An estimated 22 tCO_2e (3%) was emitted from other ECC corporate stock such as Oakwood House and the Underground Passages. Their small individual impacts mean that no energy efficiency measures have been identified for them. All estimates include the impact of refrigerant leakage from 27 RACHP units identified across the Corporate Estate.

The Matford Livestock Centre, Materials Reclamation Facility and Grade I listed Custom House emit 38, 10 and 13 tCO_2e, respectively [24]. Only the Custom House has had energy efficiency measures modelled.

4.3.1 Change in stock

The only stock change modelled in this analysis is the assumed sale of the Civic Centre in 2030/31 in the Max scenario resulting in zero electricity and gas emissions arising from this building for 2030/31. No costs have been associated with this as it is not a direct energy efficiency measure.

4.3.2 Efficiency improvements

Energy efficiency improvements are only modelled for the Corn Exchange and RAMM. Energy savings have been calculated similarly to leisure centres, applying data from the Currie & Brown reports for Riverside and Northbrook, where appropriate [18,19].

In the BAU scenario, the Corn Exchange sees a variety of improvements in 2027: double glazing, CWI, roof insulation, and LEDs. Roof insulation in 2024 is also modelled for the RAMM in this scenario, funded through the Museum Estate and Development (MEND) scheme [21].

Cost data is sourced from the Currie & Brown reports or Energy Systems Catapult [18–20]. Meeting the BAU scenario will require an estimated expenditure of £563,000.

4.3.3 Decarbonising heat

Heat decarbonisation is modelled for the Corn Exchange in 2027, Custom House in 2028, and the RAMM in 2029. In the Mid scenario, electric heating is installed into the RAMM. In the Max scenario, ASHPs are installed into all three buildings, with the RAMM being subsidised through PSDS funding [21] (the Max scenario assumes electric heating is not already installed in the RAMM). The RAMM has also been identified as a potential connection point on the Exeter heat network. The uncertainty around the scheme being operational by 2030 means that it is not included in the analysis.

The effect of F-gas emissions from these ASHP installations is also modelled using the same assumptions in Section 4.2.3. The heating capacity, refrigerant type, refrigerant charge, and installation year for each building in each scenario are shown in Table 8.

Table 8: ASHP heating capacity, refrigerant type, refrigerant charge, installation year, and scenario for each building in ECC's non-domestic estate

Building	Scenario	Capacity (kW)	Refrigerant type	Refrigerant charge (kg)	Annual leak rate	Annual leakage (kg yr^{-1})	Installation year
RAMM	Max	2000	R32	500	3%	15.00	2029/30
Corn Exchange	Max	400	R32	100	3%	3.00	2027/28
Custom House	Max	100	R32	25	3%	0.75	2028/29

Energy and cost data is derived as described in Section 4.2.3, using Energy Systems Catapult or Currie & Brown cost figures [18–20]. The Mid scenario costs ECC £182,000. Installing ASHPs in the three buildings requires an upfront cost of £6.6 million.

4.3.4 PV installation

As described in Section 6.3, a 29.5 kWp PV installation is modelled in 2026 for the Corn Exchange in the BAU scenario. The Mid scenario adds an additional 30 kWp array for the RAMM in 2026.

The amount of self-consumed PV electricity is modelled in Section 6.3, using information from ECC's current PV sites and accounting for the gradual decay of solar cells. In the BAU scenario, an estimated 7,300 kWh of electricity is saved annually, a total of 37,000 kWh up to 2030/31. Savings increase to 15,000 kWh annually in the Mid scenario, saving 74,000 kWh by 2030/31.

The installation cost of these arrays is derived on a per kWp basis from the Currie & Brown reports [18,19]. The Corn Exchange array in the BAU scenario will cost an estimated £30,100. This increases to £60,600 in the Mid scenario due to the additional RAMM array. As with leisure centres, only the reduction in OPEX due to self-consumption is modelled in this section, exporting excess generation is covered in Section 6.3.

4.3.5 Corporate Estate Summary

Modelled future emissions for each scenario are shown in Figure 12. The 2030/31 corporate estate emissions are estimated as 531 tCO_2e, 373 tCO_2e and 174 tCO_2e under the BAU, Mid and Max scenarios, respectively. Cumulative emissions from 2024/25 to 2030/31 are estimated as for 4,737 tCO_2e BAU, 4,554 tCO_2e for Mid and 4,123 tCO_2e for the Max scenario. Decarbonisation of the electricity grid is a powerful driving force, especially in the Max scenario. Gas emission factors are more static, so insulation works in the BAU scenario are vital to achieve net zero but also build a strong case for future heat electrification in the buildings.

The costs associated with meeting the three scenarios are shown in Figure 13 and Table 9. The total CAPEX required over all seven years is estimated at £600,000 for BAU, £870,000 for Mid and £7.3 million for the Max scenario. The dramatic increase in CAPEX from the Mid to the Max scenario is due to the expensive ASHP installations in the Corn Exchange and RAMM in 2027 and 2029, respectively.

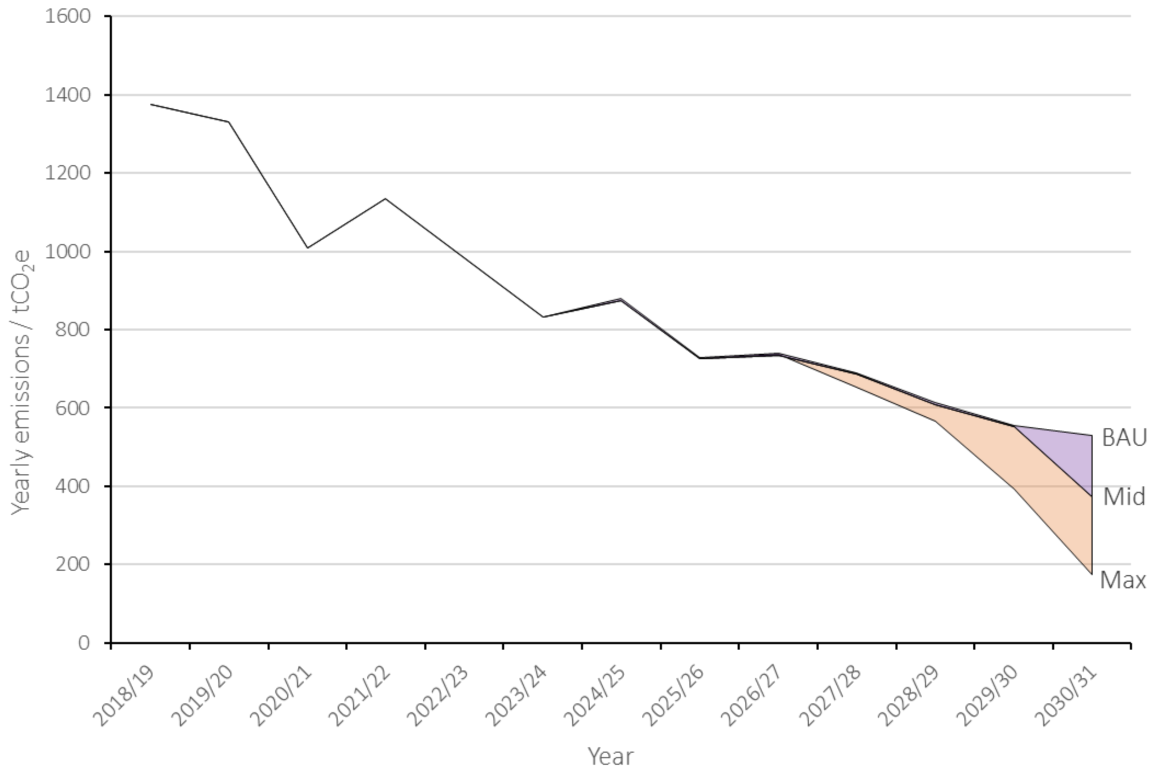

Figure 12: Projected corporate estate emissions (tCO_2e) under the three different scenarios.

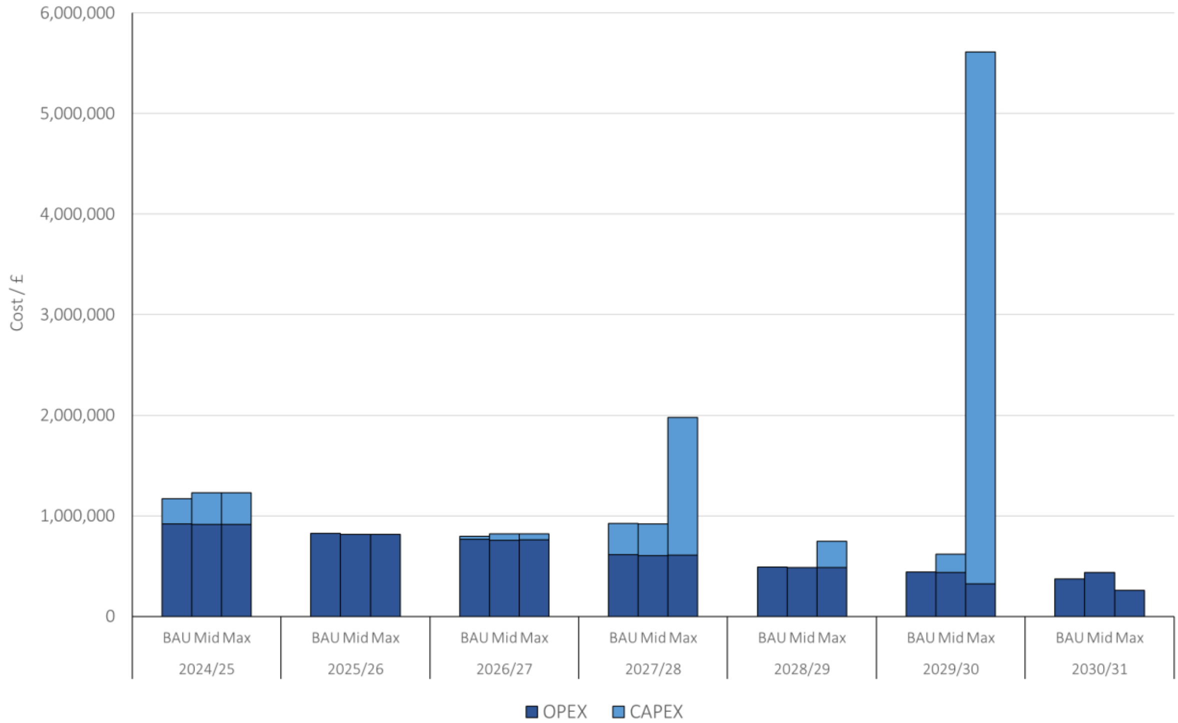

Figure 13: Annual capital and operating costs (£) associated with decarbonising ECC's corporate estate under the three different scenarios.

Table 9: Cost breakdown of corporate estate emission reduction scenarios. Only measures with costs associated with them are shown. Totals may not sum due to rounding

Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
BAU Scenario								
CAPEX	£250,000	£0	£30,100	£312,000	£0	£0	£0	£593,000
of which…								
Efficiency improvements	£250,000	£0	£0	£312,000	£0	£0	£0	£563,000
Decarbonising heat	£0	£0	£0	£0	£0	£0	£0	£0
PV installation	£0	£0	£30,100	£0	£0	£0	£0	£30,100
OPEX	£921,000	£823,000	£767,000	£613,000	£491,000	£442,000	£374,000	£4,430,000
Total	£1,170,000	£823,000	£797,000	£925,000	£491,000	£442,000	£374,000	£5,020,000
Mid Scenario								
CAPEX	£314,000	£0	£60,600	£312,000	£0	£182,000	£0	£869,000
of which…								
Efficiency improvements	£314,000	£0	£0	£312,000	£0	£0	£0	£627,000
Decarbonising heat	£0	£0	£0	£0	£0	£182,000	£0	£182,000
PV installation	£0	£0	£60,600	£0	£0	£0	£0	£60,600
OPEX	£913,000	£816,000	£758,000	£606,000	£486,000	£438,000	£438,000	£4,450,000
Total	£1,230,000	£816,000	£818,000	£918,000	£486,000	£619,000	£438,000	£5,320,000
Difference from BAU	£55,800	-£7,280	£21,200	-£7,180	-£5,490	£177,000	£64,700	£298,000

Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
Max Scenario								
CAPEX	£314,000	£0	£60,600	£1,370,000	£264,000	£5,290,000	£0	£7,300,000
of which…								
Efficiency improvements	£314,000	£0	£0	£312,000	£0	£0	£0	£627,000
Decarbonising heat	£0	£0	£0	£1,057,000	£264,000	£5,290,000	£0	£6,610,000
PV installation	£0	£0	£60,600	£0	£0	£0	£0	£65,000
OPEX	£913,000	£816,000	£760,000	£607,000	£483,000	£324,000	£260,000	£4,160,000
Total	£1,230,000	£816,000	£821,000	£1,980,000	£748,000	£5,610,000	£260,000	£11,500,000
Difference from BAU	£55,800	-£7,280	£23,800	£1,050,000	£256,000	£5,170,000	-£114,000	£6,430,000
Difference from Mid	£0	£0	£2,540	£1,060,000	£262,000	£4,990,000	-£179,000	£6,140,000

4.4 Other Facilities

Scope 1 and 2 emissions from other non-domestic properties in 2023/24 total 576 tCO_2e. Other facilities comprise remaining ECC assets such as Belle Isle, the Canal Offices, and car parks. However, following discussions with various ECC representatives, only two measures are modelled in this analysis, both for 2026. The Guildhall car park receives a 321 kWp PV array in the BAU scenario, costing £327,000 and saving around 80,000 kWh of electricity a year, a total of 400,000 kWh by 2030/31. In the Max scenario, energy efficient LEDs are installed into the Princesshay 2 car park. Using data from the Energy Systems Catapult, this would save 18,000 kWh of electricity annually. In conversation with ECC representatives, this upgrade will cost £30,000. It is noted this upgrade will also require a further £45,000 for necessary works on the electrics system but this is not accounted for in this analysis as it is not an energy saving-specific measure.

The result of these measures is shown in Figure 14. The lack of major interventions beyond BAU means that all three scenarios are closely aligned with grid decarbonisation being the major driving force behind future emissions reductions.

It should be noted that PV installations have also been modelled for the Guildhall Shopping Centre and Exeter Bus Station. No energy savings have been calculated for these arrays in this section as the leased status of these buildings means that ECC is not financially responsible for any electricity consumption at these sites. However, exported electricity is included in Section 6. In the BAU case, installing a 346 kWp array atop the Guildhall Shopping Centre and a 40 kWp array atop Exeter Bus station, will cost £393,000.

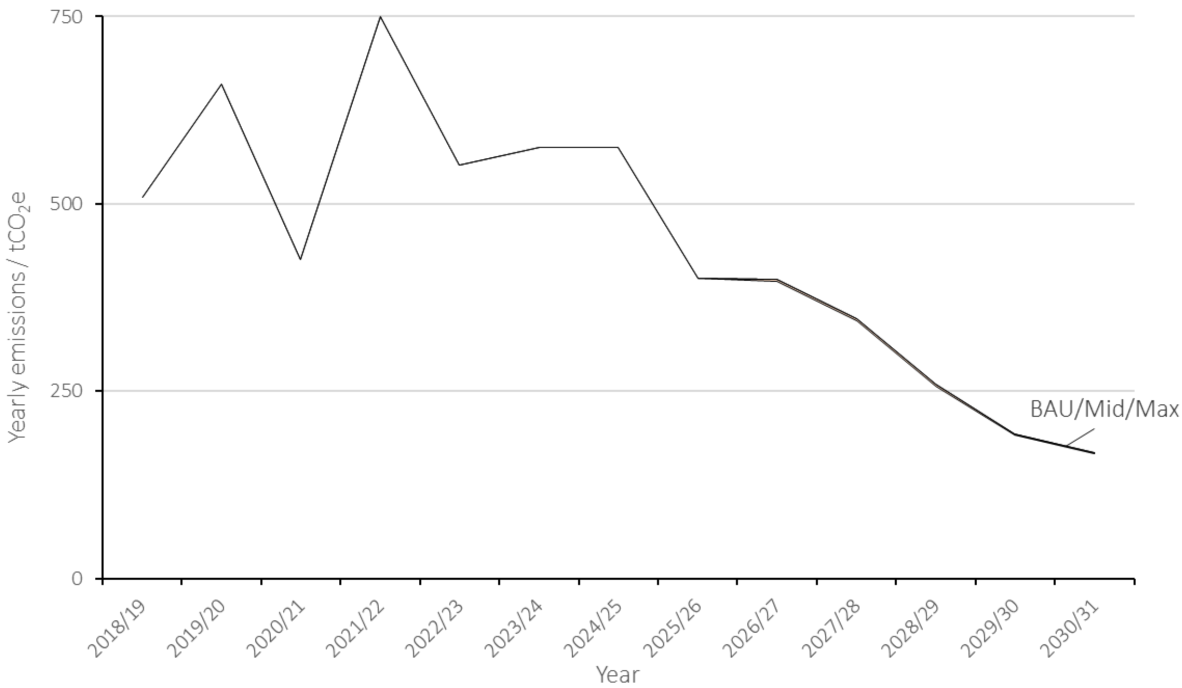

Figure 14: Projected other non-domestic emissions (tCO_2e) under the three scenarios.

4.5 Summary of Modelling Assumptions

The full range of assumptions made for each combination of measure and scenario as discussed in the previous sections is shown in Table 10.

Table 10: Modelled assumptions for non-residential buildings.

Building	BAU Scenario	Mid Scenario	Max Scenario
Riverside	• ASHP • LEDs	BAU and • CWI • Double glazing curtain walling • Double glazing rooflights • Draught-proofing external doors • Triple glazing windows	Same as Mid
Northbrook	As is	• CWI • Double glazing rooflights • Double glazing windows • Draught-proof external doors • LEDs • PV – 21.6 kWp • ASHP • Triple glazing windows	• Closure only
Wonford	• PV – 49 kWp	BAU and • CWI • Roof insulation • ASHP	Same as Mid
ISCA Centre	As is	• PV – 158 kWp	Mid and • ASHP
Exeter Arena	• PV – 72 kWp	Same as BAU	BAU and • ASHP

Building	BAU Scenario	Mid Scenario	Max Scenario
St. Sidwell's Point	• Reconfigure ASHP • PV – 146 kWp	Same as BAU	Same as BAU
Corn Exchange	• Double glazing windows • CWI • Roof insulation • LED • PV – 29.5 kWp	Same as BAU	BAU and • ASHP
Civic Centre	As is	As is	• Closure
Custom House	As is	As is	• ASHP
RAMM	• Roof insulation	BAU and • PV – 30 kWp • LED • Electric heaters	BAU and • PV – 30 kWp • LED • ASHP
Car Parks	• PV, Guildhall car park – 321 kWp	Same as BAU	BAU and • LEDs, Princesshay 2 car park

4.6 Projected Emissions to 2030/31

Modelled Scope 1 and 2 emission trajectories for ECC's non-domestic building stock under the three scenarios are shown in Figure 15. Leisure centres contribute a large proportion of ECC's Scope 1 and 2 emissions (49% in 2023/24), as such, this graph is similar to Figure 9 in Section 4.2. Thus, measures for ECC's six leisure centres will be crucial in decarbonising this sector. The 2030/31 Scope 1 and 2 emissions are estimated at 1,170 tCO_2e, 884 tCO_2e and 590 tCO_2e under the BAU, Mid and Max scenarios, respectively. Grid decarbonisation and heat pump installation into many of ECC's non-domestic stock in the Max scenario ensures the sector quickly approaches net zero. The cumulative emissions from 2024/25 to 2030/31 are calculated as for 12,211 tCO_2e BAU, 11,427 tCO_2e for the Mid and 10,602 tCO_2e for the Max scenario.

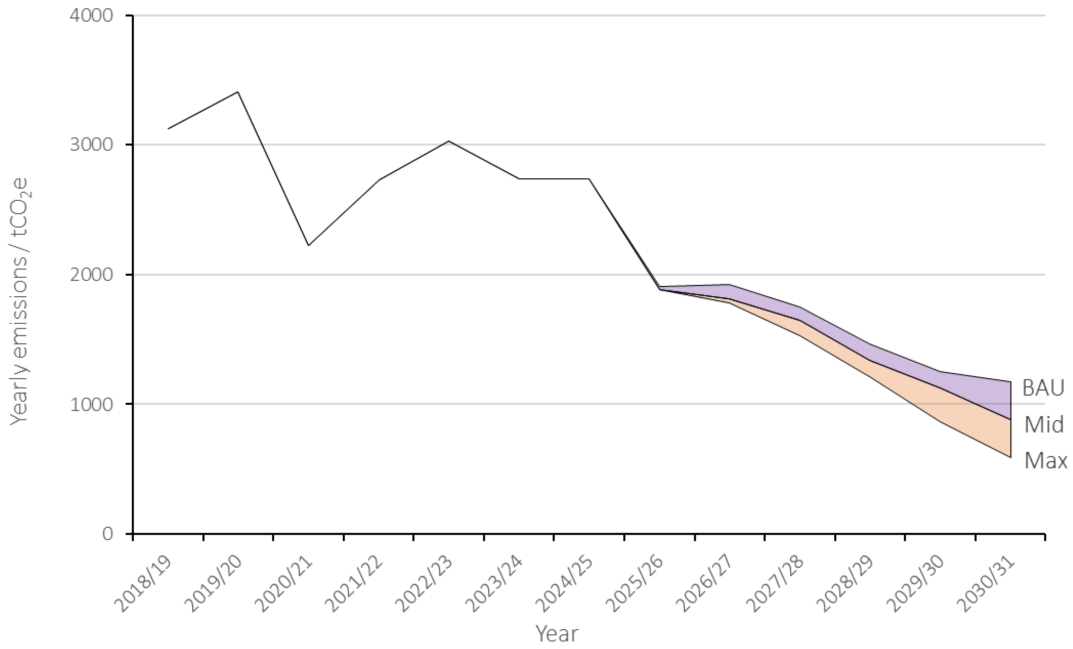

Figure 15: Projected non-domestic emissions (tCO_2e) under the three scenarios.

In the Max scenario in 2030/31, F-gases become an increasingly prominent source of emissions, accounting for 8% of the total non-domestic footprint (compared to the previous < 1%). It is important that F-gas losses are closely scrutinised, and mitigation strategies designed, including reducing leakage rates by improving refrigerant handling and equipment maintenance, and switching to refrigerants with lower a global warming potential, where possible [25].

Figure 16 and Table 11 show the upfront financial commitment required to meet each scenario each year alongside the operational energy costs. Decarbonisation of Riverside leisure centre dominates the 2025/26 CAPEX. The large spending shown in the 2029 Max scenario is due to the installation of a £5.3 million ASHP at the RAMM. Meeting the requirements of each scenario for ECC's non-domestic stock will cost a total of £5.2 million for BAU, £8.7 million for Mid and £16.8 million for the Max scenario. Including yearly operational energy costs brings the total spend on ECC's non-domestic buildings by 2030/31 to a total of £19.3 million, £22.6 million and £30.2 million for BAU, Mid and Max respectively.

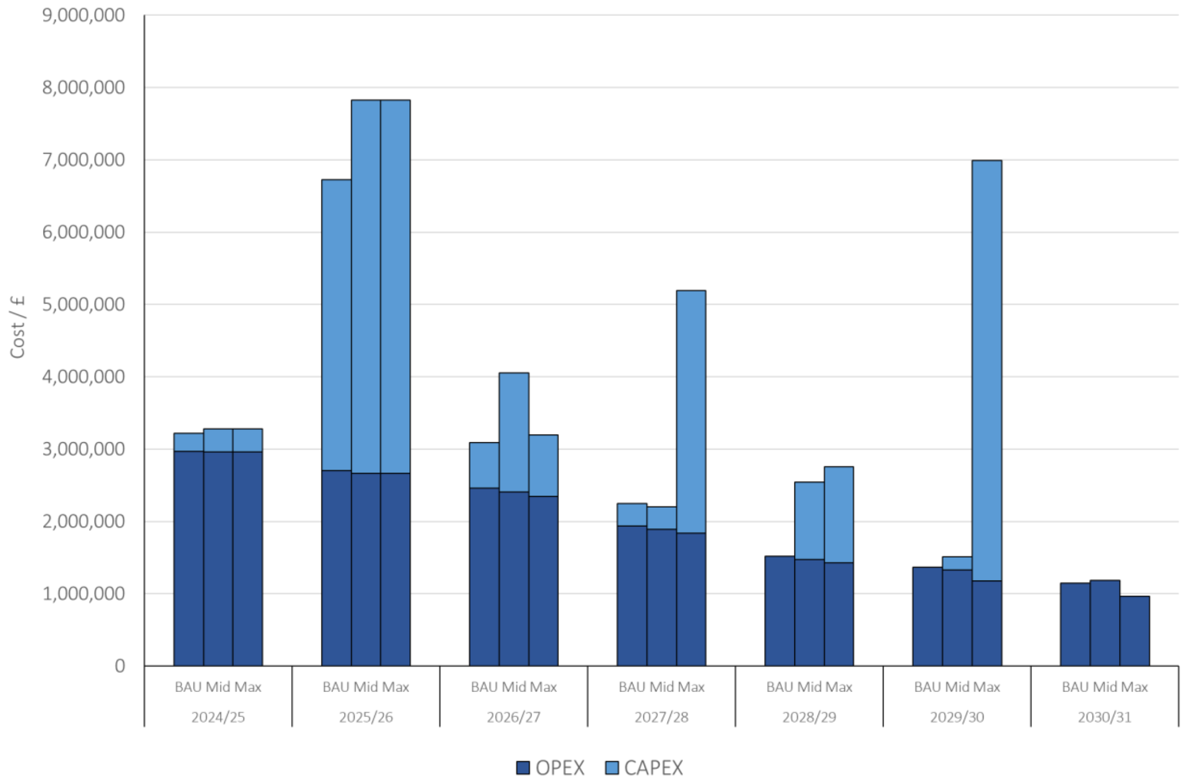

Figure 16: Annual capital and operational costs (£) associated with decarbonising ECC's non-domestic building stock under the three different scenarios.

Table 11: Cost breakdown of non-domestic emission reduction scenarios. Totals may not sum due to rounding

Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
BAU Scenario								
CAPEX	£250,000	£4,020,000	£629,000	£312,000	£0	£0	£0	£5,220,000
of which…								
Leisure centres	£0	£4,020,000	£272,000	£0	£0	£0	£0	£4,300,000
Corporate estate	£250,000	£0	£30,100	£312,000	£0	£0	£0	£593,000
Other non-domestic	£0	£0	£327,000	£0	£0	£0	£0	£327,000
OPEX	£2,970,000	£2,700,000	£2,460,000	£1,940,000	£1,520,000	£1,370,000	£1,150,000	£14,100,000
of which…								
Leisure centres	£1,200,000	£1,110,000	£1,010,000	£797,000	£624,000	£562,000	£471,000	£5,780,000
Corporate estate	£921,000	£823,000	£767,000	£613,000	£491,000	£442,000	£374,000	£4,430,000
Other non-domestic	£855,000	£764,000	£681,000	£526,000	£404,000	£363,000	£302,000	£3,890,000
Total	£3,220,000	£6,730,000	£3,090,000	£2,250,000	£1,520,000	£1,370,000	£1,150,000	£19,300,000
Mid Scenario								
CAPEX	£314,000	£5,160,000	£1,640,000	£312,000	£1,070,000	£182,000	£0	£8,680,000
of which…								
Leisure centres	£0	£5,160,000	£1,260,000	£0	£1,070,000	£0	£0	£7,480,000
Corporate estate	£314,000	£0	£60,600	£312,000	£0	£182,000	£0	£869,000
Other non-domestic	£0	£0	£327,000	£0	£0	£0	£0	£327,000
OPEX	£2,960,000	£2,670,000	£2,410,000	£1,890,000	£1,480,000	£1,330,000	£1,180,000	£13,900,000
of which…								
Leisure centres	£1,200,000	£1,090,000	£970,000	£757,000	£586,000	£528,000	£441,000	£5,560,000
Corporate estate	£913,000	£816,000	£758,000	£606,000	£486,000	£438,000	£438,000	£4,450,000
Other non-domestic	£855,000	£764,000	£681,000	£526,000	£404,000	£363,000	£302,000	£3,890,000
Total	£3,280,000	£7,830,000	£4,050,000	£2,200,000	£2,540,000	£1,510,000	£1,180,000	£22,600,000
Difference from BAU	£55,800	£1,100,000	£963,000	-£47,200	£1,020,000	£142,000	£34,200	£3,270,000

Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
Max Scenario								
CAPEX	£314,000	£5,160,000	£851,000	£3,350,000	£1,330,000	£5,820,000	£0	£16,800,000
of which…								
Leisure centres	£0	£5,160,000	£433,000	£1,980,000	£1,070,000	£529,000	£0	£9,170,000
Corporate estate	£314,000	£0	£60,600	£1,370,000	£264,000	£5,290,000	£0	£7,300,000
Other non-domestic	£0	£0	£357,000	£0	£0	£0	£0	£357,000
OPEX	£2,960,000	£2,670,000	£2,340,000	£1,840,000	£1,430,000	£1,180,000	£968,000	£13,400,000
of which…								
Leisure centres	£1,200,000	£1,090,000	£908,000	£710,000	£546,000	£491,000	£480,000	£5,350,000
Corporate estate	£913,000	£816,000	£760,000	£607,000	£483,000	£324,000	£260,000	£4,160,000
Other non-domestic	£855,000	£764,000	£675,000	£521,000	£400,000	£360,000	£300,000	£3,870,000
Total	£3,280,000	£7,830,000	£3,190,000	£5,190,000	£2,760,000	£6,990,000	£968,000	£30,200,000
Difference from BAU	£55,800	£1,100,000	£104,000	£2,940,000	£1,240,000	£5,620,000	-£179,000	£10,900,000
Difference from Mid	£0	£0	-£859,000	£2,990,000	£218,000	£5,480,000	-£214,000	£7,610,000

5 Transport

5.1 Current Sector Summary

ECC's 2023/24 emissions from all transport scopes amount to 1,300 tCO2e, a 19 tCO_2e increase from 2022/23, mostly attributable to an increase in Scope 3 commuting emissions from 390 tCO_2e in 2022/23, to 417 tCO_2e in 2023/24. A comparison of emissions by category for 2023/24 is shown in Figure 17. The largest contributor to transport emissions are the council's own vehicles, emitting 856 tCO_2e in 2023/24 (Scopes 1 & 2). Commuting follows at 417 tCO_2e whilst grey fleet and business travel contribute 16 tCO_2e and 10 tCO_2e respectively (all Scope 3 emissions).

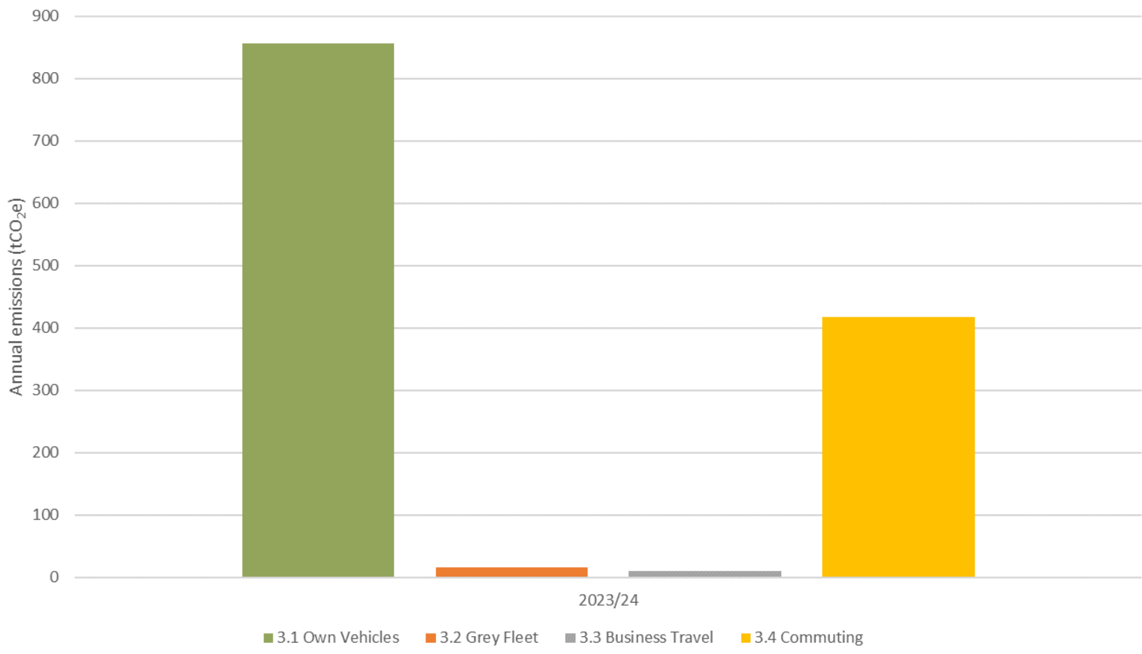

Figure 17: Annual emissions by sector 2023/24 (all scopes)

5.2 Own vehicles

Emissions form the council's own vehicles are under the direct control of the council and fall within Scope 1 & 2. Changes in emission are split into five sources, and three emission reduction scenarios modelled for each.

5.2.1 Growth of fleet

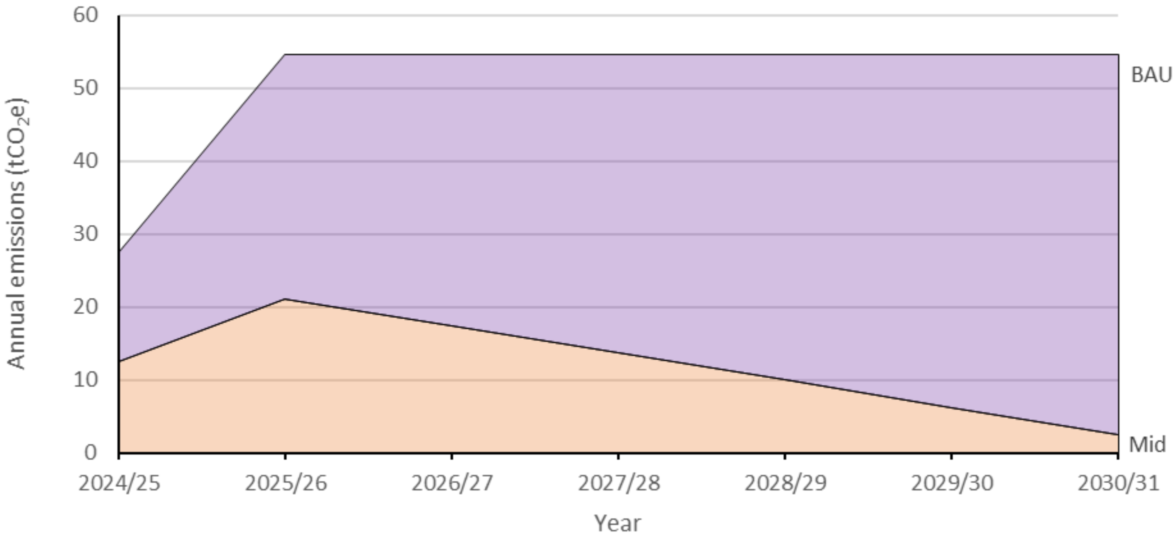

Figure 18: Growth of fleet emissions scenarios

The ECC fleet is assumed to grow in all emissions scenarios, with the addition of three food waste collection vehicles and a dedicated glass collection lorry. Under BAU, all vehicles procured are diesel, resulting in emissions from the growth of fleet increasing to and remaining at 55 tCO2e. An average fuel consumption of ECC's refuse collection vehicles (RCVs) from 2023/24 is used as a fuel use estimate for the newly procured RCVs. The cost of fuel per litre is projected to 2030 according to changes in crude oil price published by DESNZ [26]. These fuel price projections are used throughout the analysis. Each diesel RCV has an estimated monthly lease cost of £5,100 [27–29]. As the lease includes maintenance costs, monthly payments are categorised as OPEX. In total, increasing the fleet by four diesel RCVs has a lease cost of £244,800 per annum.

Under the Mid scenario, it is assumed that two of the vehicles procured are electric, alongside a phased introduction of Hydrotreated Vegetable Oil (HVO) from 2025/26 at 17% annual increments. HVO is a 'drop in fuel' and therefore can directly replace diesel without any modifications to the vehicle [30]. The price of HVO is assumed to be 47 pence higher per litre than diesel [31]. Each electric RCV has a lease cost of £9,600 per month, plus an initial CAPEX of £9,600 for a 40 kW rapid commercial charger per vehicle [32], [33]. The annual lease cost for two diesel RCVs and two eRCVs amounts to £352,800 [27–29], plus a CAPEX of £19,000 in 2024/25 for two chargers. It is assumed that all electricity used to charge refuse vehicles is supplied by the council's private wire solar connection at Water Lane, at no extra cost or emissions. The Mid case scenario results in an initial increase in emissions to 21 tCO2e in 2025/26, falling to 2 tCO2e in 2030/31 as the proportion of HVO used increases.

Under the Max scenario, all vehicles procured are electric and assumed to be charged using electricity from Water Lane. In consequence, there are no additional emissions for the growth of fleet under the Max scenario. Vehicle lease costs total £460,800 per annum, with a £38,000 CAPEX in 2024/25 for four 40 KW chargers.

5.2.2 Refuse vehicles

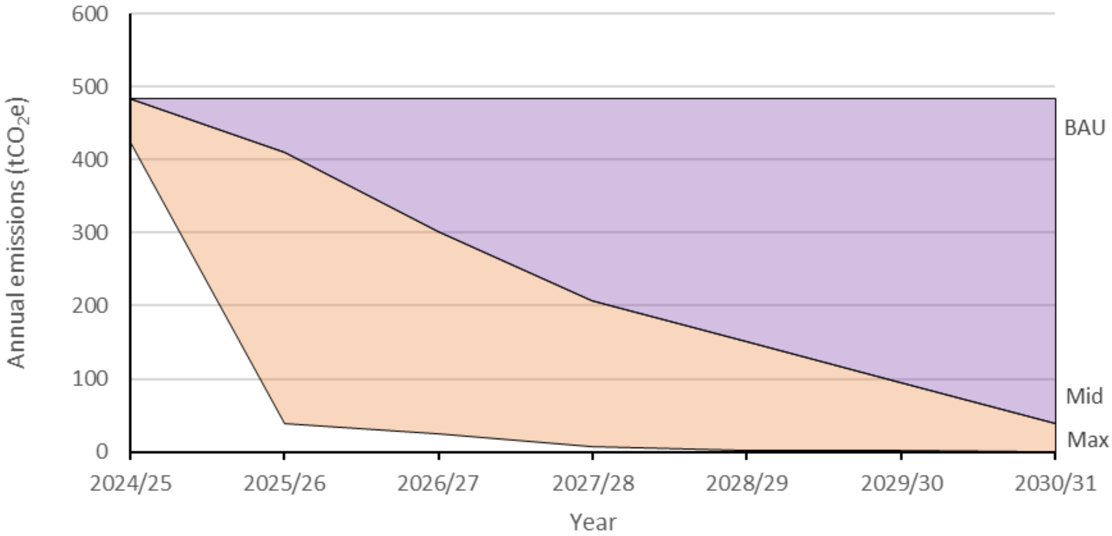

Figure 19: Refuse collection vehicle emissions reduction scenarios

Under BAU, it is assumed that RCVs are replaced with diesel vehicles at the end of their lease due to supply/ budget constraints. In consequence, emissions from RCVs remain at 483 tCO_2e, shown in Figure 19. The same cost assumptions used in 5.2.1 are used here providing a total lease cost of approximately £1 million per year for 17 vehicles.

Under the Mid scenario, three RCVs due for renewal in 2026 are replaced with electric vehicles and assumed to be charged via the Water Lane private wire connection at no extra cost or emissions. These have a total lease cost of £345,600, in addition to £856,800 for 14 diesel vehicles. Three 40 kW chargers are installed in 2026/27 with a CAPEX of £28,500. A phased introduction of HVO from 2025/26 at 17% annual increments is also assumed. Emissions therefore decrease from 483 tCO_2e in 2024/25 to 38 tCO_2e in 2030/31.

Under the Max scenario, all RCVs are replaced with electric RCVs at the end of their seven-year lease and assumed to be charged by Water Lane solar farm renewable supply. RCVs are therefore replaced incrementally, with a final lease cost of £2 million in 2030/31 when all RCVs are electric. All diesel is assumed to be replaced by HVO from 2025/26. Emissions fall steeply from 426 tCO_2e in 2024/25 to 39 tCO_2e in 2025/26, reducing to 0 tCO_2e in 2030/31.

It is assumed that the vehicle is replaced mid-way through the vehicle replacement year, resulting in 6 months emissions from diesel, and 6 months from electricity. Where vehicles lacked a replacement date on the fleet list, a replacement year of 2027/28 was assumed. These assumptions are made throughout the analysis.

5.2.3 Other vehicles

'Other vehicles' includes non-specialist vehicles such as pool cars and vans. Under BAU it is assumed that all non-specialist vehicles are replaced with an electric equivalent at the end of their lease. The assumed lease costs of the fossil fuel vehicle and its electric equivalent are listed in Table 12.

Table 12: Non specialist vehicle lease costs [27,29]

Vehicle type	Approximate monthly lease cost
Petrol car	£750
EV car	£544
Small diesel van	£544
Small electric van	£680
Medium diesel van	£840
Medium electric van	£1,500
Diesel tipper	£880
Electric tipper	£1,580

Vehicle efficiencies of 30% for diesel and 20% for petrol versus 90% for electric vehicles are assumed and used to calculate the number of kWh_e/l, providing an estimated conversion of 3.5 kWh/l which is used throughout the analysis. The DESNZ energy and emissions projections, volumed weighted electricity prices, are used to estimate electricity costs throughout [26].

The same scenario is assumed under the Mid and Max scenarios, with the addition of a phased HVO introduction of 17% per year in the mid case and a total replacement of diesel with HVO in 25/26 under the maximum scenario. Across the scenarios, a vehicle to charger ratio of 3:1 is assumed, with a cost of £1,000 per standard charger [33,34]. All scenarios result in 4 tCO_2e in 2030/31, however the Max scenario has a far steeper emissions reduction, falling from 44 tCO_2e in 2024/25 to 6 tCO_2e in 2025/26

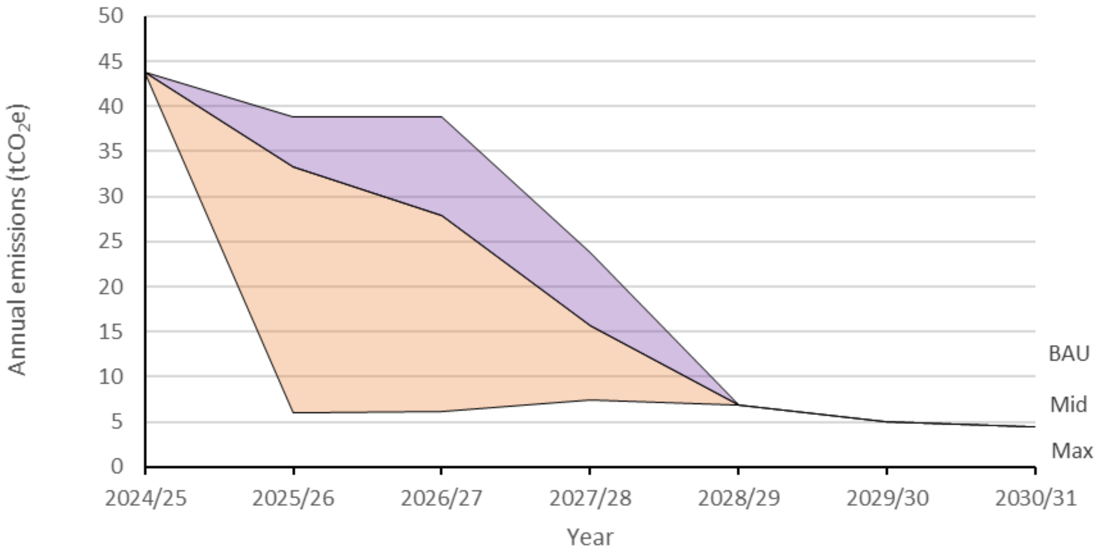

Figure 20: Other vehicles emissions reduction scenarios

5.2.4 Specialist vehicles

Under BAU, all specialist vehicles are assumed to continue to use fossil fuels, with emissions at a constant of 168 tCO_2e.

The Mid scenario assumes that 4% of specialist vehicles are electrified each year, summing 25% by 2030/31. A phased HVO introduction of 17% per year is also assumed from 2025/26 onwards. It is assumed that two vehicles are replaced with electric each year. As tipper vehicles are the most abundant in the specialist vehicle fleet, it is assumed that these vehicles will be replaced with an electric equivalent, increasing the lease from £880 to £1,580 monthly [27]. Small and large tractors are assumed to remain diesel with lease costs of £1,900 and £2,500 per vehicle per month respectively [35,36]. Figure 21 shows that under this scenario, emissions reduce gradually, from 169 tCO_2e in 24/25, to 17 tCO_2e in 30/31.

The Max scenario also assumes that 4% of specialist vehicles are electrified each year from 25/26 onwards, and that all fuel is replaced with HVO. This causes a steep decline in emissions shown in Figure 21, from 169 tCO_2e in 24/25 to 18 tCO_2e in 25/26. By 2030/31 emissions fall to 17 tCO_2e alike the mid case scenario.

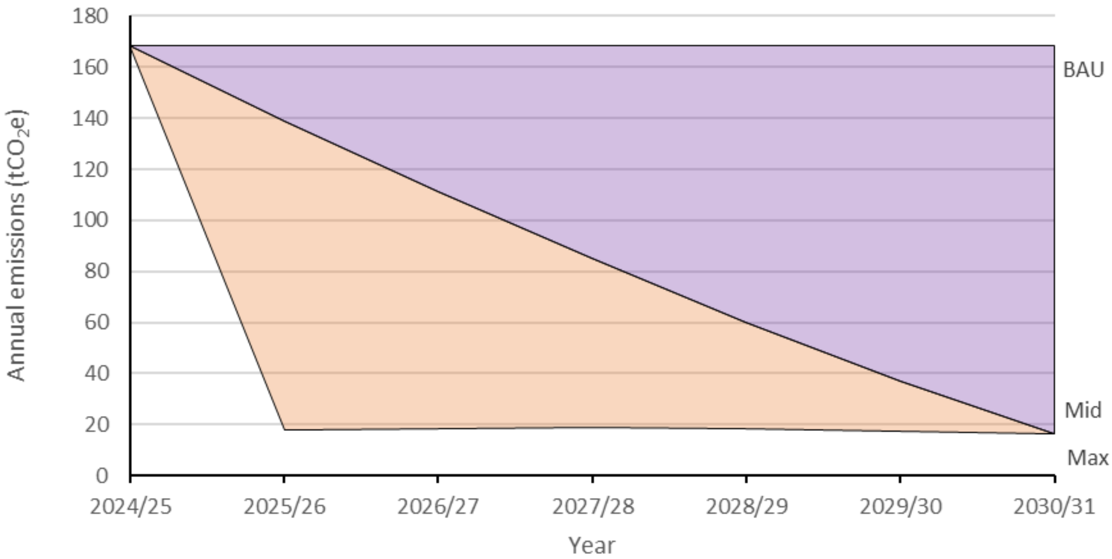

Figure 21: Specialist vehicles emissions reduction scenarios

5.2.5 Portable equipment

Under BAU, portable equipment remains unchanged, with emissions remaining at 55 tCO_2e. Under the Mid scenario, a phased introduction of HVO of 17% per annum from 2025/26, is assumed causing a gradual decline from 55 tCO_2e in 2024/25 to 6 tCO_2e in 30/31.

The Max scenario assumes that all fuel is replaced with HVO from 2025/26, and that 4% of portable equipment is replaced with an electric equivalent each year, summing 25% of equipment by 2030/31. It is assumed that two items of portable equipment are replaced annually, with an estimated CAPEX uplift of £300 compared to the fossil fuelled machinery. This is based on the price of a diesel versus electric mower (including the charger and a spare battery) [37]. Figure 22 shows that the Max scenario has a far steeper rate of decline compared to the mid case, falling from 55 tCO_2e to 6 tCO_2e between 2024/25 and 2025/26.

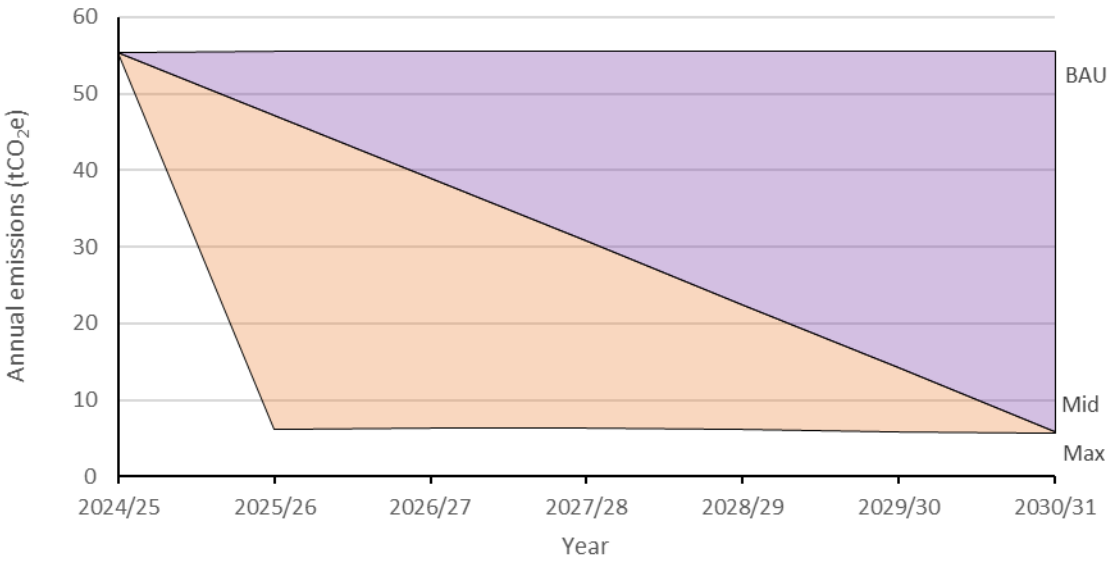

Figure 22: Portable equipment emissions scenarios

5.3 Summary of Modelling Assumptions

The full range of assumptions made for each combination of measure and scenario as discussed in the previous sections are shown in Table 13.

Table 13: Modelled assumptions for transport

Measure	BAU Scenario	Mid Scenario	Max Scenario
Growth of fleet	Procurement of three new food waste collection vehicles and one glass collection vehicle, all diesel	As BAU, half of vehicles procured are electric	As BAU, all vehicles procured are electric
Refuse vehicles	As is	Three electric RCVs procured Phased introduction of HVO from 2025- 20% increased per annum to 100% in 2030	Assume all vehicles replaced with EVs when lease period ends. The balance use HVO from 2025/26.
Other vehicles	Assume all non-specialist vehicles are replaced with EVs at the end of current lease period.	As BAU, with phased introduction of HVO from 2025/26, 17% per annum to 100% in 2030/31	As BAU, balance use HVO from 2025

Measure	BAU Scenario	Mid Scenario	Max Scenario
Specialist vehicles	As is	Phased introduction of HVO from 2025/26. 17% increase per annum to 100% in 2030/31	Assume 25% electrified by 2030/31 with balance using HVO
Portable equipment	As is	Phased introduction of HVO from 2025/26. 17% increase per annum to 100% in 2030/31	Assume 25% electrified by 2030/31 with balance using HVO

5.4 Projected Emissions to 2030/31

Figure 23 shows projected emissions from ECC's own vehicles under the three different scenarios. Under the Max scenario, overall emissions from council owned vehicles fall steeply from the current 856 tCO_2e to 69 tCO_2e in 2025/26 and to 27 tCO_2e in 2030/31. The Mid scenario follows a gradual trajectory, where emissions fall to 67 tCO_2e in 2030/31, shown by the middle line in Figure 23. In contrast, emissions under BAU increase slightly from 2024/25 levels to 801 tCO_2e in 2025/26. This number remains high, reducing only to 766 tCO_2e by 2030/31.

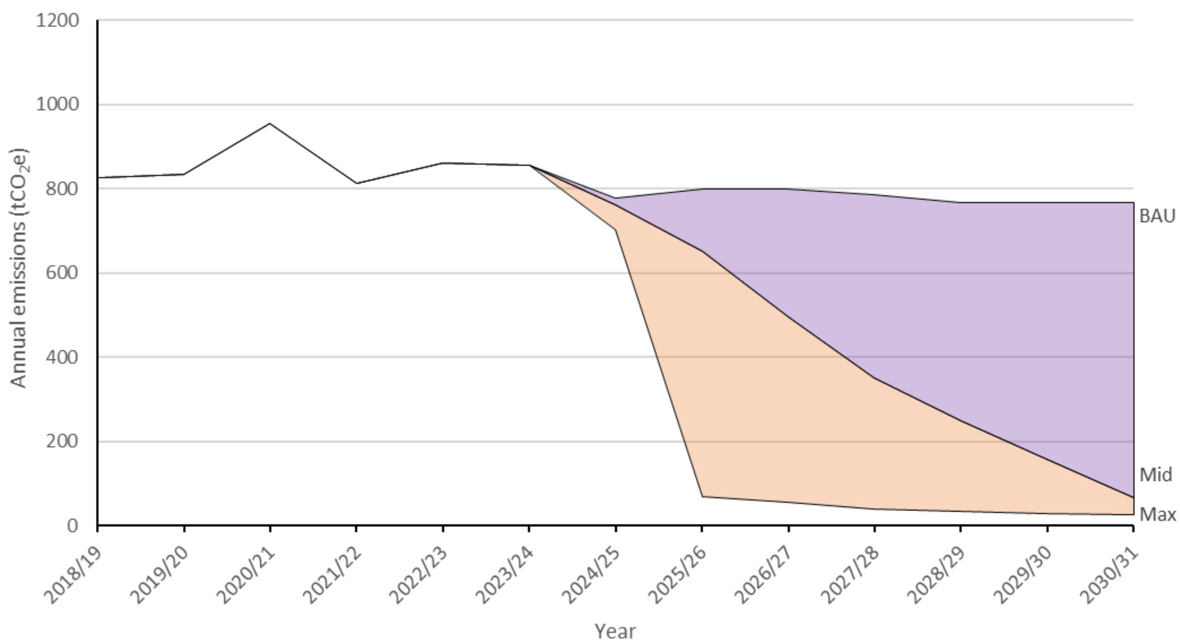

Figure 23: Own vehicles emissions scenarios

Figure 24 summarises the associated CAPEX and OPEX for each scenario across the years, including lease, maintenance, fuel and infrastructure costs. Capital costs are infrequent and small in comparison to operational costs due to vehicles being leased instead of purchased. Table 14 provides a full cost breakdown and cost difference across all transport scenarios

Table 14 shows an approximate £1.4 million cost difference between the BAU and Mid scenario total expenditure and a further £3.6 million to the Max scenario. The Max scenario leads to the fastest emissions reductions, with overall emissions reducing to a tenth of the previous year's emissions by 2025/26. The largest proportion of the council's transport emissions stem from RCVs. Refuse vehicles are therefore the council's highest priority for reducing transport emissions. While it is assumed that the electricity to charge these vehicles comes at no extra cost, these are the vehicles with the highest cost uplift (£4,500 per month) between diesel and electric alternatives. The main cost difference between the Mid and Max scenarios, stems from the proportion of eRCVs in the fleet. The Max scenario focusses on electrification of the fleet, with 100% of RCVs electric by 2030, with a cumulative Opex of £12.3 million. In comparison, only five RCVs are electrified in the mid case, including two in 'growth of fleet', therefore the increase in vehicle lease costs is far lower than in the maximum scenario. The focus instead is on increasing the proportion of HVO used in diesel vehicles to decarbonise the fleet and cumulative Opex sums £9.6 million.

The second largest emitter is the specialist vehicle fleet. Although 2030/31 emissions reach 17 tCO_2e in both the Mid and Max scenarios, the Max falls to 18 tCO_2e by 2025/26 whilst cumulative Opex amounts to £29,000 above the Mid. As Figure 29 shows, there is a range of emissions reduction between each pathway, thus an affordable but effective pathway can be found to decarbonise the council's fleet.

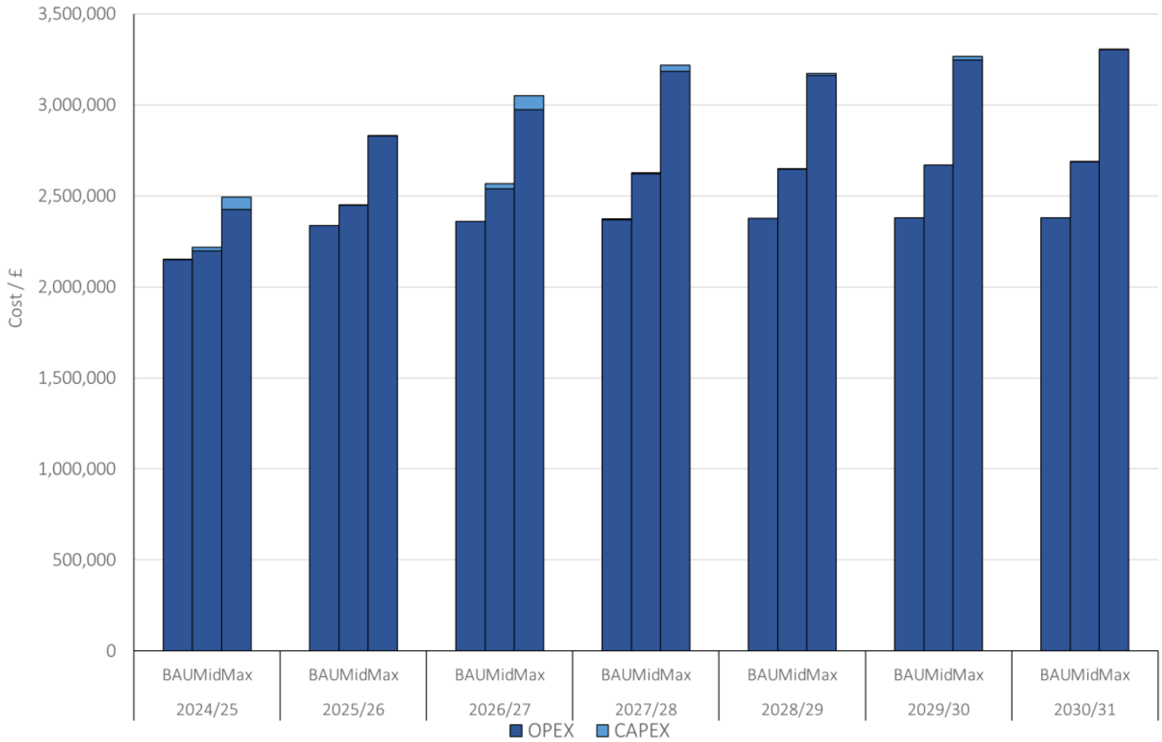

Figure 24: Costs of transport emissions reduction scenarios

Table 14: Cost breakdown of transport emissions reduction scenarios

Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
BAU Scenario								
CAPEX	£1,000	£0	£0	£5,000	£0	£0	£0	£6,000
of which...								
Other vehicles	£1,000	£0	£0	£5,000	£0	£0	£0	£6,000
OPEX	£2,151,000	£2,337,000	£2,359,000	£2,369,000	£2,377,000	£2,380,000	£2,379,000	£16,351,000
of which								
Growth of fleet	£134,000	£272,000	£274,000	£274,000	£274,000	£274,000	£274,000	£1,775,000
Refuse vehicles	£1,255,000	£1,283,000	£1,296,000	£1,296,000	£1,296,000	£1,298,000	£1,298,000	£9,021,000
Other vehicles	£147,000	£154,000	£155,000	£165,000	£174,000	£173,000	£172,000	£1,141,000
Specialist vehicles	£589,000	£599,000	£603,000	£603,000	£603,000	£604,000	£604,000	£4,205,000
Portable equipment	£26,000	£29,000	£31,000	£31,000	£31,000	£31,000	£31,000	£208,000
Total	**£2,152,000**	**£2,337,000**	**£2,359,000**	**£2,374,000**	**£2,377,000**	**£2,380,000**	**£2,379,000**	**£16,357,000**
Mid Scenario								
Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
CAPEX	£20,000	£1,000	£29,000	£6,000	£1,000	£0	£1,000	£58,000
of which...								
Growth of fleet	£19,000	£0	£0	£0	£0	£0	£0	£19,000
Refuse vehicles	£0	£0	£29,000	£0	£0	£0	£0	£29,000
Other vehicles	£1,000	£0	£0	£5,000	£0	£0	£0	£6,000
Specialist vehicles	£0	£1,000	£0	£1,000	£1,000	£0	£1,000	£4,000
OPEX	£2,198,000	£2,448,000	£2,540,000	£2,621,000	£2,648,000	£2,670,000	£2,685,000	£17,810,000
of which...								
Growth of fleet	£182,000	£366,000	£366,000	£367,000	£367,000	£370,000	£368,000	£2,385,000
Refuse vehicles	£1,255,000	£1,290,000	£1,358,000	£1,414,000	£1,418,000	£1,423,000	£1,426,000	£9,585,000
Other vehicles	£147,000	£155,000	£156,000	£166,000	£174,000	£173,000	£172,000	£1,143,000
Specialist vehicles	£589,000	£607,000	£627,000	£642,000	£656,000	£670,000	£684,000	£4,475,000
Portable equipment	£26,000	£30,000	£32,000	£33,000	£33,000	£34,000	£35,000	£223,000
Total	**£2,218,000**	**£2,449,000**	**£2,568,000**	**£2,627,000**	**£2,649,000**	**£2,670,000**	**£2,686,000**	**£17,868,000**
Difference from BAU	**£66,000**	**£112,000**	**£209,000**	**£253,000**	**£272,000**	**£290,000**	**£308,000**	**£1,511,000**
Max Scenario								
Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
CAPEX	£68,000	£2,000	£77,000	£35,000	£11,000	£20,000	£2,000	£213,000
of which...								
Growth of fleet	£38,000	£0	£0	£0	£0	£0	£0	£38,000
Refuse vehicles	£29,000	£0	£76,000	£29,000	£10,000	£19,000	£0	£162,000
Other vehicles	£1,000	£0	£0	£5,000	£0	£0	£0	£6,000
Specialist vehicles	£0	£1,000	£0	£1,000	£1,000	£0	£1,000	£4,000
Portable equipment	£0	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£4,000

OPEX	£2,424,000	£2,828,000	£2,974,000	£3,184,000	£3,162,000	£3,246,000	£3,303,000	£21,121,000
of which…								
Growth of fleet	£230,000	£461,000	£461,000	£461,000	£461,000	£461,000	£461,000	£2,995,000
Refuse vehicles	£1,433,000	£1,556,000	£1,690,000	£1,879,000	£1,839,000	£1,912,000	£1,958,000	£12,266,000
Other vehicles	£147,000	£158,000	£158,000	£166,000	£174,000	£173,000	£172,000	£1,148,000
Specialist vehicles	£589,000	£620,000	£634,000	£646,000	£659,000	£672,000	£684,000	£4,504,000
Portable equipment	£26,000	£34,000	£33,000	£31,000	£30,000	£28,000	£27,000	£208,000
Total	**£2,492,000**	**£2,829,000**	**£3,051,000**	**£3,219,000**	**£3,173,000**	**£3,265,000**	**£3,305,000**	**£21,334,000**
Difference from BAU	**£340,000**	**£492,000**	**£692,000**	**£845,000**	**£796,000**	**£886,000**	**£926,000**	**£4,977,000**
Difference from Mid	**£274,000**	**£380,000**	**£483,000**	**£592,000**	**£524,000**	**£596,000**	**£618,000**	**£3,466,000**

6 Renewable Energy

6.1 Current Sector Summary

Renewable electricity generation through installation of solar photovoltaic (PV) arrays delivers carbon savings as their output replaces alternative fossil fuel-based energy sources. PV mounted on ECC buildings, where the electricity generated is self-consumed in the buildings, is accounted for by reducing the amount of imported grid electricity and the carbon saving is reflected in Sections 3 and 4. This section considers electricity that is not directly used on site by ECC but is exported and therefore has the potential to offset carbon emissions on the pathway to net zero. In 2023/24, ECC's PV arrays generated 4,576 MWh, of which 2,989 MWh were exported, offsetting -619 tCO_2e (Figure 25).

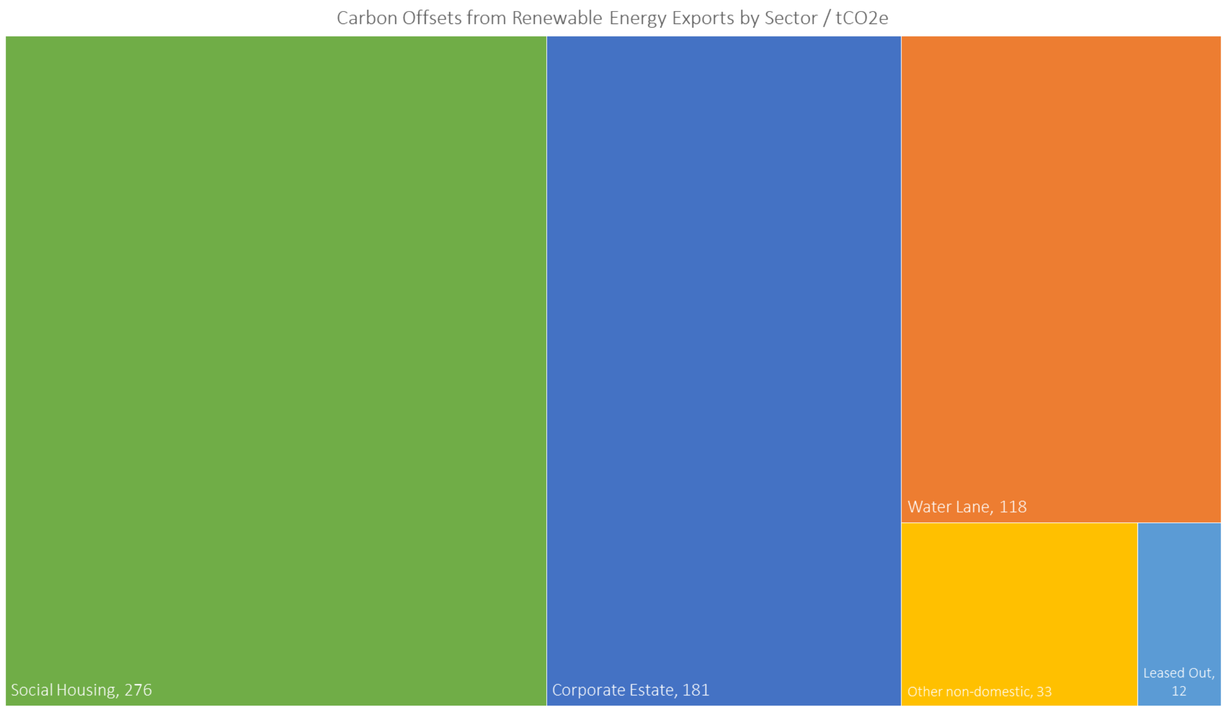

Figure 25: Breakdown by sector of 2023/24 offset emissions associated with energy exports from ECC's PV arrays in tCO_2e

In social housing, ECC's asset list indicates that 799 properties on the domestic estate have roof-mounted PV installations with a total estimated capacity of 2.5 MWp. In 2023/24 ECC's domestic PV arrays generated 2,062 MWh, of which 1,330 MWh were exported, offsetting -276 tCO_2e (Table 15).

Table 15: Estimated number of installations, electricity production, own use, and export from ECC's current domestic PV arrays in 2023/24

Installation date	N° of homes	N° of panels	Estimated generation (MWh)	Estimated own use (MWh)	Estimated export (MWh)	Average panel capacity (kWp)
Pre-2013	269	2,580	383	136	247	0.18
Post-2013	530	5,082	1,679	596	1,083	0.40
Total	**799**	**7662**	**2,062**	**732**	**1,330**	

The number of panels installed is derived from the PV modelling analysis carried out for ECC's 2020/21 carbon footprint [1]. On average, 9.6 panels are installed per home, totalling 7,662 panels. PV capacity is determined using the product specifications of most standard polycrystalline solar panel brands, assuming a 0.18 kWp average panel capacity for panels installed pre-2013 and a 0.4 kWp average panel capacity for panels installed post-2013. Generation is then estimated using a factor modelled on PVGIS[j] that indicates the average annual generation (in kWh) per unit of capacity (kWp) for an east or west facing panel (825.9 kWh yr^{-1} kWp^{-1}; see Section 3.7 for methodology). The reduced output compared to a south facing property accounts for properties where output might be compromised by shading or where the orientation or tilt are sub-optimal. Finally, exports and self-consumption (also derived from the PV modelling analysis carried out for ECC's 2020/21 carbon footprint [1]) are estimated and give a median self-consumption factor of 35% per home.

ECC has 3.4MWp of PV capacity in its non-domestic estate, including 12 roof-mounted arrays and the Water Lane ground-mounted installation. In 2023/24 ECC's non-domestic PV installations generated 2,513 MWh, of which 1,658 MWh were exported, offsetting -343 tCO_2e (Table 16).

Table 16: Electricity production, own use, export, and CO_2 emissions offset from ECC's current non-domestic PV arrays in 2023/24 (indicates leased building)*

Site	Array size (kWp)	Estimated generation (MWh)	Estimated own use (MWh)	Estimated export (MWh)	Carbon offset from exported energy (tCO_2e)	Solar generation data source
Water Lane	1,500	1,035	464	571	118	ECC Website
Livestock Centre	1,200	930	136	794	164	ECC Website
MA Car Park	150	135	36	99	20	ECC Website
JL Car Park	122	77	19	58	12	ECC Website
Riverside	120	119	119	0	0	ECC Website
Civic Centre	70	65	32	33	7	FIT PPA
MRF	50	34	17	17	3	FIT PPA
Ark	40	15	8	7	1	FIT PPA
Climb Centre*	29	32	0	32	7	FIT PPA
Wat Tyler House*	26	24	0	24	5	FIT PPA
RAMM	25	24	12	12	3	FIT PPA
Oakwood House	22	18	9	9	2	FIT PPA
Belle Isle	8	5	3	2	1	FIT PPA
Total	**3,362**	**2,513**	**855**	**1,658**	**343**	

Generation data is calculated from export data provided by ECC from Feed-In Tariff (FIT) Power Purchasing Agreements (PPAs), with estimated export assumed as 50% of the total generation. For sites without FIT PPAs, generation data is from ECC's published solar PV generation figures [38]. For leased sites all the generation is considered to be energy exported by the council (either to tenants or to the national grid). For sites owned by ECC, export data was obtained either from FIT PPAs or metered exports. No export data was provided for Riverside, so generation data was extracted from ECC's published solar figures [38], and exported energy

[j] Available at: https://re.jrc.ec.europa.eu/pvg_tools/en/

was estimated as 50% of the total generation. Own use by ECC included in Sections 3 and 4 is the difference between the generation and the assumed export.

6.2 Domestic PV Installation

Projections quantifying the installation of PV arrays on ECC's domestic estate use EPC data to identify suitable homes based on roof area (estimated from floor area) and roof tilt. Overall, 1,882 homes are identified as suitable for PV installation, with sufficient area for 18,058 panels. Assuming a 0.4 kWp average capacity per panel [39], this results in an additional 7.2 MWp installed capacity on ECC's domestic PV arrays.

The BAU scenario, assumes ECC will develops new PV on all suitable homes by 2050. The Mid scenario assumes the same milestone is achieved by 2040 and the Max scenario models the outcome if new PV opportunities are installed in all suitable homes by 2030. In all scenarios, PV installation is assumed to occur linearly until the target year, i.e. and equal number of installations every year.

As above, PV generation (in kWh) is modelled using the factor modelled in PVGIS[k] that provides average annual generation (in kWh) per unit of capacity (kWp) for an east or west facing panel (825.9 kWh $yr^{-1}kWp^{-1}$). The efficiency of PV panels deteriorates over time with most manufacturers providing a guarantee that the panel will retain 80% of its generating capacity after 20 years of service (equivalent to an average annual decrease of 1.1%). This factor is included in projections of PV generation. Exports are estimated using the 35% median self-consumption factor per home derived from the previous PV modelling analysis [1].

The CAPEX for PV installation on ECC's domestic buildings is included in section 3. However, the OPEX of exporting renewable energy generated by ECC's domestic estate has been excluded from this analysis, as there is insufficient information on the who benefits from selling renewable energy or the purchasing schemes and agreements that are or would be in place for current or future schemes. For example, installations prior to 2019 receive Feed-In Tariffs that reward both the generation and export of renewable energy. The rates are set annually by Ofgem and vary for each installation depending on size, installation date, and home energy efficiency. Installations post-2019 receive Smart Export Guarantee (SEG) tariffs that are set by and agreed on directly with energy suppliers. Estimating income from exporting renewable energy from ECC's diverse social housing PV stock without detailed information id therefore impractical. The assumption of no income leads to an overestimate of the overall costs, as the cost of domestic PV installation is quantified but its financial benefits are not.

6.3 Non-domestic PV installation

Installation of new PV arrays on ECC's non-domestic estate with potential to offset emissions via energy exports includes ten rooftop systems (Table 17). The installation date for these projects is assumed to be late 2025, although in practise there are uncertainties surrounding the timing including the future of some buildings in the ECC property portfolio and difficulties in gaining timely access to the electricity grid.

[k] Available at: https://re.jrc.ec.europa.eu/pvg_tools/en/

Table 17: ECC's currently identified non-domestic PV opportunities (indicates leased building)*

Site	Array size (kWp)
Exeter Arena	72
Wonford Sports Centre	49
Corn Exchange	29.5
Guildhall Shopping Centre*	346
Exeter Bus Station*	40
St Sidwell's Point Leisure Centre	146
Guildhall Car Park	321
ISCA	158
RAMM	30
Northbrook	21.6
Total	**1213.1**

Data on the installed capacity of potential PV projects was provided by ECC. The average load factor of ECC's current installations (9%), and the 1.1% annual panel deterioration factor is applied to estimate PV generation from future installations.

Exports from projected generation assumes the current export to generation ratio (66%) is maintained for sites occupied by ECC, with the remaining generation (34%) being self-consumed. For leased out buildings, exports are assumed to be 100% of the generation.

The BAU scenario assumes that ECC develops new roof-mounted PV installations on Exeter Arena, Wonford Sports Centre, Corn Exchange, Guildhall Shopping Centre, Exeter Bus Station, St Sidwell's Point Leisure Centre, and Guildhall Car Park. The Mid scenario assumes all new roof-mounted opportunities are implemented and the Max scenario models the outcome if all new roof-mounted PV opportunities are installed except Northbrook, which is projected to be closed under a Max Scenario (see Section 4).

The financial implications of exporting renewable energy generated from PV on ECC's non-domestic estate are modelled. The initial capital investment for PV installation is included in Section 4, while the financial benefits of selling renewable energy exports from 2024/25 to 2030/31 are quantified here[l].

Sales projections from 2024 to 2030 are made using the volume-weighted electricity wholesale prices obtained from Annex M from the 'Energy and Emissions Projections: 2022 to 2040' report by the Department for Energy Security and Net Zero (DESNZ) [2]. Values are from the reference scenario (which assumes average fossil fuel prices and economic growth and includes existing and planned policies (Table 18)) and are used to estimate export sales for both existing and new PV developments, ignoring any existing PPAs in place. Income from solar generation (not just exports) on solar sites with FIT PPAs is also excluded, as the analysis focuses on the impacts and benefits for renewable energy exports. For leased out buildings, there is no price distinction made between energy exports to the grid or energy sold to the tenant, and the volume-weighted wholesale prices are also assumed. For solar sites installed

[l] Note this analysis provides indicative estimates of income by assuming a general market price each year. Individual sites can potentially optimise their income through power sales agreements and/or market strategies.

on buildings occupied by ECC, the savings from self-consuming the energy generated are reflected as reduced electricity imports, which is included in the cost analysis in Section 4.

Table 18: Projected volume-weighted wholesale energy prices from 2023/24 to 2030/31

Year	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Price (p kWh^{-1})	10.85	11.96	10.68	9.90	7.65	5.87	5.28	4.39

6.4 Ground-mounted PV installation

Installation of free-standing ground-mounted PV arrays (GPV) on ECC's estate is modelled on the University fields at Streatham together with a second ground-mounted array in Water Lane, near Grace Road (Table 19). The installation date for these projects is assumed to be 2025 and 2028, respectively. As with the non-domestic PV installations, there is considerable uncertainty surrounding the timing and feasibility of these schemes.

Table 19: ECC's currently identified ground-mounted PV opportunities

Site	Array size (kWp)	Assumed initial financial year of production
University fields (Streatham)	2,000	2026/27
Water Lane II	2,600	2028/29
Total	**4,600**	

The analysis combines ECC data on the proposed installed capacity with the average load factor of ECC's current installations (9%), and the 1.1% annual panel deterioration factor and assumes exports to be 100% of the generation.

The BAU and Mid scenarios assume that ECC does not develop any new GPV. The Max scenario models both GPV arrays being installed.

The financial analysis includes the CAPEX to developing the arrays and the OPEX revenue from selling renewable energy exports from 2024/25 to 2030/31.

The CAPEX of GPV can vary greatly depending on the nature of the site, its capacity and solar PV market dynamics. Exeter City Council's 1.2MW array on the difficult Water Lane site cost £840,000 per MW[m] however, economies of scale on larger arrays and installation on potentially easier sites can reduce Capex to around £500k per MW [40]. The initial capital investment for developing GPV is modelled using the lower figure.

The methodology to estimate OPEX from 2024/25 to 2030/31 is the same as for non-domestic PV installations. Projections were made using the volume-weighted electricity wholesale prices shown in Table 18.

6.5 Summary of Modelling Assumptions

The assumptions made for each combination of measure and scenario is shown in Table 20.

[m] Private correspondence with Exeter City Council

Table 20: Modelled assumptions for renewable energy

Measure	BAU Scenario	Mid Scenario	Max Scenario
Domestic PV installation	Install PV on all suitable homes by 2050 – 70 homes a year	Install PV on all suitable homes by 2040 – 111 homes a year	Install PV on all suitable homes by 2030 – 269 homes a year
Non-domestic PV installation	New PV arrays in Exeter Arena, Wonford Sports Centre, Corn Exchange, Guildhall, Exeter Bus Station, St Sidwell's Point, and Guildhall Car Park– installation in late 2025	All new PV opportunities implemented– installed in late 2025	All new PV opportunities implemented, except Northbrook– installation in late 2025
Ground-mounted PV installation	None	None	University fields array installed in 2028, and Water Lane II installed in 2025

6.6 Projected Emissions to 2030/31

In the BAU scenario, ECC's PV array exported energy offsets -641 tCO_2e in 2024/25, -581 tCO_2e in 2026/27 (when new non-domestic and ground-mounted PV is installed) and -268 tCO_2e in 2030/31.

The Mid scenario, by implementing all new roof-mounted opportunities, offsets -659 tCO_2e in 2024/25, -633 in 2026/27, and -309 tCO_2e in 2030/31.

In the Max scenario, pursuing all new PV opportunities scoped offsets -726 tCO_2e in 2024/25, increasing to -997 tCO_2e in 2026/27, when 3.2MWp of additional PV capacity is installed. In 2030/31 PV exports offset -652 tCO_2e.

Figure 26 shows the comparison of the current and future scenarios for emissions reduction through renewable energy exports from both domestic and non-domestic PV arrays.

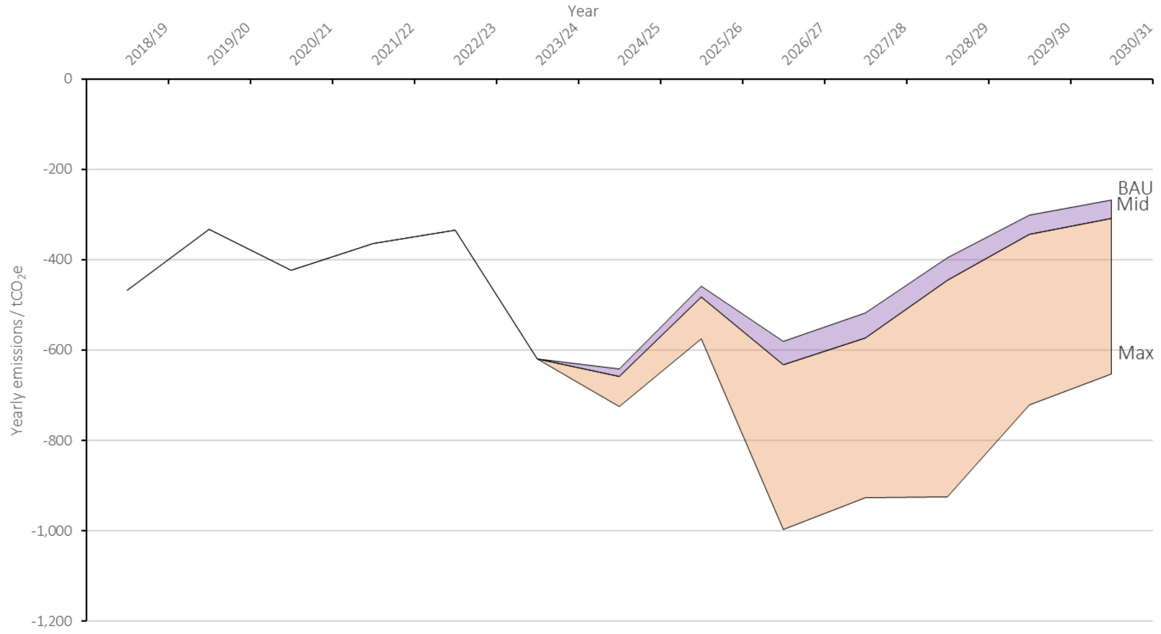

Figure 26. Annual GHG offset through renewable energy exports in different PV installation scenarios

The increases in offset emissions in Figure 26 reflect the development of new renewable energy projects, particularly in 2026/27 when 3.2MWp of additional PV are installed in the Max scenario.

Most of the offsets in 2030/31 under a Max scenario come from the domestic PV arrays (47%), and GPV (32%), with the remainder being exported by non-domestic PV arrays (21%). However, Figure 26 illustrates the annual year-on-year reduction in future carbon offsets achieved through renewable energy exports which is partly due to solar panel efficiency deterioration, but mainly due to the continuing fall in grid electricity emission factors caused by national electricity grid decarbonisation. In 2030 the grid emission factor is projected to have fallen by 70% from the current 0.207 kg CO_2e kWh^{-1} to 0.062 kg CO_2e kWh^{-1}.

From a financial perspective, in the BAU scenario, after the initial CAPEX investment reflected in the Section 4 costs, exporting ECC's non-domestic PV will provide an OPEX benefit £196,000 in 2024/25 and £92,000 in 2030/31. In the Mid scenario, exports will generate £196,000 in 2024/25, £228,000 in 2026/27 and £97,000 in 2030/31 and in the Max scenario, exports from non-domestic PV and GPV will generate £196,000 in 2024/25, £375,000 in 2026/27, and £242,000 in 2030/31 (Figure 27). The Max scenario includes capital investments of £1 million in 2025/26 and £1.3 million in 2027/28 to develop the GPV installations. OPEX is shown as a negative cost in Figure 27 as it represents an income rather than an expenditure[n].

[n] Revenue will notably increase if income from exporting domestic PV is considered

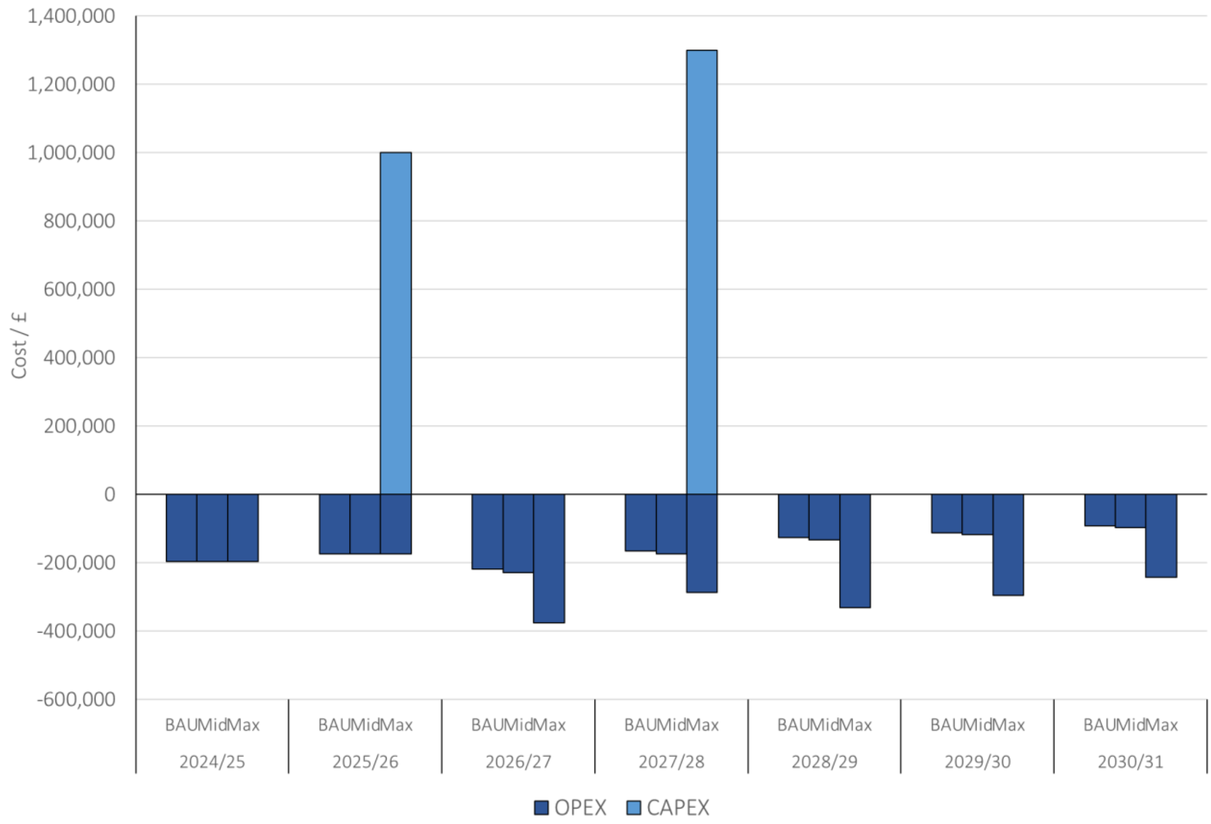

Figure 27. Annual costs from exporting renewable energy in different PV installation scenarios

A further breakdown of the costs is shown in Table 21. Overall, from 2024/25 to 2030/31 the Mid scenario generates £35,000 more than the BAU, and the Max scenario generates £780,000 more than the Mid-case and £815,000 more than the BAU. When including the CAPEX of developing GPV the cumulative costs of the Max scenario are £1.5 million higher than the BAU and the Mid scenarios, although this will reduce if considered beyond 2030 as ECC's PV portfolio continues to offset emissions and generate income.

Table 21: Breakdown of annual OPEX, CAPEX, and cost differences from exporting renewable energy between PV installation scenarios.

Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
BAU Scenario								
CAPEX	£0	£0	£0	£0	£0	£0	£0	£0
OPEX	-£196,000	-£173,000	-£218,000	-£166,000	-£126,000	-£112,000	-£92,000	-£1,083,000
Total	-£196,000	-£173,000	-£218,000	-£166,000	-£126,000	-£112,000	-£92,000	-£1,083,000
Mid Scenario								
CAPEX	£0	£0	£0	£0	£0	£0	£0	£0
OPEX	-£196,000	-£173,000	-£228,000	-£174,000	-£132,000	-£118,000	-£97,000	-£1,118,000
Total	-£196,000	-£173,000	-£228,000	-£174,000	-£132,000	-£118,000	-£97,000	-£1,118,000
Difference from BAU	£0	£0	-£10,000	-£8,000	-£6,000	-£6,000	-£5,000	-£35,000
Max Scnario								
CAPEX	£0	£1,000,000	£0	£1,300,000	£0	£0	£0	£2,300,000
OPEX	-£196,000	-£173,000	-£375,000	-£286,000	-£331,000	-£295,000	-£242,000	-£1,898,000

Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
Total	-£196,000	£827,000	-£375,000	£1,014,000	-£331,000	-£295,000	-£242,000	£402,000
Difference from BAU	£0	£1,000,000	-£157,000	£1,180,000	-£205,000	-£183,000	-£150,000	£1,485,000
Difference from Mid	£0	£1,000,000	-£147,000	£1,188,000	-£199,000	-£177,000	-£145,000	£1,520,000

The annual reduction in future income from exporting renewable energy is due both to solar panel efficiency deterioration producing less electricity and the projected fall in energy prices. In 2030, wholesale energy prices are projected to have fallen by 60% from the current 10.85 p per kWh to 4.39 p per kWh. Increases in revenue reflected in each scenario in Figure 27 are due to development of new PV arrays.

While renewable electricity generation with a business case will continue to be financially attractive, add local energy resilience, and hedge against rising energy prices, falling national grid electricity emission factors mean that its role in offsetting carbon emissions in other sectors will reduce over time.

7 Land Use Change/Afforestation

7.1 Current Sector Summary

Land use change through afforestation of unforested land delivers valuable carbon sequestration as trees capture carbon from the atmosphere and transform it into biomass, a process that has the potential to offset carbon emissions on the pathway to net zero.

ECC owns 409 ha of parks and greenspaces (P&GS), including the 162 ha of the city's Valley Parks which are managed by the Devon Wildlife Trust (Table 22).

Table 22: ECC P&GS areas [o]

Greenspace	Area (ha)
Ludwell Valley Park	80
Riverside Valley Park	40
Mincinglake Valley Park	19
Barley Valley Park	11
Duryard & Belvidere Valley Park	11
Whitycombe Valley Park	1
Other ECC owned Greenspaces	247
Total	**409**

Currently, ECC's P&GS has a 24% canopy cover (~98 ha), which sequesters -155 tCO_2e annually. The carbon sequestration rate for this calculation was derived from a recent study by Treeconomics on Exeter's treescape [41], which estimated Exeter's full canopy cover (950 ha) sequestered 1,510 tCO_2e every year (average sequestration rate = -1.6 $tCO_2e\ ha^{-1}\ yr^{-1}$).

Further tree planting efforts by ECC have increased their tree stock by 748 trees [42] (107 standard trees, 50 heritage variety fruit trees, and 591 broadleaf whips). Assuming a planting density of 1,600 trees ha^{-1} and a broadleaf yield class, these will account for 0.35 tCO_2e emissions in 2023/24.

7.2 Tree Planting

Additional tree planting scenarios to further offset the council's GHG emissions were modelled using data from the Sixth Carbon Budget [9], which provides GHG savings from planting different types of biomasses of different yield classes (Figure 28). Broadleaf YC6- managed has been assumed as a generic broadleaf yield class for the calculations, although in reality the tree species planted may differ.

[o] Source: Devon Wildlife Trust

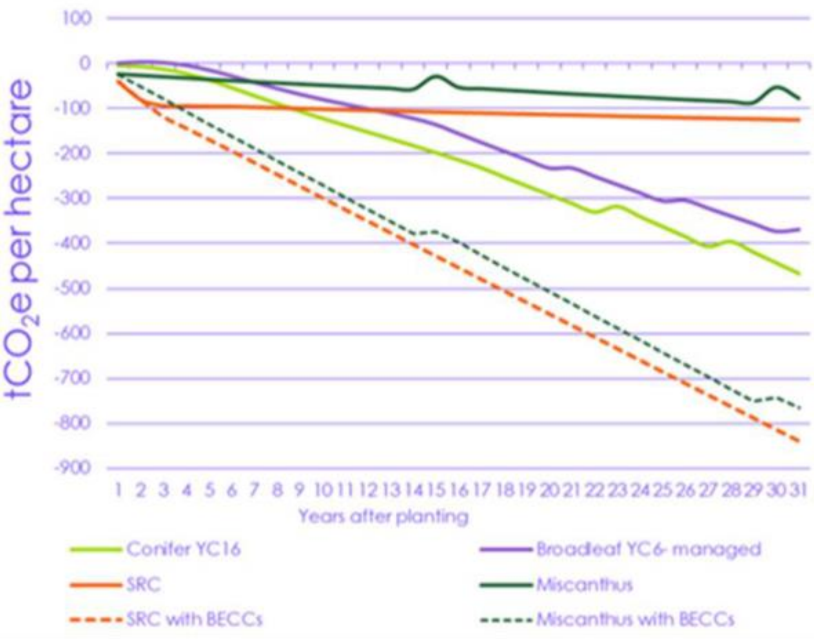

Figure 28. Cumulative GHG savings over time from planting different types of biomasses [9]

The BAU scenario assumes no additional tree planting. The Mid scenario models an increase the canopy cover of its P&GS to 30% (planting an additional 24.5 ha), as stated in ECC's Tree and Woodland Strategy 2023-2033 [43] and in its Net Zero Carbon Reduction Plan version 4.0 [42]. Assuming a planting density of 1,600 trees ha^{-1}, this would entail planting over 39,000 trees. The Max scenario, although unfeasible, models the carbon offset achieved if ECC planted 100% of its owned P&GS with woodlands. This would entail planting almost 500,000 trees to cover the entirety of the P&GS. In all scenarios, planting is assumed to take place evenly between 2024 and 2030.

The financial implications of each tree planting scenario include the initial CAPEX of planting a tree and the OPEX arising from tree maintenance costs. The National Trust estimates it costs £5 to plant a new tree sapling [44]. However, prices for tree planting can vary depending on the age of the tree, tree species, plantation size, planting location, planting density, and the service provider. There are also numerous initiatives subsidising large scale tree planting projects to make them more affordable, such as the MOREwoods scheme by the Woodland Trust which can reduce costs to as little as £1 per tree [45]. These opportunities are available to local authorities but involve undergoing an application and selection process, so they are not guaranteed. A conservative cost of £5 per tree is assumed for this analysis. A planting density of 1,600 trees ha^{-1} is also assumed.

OPEX is calculated as the overall maintenance costs for an area of woodland, including watering, mulching, pruning, weed control, pest and disease management, and monitoring. A 2011 study for the Woodland Trust estimated the annual average cost of maintaining a woodland in a managed green space is £1,065 per hectare [46]. Accounting for inflation, the revised estimated annual cost of maintaining a woodland assumed in this analysis is £1,488 per hectare. OPEX is modelled in all scenarios for both the existing tree stock, and for additional tree planting. Inflation or deflation in tree planting and maintenance prices in future years is not included in the analysis.

7.3 Summary of Modelling Assumptions

The assumptions made for each combination of measure and scenario is shown in Table 23.

Table 23: Modelled assumptions for land use/afforestation

Measure	BAU Scenario	Mid Scenario	Max Scenario
Tree Planting	No additional tree planting	Increase P&GS canopy cover to 30% – ~5,600 trees every year	Increase P&GS canopy cover to 100% – ~71,000 trees every year

7.4 Projected Emissions to 2030/31

The BAU scenario, ECC's current tree stock (including tree planting during 2023, modelled using Figure 28) will offset -154 tCO_2e in 2024/25 and -162 tCO_2e in 2030/31.

The Mid scenario, increasing ECC's P&GS canopy cover to 30% by planting broadleaf woodland would emit 3 tCO_2e in 2024/25, and offset -148 tCO_2e by 2030/31, shifting ECC's total offsets through afforestation to -151 tCO_2e and -310 tCO_2e, respectively.

The Max scenario, increasing ECC's P&GS canopy cover to 100% by planting broadleaf woodland would emit 34 tCO_2e in 2024/25, and offset an additional -1,871 tCO_2e by 2030/31, shifting ECC's total offsets through afforestation to -121 tCO_2e and -2,033 tCO_2e, respectively.

Figure 29 shows the comparison of the current and future scenarios for emissions reduction through afforestation. Note that after initial planting, broadleaf trees can be a net source of carbon, emitting up to 3 $tCO_2e\ ha^{-1}\ yr^{-1}$ [9]. This is because in the initial stage of development plant respiration can exceed photosynthetic activity as the sapling is establishing its roots. Furthermore, root establishment can disturb soils, releasing the organic carbon stored in them.

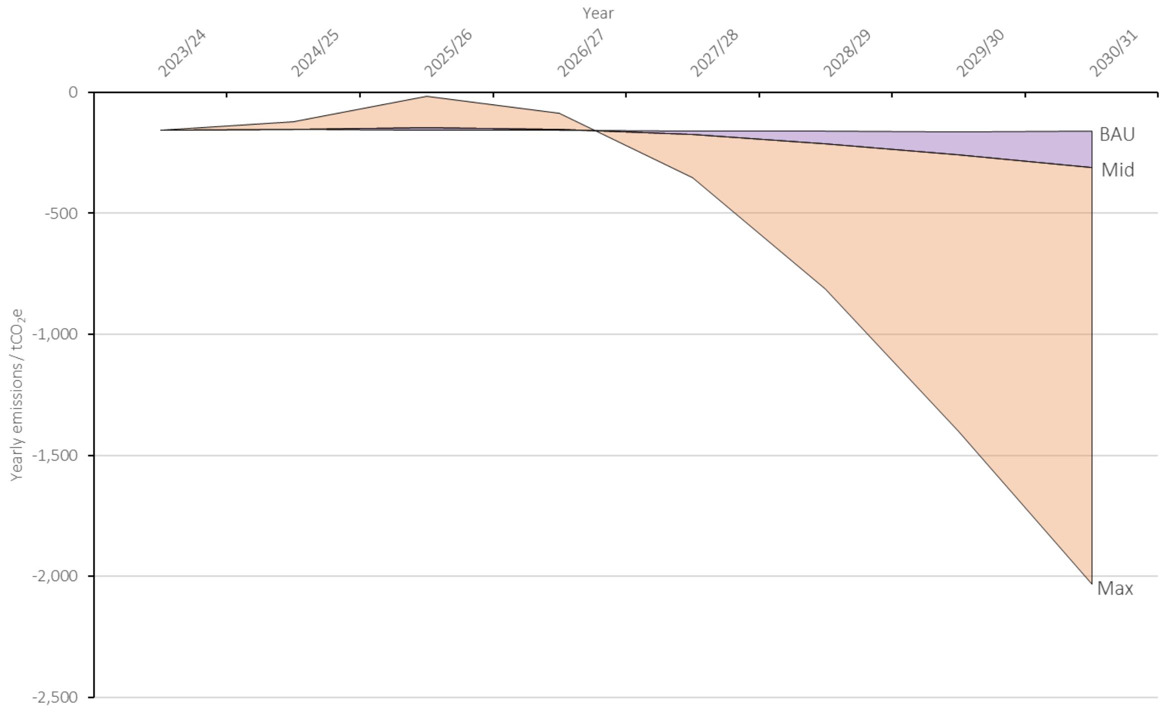

Figure 29: Annual GHG offset through land use change in different tree planting scenarios

While the Mid scenario represents valuable progress towards net zero, the ambitious scenario of 100% canopy cover in ECC's P&GS has the potential to increase potential offset emissions eight-fold. Opportunities to expand current planned efforts and increase canopy cover beyond 30% should perhaps be considered.

From a financial perspective, maintenance costs for the existing tree stock in a BAU scenario without additional planting will amount to £146,000 annually from 2024/25 to 2030/31. Increasing canopy cover to meet the goals set out in the Mid scenario will cost £28,000 annually if planting occurs evenly from 2024/25 to 2030/31. This increases annual maintenance costs by over £5,000 every year, leading to an OPEX of £151,000 in 2024/25, and £183,000 in 2030/31. Planting 71,000 trees every year to increase the P&GS canopy cover to 100% in the Max scenario would cost £355,000 annually and increases annual maintenance costs by over £66,000 every year compared to the BAU scenario, leading to an OPEX of £212,000 in 2024/25, and £609,000 in 2030/31 (Figure 30).

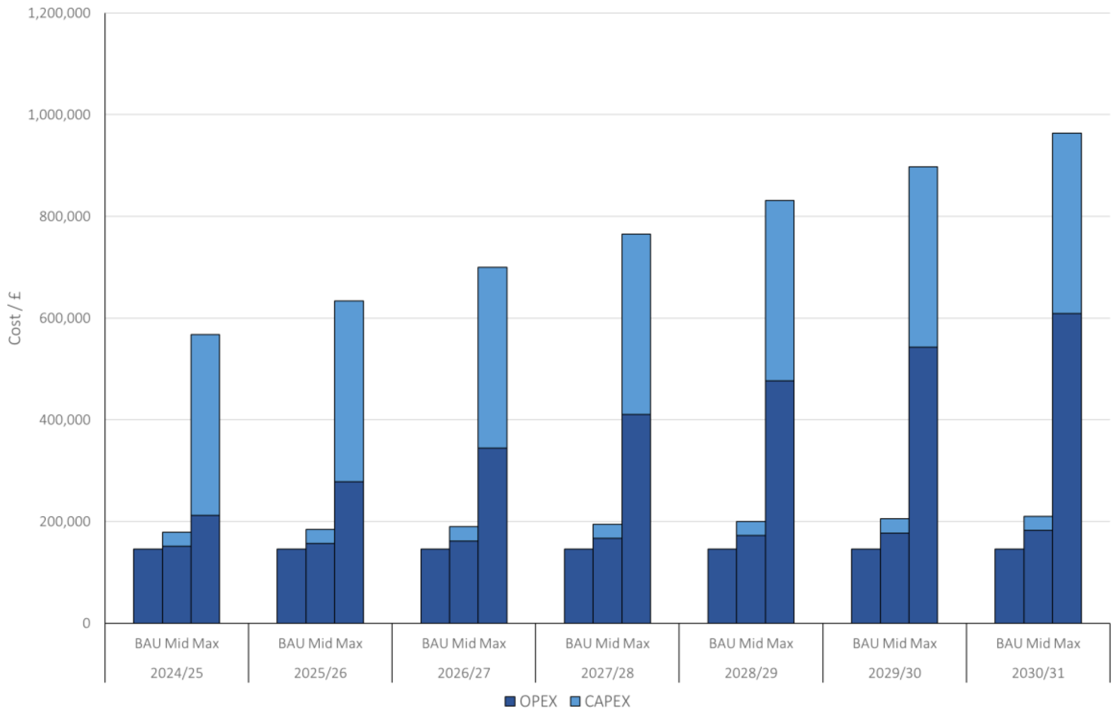

Figure 30: Annual costs for offsetting emissions through land use change in different tree planting scenarios.

A further breakdown of costs is shown in Table 24. Overall, from 2024/25 to 2030/31 the Mid case scenario costs £342,000 more than the BAU, and the Max scenario costs £4 million more than the mid-case and £4.3 million more than the BAU.

Table 24: Breakdown of annual OPEX, CAPEX, and cost differences from offsetting emissions though land use change between tree planting scenarios

Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
BAU Scenario								
CAPEX	£0	£0	£0	£0	£0	£0	£0	£0
OPEX	£146,000	£146,000	£146,000	£146,000	£146,000	£146,000	£146,000	£1,022,000
Total	**£146,000**	**£146,000**	**£146,000**	**£146,000**	**£146,000**	**£146,000**	**£146,000**	**£1,022,000**
Mid Scenario								
CAPEX	£28,000	£28,000	£28,000	£28,000	£28,000	£28,000	£28,000	£196,000
OPEX	£151,000	£156,000	£162,000	£167,000	£172,000	£177,000	£183,000	£1,168,000
Total	**£179,000**	**£184,000**	**£190,000**	**£195,000**	**£200,000**	**£205,000**	**£211,000**	**£1,364,000**
Difference from BAU	£33,000	£38,000	£44,000	£49,000	£54,000	£59,000	£65,000	£342,000
Max Scenario								
CAPEX	£355,000	£355,000	£355,000	£355,000	£355,000	£355,000	£355,000	£2,485,000
OPEX	£212,000	£278,000	£344,000	£410,000	£476,000	£543,000	£609,000	£2,872,000
Total	**£567,000**	**£633,000**	**£699,000**	**£765,000**	**£831,000**	**£898,000**	**£964,000**	**£5,357,000**
Difference from BAU	£421,000	£487,000	£553,000	£619,000	£685,000	£752,000	£818,000	£4,335,000
Difference from Mid	£388,000	£449,000	£509,000	£570,000	£631,000	£693,000	£753,000	£3,993,000

An important aspect to consider before designing a tree planting strategy is the increased carbon sequestration offered by conifers due to their faster growth rates (Figure 28). However, native tree species mixes provide a greater benefit to the local wildlife and biodiversity [47]. Climate resilience and tree diseases also need to be accounted for when selecting tree species to ensure the longevity of ECC's tree stock, e.g., the ash dieback epidemic threatens to wipe out over 80% of ash trees across the UK [48]. Finally, management practices stipulated for each yield class need to be considered to maximise carbon uptake of the afforested land.

While the analysis illustrates the potential of afforestation to reduce ECC's emissions the impact of tree planting must not be overestimated and relied upon, as even in the most ideal scenario tree planting only has the theoretical potential to offset -2,033 tCO_2e by 2030. Nevertheless, it provides an invaluable asset for long-term carbon capture and storage that will help progress towards net zero, as well as providing other benefits such as biodiversity enhancement, ecotourism, and air quality improvement.

8 Overall Results

ECC's projected Scope 1 and 2 organisational footprint to 2030/31 under the three scenarios is shown in Figure 31. The graph exhibits a similar shape to the social housing operational emission projections in Figure 5 because the sector accounts for a considerable portion of ECC's organisational footprint (86% in 2023/24) and is modelled with the most rigorous decarbonisation efforts in all the three scenarios.

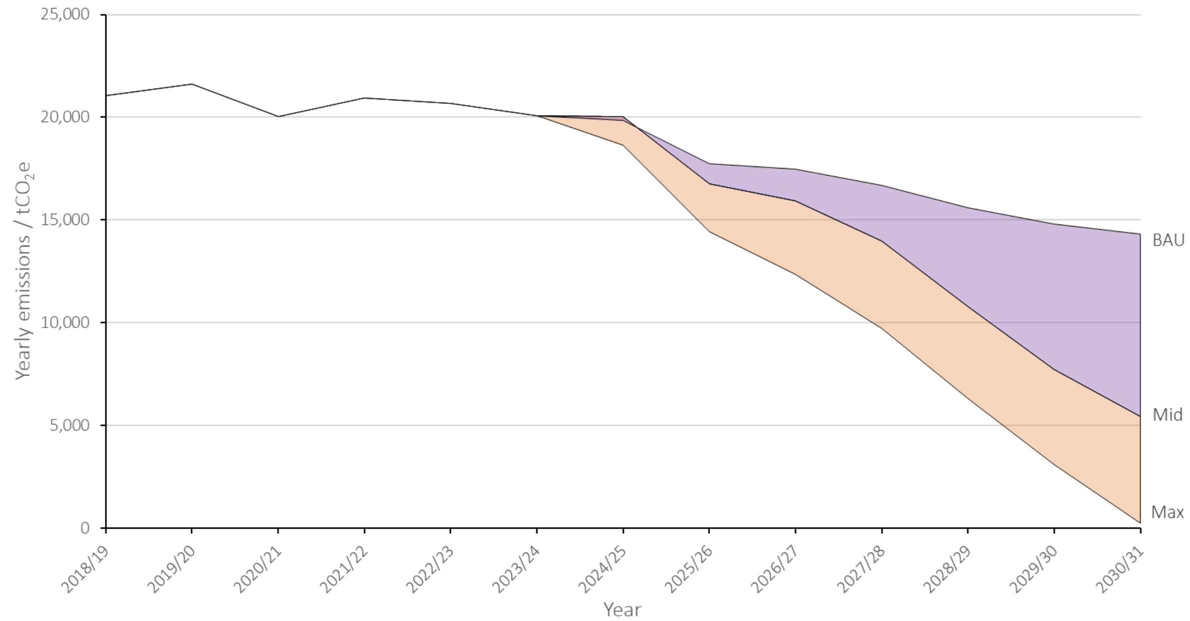

Figure 31: Projected ECC Scope 1 and 2 organisational emissions under the BAU, Mid and Max decarbonisation scenarios.

Figure 32 shows the total projected Scope 1 and 2 emissions for each year by sector under the BAU scenario. The total 2030/31 Scope 1 and 2 emissions are estimated as 14,325 tCO_2e, a 29% reduction from 2023/24 levels. Despite a 26% reduction from 2023/24 levels, social housing continues to dominate the organisational footprint with 12,818 tCO_2e in 2030/31. ECC's commitment to new Passivhaus constructions is a positive step in providing low carbon social housing but there remains a need to retrofit and decarbonise existing stock as shown in the more ambitious scenarios. Non-domestic buildings are estimated to produce 1,170 tCO_2e in 2030/31 (a 57% reduction from the 2023/24 inventory). The remaining emissions are attributed to transport which only reduce slightly in this scenario. In 2030/31, Scope 1 and 2 transport emissions are estimated at 766 tCO_2e (11% reduction from 2023/24). The lease of diesel vehicles remains the dominant procurement decision and four additional diesel RCVs are procured on top of the existing diesel fleet. Only the non-specialised vehicles are replaced with an electric equivalent. Without future tree planting and only six new non-domestic PV arrays the extent of offsets decreases to -429 tCO_2e in 2030/31 (45% *decrease*)[p]. The cumulative emissions over the seven modelled years are shown in Figure 33 and show a near linear increase.

The Mid scenario (Figure 34) sees more progress towards net zero, reaching 5,427 tCO_2e in 2030/31, a 73% reduction. The complete electrification of heat throughout social housing is a significant contributor in reducing their carbon emissions to 5,094 tCO_2e in 2030/31, a 71% reduction from the 2023/24 inventory. Widespread insulation and ASHP installation help reduce ECC's non-domestic building stock to 884 tCO_2e in 2030/31 under the Mid scenario (68% reduction). There is a large reduction in transport emissions to only 67 tCO_2e in 2030/31 (92% reduction) as the proportion of HVO and electric vehicles in the fleet increases. Despite an increase in tree planting, offsetting continues to decline in the Mid scenario to -619 tCO_2e in 2030/31 (20% reduction) due to the falling emission factor for grid electricity reducing the emissions saved by consuming exported PV energy. Figure 35 shows the cumulative emissions from 2024/25 to 2030/31, the sigmoidal relationship shows the accelerating decarbonisation efforts under this scenario.

Figure 36 details the near net zero result of the Max scenario decarbonisation measures, with Scope 1 and 2 emissions falling to just 269 tCO_2e in 2030/31. The dramatic increase in tree planting allows offsets to compensate for -2,685 tCO_2e a year which is a 247% increase from the 2023/24 extent. Without offsets, the total 2030/31 Scope 1 and 2 emissions are modelled at 2,954 tCO_2e. Extensive ASHP and PV rollout throughout ECC's social housing significantly reduces the electricity consumption compared to the Mid scenario. Offsets will be crucial in helping to mitigate residual emissions such as those arising from ASHP leakage. With all new vehicles being replaced with EVs, transport emissions stay near net zero at 27 tCO_2e in 2030/31. Cumulative emissions are shown in Figure 37, the incremental change from 2029/30 to 2030/31 highlights the impact of impact of offsets in the Max scenario.

[p] Reported as negative to indicate that these emissions are offsets.

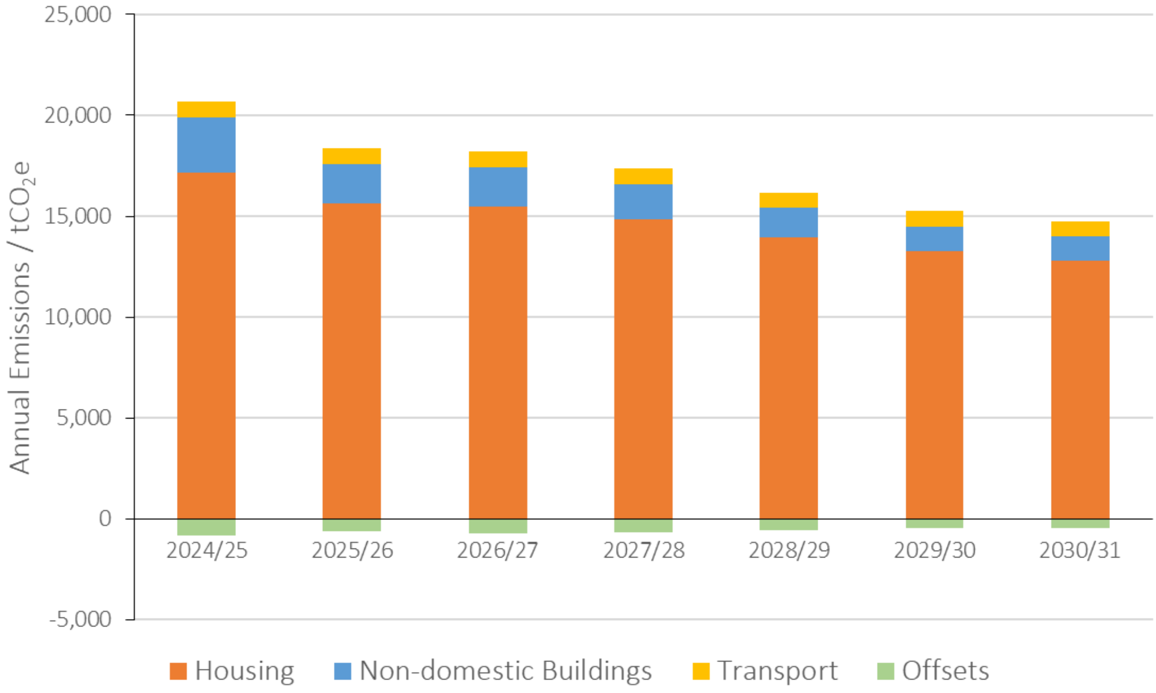

Figure 32: ECC's projected BAU annual Scope 1& 2 emissions by sector

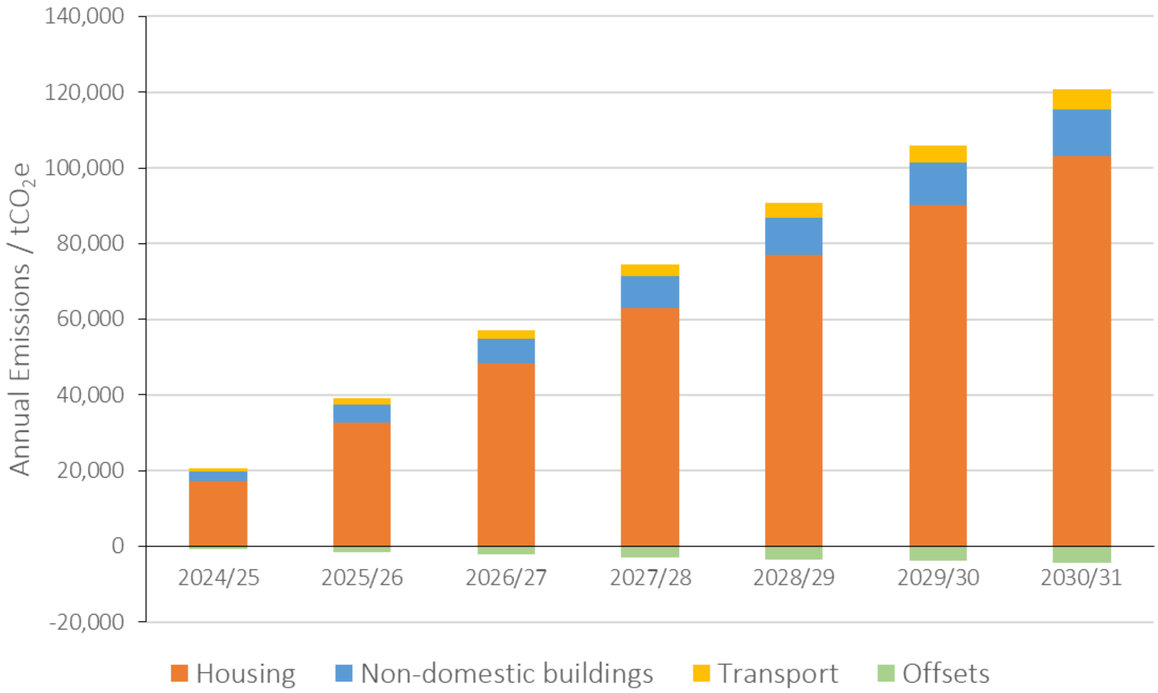

Figure 33: ECC's cumulative projected BAU Scope 1 & 2 emissions by sector

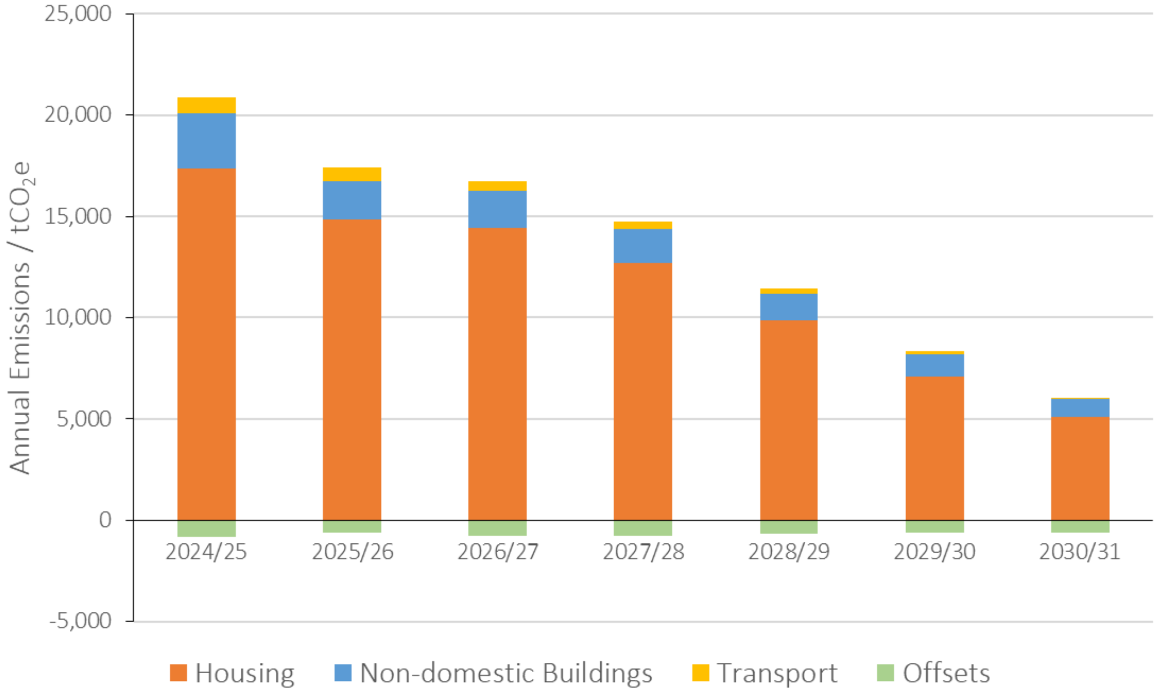

Figure 34: ECC's projected Mid scenario annual Scope 1 & 2 emissions by sector

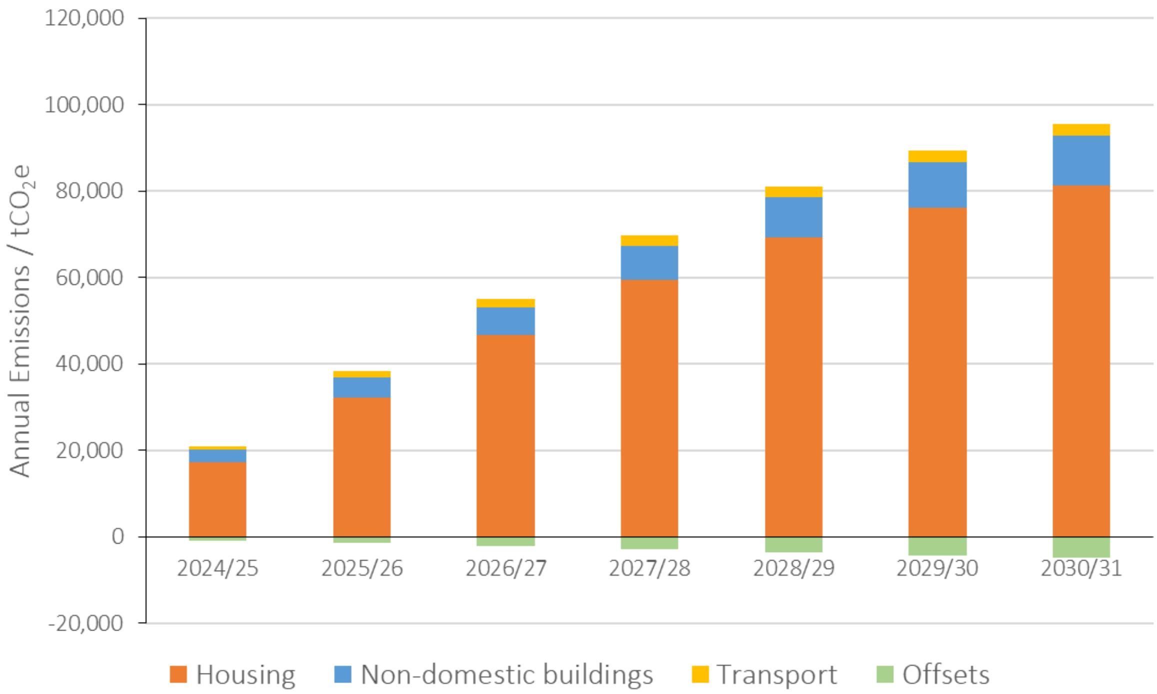

Figure 35: ECC's cumulative projected Mid scenario Scope 1 & 2 emissions by sector

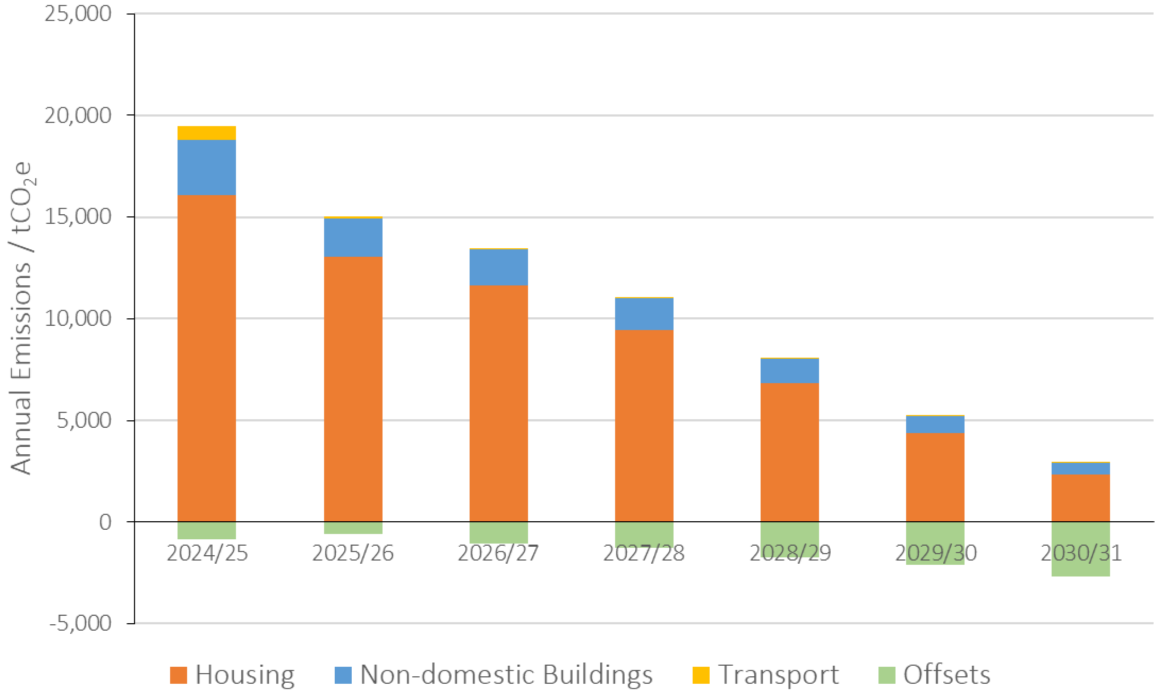

Figure 36: ECC's projected Max scenario annual Scope 1&2 emissions by sector

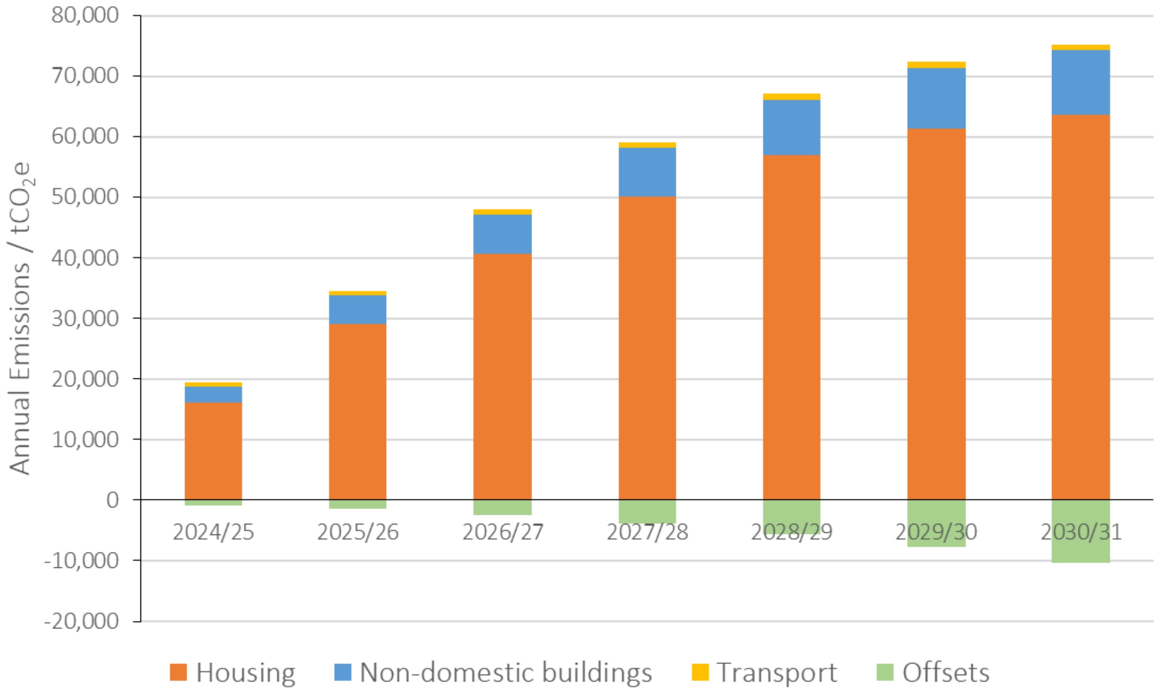

Figure 37: ECC's cumulative projected Max scenario Scope 1 & 2 emissions by sector

The total costs associated with these three scenarios are shown in Figure 38. Given that most of the capital expenditure arises from social housing the bars closely resemble that of Figure 6 but with sharp peaks in specific years/scenarios for the costly Riverside and RAMM upgrades discussed in section 4.2.5 (Figure 16). Total operational expenditure is heavily influenced by transport operational costs (Figure 24).

Over the period 2024/25 to 2030/31, meeting the BAU costs a total of £55.5 million with CAPEX of £25.1m and OPEX of £30.4m. The Mid scenario results in total estimated CAPEX of £42.9m and a further £31.8m in operational expenditure and the Max scenario in CAPEX of £93.7m and OPEX of £35.5m.

These significant costs illustrate the challenges of ECC achieving net zero Scope 1 & 2 emissions by 2030/31 and highlight that, even in the near net-zero Max scenario, some element of purchased offsets may be needed to achieve net zero in 2030/31.

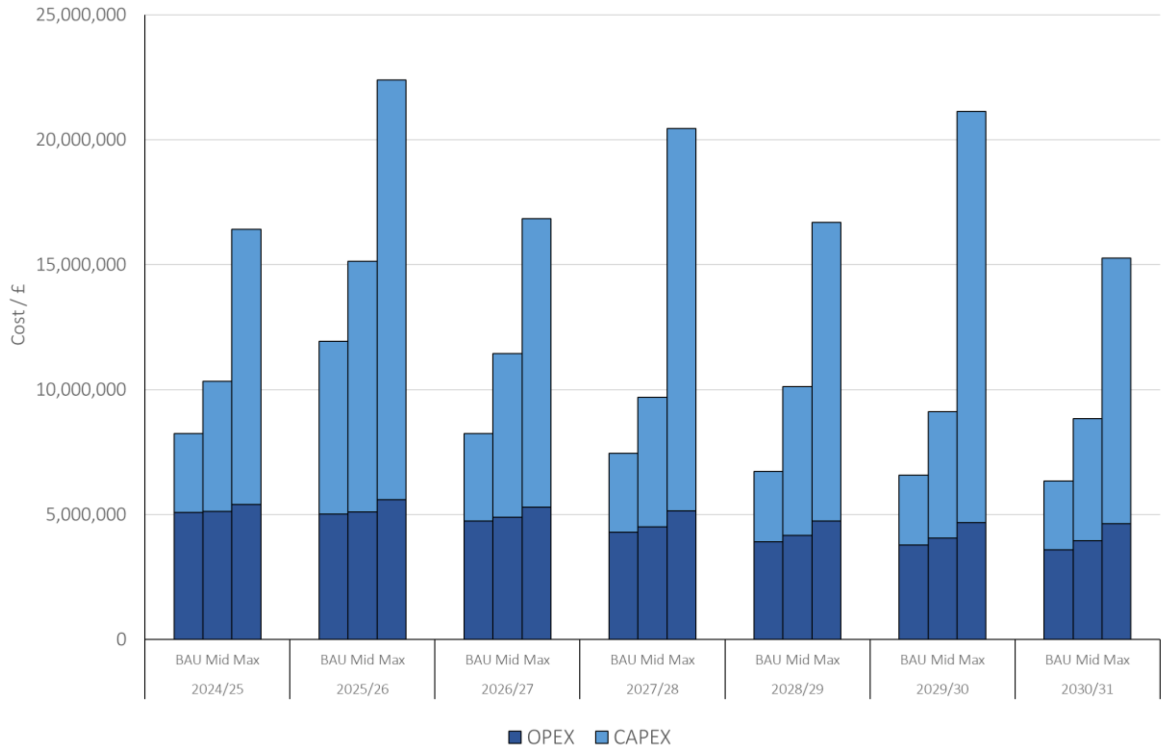

Figure 38: Annual capital and operating costs associated with decarbonising ECC's various assets under the three different scenarios.

Table 25: Cost breakdown of ECC organisational emission BAU decarbonisation scenarios. Totals may not sum due to rounding.

BAU Scenario								
Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
CAPEX	£3,160,000	£6,910,000	£3,490,000	£3,160,000	£2,820,000	£2,790,000	£2,770,000	£25,100,000
of which…								
Housing	£2,910,000	£2,890,000	£2,860,000	£2,840,000	£2,820,000	£2,790,000	£2,770,000	£19,900,000
Non-domestic buildings	£250,000	£4,020,000	£629,000	£312,000	£0	£0	£0	£5,220,000
Transport	£1,000	£0	£0	£5,000	£0	£0	£0	£6,000
Offsets	£0	£0	£0	£0	£0	£0	£0	£0
OPEX	£5,070,000	£5,010,000	£4,750,000	£4,280,000	£3,920,000	£3,780,000	£3,580,000	£30,400,000
of which…								
Housing	£0	£0	£0	£0	£0	£0	£0	£0
Non-domestic buildings	£2,970,000	£2,700,000	£2,460,000	£1,940,000	£1,520,000	£1,370,000	£1,150,000	£14,100,000
Transport	£2,150,000	£2,340,000	£2,360,000	£2,370,000	£2,380,000	£2,380,000	£2,380,000	£16,400,000
Offsets	-£50,000	-£27,200	-£71,500	-£20,100	£20,000	£33,800	£53,800	-£61,200
Total	£8,240,000	£11,900,000	£8,240,000	£7,440,000	£6,730,000	£6,570,000	£6,350,000	£55,500,000

Table 26: Cost breakdown of ECC organisational emissions Mid decarbonisation scenarios. Totals may not sum due to rounding

Mid Scenario								
Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
CAPEX	£5,210,000	£10,000,000	£6,550,000	£5,200,000	£5,950,000	£5,060,000	£4,880,000	£42,900,000
of which…								
Housing	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£4,850,000	£34,000,000
Non-domestic buildings	£314,000	£5,160,000	£1,640,000	£312,000	£1,070,000	£182,000	£0	£8,680,000
Transport	£20,000	£1,000	£28,500	£6,000	£1,000	£0	£1,000	£57,500
Offsets	£28,000	£28,000	£28,000	£28,000	£28,000	£28,000	£28,000	£196,000
OPEX	£5,120,000	£5,100,000	£4,880,000	£4,500,000	£4,160,000	£4,060,000	£3,950,000	£31,800,000
of which…								
Housing	£0	£0	£0	£0	£0	£0	£0	£0
Non-domestic buildings	£2,960,000	£2,670,000	£2,410,000	£1,890,000	£1,480,000	£1,330,000	£1,180,000	£13,900,000
Transport	£2,200,000	£2,450,000	£2,540,000	£2,620,000	£2,650,000	£2,670,000	£2,690,000	£17,800,000
Offsets	-£44,800	-£16,700	-£66,100	-£7,040	£40,100	£59,800	£85,900	£51,300
Total	£10,300,000	£15,100,000	£11,400,000	£9,700,000	£10,100,000	£9,120,000	£8,830,000	£74,700,000
Difference from BAU	£2,090,000	£3,220,000	£3,190,000	£2,260,000	£3,380,000	£2,550,000	£2,480,000	£19,200,000

Table 27: Cost breakdown of ECC organisational emissions Max decarbonisation scenarios. Totals may not sum due to rounding.

Max Scenario								
Year	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	Total
CAPEX	£11,000,000	£16,800,000	£11,500,000	£15,300,000	£12,000,000	£16,500,000	£10,600,000	£93,700,000
of which…								
Housing	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£10,300,000	£71,800,000
Non-domestic buildings	£314,000	£5,160,000	£851,000	£3,350,000	£1,330,000	£5,820,000	£0	£16,800,000
Transport	£67,500	£1,600	£76,600	£35,100	£11,100	£19,600	£1,600	£213,000
Offsets	£355,000	£1,360,000	£355,000	£1,660,000	£355,000	£355,000	£355,000	£4,790,000
OPEX	£5,400,000	£5,600,000	£5,290,000	£5,150,000	£4,740,000	£4,670,000	£4,640,000	£35,500,000
of which…								
Housing	£0	£0	£0	£0	£0	£0	£0	£0
Non-domestic buildings	£2,960,000	£2,670,000	£2,340,000	£1,840,000	£1,430,000	£1,180,000	£968,000	£13,400,000
Transport	£2,420,000	£2,830,000	£2,970,000	£3,180,000	£3,160,000	£3,250,000	£3,300,000	£21,100,000
Offsets	£16,100	£105,000	-£30,500	£124,000	£145,000	£248,000	£366,000	£974,000
Total	£16,400,000	£22,400,000	£16,800,000	£20,400,000	£16,700,000	£21,100,000	£15,300,000	£129,000,000
Difference from BAU	£8,170,000	£10,500,000	£8,590,000	£13,000,000	£9,960,000	£14,500,000	£8,910,000	£73,600,000
Difference from Mid	£6,070,000	£7,240,000	£5,400,000	£10,800,000	£6,590,000	£12,000,000	£6,420,000	£54,500,000

9 Glossary

ASHP – Air Source Heat Pump

BAU – Business as Usual scenario

BEIS – Department for Business, Energy and Industrial Strategy

C&B – Currie and Brown

CAPEX – Capital Expenditure

CCC – Climate Change Committee

CIBSE – Chartered Institution of Building Services Engineers

CoP – Coefficient of Performance

CPI – Consumer Price Index

CWI – Cavity wall insulation

DESNZ – Department for Energy Security and Net Zero

ECC – Exeter City Council

eRCV– Electric Refuse Collection Vehicle

EPC – Energy Performance Certificate

EV– Electric Vehicle

F-gas – Fluorinated gas

FIT – Feed-In Tariff

GHG – Greenhouse gas

GPV – Ground-mounted solar photovoltaic

HVO – Hydrotreated Vegetable Oil

ha – Hectare

kW – Kilowatt

kWh – Kilowatt hour

kWp – Kilowatt peak

LI – Loft Insulation

Max – Net Zero scenario

MEND – Museum Estate and Development Fund

MCS – Microgeneration Certification Scheme

Mid – Mid Case scenario

MWh – Megawatt hour

MWp – Megawatt peak

MWh – Megawatt hours

NEED – National Energy Efficiency Data

Ofgem – Office of Gas and Electricity Markets

OPEX – Operational Expenditure

ONS – Office for National Statistics

P&GS – Parks and greenspaces

PPA – Power Purchasing Agreement

PSDS – Public Sector Decarbonisation Scheme

PV – Photovoltaic

PVGIS – Photovoltaic Geographic Information System

R32 – HFC-32 refrigerant (Difluoromethane)

RACHP – Refrigeration, Air Conditioning, and Heat Pump

RAMM – Royal Albert Memorial Museum

RCV– Refuse Collection Vehicle

SEG – Smart Export Guarantee

tCO_2e – Tonnes of carbon dioxide equivalent

YC – Yield Class

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