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Exeter City Council corporate carbon footprint
Achieving net zero by 2030

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Cover image:
Exeter Livestock Centre PV array

Management Summary

Exeter City Council (ECC) declared a Climate Emergency in 2019 and as part of this commitment aims to achieving "net zero" greenhouse gas (GHG) emissions for its own corporate activities by 2030. ECC commissioned the Centre for Energy and the Environment (CEE) at the University of Exeter to assess the potential to achieve the commitment.

The definition of "net zero" in this context includes all GHG emissions arising from ECC's direct and indirect activities including its supply chains, which together result in the Council's gross GHG emissions. Deducting the emissions mitigated through the export of renewable energy and land use change gives its net GHG emissions. The aim is to achieve net emissions as close to zero as practicable by 2030. The remaining net emissions require purchase of carbon offsets. The objective is to achieve net zero with as little reliance on offsets as is practicable.

In 2020/21 GHG emissions totalled 52,551 t CO_2e. The most significant change from 2018/19 is a reported increase of over 500% in indirect GHG emissions. This is a result of improved data, methodologies that are more detailed and, most significantly, changes in the activity levels. Indirect emissions are now twice direct emissions, which have fallen a modest 4% over the two-year period (including the impact of Covid), one-fifth of the rate needed to achieve net zero in 2050.

The assessment uses seven emissions sectors: non-domestic buildings, council-owned housing, transport, procurement, F gases and waste, renewable energy, and land use change / afforestation. The assessment of each sector 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 a pre-determined trajectory, but a combination of aggressive carbon reduction measures across all sectors that provide a set of options to pursue the net zero ambition.

In 2020/21 the council's non-domestic building stock emitted 2,236 t CO_2e. The Royal Albert Memorial Museum has the largest footprint. More generally, around 80% of building emissions are associated with the council's corporate estate and leisure centre buildings. The expectation is that increase in building use post-Covid will see increasing emissions in 2025. This is expected to be countered to some extent by grid decarbonisation. Non-domestic building energy consumption is 40% electricity so this has a significant impact on emissions. However, pre 2025 (including savings from energy efficiency and PV) is insufficient to reduce emissions. Outside its effect on existing electricity use, the grid emissions factor also plays a role in the next largest projected emissions reduction post 2025; the switch from gas heating to heat pumps across the estate. Energy efficiency makes a similar contribution. The projections also include some speculative changes in assets that reduce the estate footprint. By 2030 emissions are projected to fall to 602 tCO_2e, a 73% reduction from 2020/21.

Emissions from the council's housing contributes a third of gross emissions and is the sector with by far the most significant contribution to direct emissions (85%). Extensive analysis of data from Energy Performance Certificates quantifies a range of measures on existing council homes, which, despite emission increases from 1,000 new homes, reduce the sector's emissions from 17,319 t CO_2e in 2020/21 to 1,916 t CO_2e in 2030 (89%). Energy efficiency measures and rooftop PV contribute 5% and 3% respectively, but post 2025 deep retrofit and heat pumps make up the bulk (70%) of the savings. These expensive measures are required to make significant progress in the housing sector.

A detailed bottom-up analysis of the council's transport, including previously unidentified vehicles and equipment, shows emissions of 1,018 t CO_2e in 2020/21. Of these, 82% are from ECC's fleet and 9% from red diesel (used in the maintenance of public and green spaces). Reducing emissions relies on electrification across the sector. The projections include an extension of the current enlightened initiative to replace high emission waste trucks with electrically powered vehicles and the assumption that an electric vehicle replaces every vehicle that leaves the fleet from now on. As a result, fleet emissions in 2030 are 11% of current levels. Overall transport emission including those over which the council has less control, e.g. staff commuting, are projected to fall to 331 t CO_2e, a 68% reduction from 2020/21.

Indirect emissions from the goods and services ECC bought in 2020/21 is the largest source of emissions (61% or 32,380 t CO_2e). Nearly half of these emissions are a result of the St Sidwell's point development; construction, which is a very carbon intensive activity, is responsible for 60% of 2020/21 emissions. Projections assume that similar construction activity does not take place in 2030 although 100 new homes built each year are included. The 2030 projection shows emissions reduced to 9,658 t CO_2e, largely due to a fall in embodied construction emissions. Indirect emissions from external sources are inevitably those over which ECC has least control and, while it is important to take steps to influence indirect emissions, this should not overly divert attention from reducing direct emissions where the Council is in control.

Emissions from ECC's own waste disposal and use of F gases are currently small (21 t CO_2e in 2020/21). However, this is the only sector where projections show a significant rise in emissions. 2030 emissions increase over tenfold to 252 t CO_2e due to F gas leakage resulting from the rollout of 5,500 heat pumps in homes and non-domestic buildings. This new source of GHG emissions will need to be closely scrutinised.

Exported renewable energy and changes to land use through afforestation are deducted from ECC's gross emissions. ECC's non-domestic and domestic PV generated an estimated 2,600 MW in 2020/21 exporting 1,800 MW that offset 423 t CO_2e. Projections show that expansion of the PV portfolio on non-domestic buildings, from ground arrays and house rooftops has the potential to increase total generation to 15,200 MW with exports offsetting 756 t CO_2e. Grid decarbonisation means that the offset GHG emissions do not match the dramatic increase in generation. The planting of broadleaf trees over 25% of the Valley Parks and other greenspace between now and 2030 offsets 829 t CO_2e in 2030.

Achieving net zero—whether nationally, locally, or organisationally—requires broad action across all sectors. The projections for ECC reinforce this message and show that delivering net zero in a timeframe as tight as 2030 is challenging.

The combination of aggressive carbon reduction measures included in the projections indicate the potential to reduce 2020/21 net emissions from 52,551 t CO_2e to 11,174 t CO2e, a fall of 79%. Indirect emissions from procurement dominate the residual 2030 emissions (76%). Excluding procurement, residual emissions fall 92% from 20,171 t CO_2e to 1,516 t CO_2e with housing the largest remaining emitter (62%). Offset of these 2030 emissions through the purchase of Pending Issuance Units (PIU) for UK Woodland Carbon Units, assuming an average cost of £13.5 t CO_2e, would cost £151k and £20k respectively. Alternatively, based on the land use change analysis in Section 9, direct coniferous tree planting between now and 2030 of 941 ha or 128 ha respectively achieves these offsets.

Annual assessment of the council's GHG emissions to identify the changes that have taken place each year will enable the evaluation and updating of the actions required to deliver net zero.

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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 corporate activities by 2030. The Centre for Energy and the Environment (CEE) at the University of Exeter was commissioned by ECC to assess the potential to achieve this commitment.

The definition of "net zero" in this context includes all 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 gross GHG emissions. Deducting the emissions mitigated through the export of low carbon energy and land use change gives net GHG emissions. The aim is to achieve net GHG emissions as close to zero as practicable by 2030. Remaining net emissions require the purchase of carbon offsets. The objective is to achieve net zero with as little reliance on offsets as is practicable.

The approach taken is to update ECC's carbon footprint from the assessment made in 2018/19 (Section 2), and assess the potential to reduce these emissions across seven sectors: non-domestic buildings, council-owned housing, transport, procurement, F gases and waste, renewable energy and land use change / afforestation (Sections 3 to 9).

The assessment of carbon reduction potential in each sector includes:

- 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.

The sector assessments are desk based, as there was no scope for detailed site visits or audits. However, the use of improved data and methodologies to develop a more detailed evaluation of emissions for each sector feeds back into the updated footprint. These changes inevitably lead to adjustments in the 2020/21 footprint when compared to 2018/19.

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 a pre-determined trajectory, but a combination of highly aggressive carbon reduction measures across all sectors that provide a set of options to pursue the net zero ambition.

2 ECC's current carbon footprint

ECC's carbon footprint for the most recent financial year (1st April 2020 to 31st March 2021) follows the same approach as the 2018/19 footprint[a]. The footprint is prepared in accordance with Chapter 3 of HM Government 2019, *Environmental Reporting Guidelines*[1] with a financial control approach taken to organisational boundaries. The guidelines require the classification of GHG emissions into three groups or Scopes:

> Scope 1 (direct emissions from owned sources), including combustion of fuel in boilers in council owned buildings for heating and hot water, refrigerant leaks from council equipment and fuel in council vehicles.
>
> Scope 2 (indirect emissions from generation of purchased electricity) which covers all electricity use across the council's services
>
> Scope 3 (other indirect) including GHG emissions embodied in all material and services bought by the council, business travel, grey fleet use and commuting, waste disposal, etc..

Calculations generally involve combining activity data with emission factors[2] to estimate emissions across a range of categories. Activity data includes specific information from each category considered, for example the amount of energy used in a building, or fuel used in a vehicle. It is vital that this data is collected to accurately assess the carbon footprint initially, and to track progress over time. In some cases, the availability of data is good but in others, there is scope to improve data collection processes to align with the objective of measuring and reducing GHG emissions.

The footprint categories are derived from simplified Government guidance (based on the old National Indicator 185[3]) that result in 11 categories across the three scopes. In many cases specific issues are split across multiple categories e.g. "transport" sits within "owned transport" (for the combustion of fuel in vehicles owned by ECC), "purchased materials and fuel" (for Well to Tank [WTT]) emissions, and "transport related activities" (for commuting and travel in vehicles not owned by ECC).

The calculation of emissions from ECC's Scope 2 electricity consumption uses the published carbon intensity of the national electricity grid[b]. The carbon intensity of the grid has declined significantly in recent years. The Climate Change Committee (CCC) forecasts that significant falls in grid intensity will continue as increasing amounts of renewable and low carbon energy comes onto the system (See Figure 1)[4].

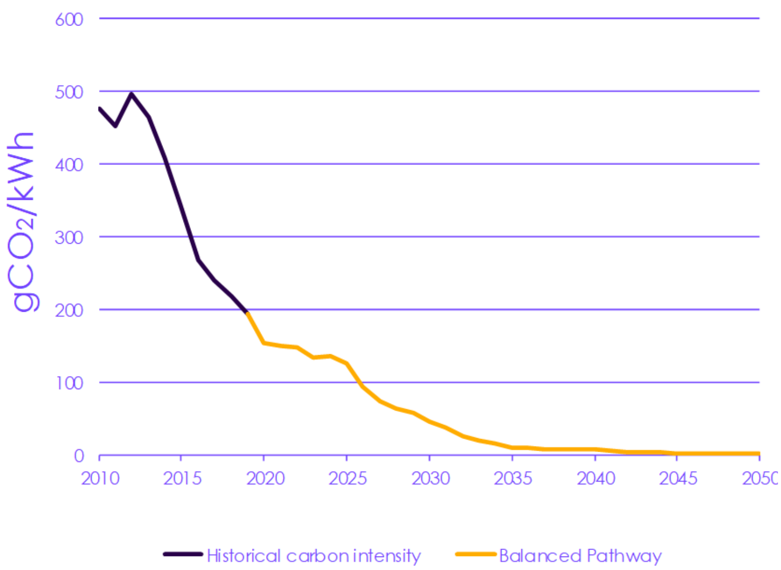


Figure 1: UK electricity grid carbon intensity (source CCC Sixth Carbon Budget)

[a] A footprint was not formally produced for 2019/20 due to disruptions caused by the Covid-19 pandemic
[b] For a discussion of alternative Scope 2 GHG accounting methods see Appendix 1.

For 2020/21, total emissions are 52,551 t CO_2e. Figure 2, which uses the categories in the guidance[c], shows 2020/21 compared to the 2018/19 footprint.

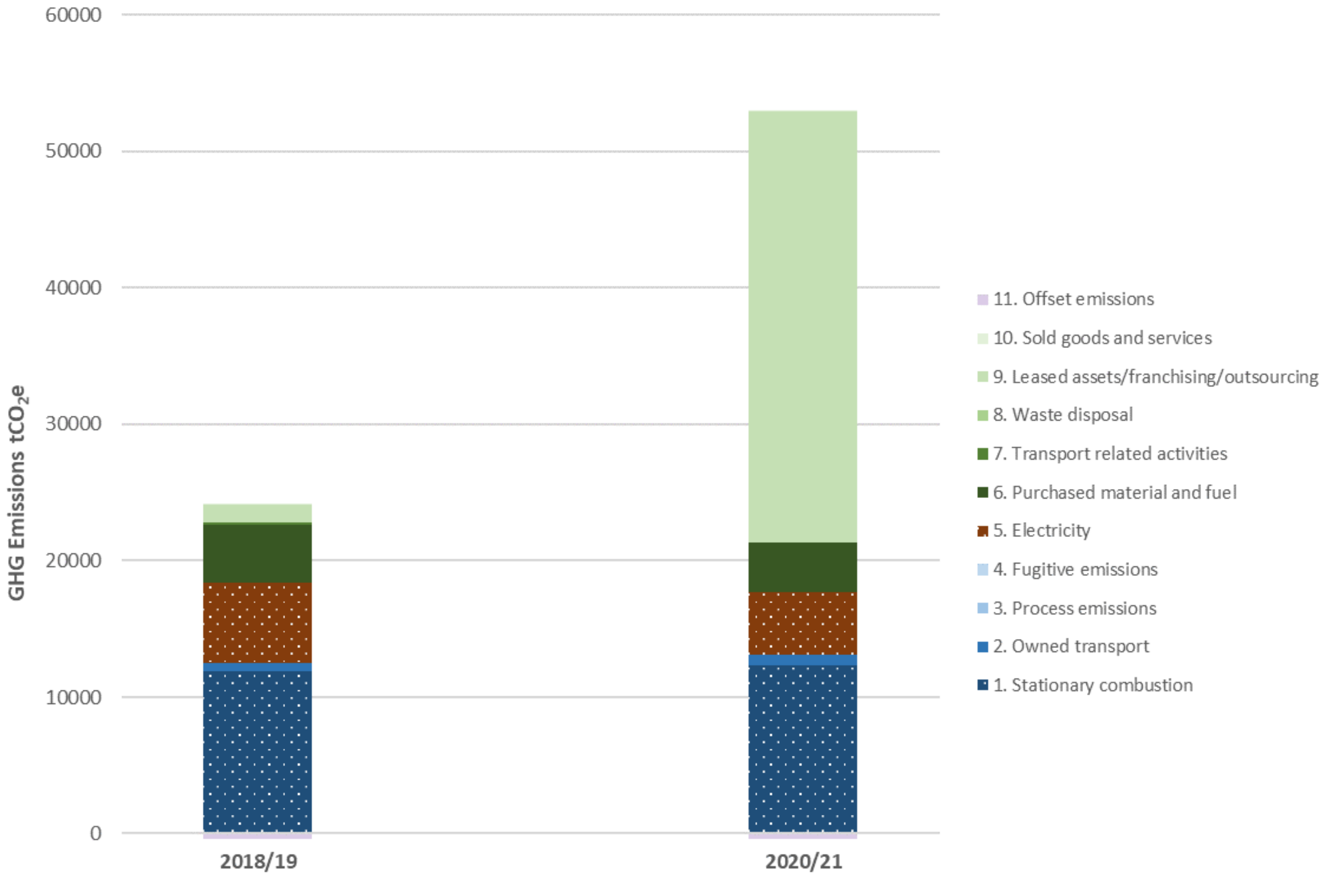
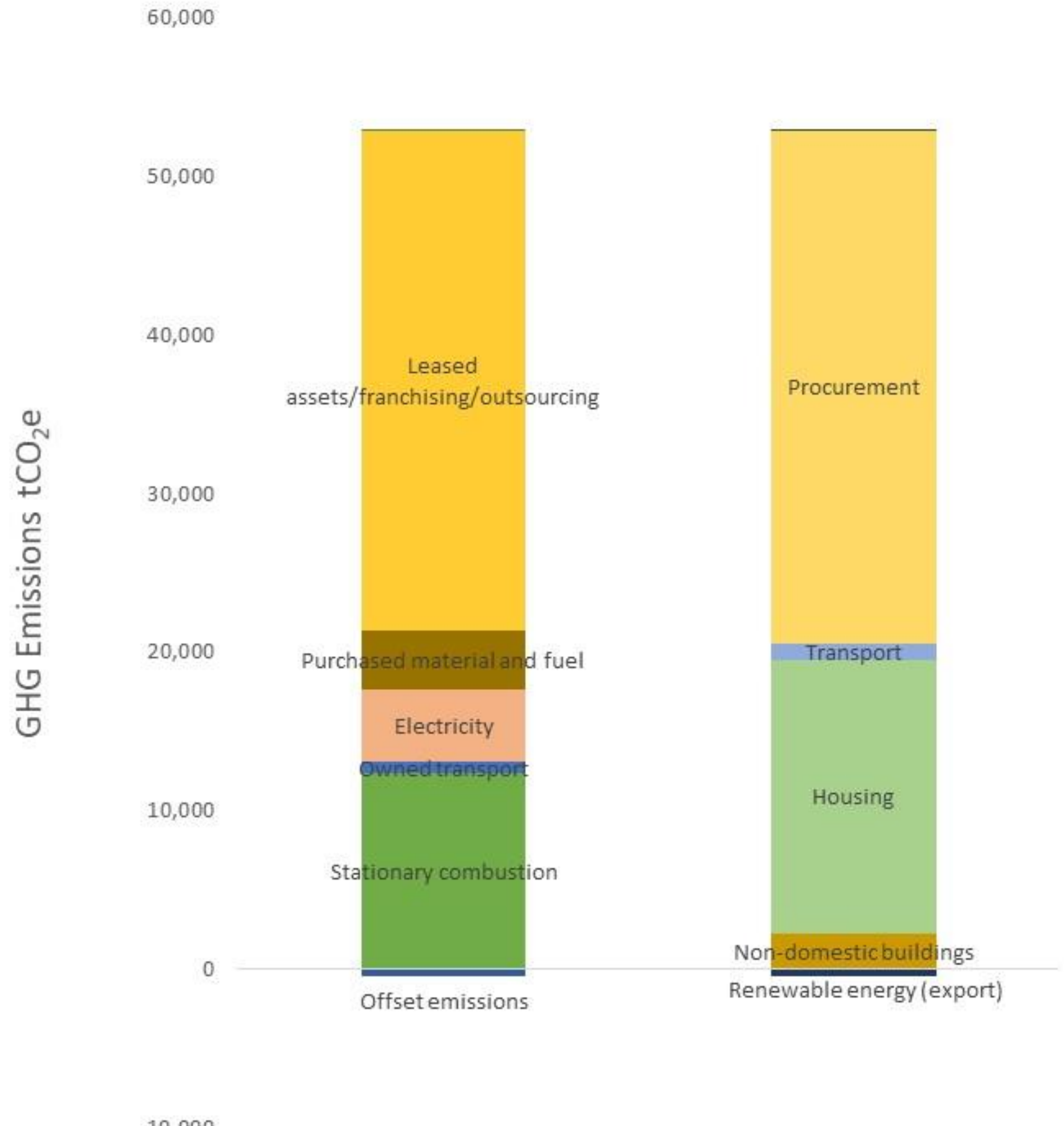


Figure 2: ECC's GHG emissions by footprint reporting category for 2018/19 and 2020/21 showing Scope 1 (blue) Scope 2 (red) and Scope 3 (green)

The most significant change from 2018/19 is a 517% increase in Scope 3 emissions. This is a result of improved data, more detailed methodologies and, most significantly, changes in the activity levels describes in later sections. Scope 3 emissions are now double those from Scopes 1 and 2, which have fallen a modest, and partly Covid driven, 4% over the two-year period.

To provide more clarity, the 11 categories included in the footprint table (see Appendix 2) were re-mapped into 6 sector categories for this report. Figure 3 shows the breakdown of emissions by footprint category and report sector category. The sections following discuss details of emissions within each sector category, with the addition of a land use change and afforestation sector that projects future emissions offset by tree planning in the Valley Parks and other greenspace.

[c] The guidance "leased assets/franchising/outsourcing" category is in ECC's case populated with the embodied GHG emissions in procured services



	Footprint reporting categories	Sector categories
Renewable energy (export)		-423
F gas and waste		21
Procurement		32,380
Transport		1,018
Housing		17,319
Non-domestic buildings		2,236
Offset emissions	-423	
Sold goods and services	23	
Leased assets/franchising/outsourcing	31,576	
Waste disposal	3	
Transport related activities	32	
Purchased material and fuel	3,664	
Electricity	4,537	
Fugitive emissions	18	
Process emissions	0	
Owned transport	769	
Stationary combustion	12,352	

Figure 3: ECC's footprint in 2020/21 organised by category as annually reported (left), and by category as considered in this report (right)

3 Non-domestic buildings

3.1 Detailed sector summary

The 2020/21 footprint shows GHG emissions of 2,236 t CO_2e from non-domestic buildings, of which 60% are associated with electricity consumption, and 40% from gas.

There are 424 sites/assets included in the footprint, ranging from very large buildings to small individual landlord supplies in tenanted areas. Emissions are classified into nine categories, as shown in Figure 4.

Historic fabric and demanding climatic requirements mean that the Royal Albert Memorial Museum (RAMM) has the largest GHG emissions. More generally, around 80% of all emissions are associated with the council's buildings (corporate estate) and leisure centres. These two categories of buildings are also characterised by being users of gas (as shown in Figure 5). In general, there is good quality energy consumption data from non-domestic buildings that should support annual monitoring of progress.

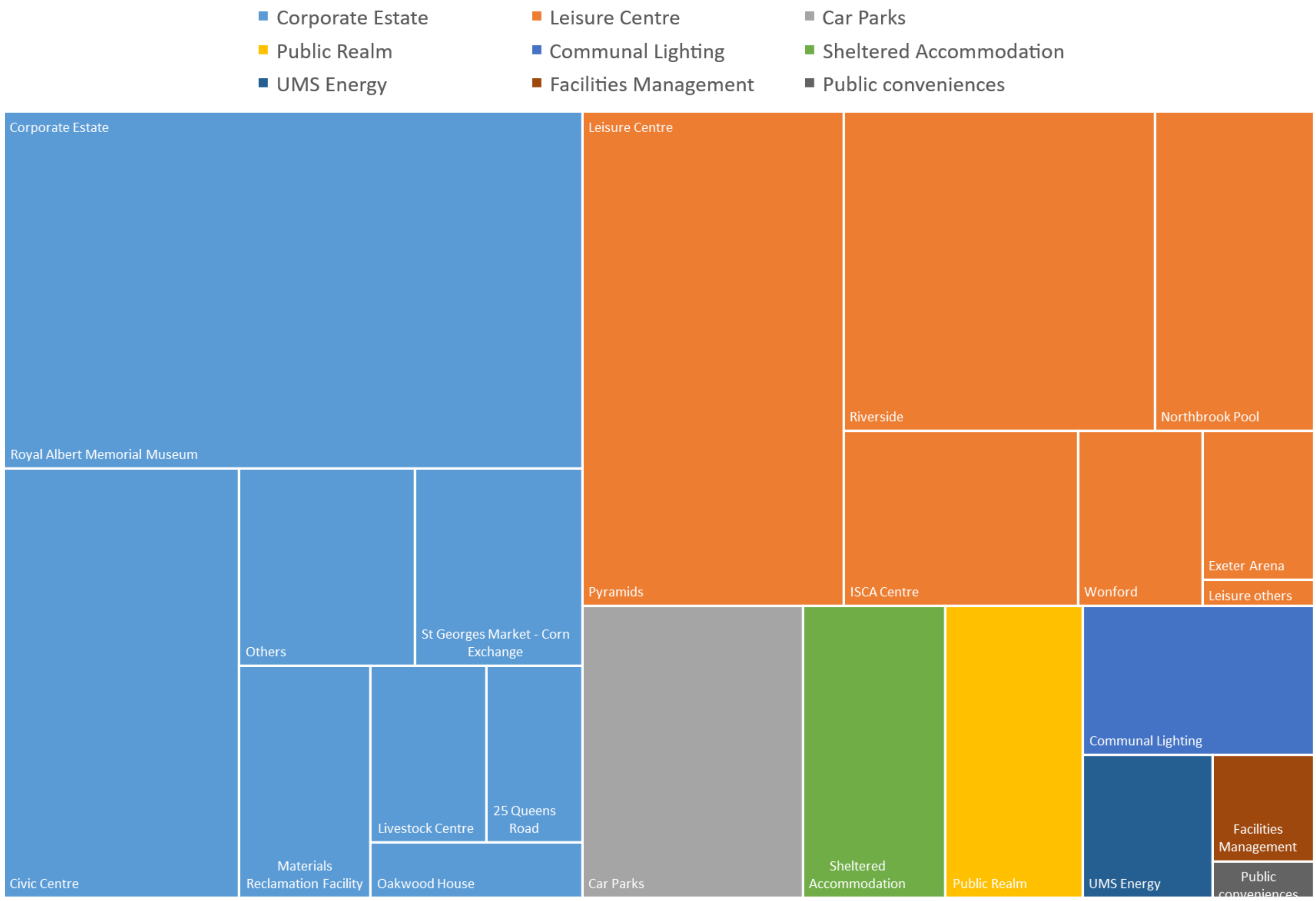


Figure 4: Breakdown of GHG emissions from non-domestic buildings by category

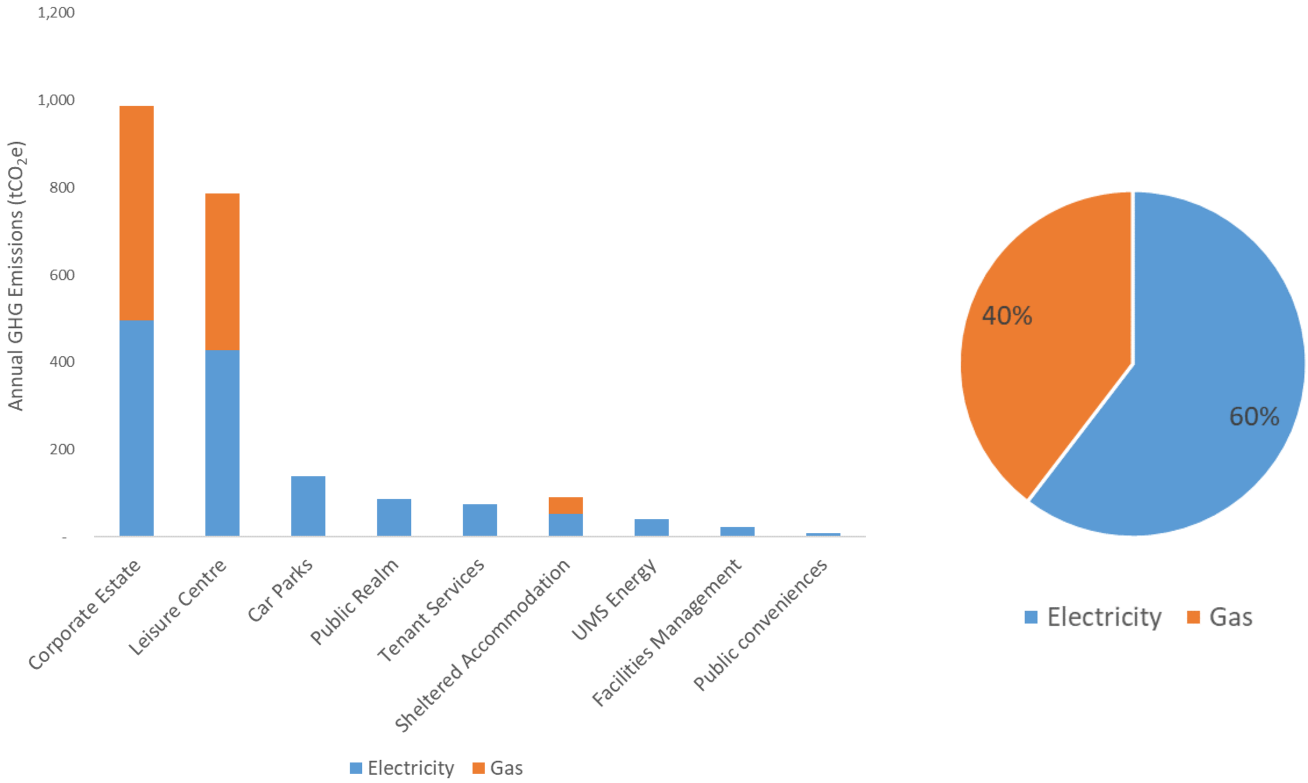


Figure 5: Split of GHG emissions by category for electricity and gas (left) and total split (right). Gas is only significant in the corporate estate and leisure centre categories

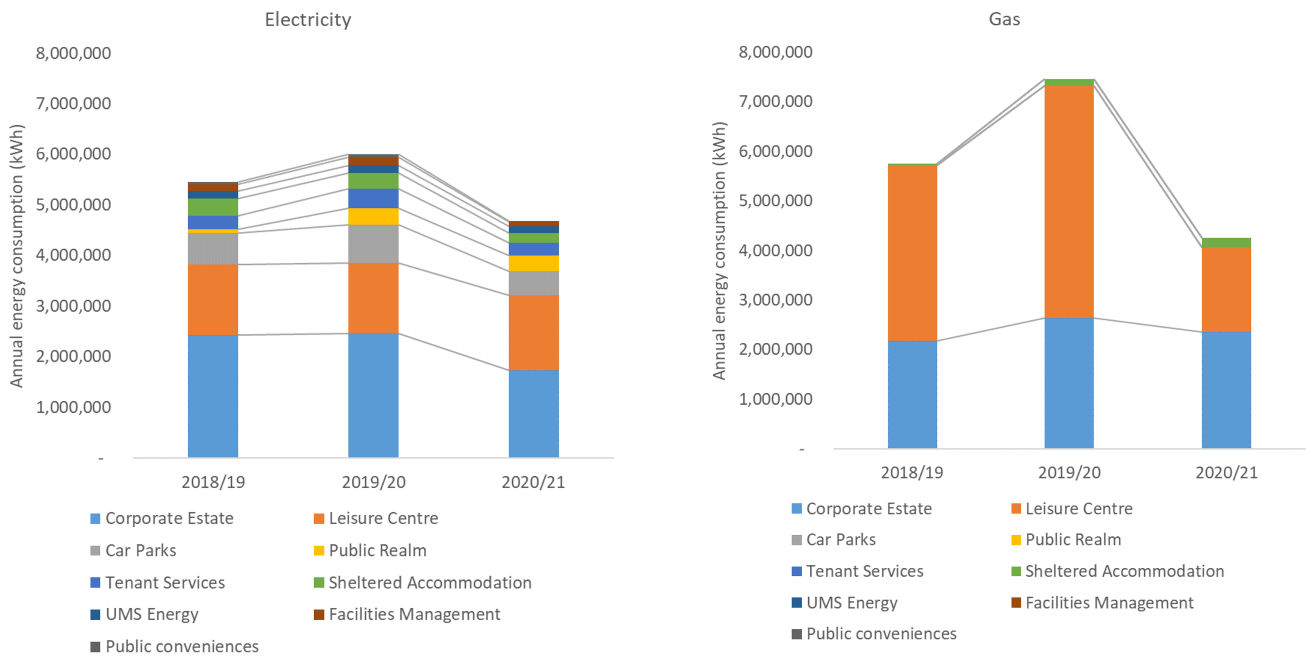


Figure 6: GHG emissions from the previous three years from electricity (left) and gas (right). The reduced emissions in 2020/21 are a result of the Covid pandemic and are not likely to be representative going forward.

A review of energy data from the previous three years (see Figure 6) shows that the 2020/21 data (which runs from April to March) was heavily influenced by Covid (many buildings were closed for periods during the year). In any year, external temperature affect the amount of energy used to heat buildings. Finally, between now and 2030 ECC will occupy new buildings, and dispose of others in their portfolio. Accounting for these factors is important in planning for the 2030 net zero target. The 2020/21 footprint was adjusted as follows:

- Covid impact: Buildings and sites were reviewed on an individual basis, and energy demand reverted to the 2019/20 level where it appeared Covid was a likely factor in a decline in demand.
- Temperature effect: From analysis of the previous 14 years of regional external temperature data using degree day theory[5] it was found that 2018/19, 2019/20 and 2020/21 were all warmer than the average over the period by 8%, 7% and 2% respectively. It has been assumed that 80% of gas consumption (used for space heating) is dependent on the external temperature (the balance is assumed to be used for other uses such as hot water) and energy demand was adjusted (increased) to account to a "typical" year.
- Change in assets: There is uncertainty regarding which buildings may be disposed of by 2030, and what new buildings might become incorporated into ECC's portfolio (either constructed from new, or purchased). There are however several projects where there is more certainty, and these were included in adjustments to the most recent footprint[d].
    - The opening of the St Sidwell's Point swimming pool, at which point Pyramids will be closed and redeveloped outside ECC's footprint.
    - A number of infrastructure projects committed to in ECC's Capital Programme, mainly multi-storey car parks.
    - The full reopening of the Riverside Leisure Centre in Summer 2021 will mean that energy consumption will be higher than the previous 3 years, so an estimate was made based on the most recent few months of energy data.
    - More uncertain changes (i.e. where there is no policy or commitment in place) to ECC's non-domestic estate are discussed in Section 3.3.

These adjustments result in an overall increase in emissions from 2,236 t CO_2e to 3,461 t CO_2e (a 55% increase). Figure 7 shows the incremental changes; the reopening of buildings to normal capacity is estimated to be responsible for a 957 t CO_2e increase (43%); adjusting for a year with normal (i.e. slightly cooler) weather a further 94 t CO_2e (3%); and the change in assets, an increase of 174 t CO_2e[e].

Figure 7: Changes to 2020/21 emissions resulting from Covid bounceback, the temperature effect, and known change in assets and occupancy levels

[d] The closure of the Belle Isle depot and consolidation of those services at the Exton Road depot is assumed to have a very marginal effect on building emissions and so was not included.
[e] There is a 455 t CO_2e decrease from selling Pyramids which is more than offset by the added 294 t CO_2e from St Sidwell's Point and the increase of 335 t CO_2e from the full reopening of the Riverside Leisure Centre.

3.2 National policy framework

The high-level assumptions and projections for non-domestic buildings at a national level are as follows:

- The decarbonisation of the electricity grid will reduce emissions from consumption of electricity in non-domestic buildings.
- The CCC Net Zero Technical Report[6] assumes a 25% reduction in heat demand in non-domestic buildings by 2050, though clarity was not given as to how this might occur. The remaining heat decarbonises using low carbon heat networks (46% of the demand) and heat pumps (the remaining 54%). It also assumes the electrification of non-heat uses of gas and oil (e.g. catering), and a 21% reduction in electricity demand from non-heat uses (e.g. lighting) due to energy efficiency.
- The CCC Sixth Carbon Budget[7] report assumes a 26% reduction in energy consumption in 2030 compared to the CCC's 2018 baseline (based on the application of findings from the Building Energy Efficiency Survey (BEES) study). The CCC applied several measures (building controls, fabric, carbon and energy management, lighting, refrigeration, swimming pools, heating, and hot water) across non-domestic buildings in different sectors whilst excluding other more expensive measures (humidification, small appliances, ventilation, air conditioning and cooling, and building services distribution systems) and those associated with replacement of heat sources. These were handled separately by assuming that non-domestic buildings are switched from gas and oil heating (where applicable) to a mix of heat pumps (65% in 2050), district heating (32%), hydrogen boilers (5%) and direct electric heating (1%). The CCC has not included biomass boilers as a replacement technology for public or commercial buildings "as a matter of principle". Nationally, the CCC project non-traded (i.e. direct) emissions from non-domestic buildings will fall from 20.4 Mt CO_2e in 2020 to 13.8 Mt CO2e in 2030 (a 33% reduction) through a combination of energy efficiency and fuel switching, though some of this will be shifted to traded emissions (i.e. electricity).
- The CCC 2021 Progress Report[8] states for non-residential energy efficiency and behaviour change that "commitments of 20% efficiency savings in business and 50% reduction of public emissions by 2032 are in line with the CCC pathway. Policy proposals only cover private-rented and larger buildings to date and there is little evidence for reduced energy demand at present".

3.3 Opportunities

The factors and opportunities identified for decarbonising non-domestic buildings are as follows.

3.3.1 Decarbonisation of electricity

National policy projections decrease the carbon intensity of electricity delivered through the grid. The consumption of electricity by ECC is included in the footprint under both Scope 2 (from the generation of electricity in power stations, wind farms etc.) and Scope 3 (from losses associated with Transmission and Distribution [T&D] and the Well to Tank [WTT] overhead applied to both Scope 2 and T&D emission factors). In 2020 the Scope 2 electricity factor used in the footprint was 0.233 kg CO_2e/kWh. The emission factors produced by government for company reporting lag the actual values by 2 years and so in 2030 (the 2030/31 footprint), the actual 2028 emission factor will apply when ECC report their carbon footprint. The CCC 6th Carbon budget projects this to be 0.065 kg CO_2e/kWh (a 72% reduction on the current value). Projections for T&D and WTT emission factors are not published. Analysis of the most recent four years of emission factors show that the T&D factor has fallen by a similar amount to the generation factor and, while the WTT factors have been falling at a similar rate until 2021, they increased significantly this year due to a method change applied by government. The approach taken here (in all sectors) has been to assume the ratio of WTT emissions to direct emissions from the most recent year is the same in 2030, and therefore the total Scope 2 and 3 emission factor for electricity would be 0.089 kg CO_2e/kWh (down from 0.288 kg CO_2e/kWh). This effectively means under a "do nothing" approach for ECC, emissions from any electricity consumption will fall by 71% between the most recent year of data and 2030.

The installation of renewable generation (e.g. PV panels) which produces electricity that is consumed on site provides carbon free operational energy and financial savings from the date it is commissioned. Grid decarbonisation means that early installation leads to the greater carbon savings. However, in the long term, the improvement in the grid emission factor reduces the potential for renewable generation to offset gross emissions[f]. In conversation with BEIS, an alternative (and more conservative) approach could be to keep Scope 3 electricity emission factors constant at the most recent values (2021). This results in a total 2030 emission factor of 0.144 kg CO_2e/kWh, (a 50% reduction on the 2020/21 total emission factor), which is 62% higher than the value assumed, and a 50% reduction on the 2020/21 footprint.

3.3.2 Change in assets (speculative)

The period to 2030 extends beyond the currently planned five-year capital programme. Changes to ECC's corporate estate in 2030 are therefore unknown. Nonetheless, adding or removing buildings from the estate can potentially have large positive and negative impacts on the overall carbon footprint.

Changes can include the sale of buildings to other users or demolition construction of new facilities on sites that may or may not have similar uses to that previously. Service needs and detailed financial assessments (including reductions in the energy and maintenance costs of older buildings) will drive such changes with GHG impacts an important but secondary consideration. Energy efficient new builds will generally have lower operational emissions. However, the assessment of the GHG impact should account for the lifetime emissions of each project. Lifetime assessments can show that refurbishment and/or reuse can be lower carbon outcome than new build.

The approach taken is to highlight the potential impact of changes to various buildings in the estate, for demonstration purposes. These examples are not an endorsement or recommendation, and each case outcomes will depend on many factors that extend beyond the carbon impact. The buildings considered are as follows:

- In conjunction with potential development at CityPoint, sell the Civic Centre for development by others and build a smaller facility near to the bus station. Assumptions in this scenario are that the new building will be 25% of the floor area of the Civic Centre[g], achieve a top 10% benchmark performance for electricity and "non-electrical energy" and that it will meet heat demand using an ASHP.
- The removal of the Northbrook Pool from the estate.
- Renovation and extension of the Wonford Leisure Centre. The assumption is that after demolition of the existing building, the replacement building has a floor area schedule that achieves a top 10% benchmark performance for electricity and "non-electrical energy" and meets heat demand using an ASHP.
- The addition of new landlord areas in a shopping centre.

The Liveable Exeter project is not included.

3.3.3 Efficiency and demand reduction

Greenhouse gas emissions from ECC's buildings can be reduced by using less energy in those buildings, either by reducing the demand for energy (for example by improving insulation) and/or by delivering that energy in a more efficient way (for example with more efficient systems and controls). Section 3.1 shows that currently emissions arise from buildings across a range of services, with the corporate estate and leisure centres being the most significant. Within these services, a relatively small number of large buildings dominate. The RAMM, Civic Centre, Riverside, Northbrook Pool and ISCA centre make up almost two-thirds of non-domestic building GHG emissions. It is worth noting that the two largest emitters of GHG (Riverside and RAMM) have recently undergone general refurbishment works.

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[f] For renewable energy generation it is assumed that only the Scope 2 factor is applied, as it is assumed T&D is accounted for by the final users of any grid electricity, and renewable energy has no associate WTT emissions. Associated embodied emissions impact emissions through Procurement.

[g] The Covid pandemic has resulted in significant changes to working patterns, including home working. The majority of ECC jobs are service based e.g., at depots, and so the potential for home working is limited. The most relevant site where home working is a consideration is the Civic Centre, and it is assumed that the impact of home working is included in any potential sale of the building, and provision of a smaller one in its place.

Estimating the potential for carbon reduction from the estate requires individual investment-grade audits of each building, to identify potential savings and to establish whether energy savings meet a business test. Resource was not available to survey individual buildings as part of this study. The approach taken examined the currently available data about the building stock, together with other reference documents, to make high-level estimates of the potential that might be available to reduce energy consumption from the estate. The data includes:

- A spreadsheet produced by ECC identifying potential opportunities at each building[h].
- A Schedule of Condition and Estimated Costs for Exeter City Council Leisure Estate[i], which highlighted that that most boilers, pumps, hot water and Air Handling Units (AHUs) are due to be replaced in the next 3-5 years and that all lighting would need replacing within 10 years.
- Previous work by the University of Exeter[9] looking at the potential for energy reduction at ECC's leisure centres.
- Discussions with key ECC staff about the potential at various sites[j].
- ECC's Capital Programme Schedule. The schedule breaks down ECC's planned capital expenditure for the next 5 years (average £7.5 million per year) by:
    - Condition survey backlog (approximately £5 million total): This is investment for a backlog of construction costs for identified buildings to reach Condition B (Satisfactory: Performing as intended but exhibiting minor deterioration) though not explicitly connected to improving energy efficiency.
    - Corporate property maintenance requirements (approximately £22 million total): As with the backlog list, this is to enable identified buildings to reach Condition B. The majority of the spend is for structural repairs and improvements to multi-storey car parks (£18.5 million) which would not necessarily impact operational energy consumption, though would result in emissions from construction works (covered in Section 6). There are also planned roof replacements for the Guildhall (£614k), RAMM (£989k), Civic Centre Phase 3 (£230k) and a package of measures including heating system replacement at Brandninch Place (£242k). For all of these, Part L2B of the Building Regulations requires an improvement in energy performance.
    - Engineering maintenance requirements (approximately £11 million total): This spend is almost entirely on infrastructure projects which would not impact operational energy consumption, though as with the car park works could impact embodied carbon emissions.
- The Building Energy Efficiency Survey (BEES)[10] [7], which is referred to extensively by the CCC in its general analysis of the sector. This provides breakdowns of energy consumption and total abatement opportunities across various end uses for different sectors in the UK.

The data above enabled the formulation of an indicative programme of energy efficiency and demand reduction interventions with the following key assumptions:

- Improvements to space heating and hot water systems (see Section 3.3.4 - decarbonising heat).
- Improvements to the RAMM. The RAMM is one of ECC's highest emitting buildings; it reopened after an extensive refurbishment in 2011. A breakdown of end use energy is not available, though the majority is likely to be for space conditioning and lighting. Due to its complexity, the building ideally needs a full decarbonisation survey to identify the changes needed. For this analysis, the following is assumed:
    - No change to the external fabric (walls and glazing) due to the age and historic nature of the building.
    - There is an existing application to the Arts Council for works on the roof (102,566 kWh gas saving), upgrade of halogen lighting to LED (58,333 kWh electricity saving), and for 20 kW of solar PV. These measures are implemented prior to 2025.
    - The spaces housing the temporary exhibitions are controlled to very tight temperature and humidity levels (19°C +/-0.5, 50-55% humidity; a requirement to display items from important lenders). A

[h] "Renewable Plan.xlsx" provided by Paul Wotton 16th November 2021
[i] September 2021, Randall Simmonds
[j] Including Jo Pearce, Paul Wotton and Mike Carson for the estate in general terms, Tim Webb and Darren Summers regarding the Leisure Centres, and Alison Hopper Bishop regarding the RAMM.

speculative option is included loosening environmental control (to 40 to 60% humidity) with estimated savings based on CIBSE Guide F energy intensity values and these spaces occupying 17% of the building floor area. This would only be possible with the wider support of the sector, or from changes in approach to curation. This results in an 18% reduction in electricity consumption and a 12% reduction in gas consumption.
    - Other permanent gallery spaces (with open objects on display) have temperature control at 20.5°C +/-2.5 and relative humidity at 48-60%. Here the speculative option is a reduction to 35-65% with an accompanying overall 2% and 5% reduction in building electricity and gas consumption.
    - Replacement of the AHU resulting in generic savings identified from the BEES study.
- Improvements to the Leisure Centres (Riverside, ISCA Centre, Exeter Arena):
    - Fabric improvements are assumed to have the potential for energy saving based on the BEES study, which for the sector, averages an 8% reduction in building gas consumption (or 10% where a pool is present). Implemented post-2025.
    - Improvements to or implementation of BMS systems, carbon management measures, and ventilation upgrades are estimated based on the BEES study based on sector wide average improvements to electricity and gas consumption (BMS 3% electricity, 9% gas; carbon management 7% and 8%; Ventilation 5% and 0% respectively). BMS and carbon management measures implemented pre-2025 and ventilation improvements post-2025.
    - Lighting replacement between 2025 and 2030 (as in the leisure condition survey) with reduced electricity consumption data from a University of Exeter leisure centre report and an assumed improvement in efficacy from 95 lumens/Watt to 203 lumens/Watt).
    - Reductions in energy consumed by the swimming pool are estimated based on the BEES study (assumes 24% reduction in electricity consumption and 25% of heat consumption within swimming pool energy use in the leisure sector). Implemented post-2025.
- Improvements to the Corn Exchange, with the same savings assumptions as the leisure centres (except lighting based purely on the BEES study with an 11% potential saving).
- Improvements to all remaining buildings and sectors, assuming a 20% improvement in energy efficiency can be realised by 2030 (as per the CCC's projections and labelled as "general efficiency" in Figure 8).
- Any new buildings constructed (e.g., St Sidwell's Point and potential replacements for the Civic Centre or Wonford Leisure Centre) or included in the asset disposal scenarios are excluded from having energy efficiency measures applied.

Figure 8. provides a summary of the combined impact of these measures on total annual electricity (20% reduction) and gas (26% reduction) consumption by measure. Table 1 shows the approximate simple payback period for a range of measures averaged across the community, arts & leisure sector from the BEES study.

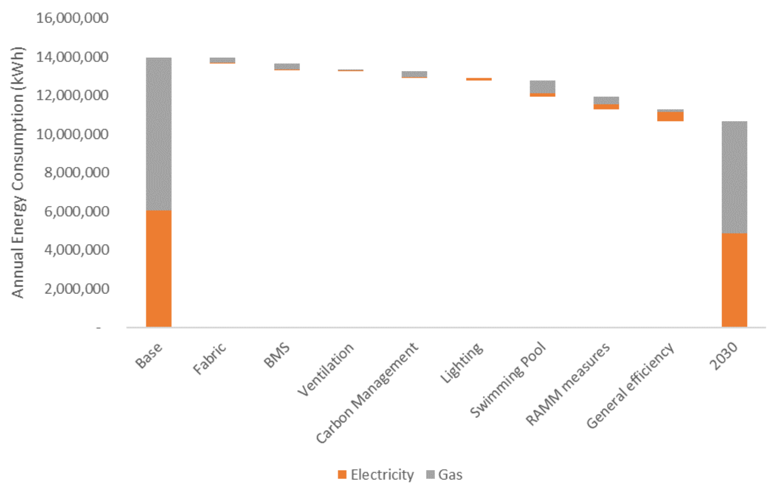


Figure 8: Savings in energy by measure across all ECC's corporate estate

Table 1: Simple payback period for a range of energy reduction measures from the BEES study for the community, arts & leisure sector

Measure	Simple Payback (years)
Air conditioning and cooling	11
Building fabric	19
Building instrumentation and control	5
Building services distribution systems	49
Carbon and Energy Management	3
Hot water	12
Humidification	0
Lighting	7
Cooled storage	5
Small appliances	22
Space heating	16
Swimming pools	11
Ventilation	9

3.3.4 Decarbonising heat

Following the decarbonisation of the electricity network, assumptions about asset changes, and demand reduction measures, around 70% of the remaining emissions from ECC's non-domestic buildings are likely to be from the use of natural gas; shifting to lower carbon alternatives will be necessary to achieve net zero carbon targets. Potential options include:

- Heat pumps: Air source heat pumps (ASHP) and ground source heat pumps (GSHP) absorb heat in the external air or ground respectively for use within buildings. Low carbon grid electricity means that by 2030 heat pumps are a significantly lower carbon option. Their efficiency (known as the Coefficient of Performance [CoP]) improves as the temperature difference between inside (supply temperatures) and outside decreases, which in practical terms means they are most effective in well insulated buildings with low temperature (large emitter) heating systems. Retrofitting heat pumps into poorly insulated buildings equipped with higher temperature systems is likely to lead to low efficiencies and high running costs. An economic comparison between heating with gas boilers and heat pumps will depend of the difference between gas and electricity prices combined with the efficiencies of the appliances. Recently the price of electricity has been about 4.3 times greater than gas. Assuming the current efficiency of a gas system is 80%, the CoP of a heat pump would need to be at least 3.4 for the operational energy cost of a HP to be no higher than gas. Experience has shown that seasonal CoPs above 3 can be difficult to achieve. In addition, heat pumps (and especially GSHPs) are significantly more expensive than gas boilers. Replacing gas boilers with heat pumps is currently challenging both from a technical and economic perspective. In discussion with other local authorities ECC has identified two recent case studies:
    - The proposed replacement of an existing heat source with ASHPs (rated at 500 kW) at a leisure centre with swimming pools of comparable size to Riverside. Here it was found that the project was not financially viable for the conditions set by the project, that noise was a significant factor, and that it would necessitate expensive local sub-station upgrades from 250 to 400 kVA.
    - The replacement of existing gas boilers (74% efficient for space heating boiler and 80% efficient for hot water boiler) with ASHPs in an office building using Salix funding. The calculations assume an air-to-air ASHP with a generous seasonal COP of 5 meeting 90% of the building's heat demand and an air-to-water ASHP with a seasonal COP of 4 serving the balance. Energy costs were taken as 7 p/kWh for gas

and 25 p/kWh electricity. The financial payback was over 50 years for both systems (in excess of the 20-year lifetime of the ASHPs).

These examples demonstrate that the financial cost and carbon benefits of adopting heat pumps needs careful assessment. It is also important that heat pumps are located and installed to minimise noise and vibration nuisance.

- Direct electric heating: As with heat pumps, by 2030 direct electric heating should be a significantly lower carbon option than gas heating (though higher than heat pumps). However, whilst panel heaters are cheaper than heat pump systems, running costs are several times higher. Direct electric heating is therefore not included.
- District Heating (DH): District heating is a method for distributing heat produced in a centralised location (at an energy centre). Historically heat generation is from gas, often with Combined Heat and Power (CHP). However, as the electricity grid has decarbonised the carbon benefit of this approach has eroded, especially as the distribution of heat in insulated pipes results in system losses. Where there is a local low carbon source of heat then DH can still be a viable low carbon option for replacing gas heating in buildings. For most of the significant buildings in ECC's corporate estate, there are no immediately suitable low carbon heat sources (gas-led City Centre DH initiatives have not been successful). The Riverside is a possible exception, with the Energy from Waste (EfW) site at Marsh Barton being some 2 km away. However, the heat from the EfW would first need to be utilised in the Water Lane and Marsh Barton mixed-use developments, both of which are likely to be a pre-requisite for extending a network as far as Riverside. DH is therefore not included.
- Hydrogen: Nationally, there are decarbonisation pathways that envisage the use of hydrogen as a replacement or partial replacement of natural gas in centralised infrastructure. As this is highly uncertain and unlikely to materialise prior to 2030, it is not included.
- Biomass: The CCC des include the use of biomass boilers in public or commercial buildings as "biomass resources could be better used as part of engineered removals or in other sectors where alternatives are limited". In practise, experience with biomass boilers has shown that they are difficult to retrofit and run successfully in commercial buildings.

From the above, heat pumps are taken to be the preferred option and are included in the buildings within the estate with the highest emissions from gas use (Riverside, RAMM, ISCA, Arena and Corn Exchange). It is assumed that an overall CoP of 3.0 (for space heating and hot water) is achieved and that existing systems have an efficiency of 80% i.e., 1 kWh of electricity displaces 3.75 kWh of gas.

The heat scenario envisaged is an indication of the potential for carbon reduction. As noted above, there are significant technical and financial barriers to achieving it in practice; each site needs detailed appraisal.

3.3.5 Renewable energy

Section 8 gives a schedule of potential implementation of building scale PV across the estate and assesses the proportion that is exported (and so classified as an offset in that section), together with the amount that is self-consumed and therefore results in the avoided import of grid electricity. Self-consumption is included on an individual building basis within this section of the analysis.

3.4 Target for 2030

Projections suggest a reduction in the emissions from non-domestic buildings from 2,236 to 602 tCO_2e in 2030 (-73%). The projections are based on:

- Emissions increasing by 55% on the 2020/21 total due to envisaged return to "business as usual" following Covid, consideration of average temperatures for the region, and known changes to ECC's assets with the full reopening of Riverside and the addition of St. Sidwell's Point more than offsetting the closure of the Pyramids Leisure Centre.

- The continuing decarbonisation of the electricity grid, which results in a windfall carbon reduction for all current electricity consumption and provides incentive to switch from natural gas to electric solutions.
- Estimates of a range of energy efficiency interventions quantified from national sector level data supplemented with local information. It is important to note that firming up these estimates requires detailed site-by-site evaluation. The assumptions result in a 20% reduction in electricity consumption, and a 26% reduction in gas consumption.
- The scenario assumes that towards the end of the decade (i.e. beyond ECC's current Capital Programme) that the Civic Centre is sold and replaced with something new and much smaller, that the Wonford Leisure Centre is refurbished and extended , and that the Northbrook Pool is disposed of. There is no suggestion that this is council policy; these assumptions are included to provide an indication of the magnitude of potential carbon reduction that such measures can achieve.
- The replacement of gas heating in ECC's major buildings with low carbon alternatives. Given the limited potential for low carbon district heating or hydrogen, this is likely to be electrified heating, with heat pumps being the lowest energy and carbon option. Recent experience from other local authorities indicates there may be technical and financial barriers to implementing this.
- The inclusion of PV on any suitable outstanding roofs across ECC's non-domestic estate. The potential for carbon reduction from this measure is relatively low, and falls over time as the wider electricity network decarbonises.

Figure 9 shows projected emissions from non-domestic buildings for ECC in 2020, 2025 and 2030.

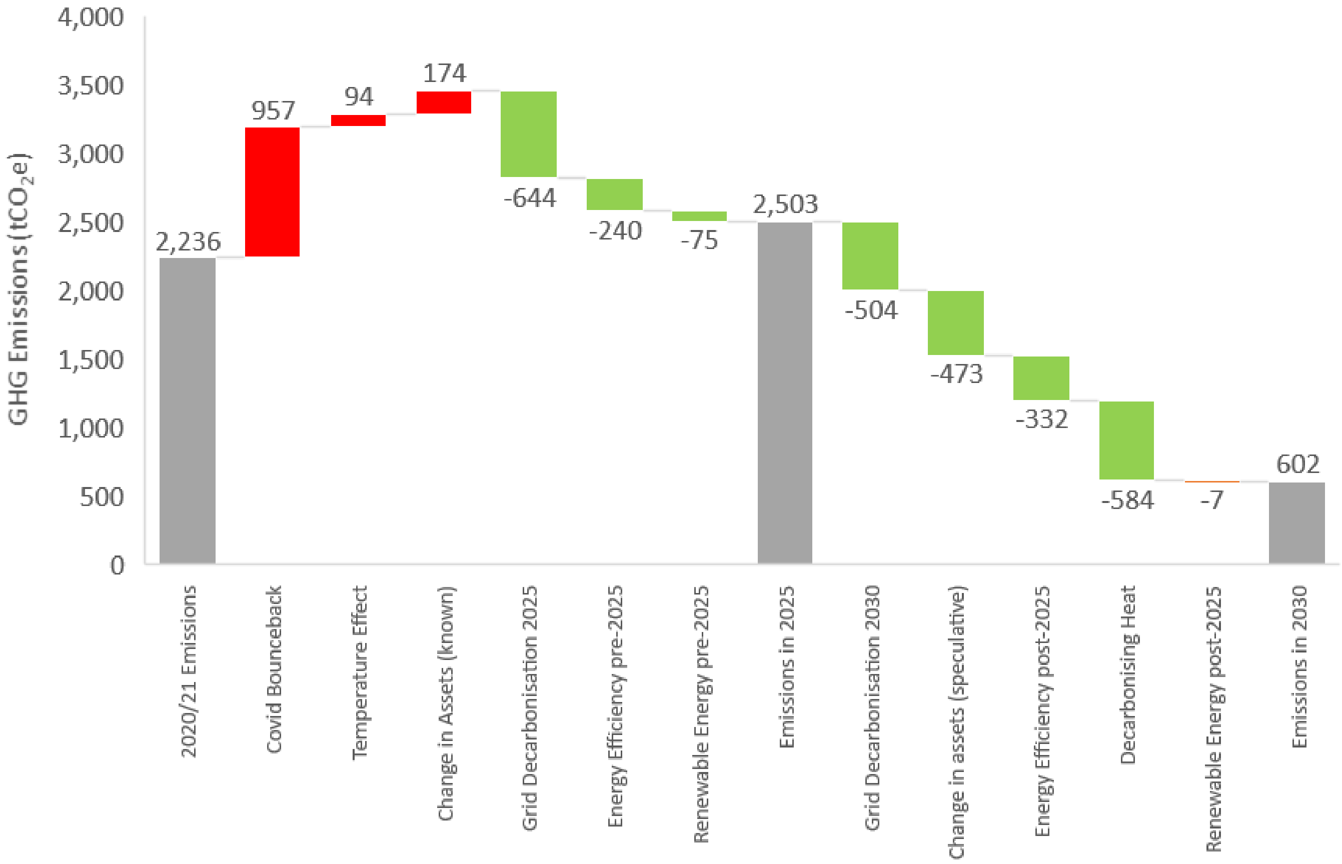


Figure 9: Measures to reduce ECC non-domestic building emissions to 2025 and 2030 (including WTT emissions)

4 Housing

4.1 Detailed sector summary

ECC's council owned housing contributed 33% of gross emissions in 2020/21 (17,319 t CO_2e). As of April 2021[k] it comprises 4,835 dwellings of which 2,557 (53%) are flats/bedsits, 254 (5%) are bungalows, 954 (20%) are terraced houses and 1,070 (22%) are houses (see Figure 10).

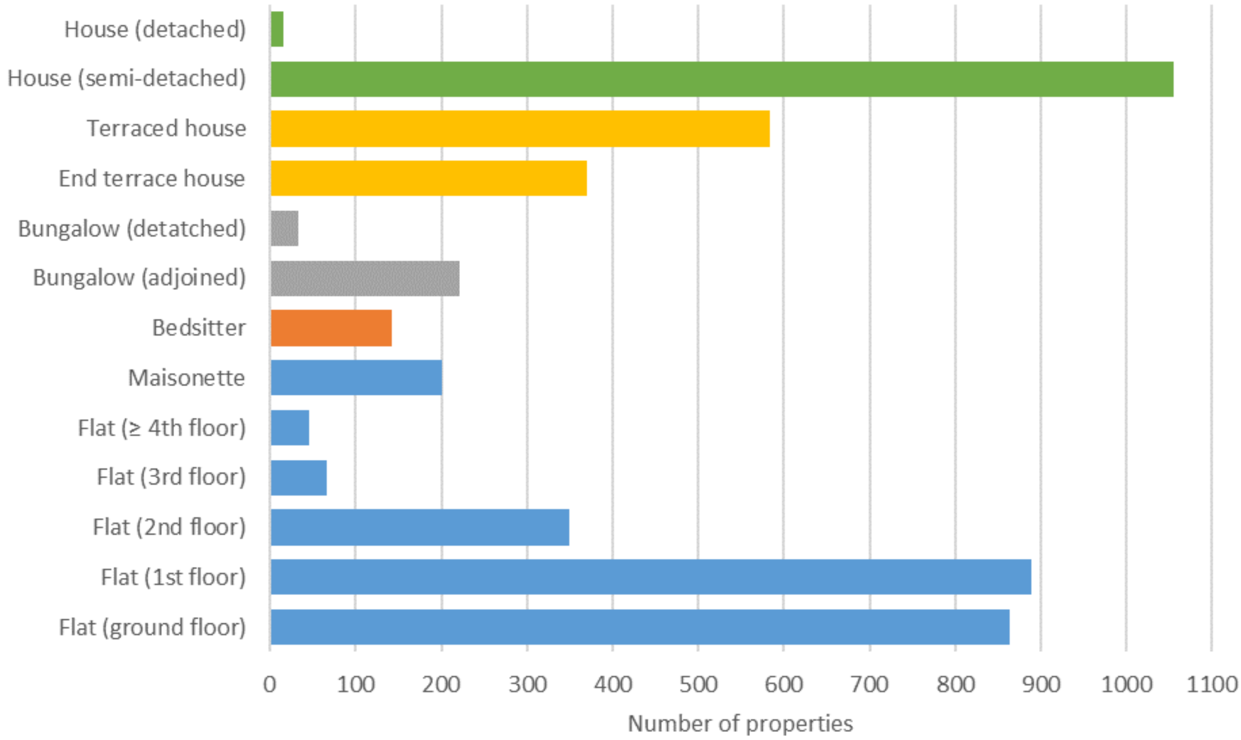


Figure 10: Domestic properties by type

4.1.1 Data acquisition and processing

A list of council homes provided by ECC gives data on the physical attributes including built form and construction as well as details of the heating systems. There are also fields for floor area and current SAP ratings. There is little quantitative data on energy use.

Data from Energy Performance Certificates (EPCs) is now available to download from a dedicated portal set up by the Department for Levelling Up, Housing and Communities (DLUHC)[l]. Registration with the site allows access to filtering tools (including by local authority) and an option for bulk data download in csv format. The EPC data includes all the assessment details including estimated energy costs for main and secondary heating, domestic hot water (DHW) and lighting. While the EPC data represents only a snapshot at the time that the assessments were carried out and some properties may have been improved since, there is currently no better accessible source for estimating address level data.

The EPC data for the whole of Exeter contains approximately 47,000 records and requires a considerable amount of pre-processing before it can be used, this includes removing duplicate assessments and accounting for anomalies in the numbering system (which is not unique to each building) to leave only the most recent assessments (approximately 37,000 records). Matching the EPC data to ECC assets ultimately relied on 'string matching' of addresses, which is difficult where different address formats are used. The use of Unique Property Reference Numbers (UPRNs) would

[k] Details provided in an ECC spreadsheet
[l] epc.opendatacommunities.org

simplify this process and while the ECC asset list gives the UPRN for each property, the EPC bulk data has only recently included a UPRN field and, of the matched addresses, only about 50% include a UPRN. This may improve in time.

The matching process eventually yielded EPC data for 2,444 of the ECC addresses, about 51% of the total number. The portal currently has records up to the end of September 2021 and it might have been expected that more addresses from the ECC asset list would have been included in the search as almost all of them appear to have EPC ratings. However, the portal is relatively new and therefore may not be entirely complete.

Details for addresses without EPC data were 'cloned' from similar homes, mostly from those in the same street (2,385 addresses), and in a small number of cases, based on postcode averages (8 addresses).

EPC energy data for heat, secondary heat, DHW and lighting is provided in the form of cost, and was converted into energy (kWh) by reverse-engineering the EPC Standard Assessment Procedure (SAP) calculations that would have been used to generate them. Calculations typically require the application of factors relating to the cost of energy, the proportion of energy that is used for main and secondary heat, and the proportion of consumption at higher tariff rates (in the case of address with dual tariff meters). The factors have changed with successive iterations of the SAP so addresses had to be matched to the appropriate document according to the date when the assessment was carried out.

The EPC data includes regulated energy sources (space heating, water heating and lighting) but not electricity used otherwise, for example in appliances. Ofgem provides typical domestic consumption values (TDCVs) based on returns from electricity suppliers at a national level which are reviewed on an annual basis. This are given at 'high', 'medium' and 'low' consumption levels for gas, electricity and dual tariff meters (where a 45/55% split is assumed for day/night consumption). The TDCV figures do not account for regional or local variations and an alternative dataset from BEIS was used which gives TDCVs for domestic meters at the postcode level. The 2020 release gives consumption from 2019.

This postcode level data is used in the production of subnational energy consumption statistics but on its own is considered 'experimental' so is provided with some caveats[11]. Postcodes with fewer than five addresses for example are excluded on the basis of disclosure, as are postcodes where more than 90% of consumption is due to a single meter. These however may be included in the data for partial postcodes (EX1, EX2 and so on) providing they are not considered too disclosive. Domestic meters with more than 100,000 kWh or less than 100 kWh are also excluded.

The TDCV data is matched with the Exeter EPC data by postcode and the electricity used for heating and lighting subtracted from the TDCV to give an estimate of unregulated electricity use. While the calculation for unregulated electricity may not hold up at an individual address level, aggregated over all of the ECC addresses it should give a better estimate than using national figures.

4.1.2 Energy and emissions in 2020

Figure 11 shows estimates of energy by end use for all of the ECC addresses from the methodology outlined above.

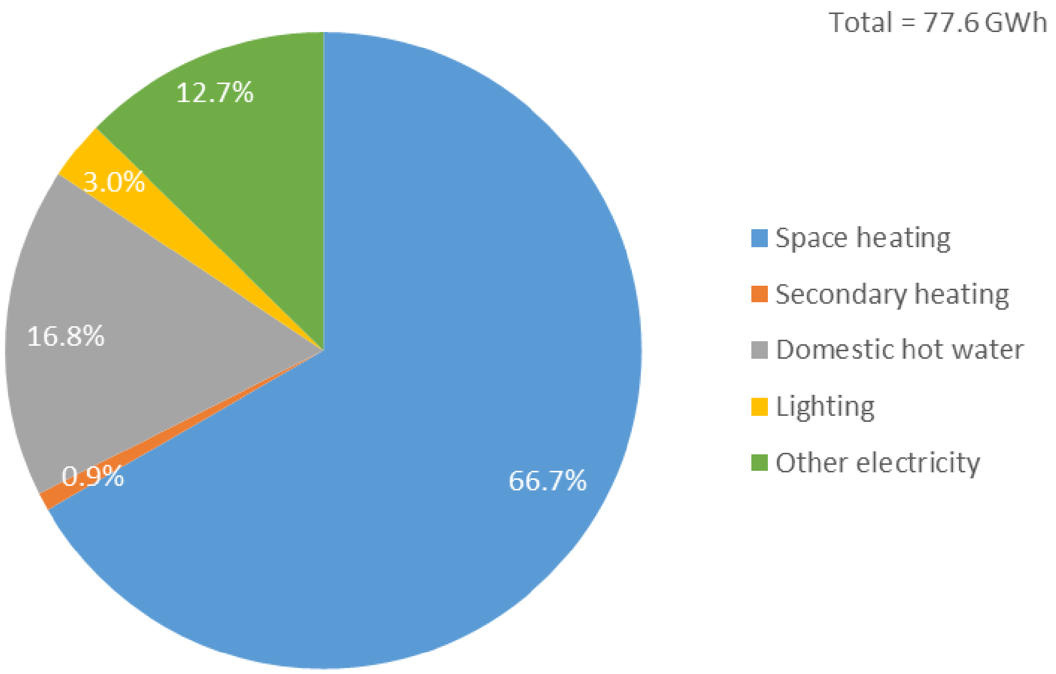


Figure 11: Estimated energy by end use in 4,835 domestic addresses

Energy use is dominated by space and water heating which is estimated at 65.4 GWh of which 95% (62.4 GWh) comes from gas. Most homes (93%) currently use gas as their main source of heat (Figure 12). Additional secondary heating is used in 607 (13%) of homes, mostly using electricity (368 homes) or gas (213 homes) with 25 homes listed in the EPC data as using solid fuel. In most cases water heating is done through the main system (92%, 4465 addresses) with the remaining homes using electric immersion heaters (7%, 338 addresses) or point of use water heaters (22 addresses) which are almost all electric. Homes that are part of community heating schemes (11 addresses) are provided with both space and water heating.

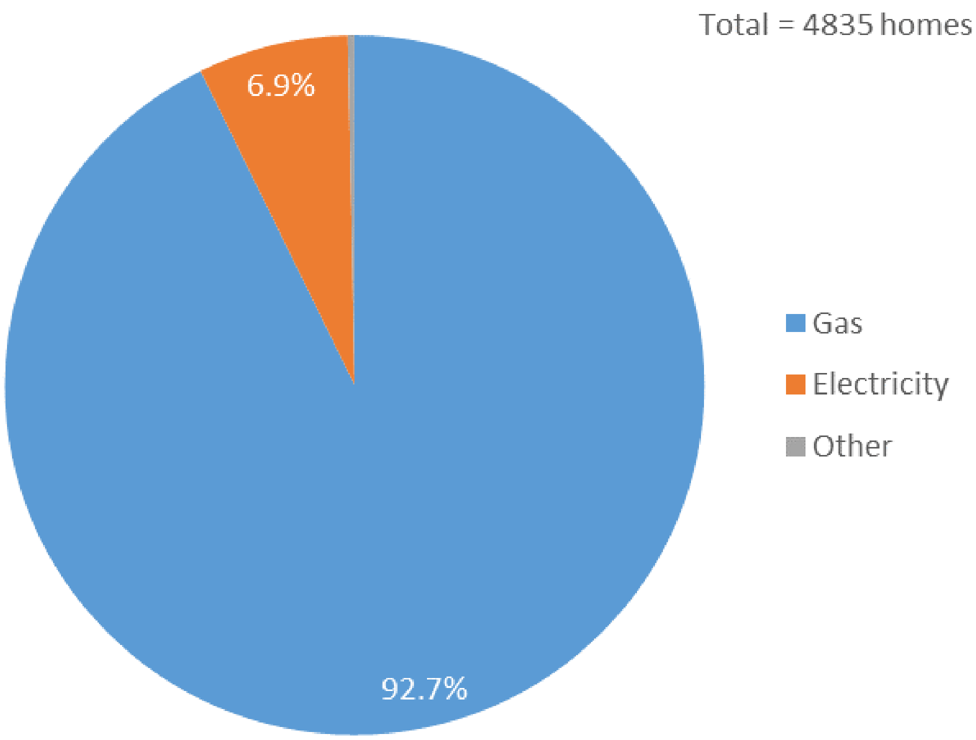


Figure 12: Number of homes using different fuels for the main source of heat

Emissions from energy consumption are estimated at 17,377 tCO_2e and have been broken down by end use in Figure 13.

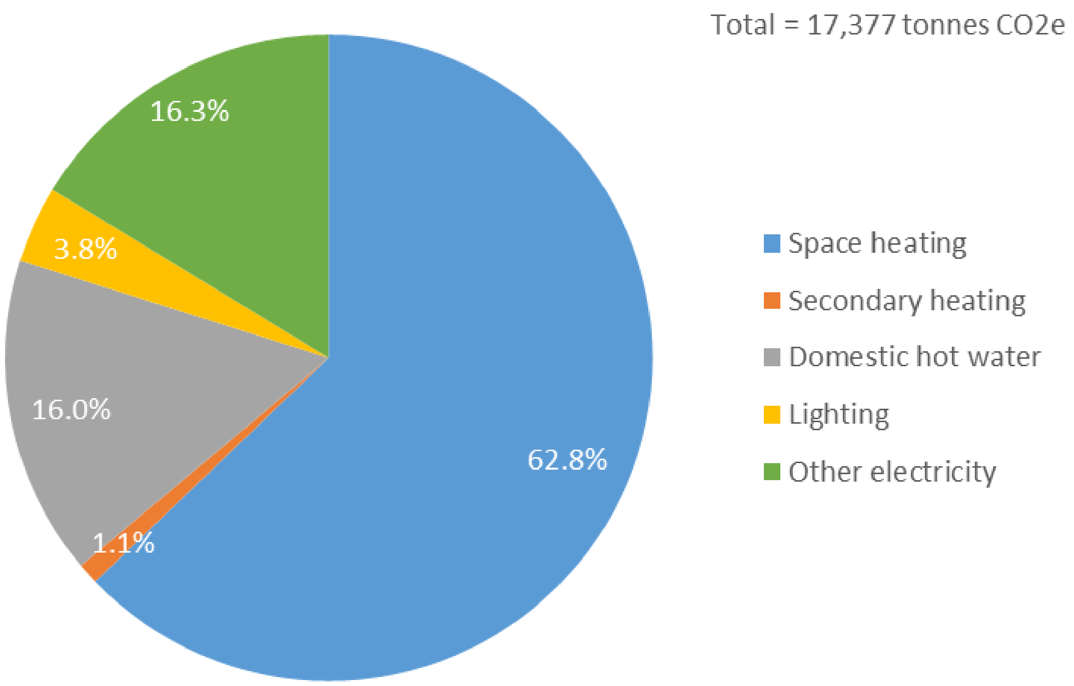


Figure 13: Estimated emissions from homes in 2020 by end use

A modest adjustment to the emissions total can be made as a result of renewable energy technologies, in particular the self-consumption of electricity generated by photovoltaic (PV) panels on some of these homes. There are 23 addresses which include solar DHW but energy saving and emissions reduction from solar hot water are difficult to quantify as they depend very much on storage and the extent to which occupants engage with the system. Given that they are small in number the energy and emissions savings for solar hot water are ignored.

Data on PV generation is not available directly but is derived from a report by E.ON[12], who installed PV at addresses across the ECC estate around 2012. The ECC asset list includes a field indicating which properties have solar PV panels. The initial list from E.ON included 283 properties with solar PV while the ECC asset list has 280 properties. There are some address-level disagreements between the two sets of data and a search for unique instances gave 310 addresses with PV. Properties that are not on the current ECC asset list are removed to leave 296 addresses where it is assumed that solar PV is installed.

Neither of the sources give the capacity or annual output of the individual systems. The E.ON report was supplemented at the time with some supporting data which gives the electricity generation at each address for the month of November 2012. The November data was used in conjunction with the solar modelling platform PVGIS[m] and images from Google Street View to estimate the number of panels and average panel capacity at each address. From this an estimate of annual generation at all sites was extrapolated so that it matched an annual assessment figure from E.ON. While exported solar electricity contributes to the decarbonisation of grid electricity, emissions at source are reduced when PV is consumed on site and an estimation of self-consumption was drawn from the Microgeneration Certification Scheme (MCS) guidance[13]. The MCS document provides tables to estimate self-consumption by annual output in three scenarios: occupants who tend to be out all day, out half of the day or in all day. It is assumed that the average case is best represented by an 'out-half-of-the-day' scenario and the table values are interpolated to give estimates of self-consumption at all of the addresses with PV.

[m] https://re.jrc.ec.europa.eu/pvg_tools/en

The efficiency of PV panels deteriorates over time with most manufacturers providing a guarantee that the panel will retain 80% of their generating capacity after 20 years of service. This equates to an annual decrease of $\sqrt[20]{0.8} = 0.989$ for each year of operation. After 8 years (from 2012) the panels might therefore expect to be generating at $(0.989)^8 = 0.915$ of their capacity when new.

Including degradation from new, the annual output from the existing PV installations is estimated at 554 MWh, with self-consumption estimated to be 199 MWh (the average proportion of self-consumption is 0.376). This figure is subtracted from overall electricity consumption and provides an emissions credit of 57 t CO_2e when multiplied by the corresponding emissions factor for electricity.

Total emissions from all sources is estimated at 17,319 t CO_2e, approximately 75% of which is due to the combustion of gas and the majority of the remainder from electricity (Figure 14). Other sources, including LPG, solid fuel and district heating account for less than 0.4% of total emissions.

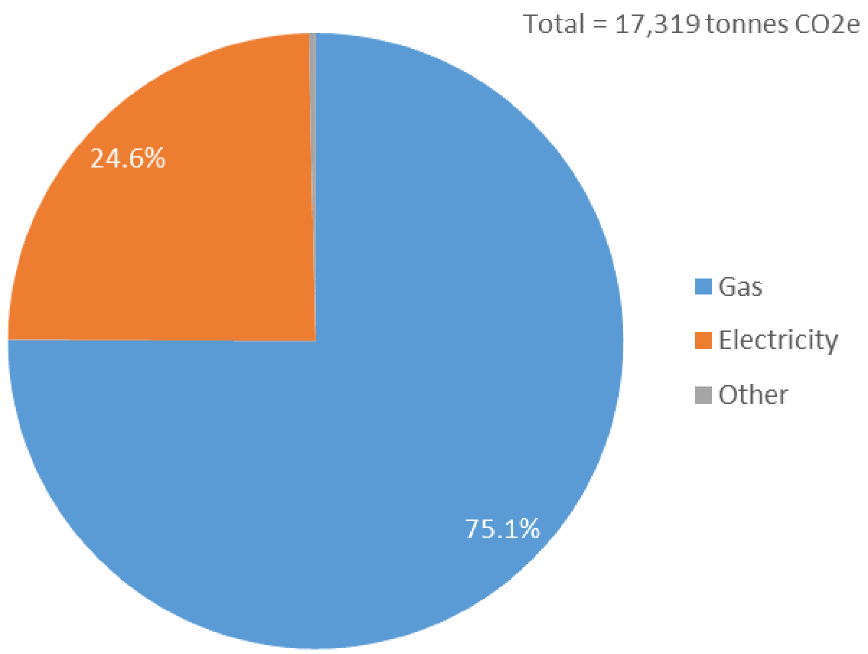


Figure 14: Estimated emissions from homes in 2020 by fuel

4.2 National policy framework

In the Sixth Carbon Budget UK residential emissions in 2019 are estimated to be 70.5% of emissions from buildings (20.6% of total emissions). UK housing is diverse and relatively inefficient so there is no 'one-size-fits-all-approach' to decarbonisation. The CCC notes a lack of progress on decarbonisation with housing emissions remaining largely flat in recent years. The implementation of key measures is slower than would be required to deliver Net Zero due to immature supply chains, low levels of public engagement and, until very recently, the low cost of gas.

The delayed Heat and Buildings Strategy[14] released in October 2021 announced funding of £3.9bn for low carbon initiatives in homes but appears somewhat lower than the 2019 manifesto commitment of £9.2bn and arrives off the back of the scrapping of the £1.5bn Green Homes Grant which failed to live up to expectations. The domestic element aimed at homeowners reached less than 7% of the intended target of 600,000 households although the Local Authority Delivery (LAD) scheme targeting homes with an E, F or G EPC rating has been extended.

The reaction to the strategy has been mixed with concerns over the ambition and funding being made available. Specific criticisms from the CCC include a lack of focus on fabric efficiency where the implementation of measures remains slow and some way behind the peak delivery levels that were seen in 2012 (Figure 15).

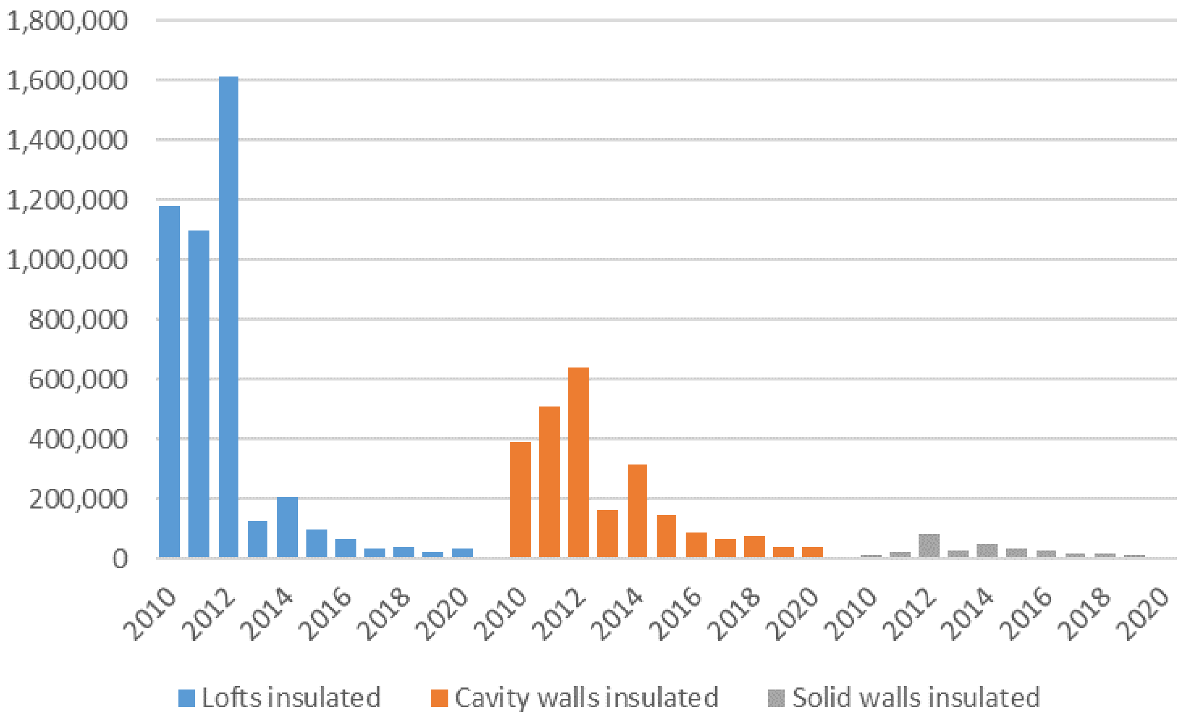


Figure 15: Progress in fabric efficiency improvements since 2010 (CCC)

Notable targets include a commitment to phasing out the installation of new gas boilers from 2035, reducing the costs of installing heat pumps by at least 25% by 2025 and developing the market for heat pumps to the point where it will be able to install to install at least 600,000 heat pumps per year by 2028. All new buildings in England will be 'ready for Net Zero' from 2025 through the Future Homes Standard with an ambition to build 300,000 new homes a year by the mid-2020s. Amending of building regulations is promised to ensure higher levels of energy efficiency and to drive the installation of low carbon heating to prevent the need for more costly retrofits. While further trials and research are carried out, a decision on the role of hydrogen is postponed until 2026.

Much of the policy detail is yet to be revealed although a timetable for a series of consultations and demonstrators is provided in the annexes.

The Climate Change Committee (CCC) describes four broad areas where emissions from buildings are likely to be reduced:

- Behaviour change;
- Increasing the energy efficiency of the building stock;
- Improving the energy efficiency of lighting and electrical appliances;
- Switching away from fossil-fuel based heat.

Behaviour change incorporates a range of actions, some of which require simple adjustments like turning things off or considering energy efficiency when making appliance purchases. Often however the changes are more profound and affect the way that homes are heated and controlled and will need to be implemented alongside enabling technologies and smart management systems so that consumers do not become overwhelmed or disengaged. Improving the controllability of heating systems and using financial signals through time-of-use pricing and smart infrastructure will aim to promote the demand management and load shifting behaviours that will be needed to facilitate the increased penetration of renewable energy into the electricity mix.

Many of these enabling technologies are in their infancy and are considered more likely to be implemented at scale in the period after 2025. In this assessment they are brought in as a suite of measures after more readily quantifiable changes are made and are considered as part of a 'whole house approach' to bring building performance to levels expected in Passivhaus/EnerPhit standards.

The energy efficiency of the fabric of the building stock in this assessment is primarily addressed through loft and cavity wall insulation (CWI) in the first instance and solid wall insulation (SWI) later. Data and metrics that are based on actual performance rather than models are being developed through the National Energy Efficiency Data-Framework (NEED) and it is hoped that regulatory requirements will follow in an attempt to bridge the 'performance gap' between modelled and actual performance.

Electrical efficiency of appliances in operation and standby has been driven by industry standards, and (prior to 2016) by EU legislation. A 12% decrease in residential electricity consumption between 2008 and 2018 has taken place despite population growth of 7% and is expected to continue [15].

With a typical design life of 15 years, many of the existing fossil fuelled heating systems will need to be replaced over the next ten years or so and in its Balanced Pathway the CCC envisages phasing out the installation of fossil fuel boilers before 2035. The switch to technologies such as heat pumps will be made easier if building fabric and thermal efficiency is brought up to recommended standards beforehand. The CCC considers that in most cases switching to efficient electric heating systems (largely heat pumps) offers the most viable route to the largest emissions savings. As the power sector continues to decarbonise, the emissions savings from these technologies will also accrue.

4.3 Opportunities

The most readily quantifiable measures for the domestic housing stock are considered individually in the following sections. These include relatively simple or low-cost measures such as ensuring that all lofts and cavities are insulated. A continuation of the rollout of PV can also be considered; while Feed-in Tariffs (FITs) are no longer available the cost of installations has fallen considerably. The council has said that it plans to provide over 500 new homes before 2025 [n] which will increase emissions from housing, but it is assumed that these will continue to be built to Passivhaus standards in order to minimise the impact on emissions. It is assumed that this rate of provision will continue over the period 2025 to 2030 to provide a further 500 new homes. Additional homes that may be delivered through the Liveable Exeter project are not included.

For the purposes of the analysis, it is assumed that the majority of the simpler measures would be carried out before 2025. More challenging measures including solid wall insulation (SWI) on homes without cavity walls and replacing gas boilers with air source heat pumps (ASHP) and are more likely to be successful when steps have been taken to improve fabric efficiency. It is assumed therefore that these measures are more likely to be carried out post 2025. As a well-established technology, PV installations are assumed to be carried out over the whole period up to 2030.

It is hard to quantify all possible measures directly, the use of smart technologies in conjunction with storage and modified behaviours for example will vary considerably between homes and without more detailed information is hard to model directly. Instead, a final 'catch-all' is considered where a Passivhaus/EnerPhit energy standard of 15 kWh/m^2 is achieved through a combination deep retrofit and energy saving strategies by following a whole house approach.

Other impacts that will reduce energy use and emissions without the council acting directly include the steady increase in the efficiency of appliances and the decarbonisation of the grid as the penetration of renewable energy sources increases. These are considered separately in the period up to 2025 and the period between 2025 and 2030 as the impact will vary depending on the carbon intensity of grid electricity and the extent to which domestic heating is electrified.

[n] https://news.exeter.gov.uk/stunning-new-passivhaus-council-homes-unveiled-in-exeter

4.3.1 New Passivhaus dwellings

The 1,000 new dwellings are assumed to be built to low energy standards to minimise emissions. The ECC asset list includes 66 addresses which have been designed to low energy/Passivhaus principles. These include:

- Chester Long Court (26 flats)
- Knights Place (18 flats)
- Rowan House (3 flats)
- Reed Walk (6 terraced houses)
- Silverberry Close (8 terraced houses)
- Barberry Close (5 terraced houses)

Assuming that the new homes broadly match the current mix of flats and houses, the EPC data can be used to clone a typical ECC low energy dwelling to derive energy consumption figures. Within the existing low energy homes 45 have gas boilers as their main heating system while the remainder use either direct electric heating or warm air systems. It is assumed that all new dwellings would install ASHP to minimise emissions.

Statistics from BEIS[16] and work carried out for the CCC[17] show that the seasonal performance factors for ASHP have improved from the legacy installations where the average seasonal performance factor (SPF) was 2.5. Instead, it is assumed that current trends will see SPFs for space heating with ASHPs increasing from 3.0 in 2018 to 3.5 in 2028. The SPF for DHW from an ASHP is assumed to be 2.3.

An average SPF over a build out period between 2020/21 and 2025 was taken as 3.2 for space heating, improving to 3.44 in the post 2025 period, with an SPF of 2.3 for DHW maintained over all builds. In the current mix of low energy homes, replacing boilers with an assumed efficiency of 89% and 100% for direct electric heating with ASHP would result in average annual space and DHW demand of 900 kWh per home and associated emissions of 166 kg CO_2e in 2025. By 2030 the average reduces to 884 kWh per home with emissions of 79 kg CO_2e

4.3.2 Loft and cavity wall insulation

The potential impact of loft and cavity wall insulation (CWI) has been assessed using the National Energy Efficiency Data Framework (NEED)[18], which combines data from multiple sources to derive representative figures for the energy saving potential of various measures. These are broken down by their impact on homes in a series of categories including EPC rating, property age, property type, occupancy and so on. The sample sizes on which the figures are base is modest (up to a thousand or so in each category) but are expected to be added to as more data becomes available.

The median impact of loft and cavity wall insulation by EPC category in the NEED Framework is summarised in Table 2.

Table 2: Median energy saving potential for loft and cavity wall insulation (NEED)

EPC rating	Loft insulation	Cavity wall insulation
A - C	4.3%	7.1%
D	5.4%	7.8%
E - G	4.7%	6.1%
No rating	3.3%	8.3%

The EPC data provides information on the nature of the installation (for example depth of loft insulation) and a qualitative assessment of its current state (from 'very good' to 'very poor'). Most of the ECC properties have existing insulation in lofts and cavities and for those with lofts 4,122 (85%) have insulation considered to be 'good' or 'very good', while 4,430 homes with cavity walls (92%) are said to be insulated.

The NEED data reflects the impact compared to no insulation and many lofts are seen to be partially insulated and would benefit from top-up insulation to bring them up to the 270 mm recommended. Data from the Energy Saving Trust[19] indicates that top-up insulation (from 120 mm to 270 mm) has a saving about 8.9% that of going from 0 mm to 270 mm.

If loft insulation and top-up insulation is applied to all properties with less than the recommended 270 mm/300 mm, as well as to those where the condition is deemed 'average' or worse there is an estimated emissions saving of 52 t CO_2e for loft insulation and 87 t CO_2e for cavity wall insulation.

4.3.3 Improvements in energy efficiency

In the CCC Sixth Carbon Budget sector summary on electricity generation, residential electricity consumption is said to have fallen by 12% between 2008 and 2018 due to improvements in energy efficiency of lighting and appliances. Further, it says that this trend is likely to continue so an annual adjustment to the lighting and unregulated emissions can be made of $\sqrt[10]{(1-0.12)} = 0.987$ which over the first five-year period might be expected to reduce consumption to $(0.987)^5 = 0.938$ of its value - a reduction of 6.2%.

Estimates for lighting and unregulated energy would reduce by 747 MWh by this measure resulting in emissions savings of 217 t CO_2e

The material savings here will be driven by industry standards and government policy but, given the relative scale of this reduction compared to measures such as insulation, there may be an indirect role for ECC to maximise the potential benefit, for example by continuing to support, promote or endorse energy saving technologies and low energy appliances and/or to provide advice on where to access good quality information.

4.3.4 Further deployment of solar photovoltaic panels

Since the financial support for PV through Feed-In Tariffs (FITS) has been withdrawn there has been a notable decrease in the number of small-scale installations. The Smart Export Guarantee which launched in 2020 pays a nominal price for exported electricity (generally between 1 p/kWh and 6 p/kWh) and even though panels and installation costs have fallen considerably consumers have been less prepared to accept longer payback periods. However, as more systems switch from fossil fuels to electricity and the use of electric vehicles (EVs) becomes more prevalent the economic arguments will change for many consumers, particularly if elements of the switch to homeworking through the Covid pandemic persist and the percentage of self-consumption of PV generated electricity increases. The use of EVs in conjunction with options for smart charging and vehicle-to-grid technology may provide another driver for domestic PV.

The potential for increased deployment of domestic PV in the ECC housing stock is based on current consumption as there is little evidence on the potential adoption of EVs among ECC tenants or their working patterns.

Estimating the potential for further deployment of PV was based on EPC data on built form (homes with roofs) and floor area which was used to give an estimate of the number of standard 1.6m × 1.0m panels that might fit on a pitched or flat roof (with allowances made for margins at the edges and gaps between rows). The peak generating capacity of panels has increased since the first wave of installations in 2012 so a capacity of 250 W_p per panel has been assumed. No account has been made for cross-gable roofs, hipped roofs, the presence of dormers, chimneys, or services so the analysis will not necessarily stand up at an address level but should give a reasonable approximation in aggregate. In terms of the potential output PVGIS was used to determine an average annual output figure based on an east or west orientation. The reduced output compared to an ideal south facing property should account for those properties where it is not possible to install PV or where output might be compromised by shading.

If half of the currently available properties were to install PV before 2025 the annual generation is estimated to be 2,752 kWh of which an average of 996 kWh would be consumed, and the remainder exported. As a first estimate, the assumption is also made that new low energy homes have some solar capacity with the self-consumption based on the average of existing dwellings. In terms of avoided emissions in 2025 this would amount to 334 t CO_2e.

4.3.5 Grid decarbonisation

As discussed in Section 3.3.1 the decarbonisation of the grid will occur largely as a result of national rather than local policies although exported electricity from domestic roofs will contribute in a small way to the renewable content of grid electricity.

Taking into account the modest improvements in building fabric efficiency, self-consumption of solar electricity and electrical efficiency improvements, the projected decrease in grid emissions is estimated at 1,517 t CO_2e making it by far the largest contributor to decarbonising housing in this first period and almost three time the additional emissions from the additional low energy homes.

4.3.6 Solid wall insulation

Solid wall insulation (SWI) can be technically challenging to install and expensive and is considered a measure that would most likely be attempted after easier options have been completed. In this assessment it is assumed that any SWI would be carried out in the later period between 2025 and 2030.

Referring again to the NEED Framework it can be seen that the potential for energy saving with SWI is greater in percentage terms than for loft and cavity wall insulation (Table 3).

Table 3: Median energy saving potential for solid wall insulation (NEED)

EPC rating	Solid wall insulation
A - C	19.0%
D	18.9%
E - G	16.3%
No rating	18.0%

The number of properties for which SWI might be suited was determined from the EPC data where construction details include properties that are described as 'system built' (pre-fabricated), 'timber frame', 'solid brick' or 'stone' along with those described as having 'no insulation'. This gives 502 buildings where SWI may be appropriate. Three homes described as being constructed from cob were not included as these are likely to require specialist attention.

The resulting annual energy savings from SWI are estimated to be 1,176 MWh, 96% of which would be through reduced gas consumption. The resulting emissions savings would be 244 tCO_2e.

4.3.7 Replacing fossil fuelled heating with air source heat pumps

With reasonable steps taken to improve fabric efficiency ASHPs are considered a viable alternative to heating with gas (and other fossil fuels such as LPG) in 3,510 homes. The installation of heat pumps on this scale needs ensure that they are located and installed to minimise noise and vibration nuisance and the leakage of high global warming potential F gas working fluids (as highlighted in Section 7).

The switch to heating with electric will by itself deliver large emissions savings as a result of falling grid emissions up to 2030. Homes with other forms of electric heating have therefore been ignored in the first instance. Where heat pumps deliver space heating and hot water the energy requirement will also reduce due to the heat pump efficiencies (SPFs). As described in Section 4.3.1 SPFs are expected to increase over the coming years and an average figure of 3.2 for space heating rising to 3.44 by 2030 and 2.3 for water heating have been assumed. With new heating systems it is assumed that the precise heat loss calculations that are required when specifying heat pumps correctly will mean that all forms of secondary heating become redundant.

The shift to ASHPs results in an annual fall in gas and fossil fuel consumption of 61,976 MWh and a corresponding increase in electricity consumption of 15,294 MWh. The net impact on emissions is a reduction of 9,871 t CO_2e driven by electrical efficiency and heat pump efficiency.

4.3.8 Deep retrofit and other energy saving

Additional measures that are hard to model directly at this scale include the use of smarter technologies, thermal and electrical storage (including vehicle-to-grid), managed ventilation and heat recovery, and modified behaviours. Taking a whole house approach where measures need to be considered holistically means that precise measures will be different for each property type. A combination of all these is to be likely to be necessary to get emissions from homes as close to zero as possible. The Passivhaus/EnerPhit standards currently represent best practice and expect annual heat consumption not to exceed 15 kWh/m^2. Taking the all the floor areas from the EPC data and multiplying by this figure gives the likely best-case scenario for the heat requirement of all homes in the ECC estate. At this stage it is assumed that ASHPs are installed in all homes where they are viable. Additional energy and emissions savings arise from electricity alone.

The resulting reduction in annual electricity consumption is 8,222 MWh with a corresponding emissions reduction of 1,520 t CO_2e in 2030. As the carbon intensity of grid emissions reduces so does the emissions saving potential of energy saving measures, however it does increase the likelihood of achieving net zero as the remaining emissions can be offset with less reliance on generating renewable energy.

4.3.9 Final deployment of solar photovoltaic panels

The rollout of PV to the remaining homes that are able to take panels is modelled in the same manner as in Section 4.3.4. Panels originally installed in 2012 will be at or near the end of their expected operating lifetime while those installed in the period between 2020/21 to 2025 will have seen their effective capacity decline over 5 years and will be operating at around 94.6% of their new capacity. Self-consumption patterns are assumed to be the same as in the first period although it is likely that the use of storage and vehicle-to-grid technologies in conjunction with smarter systems, and perhaps time-of-use charging by energy suppliers, will see the percentage of self-consumption for most systems increase. The estimated reduction in electricity consumption is 1,097 MWh with associated emissions savings of 203 t CO_2e.

4.3.10 Further improvements in energy efficiency and grid decarbonisation

Following on from Section 4.3.3 and Section 4.3.5 the electrical efficiency of appliances in this post-2025 period continues to improve at the same rate resulting in emissions savings of 146 t CO_2e and 2,074 t CO_2e respectively.

Unregulated emissions in this simple model have been estimated by subtracting regulated energy consumption from TDCVs. These are likely to change in the future. However, it is hard to predict whether they will continue fall as a result of continued efficiency savings or whether they could see increases as a result of wider adoption of technology and gadgetry or a 'rebound' effect (as the increased penetration of renewable energy and lower grid emissions leads to more ambivalence around energy saving).

4.4 Target for 2030

Projections suggest a reduction in the emissions from domestic housing in from 17,319 to 1,916 tCO_2e in 2030 (-89%). The projections for emissions from the current stock of domestic homes and anticipated new low energy homes are based on a bottom-up assessment of emissions associated with current homes and a combination of a direct and indirect measures that might be expected in the intervening period.

- Baseline emissions of 17,319 t CO_2e for the existing stock of 4835 homes are based on information provided by ECC which has been matched with the EPC database to determine energy use.
- An increase of 536 t CO_2e as a result of 500 new low energy/Passivhaus homes announced by ECC which are assumed to be heated with ASHP. The associated emissions savings will accrue as grid electricity decarbonises.
- Ensuring that loft and cavity wall insulation is up to recommended standards in all existing homes will deliver savings of 52 t CO_2e and 87 t CO_2e respectively and appear modest as most homes are already at or near the required standard. However, such measures will ensure that homes are in a better position to switch to ASHP as heating systems are replaced.
- Electrical efficiency of appliances has been improving consistently and delivers savings of 217 t CO_2 to 2025 and while ECC is not directly responsible for these it can promote the use of high efficiency appliance options.
- The self-consumption of solar PV generation saves 334 t CO_2e to 2025 based on deployment in half of all suitable existing and new homes. The end of FITs means that the economic appraisal of PV is not as straightforward as it once was as savings are dependent on maximising the avoided costs and emissions of imported electricity. As the penetration of smart systems, storage and EVs increases the economic benefits will become more favourable.

- At 1,517 t CO_2e grid decarbonisation is likely to be a major source of emissions reduction to 2025 and while this may be appear as something of a 'free-hit' as key measures will largely be determined by national energy policy, lower emissions factors will be aided by energy reduction measures and exported electricity.
- This leaves interim emissions in 2025 of 15,650 t CO_2e.
- A further 500 low energy homes will add emissions of 325 t CO_2e by 2030.
- Solid wall insulation applied to 502 homes will reduce emissions by 244 t CO_2e but perhaps more importantly will lay the groundwork to enable more of those homes to switch to ASHP.
- Installing ASHP in 4,495 homes that are not already heated electrically will yield the greatest reduction in emissions if homes can be made ready to accept them by upgrading thermal performance. Resulting emissions savings are estimated at 9,871 t CO_2e due to the reduction in the emissions intensity of grid electricity and reduced energy consumption if the improvement in SPF for ASHPs can be achieved by 2028.
- A combination of smart technologies, heat recovery, thermal and electrical storage are likely to be necessary to get homes to the Passivhaus/EnerPhit standard for annual space heating of 15 kWh/m^2. Taking the whole house approach to deliver the deep retrofit in a manner appropriate for each property type would deliver further savings of 1,520 tCO_2e.
- Installing PV on remaining homes saves an estimated 203 t CO_2e, a figure which has lessened as a result of falling grid emissions. However, measures such as PV, particularly when coupled with storage assets, will provide the basis for the shift to a low carbon electricity grid as they will introduce flexibility and reduce the load on electricity infrastructure.
- The increase in appliance efficiency is predicted to continue and could lead to further reduction in emissions of 146 t CO_2e in the period 2025-2030. ECC can support the adoption of low energy appliances and devices.
- As emissions from grid electricity approach zero towards 2030 the emissions savings have the greatest impact where heating has transitioned away from fossil fuels. In this second period an additional emissions reduction of 2,074 t CO_2e is anticipated.
- The collective impact of all the measures in 2030 is a 90% reduction from domestic housing to 1,916 t CO_2e.

The emissions reductions for the measures outlined above are summarised in Figure 16:

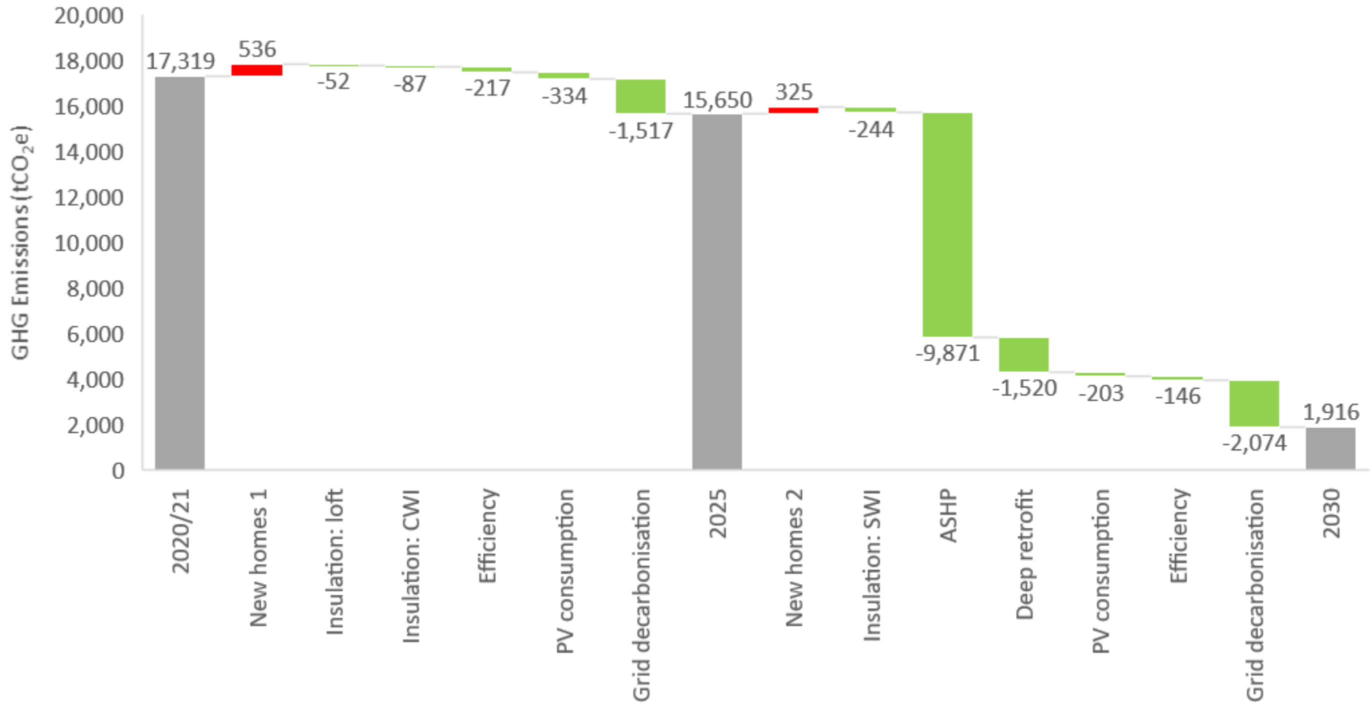


Figure 16: Measures to reduce ECC emissions from domestic housing to 2025 and 2030 (including WTT emissions)

5 Transport

5.1 Detailed sector summary

Emission from transport in 2020/21 totalled 1,108 t CO_2e. Direct (Scope 1) transport GHG emissions arise from vehicles and other machinery[o] owned or rented by the Council: the ECC fleet. Indirect transport emissions come from employee business travel, the "grey fleet" (employee vehicles used for work and claimed on expenses) and staff commuting. Indirect embodied emissions are included under procurement (Section 6).

5.1.1 Direct emission from transport

The transport footprint for the ECC fleet is built up from fuel consumption data for individual vehicles, which is available for the majority of the fleet. The exceptions are red diesel used in specialist vehicles and portable machinery used by the Public and Green Spaces team. In this case bulk red diesel (for vehicles) and petrol card data (for portable machinery) has been used to calculate emissions. Total 2020/21 emissions (direct and WTT) are shown in Table 4.

Table 4: ECC transport emissions in 2020/21 (including WTT)

Fuel	Diesel (t CO_2e)	Petrol (t CO_2e)	Electric (t CO_2e)	Total (t CO_2e)	Percent %
Car parking services	3.8	0.0	0.2	4.0	0.4%
Cleansing - refuse trucks	556.3	0.0	0.0	556.3	58.3%
Cleansing - other	151.1	0.3	0.2	151.6	15.9%
Housing	0.7	0.0	1.4	2.1	0.2%
Leisure and museum	1.3	0.0	0.0	1.3	0.1%
Public & green spaces	203.2	30.8	2.4	236.4	24.8%
Waterways	1.8	0.0	0.0	1.8	0.2%
Other	0.0	0.5	0.7	1.2	0.1%
Total 2020/21	**918.1**	**31.7**	**4.9**	**954.7**	**100.0%**

Nearly all (99%) vehicle emissions come from the waste service (74%) and public and green spaces (25%).

The highest emission vehicles in the fleet are refuse collection vehicles (typically Dennis Eagle Olympus 16) which in 2020/21 had average annual emissions of 33 t CO_2e each. ECC has 16 of these giving total 2020 emissions of 528 t CO_2e. Four other waste and cleansing vehicles have average 2020 emissions of 19 t CO_2e (total 78 t CO_2e) with 18 Iveco and Isuzu lorries run by cleansing, public and green space and waterways contributing a total of 82 t CO_2e. Together these 38 vehicles contributed 89% of non-red diesel road vehicle emissions.

Red diesel consumed by 20 public and green space vehicles (not including the lorries above) represented 10% of 2020/21 emissions which, together with petrol for portable equipment (3%), was half of the department's emissions.

Direct emissions are those over which the Council has most control. Given the uncertainties over indirect emissions, these should be the focus of initial efforts to reduce transport emissions.

5.1.2 Indirect emissions from transport

ECC's indirect transport emissions come from business travel, mileage undertaken in staff vehicles on council business (so-called "grey fleet" miles) and staff communing. Estimates of business travel emissions are made from spending and are included under procurement (see Section 6). Grey fleet mileage data is available. Emissions for the last 3 years have fallen from 21 t CO_2e to 20 t CO_2e and most recently to 16 t CO_2e in 2020/21. The most recent fall has an element of Covid impact. ECC's estimates of commuting mileage give emissions of 202 t CO_2e in 2018/19 and 244 t CO_2e in

[o] Portable machinery used by the Public & Green Spaces team is included in transport emissions

2019/20. In 2020/21 the council estimates that commuting emissions were 10% of the 2019/20 figure (24 t CO_2e). Post Covid, the extent to which normal staff travel patterns will resume is unclear making estimation of future indirect emissions difficult.

5.2 National policy framework

In the Sixth Carbon Budget the CCC's balanced pathway projects:

- 9% of car miles can be reduced (e.g. through increased home-working) or shifted to lower-carbon modes (such as walking, cycling and public transport) by 2035.
- High take-up of electric vehicles (EVs) with conventional cars, vans and plug-in hybrids ended by 2032 at the latest.
- The roll-out of zero-emission HGVs accelerates to reach nearly 100% of sales by 2040.
- Continuing vehicle efficiency improvements.
- A reduction of 3% in van miles by 2035 through measures such micro-consolidation centres.
- HGV logistics measures to reduce miles driven by lorries.
- All sales of new buses are zero-carbon by 2035.
- Diesel trains are phased out by 2040.

The Government has set 2030 as the date when the sale of petrol and diesel vehicles should stop with all new cars and vans being fully zero emission at the tailpipe in 2035. It is also proposing that the sale of new diesel HGVs should end in 2040.

5.3 Opportunities

5.3.1 ECC Fleet

The main source of ECC fleet emissions is from essential cleansing and public and green space services. Refuse collection and grass cutting are unlikely to yield material opportunities for mileage reduction and, given the nature of these services, efficient driving is likely to have little to contribute. However, in other services mileage reduction and increased vehicle efficiency offer potential opportunities for emissions reduction.

Tasking each department using vehicles with reducing annual mileage starts with measuring and reporting mileage and giving feedback to staff. This can be followed by target setting by department and then for individuals. Adopting processes which minimise the need to travel and ensure the shortest trip distances together with training staff to ask, "is this journey essential?" before each trip can also support a mileage reduction strategy.

Efficiency improvements are achieved by choosing the smallest vehicle practical for the needs and by driving it efficiently. Efficient driving can be encouraged through training such as that provided by Lightfoot. This will be particularly important as electric vehicles are introduced to the fleet[p].

Migrating the fleet to low and zero emission vehicles will be an essential part of the transition. Identifying how and when waste and public and green space vehicles can be electrified will determine the speed and success of emission reduction. 2021 emissions from the fleet totalled 830 t CO_2e.

ECC's vehicle replacement schedule for higher emission vehicles (above 10 t CO_2e/year) is summarised in Table 5.

[p] https://www.fleetandleasing.com/leasing-news-1/driver-training-essential-for-electrifying-fleets-says-lightfoot/

Table 5: Replacement schedule for high emission vehicles in ECC's fleet

Year	Vehicle type (s)	Number	2020/21 emissions t CO_2e
Pre 2021	Other waste	2	38
2022	Refuse collection	3	98
2023	Street sweeper & other waste	2	40
2024	Refuse collection	3	107
2026	Refuse collection	10	309
2027	Refuse collection	2	40
Total		**20**	**632**

Table 6 summarises the replacement schedule for more moderate emission vehicles: the 27 Iveco and Isuzu trucks in the fleet.

Table 6: Replacement schedule for Iveco and Isuzu trucks in ECC's fleet

Year	Vehicle type (s)	Number	2020/21 emissions t CO_2e
Pre 2021	Public & green space lorry	1	5
2021	Housing lorry	1	6
2022	Public & green space lorry	1	6
2024	Cleansing & Public & green space lorries	5	25
2025	Public & green space lorries	2	10
2026	Public & green space & Waterways lorries	8	28
2027	Cleansing & Public & green space lorries	8	30
Total		**26**	**110**

High emission vehicles were responsible for 76% of emissions with the moderate emission vehicles responsible for a further 13%.

ECC has ordered three electric refuse collection vehicles for delivery in 2022 replacing those due to be retired from the fleet in the year, demonstrating that electrification of the fleet is a realistic opportunity. Assumed electrification is in line with vehicle post 2021 replacement schedule, i.e. all replacements are electric. This is an aggressive assumption as, for example, there are no suitable currently replacements for 3.5 tonne vans and 7.5 tonne refuse vehicles. The timing of replacements with electric alternatives is therefore likely to slip.

The replacement of petrol and diesel vehicles with EVs to 2025 yields in a reduction of 277 t CO_2e giving a resultant 472 t CO_2e. By 2030 the entire fleet is assumed to be electric and emissions reduce by a further 391 t CO_2e to a residual 81 t CO_2e.

5.3.2 Other direct transport

28 specialist vehicles operated by the Public and Green Spaces team use red diesel, emitting 94 t CO_2 in 2020/21. The vehicles include tractors, mowers, sweepers, tele-handlers, etc. The specialist nature of these vehicles and their relatively small markets make it less certain that low and zero carbon alternatives will be developed, particularly before 2030. The council will therefore need to use the knowledge and expertise of the public green space team to develop a zero red diesel strategy. In the interim, the assumption is that 25% of red diesel use is electrified between 2025 and 2030.

There are some 282 items of portable equipment. Public and green spaces operate the majority (249), with waterways operating 13 with the remainder being scattered across various other departments. 244 are fossil fuelled (132 two stroke (petrol with oil added), 95 petrol, 15 diesel, 2 butane gas) with emissions of 31 t CO_2e annually[q]. As with specialist

[q] The balance of equipment is battery/electric. Emissions from this equipment are captured by electricity consumption.

vehicles, the development of low and zero carbon alternatives with the equivalent functionality is less certain, particularly before 2030, and the knowledge and expertise of the public green space team will be needed to develop a low carbon portable equipment strategy. In the interim, the assumption is that 25% of portable equipment use is electrified between 2025 and 2030.

5.3.3 Indirect transport

The council has less control over indirect transport emissions particularly commuting which, pre Covid, historically represented over 90% of indirect emissions. However, policy on business travel (included under procurement in Section 6) and grey fleet miles can encourage or mandate the use of low and zero carbon travel alternatives.

The council has estimated that Covid reduced commuting emissions in 2020/21 by 90%. As the pandemic recedes it is assumed that commuting levels return to the pre-pandemic levels (an average of 2018/19 and 2019/20) raising commuting emissions from 24 t CO_2e in 2020/21 by 200 t CO_2e.

The Sixth Carbon Budget provides data on car mileage reduction (9% by 2035, with 3% by 2025 and 6% by 2030) and the penetration of EVs (9% in 2025 and 34% in 2030)[r]. Assumed uptake of EVs by ECC's staff is assumed to be in line with national trends and these figures provide estimates of the reduction in grey fleet and car commuting emissions. There is the potential to be augmented these assumptions with forward looking ECC policies on business travel and commuting which could deliver significant improvements on national trends.

Commuting on public transport will inevitably rely on changes driven nationally but it is unlikely that all buses and trains serving Exeter will be low and zero carbon by 2030. Commuting emissions therefore persist beyond 2030.

The CCC estimates that in 2030 69% of new buses sold will be zero carbon[s]. Assuming a linear rise from 2021 to 2030 and a 15-year vehicle life suggests that 5% of bus fleets will be zero carbon in 2025 increasing to 23% in 2030. Emissions from bus commuting reduce accordingly. The CCC assumes that nationally there is little change in rail electrification between 2020 and 2030 (41% to 44%). Emissions from trains serving Exeter therefore do not reduce over this period.

5.4 Target for 2030

Projections suggest a reduction in the emissions from transport from 1,108 to 331 tCO_2e in 2030 (-68%). The projections are based on:

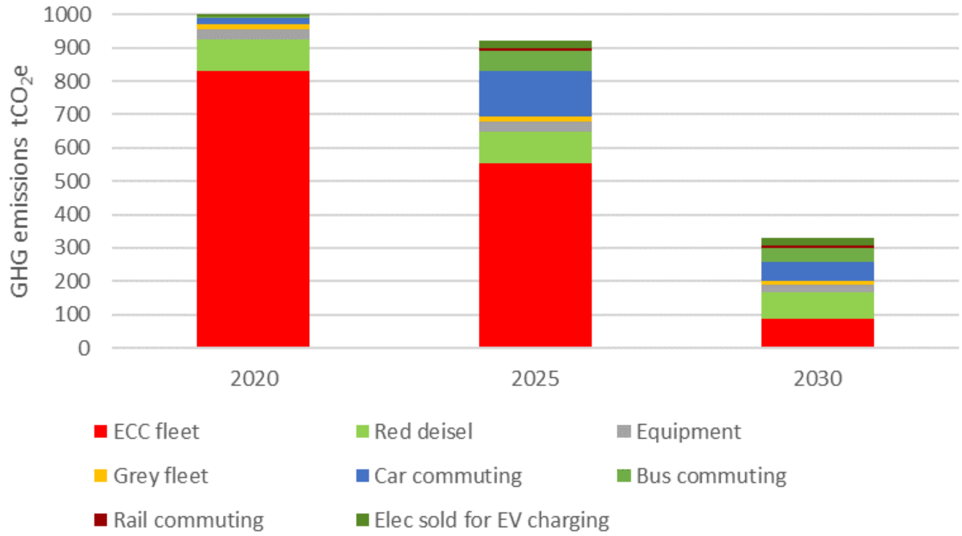
- A Covid bounceback in staff travel to pre pandemic levels before 2025
- The vehicle replacement programme acquiring 100% electric vehicles between now and 2030
- Reductions in staff car grey fleet and commuting mileage by 3% to 2025 and an additional 3% between 2025 and 2030
- Electrification of cars and busses used for staff commuting in line with national trends between now and 2030
- Electrification of 25% of public and green space specialist and portable equipment between 2025 and 2030

Table 7 and Figure 17 show projected transport emissions for ECC in 2020, 2025 and 2030.

[r] Sixth Carbon Budget, Charts and data in the report, CCC, 2021 (surface transport key assumptions & charts 3.1b and B2.2)
[s] Sixth Carbon Budget, Charts and data in the report, CCC, 2021 (surface transport key assumptions)

Table 7: ECC transport emissions in 2020, 2025 and 2030 (including WTT emissions)

Category	2020/21 t CO_2e	2025/26 t CO_2e	2030/31 t CO_2e	2020 %	2025 %	2030 %
ECC fleet	830	552	89	82%	60%	27%
Red diesel	94	94	76	9%	10%	23%
Equipment	31	31	25	3%	3%	8%
Grey fleet	16	18	9	2%	2%	3%
Car commuting	17	135	58	2%	15%	17%
Bus commuting	6	59	42	1%	6%	13%
Rail commuting	1	9	9	0%	1%	3%
Electricity sold for EV charging	23	23	23	2%	2%	7%
Total	1018	921	331	100%	100%	100%
% change from 2020/21		-10%	-68%			



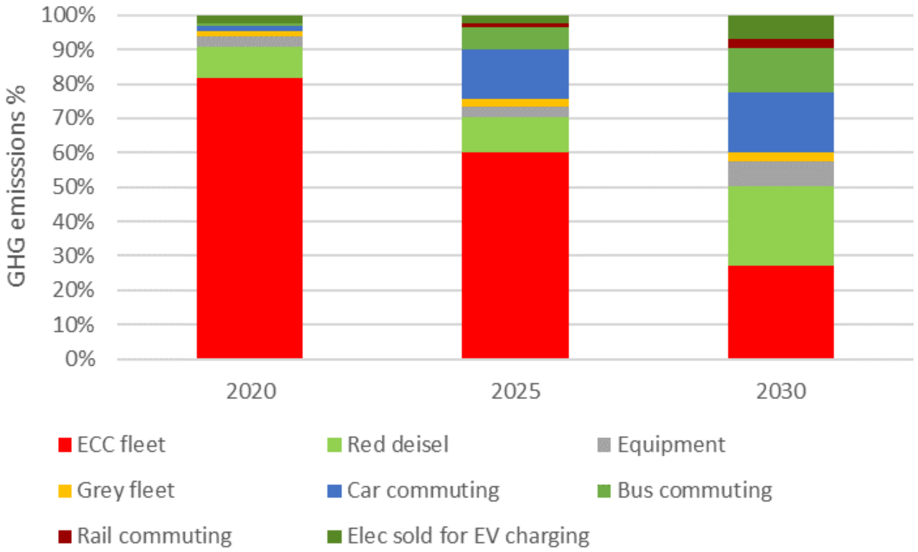


Figure 17: ECC transport emissions in 2020, 2025 and 2030 (including WTT emissions) in absolute and percentage terms

Figure 18 shows the measures that contribute to the reduction in each 5-year period.

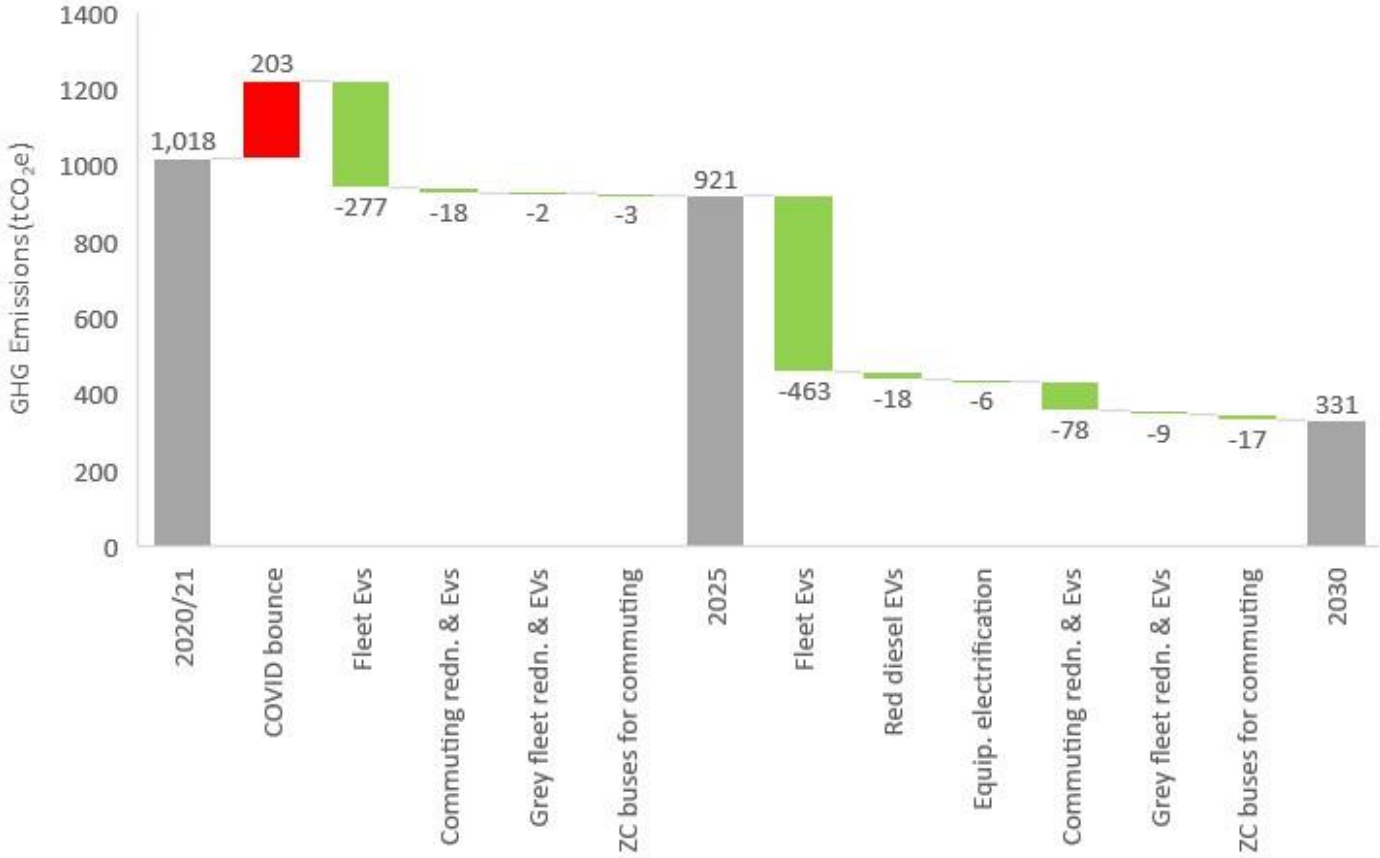


Figure 18: Measures to reduce ECC transport emissions to 2025 and 2030 (including WTT emissions)

6 Procurement

6.1 Detailed sector summary

Emissions from procurement are the most significant part of ECC’s footprint at 32,380 t CO_2e, 61% of total 2020/21 emissions. Emissions from procurement span a broad range of activities and include capital and revenue spend. The total spent by ECC (excluding distribution of business grants) for 2020/21 was £77.2 million. This is an order of magnitude larger than the amount used for the footprint in 2018/19, which did not capture all Council spending.

£3.2 million (4%) of the £77.2 million 2020/21 spend was on suppliers whose emissions are captured in the footprint using better direct data (e.g. energy companies and Strata whose emissions are included in building energy use). The remaining 96% of spend does not have any specific carbon emission data associated with it and requires the use of much less accurate proxy emission factor as detailed in Annex E of the Government’s Environmental Reporting Guidelines. This allocates suppliers to sectors within the UK economy and applies a kg CO_2/£ spent factor to determine emissions. Figure 19 shows the results. Approximately 60% of emissions are from construction activities, 18% from “unallocated” spend (see next paragraph), and the remaining 22% from specific sectors that are likely to be mainly revenue spend.

This simplified spend method is helpful in providing an initial approximation of potential impact from procurement, but beyond this there are numerous critical disadvantages to the approach. Firstly, there is significant potential to misallocate the sector to the supplier. Without the capture of sector specific information as part of the procurement process, manual sector assignment takes place as part of the production of the footprint. The data contains nearly 9,000 entries for the year and so it is not possible to allocate all of them manually. Instead, manual assignment was limited to items over £50,000 identifying 129 suppliers and capturing 82% of spend. The remaining 18% of spend was labelled as “unallocated” and an emission factor applied based on the average of all allocated spend. Even for those suppliers that are manually allocated, there is sometimes ambiguity as to which was the most suitable sector, and sometimes a supplier may be providing goods or services spanning more than one sector within the contract.

A further issue with this approach is that because emissions are based on spend multiplied by an emission factor (that is out of the control of ECC), the only way to “reduce” calculated emissions would be to spend less. Whilst sometimes this would be genuinely beneficial (both from a financial and environmental perspective e.g., by increasing the amount that is re-used within the organisation), it also by definition penalises spending more on “better” products e.g., those with lower upfront embodied or lifecycle emissions (or costs).

Finally, the emission factors themselves are crude and dated. Annex E of the Environmental Reporting Guidelines still uses factors from 2009, and whilst there have been some revisions to emission factors since, many originate from the same data (and are not internally consistent), or remap the sectors, with high discrepancies between emission factors within sectors (shown in Figure 20). For example, the emission factor for the Construction sector (the largest ECC category by spend) is four times greater in the 2009 Environmental Reporting Guidelines than in the 2017 UK Carbon Footprint to the point where it is not apparent whether the scope of these two emission factors is truly comparable.

Within ECC’s spend, approximately half has been allocated to Construction, though within this there is considerable diversity, for example the construction of the new St. Sidwell’s Point swimming pool complex as well as various maintenance contracts. The carbon impact of these activities will clearly be different (even on a kg CO_2/£ spent basis), and in particular “big ticket” construction projects are not predictable on a year-to-year basis (and ECC’s capital budget is agreed up to 5 years in advance). This means that determining the procurement footprint from year to year and particularly for a year as far away as 2030 is not possible as it strongly depends on what might be built in that year. For example, in 2020/21, £28.4 million (37% of total annual spend resulting in 43% of procurement emissions) was paid to the contractor of St. Sidwell’s Point.

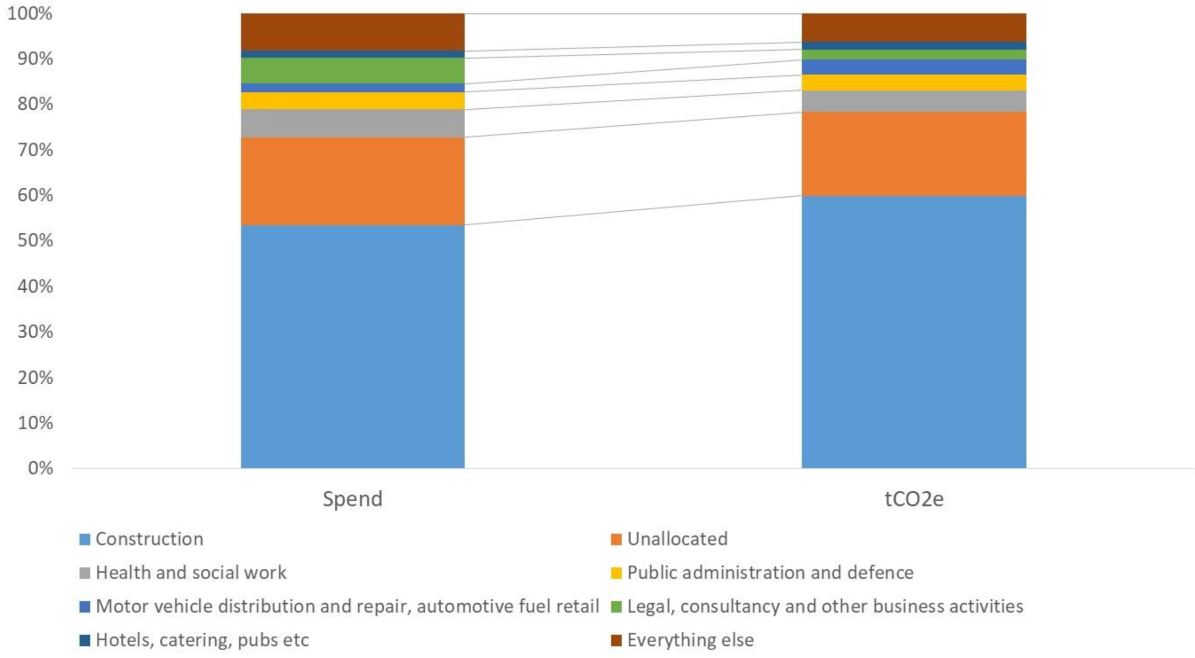


Figure 19: Sector breakdown of spend and resulting emissions for all spend that does not have direct emission data associated with it i.e., 96% of ECC's total spend

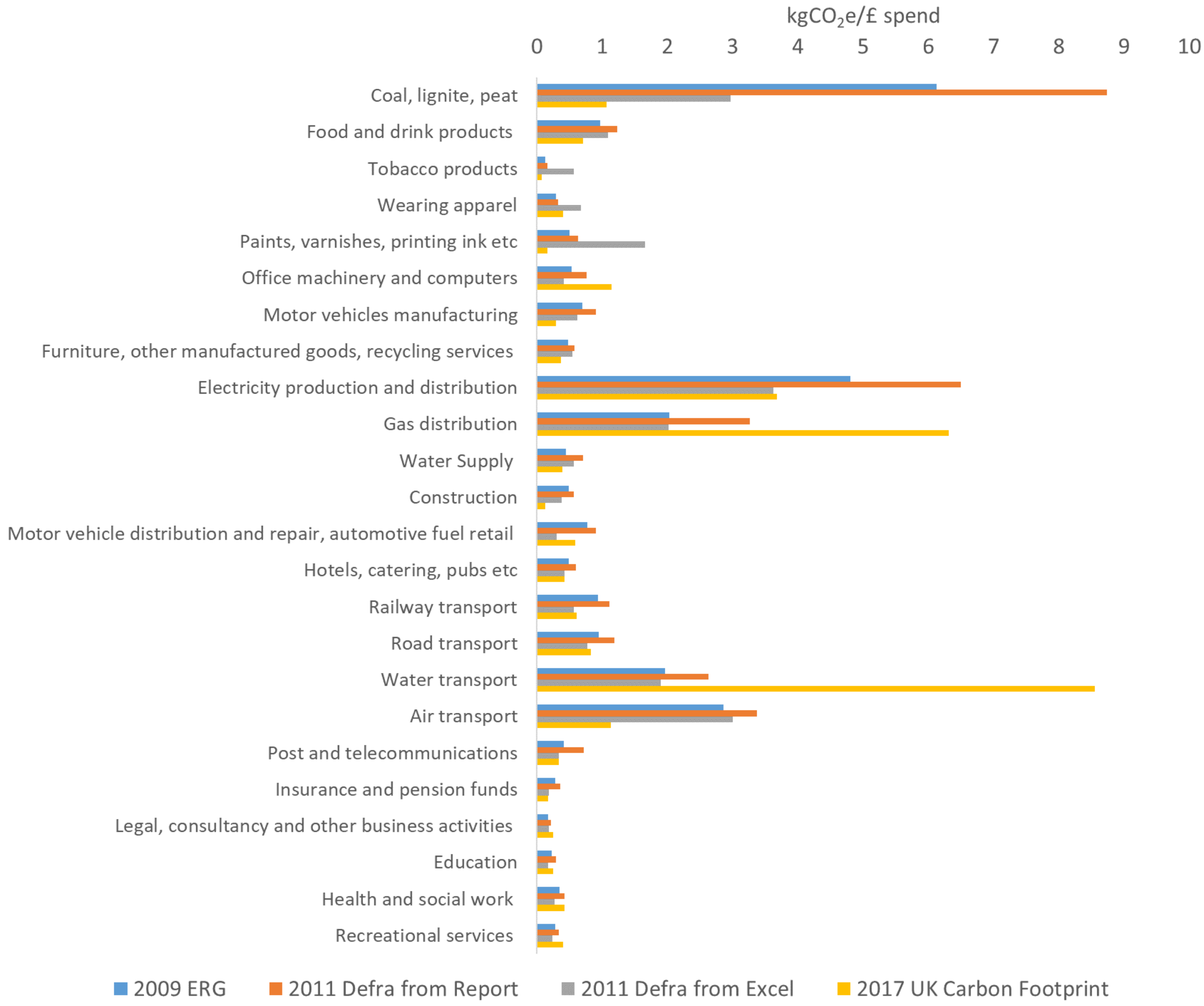


Figure 20: Scope 3 procurement emission factors from various sources filtered to show only categories where data is estimated for each source

6.2 National policy framework

Current national policy does not address directly ECC's procurement activities. However, there are several indirect policy areas that should improve data quality and emissions reduction including:

- Major contracts to Central Government requiring quantification of carbon impact. Whilst this will not directly affect ECC, the policy is helpful in readying supply chains more generally.
- The SECR (Streamlined Energy and Carbon Reporting) regulations now require large companies[t] to disclose their annual greenhouse gas emissions and intensity ratio (e.g., kg CO_2/£ spent). This should enable much more specific information to be available from those suppliers, in addition to providing incentive to those suppliers to reduce those emissions year on year.
- The greenhouse gas aspects of Building Regulations for new buildings have to date focussed on operational energy performance, and even the proposed "Future Homes Standard" changes planned for 2025 will still only consider operational emissions. However, there is a growing realisation of the need to include embodied emissions, and there are several emerging guidelines that cover embodied emissions being adopted in local planning policy, notably in London through the "London Energy Transformation Initiative" (LETI)[u]. As this issue gains prominence, consultants and contractors will have higher levels of readiness to measure and reduce embodied emissions from construction projects.
- Whilst the kg CO_2/£ spent emission factors are unreliable, there are an increasing number of private sector organisations who are developing products and services that aim to plug this gap, and it is expected that these should be more widely available over the period to ECC's planned decarbonisation in 2030.
- The general decarbonisation of the UK and global economies should have knock-on effects on all procurement by ECC. For example, all ECC's suppliers will benefit from the reducing carbon intensity of the electricity grid, just as ECC is.

6.3 Opportunities

6.3.1 Improve data capture

"You can't manage what you can't measure". At present, the quality of procurement GHG emissions data is poor, as is the default condition for organisations nationally. Only 4% of the council's spend can be converted to greenhouse gas emissions using direct measurement (e.g., units of energy consumed rather than amount spent on energy). The remaining 96% is based on an inaccurate spend method. To improve data capture so that year-on-year quantification of procurement emissions are both meaningful and provide incentives for ongoing reduction, it is recommended that all suppliers for new contracts exceeding £50,000 (in 2020/21 this captured 82% of all spend) should be required to state the associated greenhouse gas emissions with that contract for each financial year. For large organisations, this information should be readily available due to their obligations under the SECR regulations. Small and medium organisations should be encouraged to provide similar information as part of their own commitments to mitigate climate change. Where this is not available, as a minimum suppliers should provide the corresponding sector for spend to minimise the effort and error associated with manual allocation, and this information be recorded in procurement records.

6.3.2 Consider the need for new buildings

Construction was by far the most significant sector for greenhouse gas emissions from procurement, with 54% of spend on items where emissions were calculated using the spend method, and 60% of the overall emissions. St. Sidwell's point dominated with 43% of all procurement emissions. Clearly, constructing new buildings has the potential to be a

[t] Turnover more than £36 million, balance sheet over £18 million, or more than 250 employees.
[u] https://www.leti.london/

significant contributor to the Council's footprint. Questioning the need for new buildings, as opposed to reorganising, extending the life of, or refurbishing existing assets, results in lower environmental impact (see Figure 21).

Unlike general operations of the Council where emissions arise annually (e.g., fuel use in buildings and vehicles, spend on ongoing services), construction projects result in embodied emissions in the year of construction (and if the whole life cycle is considered, at regular maintenance periods and at the end of life/demolition). Therefore, the impact in any given year is highly dependent on what (if anything) is constructed in that year. The projected scenario assumes that St. Sidwell's Point is a one off. However, when there are other non-residential construction projects they will contribute additionally to the footprint.

An annual pipeline of 100 homes delivered by the Council is included.

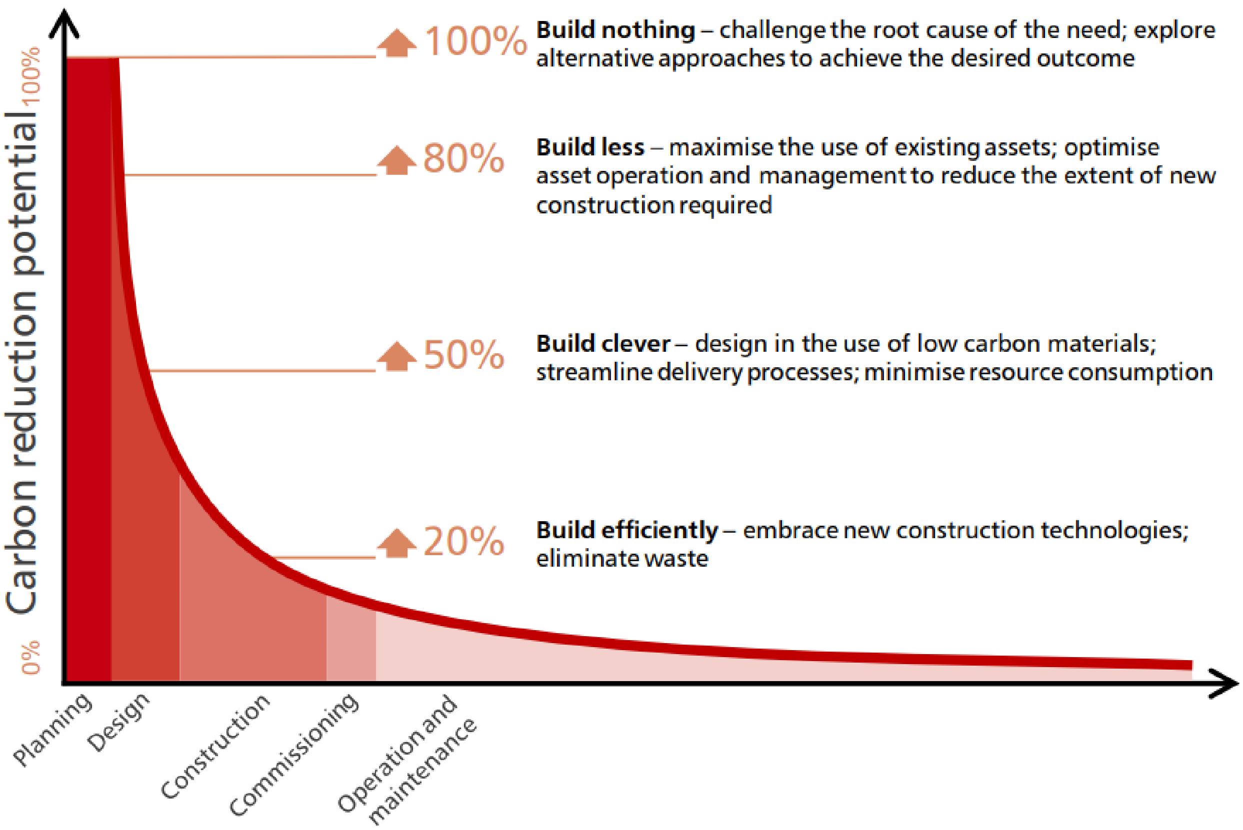


Figure 21: Carbon reduction potential of various build strategies[20]

6.3.3 Follow circular economy principles

Where a need for new goods and services is demonstrated, it is important to follow circular economy principles to minimise environmental impact. Figure 22 compares a linear and circular approach. Following a hierarchy of repair, reuse, remanufacture, and recycle, goods are involved in one less part of the value chain each time, leading to significantly reduced environmental impact. It is important that, as per the recommendation to improve data capture, circular economy decisions are taken with good quality data, i.e. from the suppliers. Failure to do so may result in simply looking to spend the lowest amount possible (as this returns the lowest emissions using the simple spend method), when sometimes solutions with higher upfront costs have lower lifecycle emissions (and potentially overall costs too). Greenhouse gas emissions should be a determining factor alongside cost and quality considerations when awarding new contracts. It is recognised that it is not straightforward to do this for existing contracts, but by 2030 most contracts in place will be new.

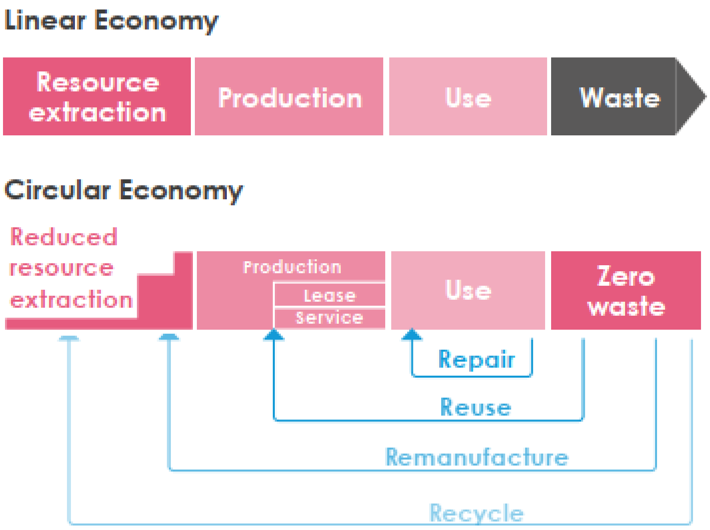


Figure 22: Circular Economy Principles, compared to existing Linear Economy (Source LETI [21])

Whilst for most sectors or products and services there are no specific standards that can be applied to set targets or requirements through procurement, the construction of new buildings (which is the most significant source of emissions for the Council) is a notable exception. LETI have produced benchmarks for different building types as shown in Figure 23 shown on an A++ to G scale. A rating of E is equivalent to business as usual. The assumption is that this is how buildings would otherwise be constructed in Exeter. The upfront-embodied carbon for new homes for an E rated building is 850 kg CO_2e/m^2 as opposed to 300 kg CO_2e/m^2 for an A rated building (the LETI 2030 target) or 100 kg CO_2e/m^2 for A++. This demonstrates the significance of construction emissions, and the potential savings compared to business as usual were ECC to construct new buildings to higher standards. The assumption in the trajectory is that by 2025 the 100 new homes annually are built to an A rating and that all other construction achieves a similar equivalent reduction in emissions. By 2030 the target is increased to A++.

Interestingly, if it is assumed that the build cost of a new dwelling is £1,750/m^2 (at the lower end of the market), then an E rating implies 0.49 kg CO_2/£ spent which is the same as the emission factor used for construction when using the simple spend method. Ratings of A and A++ (at the same build cost) result in 0.17 kg CO_2/£ spent and 0.06 kg CO_2/£ spent respectively, highlighting the potential limitations of using the spend method alone.

Upfront Carbon, A1-5 (exc. sequestration)

	Band	Office	Residential	Education	Retail
	A++	<100	<100	<100	<100
	A+	<225	<200	<200	<200
LETI 2030 Design Target	A	<350	<300	<300	<300
	B	<475	<400	<400	<425
LETI 2020 Design Target	C	<600	<500	<500	<550
	D	<775	<675	<625	<700
	E	<950	<850	<750	<850
	F	<1100	<1000	<875	<1000
	G	<1300	<1200	<1100	<1200

Embodied Carbon, A1-5, B1-5, C1-4 (inc. sequestration)

	Band	Office	Residential	Education	Retail
	A++	<150	<150	<125	<125
	A+	<345	<300	<260	<250
	A	<530	<450	<400	<380
RIBA 2030 Built Target	B	<750	<625	<540	<535
	C	<970	<800	<675	<690
	D	<1180	<1000	<835	<870
	E	<1400	<1200	<1000	<1050
	F	<1625	<1400	<1175	<1250
	G	<1900	<1600	<1350	<1450

All values in $kgCO_2e/m^2$ (GIA)

Figure 23: Upfront and lifecycle embodied carbon for different building typologies (Source: LETI)

It is much less easy to specify targets for other parts of ECC's procurement. Most of ECC's spend is on services rather than goods, and it is therefore assumed that most suppliers are based nationally and that their emissions arise in the UK. For all spend on goods and services other than construction, the scenario assumes that emissions from those contracts fall in the same proportion as the CCC identify in their Sixth Carbon Budget report to 2030. There is clearly a much higher chance of this being realised in practice if ECC obligates suppliers to provide contract specific emissions data, and uses this in the contract selection process.

6.4 Target for 2030

Projections suggest a reduction in the emissions from procurement from 32,380 to 9,658 tCO_2e in 2030 (-70%). The projections are based on:

- Improving data capture, as an enabling measure that will both improve the accuracy of the footprint and provide the foundations for incentivising suppliers to reduce their emissions.
- Making use of existing assets before committing to new construction projects.
- Setting firm embodied carbon targets (A by 2025 and A++ by 2030) for all new Construction projects.
- Using greenhouse gas emissions as part of the selection process for new suppliers capturing all contracts (not just Construction), with the aim of decarbonising these contracts at least as fast as the UK's general decarbonisation trajectory.

Figure 24 shows projected emissions from procurement for ECC in 2020, 2025 and 2030.

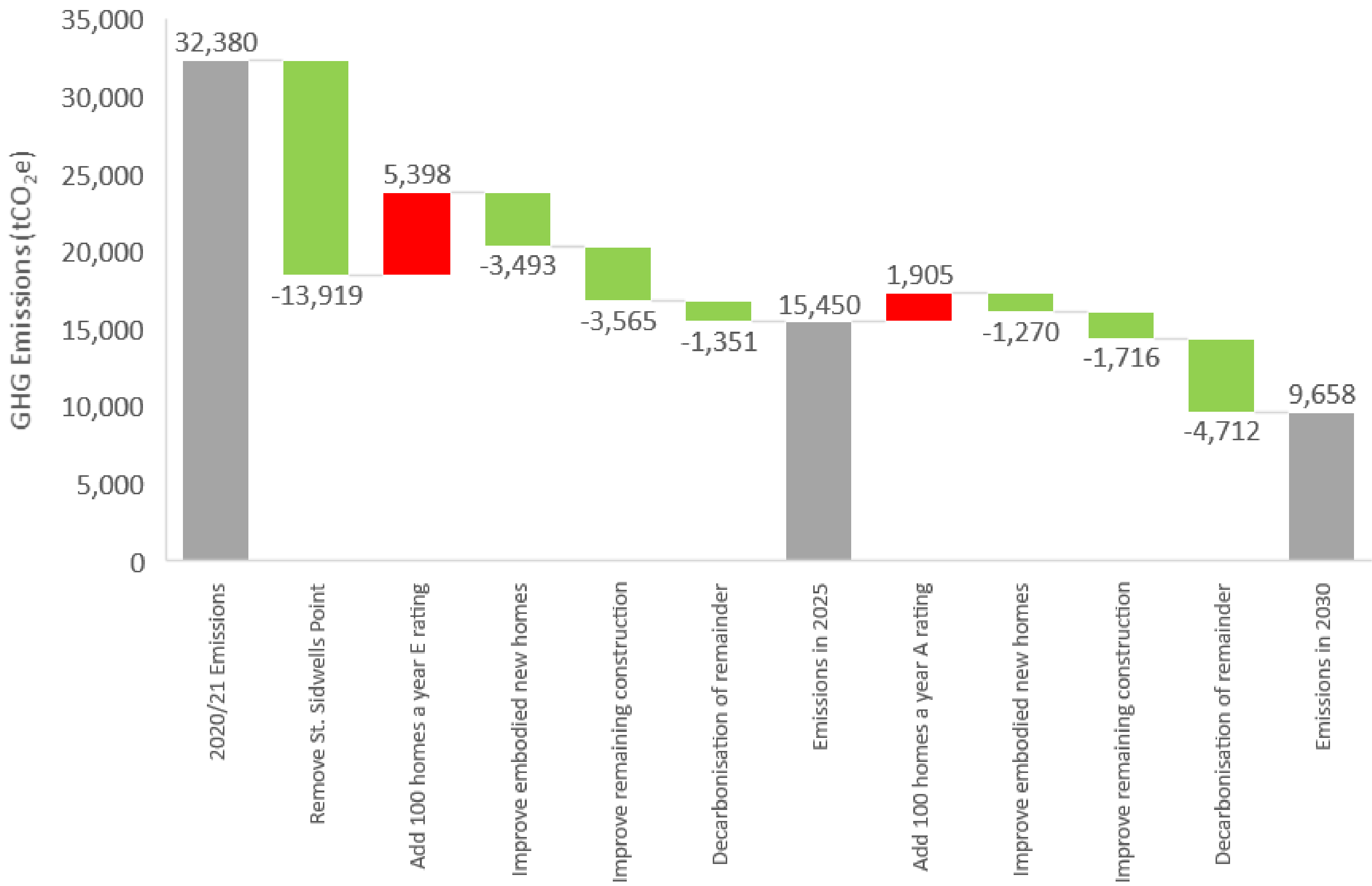


Figure 24: Measures to reduce ECC procurement emissions to 2025 and 2030

7 F gas and waste

7.1 Detailed sector summary

This section only considers ECC's own waste and F-gas emissions, not the waste it collects or the F-gas emitted in the city.

The City Council makes provision for recycling in its offices and composts much if it parks and green space material. However, the current footprint has no waste volume and composition data available for calculating emissions from waste and limited information on F gases. The management of these emission sources requires the collection of data to measure how much of what waste types ECC disposes of and a complete F gas inventory.

An initial estimate of waste emissions can be made using the number of staff employed (635[v]) together with an estimate of waste generated per person (200 kg/year[w]), resulting in 127 tonnes/year. Table 8 shows estimated GHG emissions for landfill and non-landfill disposal (assuming 60% of the waste is paper).

Table 8: Estimated ECC corporate waste emissions for landfill and non-landfill disposal

Waste type	Amount t/year	Emissions factor kg CO_2e/tonne		GHG emissions t CO2e	
		LF disposal	Non- LF disposal	LF disposal	Non- LF disposal
Paper kg	76	1041	21	79.3	1.6
Residual kg	51	467	21	23.7	1.1
Total	**127**			**103.1**	**2.7**

The table illustrates the relatively small contribution of waste emission to the organisational footprint.

Some information on F gases is available from the leisure sites. Although the surveys are not complete, the information available, combined with assumptions about the missing data points, provides estimated emissions for the Riverside and Arena sites (see Table 9).

Table 9: Estimated F gas emission from the Riverside and Arena leisure sites

Leisure site	No. of units	Refrigerant type	Weight kg	GWP kg CO_2e/kg	Leak rate[x]	t CO_2e
Riverside	13	R410A	84.5	2,088	3%	5.3
	11	R407C	64.9	1,774	3%	3.5
	1	R32	2.6	677	3%	0.1
	1	R224	9.3	587	3%	0.2
Riverside total	26					9.0
Arena	2	R32	5.2	677	3%	0.1
Total leisure	**28**					**9.1**
Average per unit						0.3

[v] Email correspondence 30 July 2020

[w] There is a dearth of data on commercial waste. This estimate and the 60% paper assumption is from a 2013 source which references 2004 data and both may well be outdated (see https://cundall.com/Cundall/fckeditor/editor/images/UserFilesUpload/file/WCIYB/IP-6%20-%20CO2e%20emissions%20due%20to%20office%20waste.pdf).

[x] From DEFRA Environmental Reporting Guidelines

Satellite images of other ECC buildings suggest that there may be a total of 27 condenser units on the Civic Centre, RAMM and the Corn Exchange buildings. If these units have the same average emissions as the leisure sites, emissions from these other ECC buildings are estimated at 8.7 t CO_2e giving total estimated annual F Gas emissions of 17.8 t CO_2e

7.2 National policy framework

National waste policy primarily addresses municipal waste rather than waste generated by organisations which is classified as commercial and industrial (C&I) waste.

In the Sixth Carbon Budget, where waste forms 6% of baseline GHG emissions in 2020, the CCC's Balanced Net Zero Pathway calls for:

- Waste prevention and reduction including a 50 % reduction in edible waste by 2030 (vs 2007)
- Increased recycling rates to above 70% (currently households 45% and C&I ~55%)
- Installation of carbon capture and storage at EfW plants
- Improved landfill methane capture, banning biodegradable waste from 2025 and ceasing landfill by 2040
- Waste water and composting improvements

National data on commercial and industrial (C&I) waste, which makes up the majority of UK waste, is very poor. Publication of C&I arisings data is sporadic (every 2-3 years) and composition and recycling data is not collected. The Government's recent Net Zero Strategy[22y] does not refer to C&I waste.

Emissions factors for most wastes are low with the recycling and EfW disposal for all categories of waste (refuse, electrical, metal, plastic and paper) assigned a factor of 21.3 kg CO_2e/tonne. Factors for anaerobic digestion and landfill of non-biodegradable waste are lower at 9.0 kg CO_2e/tonne. Higher factors are assigned to landfill of C&I refuse (467 kg CO_2e/tonne) with landfill of paper the highest at 1,042 kg CO_2e/tonne. Avoiding landfill is important.

The same is not true for F gases, some of which (Sulphur hexafluoride [SF6]) have emission factors 22,800 times that of CO_2. Regulation is the main tool for national reductions in F gas emissions. Current regulations require a range of measures to reduce emissions, including controls on what gases are on the market, product bans, leak checks and mandatory certification for handlers of F gases. The regulations target a 79% reduction in consumption from 2015 levels by 2030. F gas regulations are currently under review with the potential that the revised regulations may go further.

7.3 Opportunities

Once the Council's corporate waste leaves its premises it enters a policy vacuum. This argues for strong action on waste prevention, reduction and recycling in-house. The first priority is to obtain accurate waste data. Waste data may be available from the City Council's waste collection contractor. Alternatively, estimates require records of the numbers of containers and collection frequencies. The aim should be for an annual ECC waste report that includes:

- Total tonnes per annum
- A breakdown into categories by weight (e.g. paper, glass, aluminium, plastics, WEEE, aggregates, hazardous etc.)
- The final destination of the waste reported (e.g. 30% re-used , 50% recycled, 10% incinerated with energy recovery, 10% to landfill)
- The above will form a base year against which targets can be set to measure the effect of waste prevention activities and recycling initiatives.

In the absence of this data it is not possible to identify specific opportunities for emission reduction. However, Table 8 emphasises the immediate attraction of using a contractor that can guarantee no waste going to landfill.

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y

The recommended approach to F gases is contained in Annex C of the Government's Environmental Reporting Guidelines, which provide the recommended method for assessing emissions. This requires an inventory of refrigeration, air conditioning and heat pump equipment that records for each item: the refrigerant type, the charge capacity and the time in use during the reporting period. A comprehensive survey of ECC's assets is required to collect the information which can them be used to plan an F gas reduction programme.

Looking ahead, good record keeping will be essential as the installation of heat pumps in homes and non-domestic buildings will inevitably lead to an increase in F gas emissions. The calculation of F gas emission increases are on the basis that every home in ECC's stock where a heat pump is installed increases the R32 refrigerant inventory by 2.2 kg and that there is a 3% annul leak rate. The GWP of R32 is about one third of the currently commonly used R410a. It is important to specify lower GWP refrigerants for new heat pump installations.

Section 4.3.7 assesses the deployment of heat pumps in council owned homes. There are currently 10 homes with heat pumps. Looking ahead, the 1,000 new homes built evenly either side of 2025 will have heat pumps. After 2025, 4,495 existing homes will have heat pumps installed prior to 2030. Leakage from these appliances give rise to additional emissions of 23 t CO_2e in 2025 and a further 223 t CO_2e in 2030. Heat pumps in in non-domestic buildings are also responsible for some leakage.

7.4 Target for 2030

Projections suggest an increase in the emissions from waste and F gases from 21 to 252 tCO_2e in 2030 (+1104%).

As reliable information on the amount of ECC's waste and F gases is not currently available, the immediate target is to quantify ECC's own waste volumes and the Council's full inventory of F gas.

Projections of GHG emissions are based on:

- The assumption that none of ECC's corporate operational waste is landfilled
- No future changes in waste volumes or disposal methods
- All existing F gas appliances with high GWP F gas will be replaced or recharged with R32 before 2025
- Heat pumps deployed in 1,000 new build and 4,499 existing ECC homes by 2030 leading to a 245 t CO_2e rise in F gas emissions
- Heat pumps deployed in ECC non-domestic buildings between 2025 and 2030

Figure 25 shows projected emissions form the waste and F gas sector to 2030.

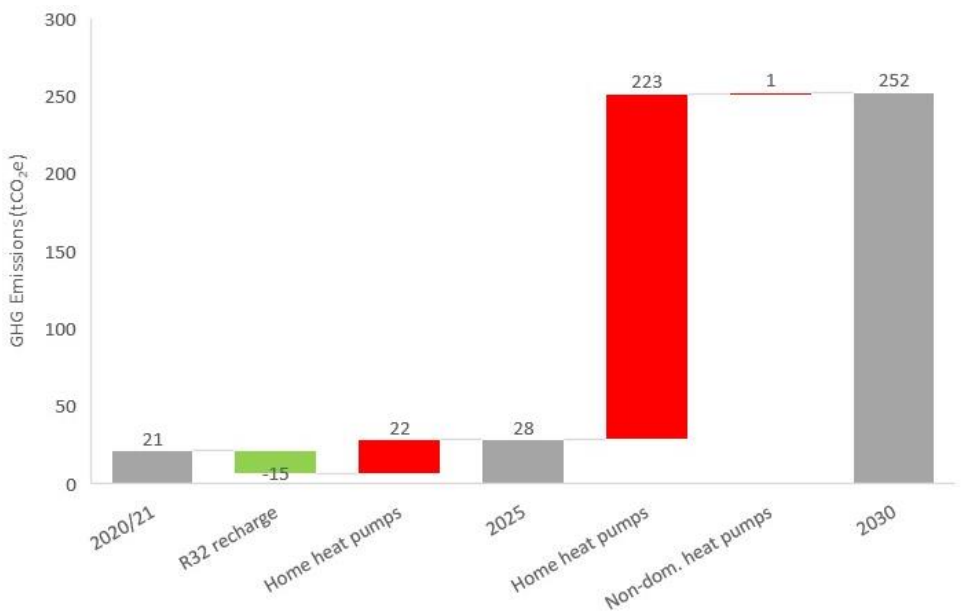


Figure 25: ECC's projected emissions from the waste and F gas sector in 2020, 2025 and 2030

8 Renewable energy

8.1 Detailed sector summary

The City Council has been an exemplar in the deployment of solar photovoltaic (PV) arrays. ECC currently has some 2 MW of PV capacity on its estate which exported[z] 1,459 MWh of electricity in 2020/21 offsetting 340 t CO_2e (as shown in Table 10).

Table 10: Electricity production, own use and CO_2 emissions offset from ECC's current PV installations

Site	Array size (kW)	Estimated generation (MWh)	Estimated own use (MWh)	Export 2020/21 (MWh)	CO_2 offset 2020/21 (tCO_2e)
Civic Centre	70	71	71	0	0.0
Oakwood House	22	22	11	11	2.6
Ark	40	41	41	0	0.0
MRF	50	51	51	0	0.0
Belle Isle	8	8	7	2	0.4
RAMM	25	25	19	7	1.6
MA Car Park	150	152	0	152	35.4
JL Car Park	122	124	14	109	25.5
Wat Tyler	26	26	15	11	2.7
Climb Centre	29	29	12	17	4.0
Livestock Centre	1,500	1,519	369	1,150	268.1
Total	**2,042**	2,068	608	1,459	340.2

ECC's estate is not suitable for the installation of other types of renewable energy on a material scale. This section will therefore consider PV only.

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. This equates to an annual decrease of $\sqrt[20]{0.8} = 0.989$ for each year of operation. This factor is included in projections of PV generation.

The continuing fall in grid electricity emission factors means that future offsets will gradually reduce. In 2030 the grid emission factor is projected to have fallen from the current 0.233 kg CO_2e/kWh to 0.065 kg CO_2e/kWh so, while renewable electricity generation with a business case will continue to be financially attractive and resource effective, its role in offsetting carbon emission reductions in other sectors will decline. For example, the export of 1.46 GWh in 2030 will offset 94 t CO_2e, a reduction of 72% compared to the 340 t CO_2e offset in 2020.

8.2 National policy framework

National policy no longer incentivises the installation of PV which must be justified on its own business case and, while the Sixth Carbon Budget discusses the role of ground mounted PV in contributing to the electricity system, building-based PV, because of its relatively small scale in a national context, is not referred to.

[z] Electricity generated by PV is also consumed on site. Self-consumption is accounted for in carbon terms by deducting it from overall electricity consumption.

8.3 Opportunities

8.3.1 Non-domestic PV

The City Council's is currently developing a 1,200 kWp ground mounted array at Water Lane and a 160 kWp array on the roof of the Riverside leisure facility.

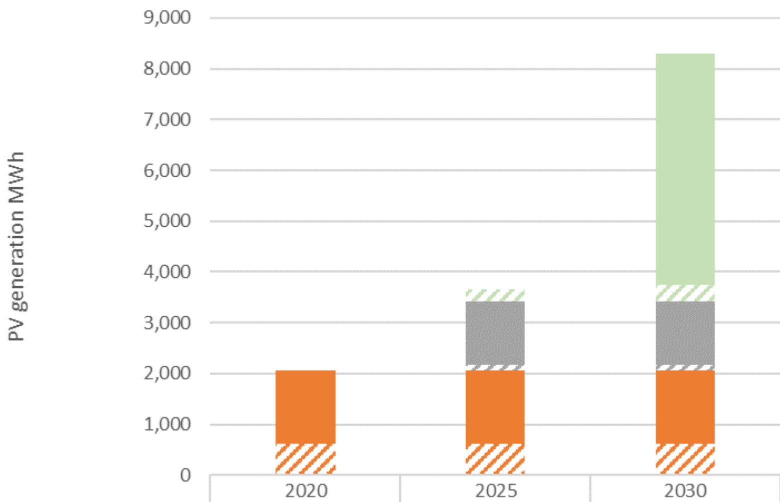
Potential future non-domestic schemes comprise two larger ground-based arrays and six rooftop systems. However, there are considerable uncertainties over the timing of future schemes caused by scarce in-house resources, variability in the factors contributing to the business cases, the future of some buildings in the ECC property portfolio and the difficulties in gaining timely access to the electricity grid.

Table 11 summarises the currently identified potential future non-domestic opportunities and the assumed installation periods.

Table 11:ECC's currently identified non–domestic PV opportunities

Site	PV capacity kWp	Assumed installation period
Guildhall	200	2020-25
ISCA	40	2025-30
Arena	50	2025-30
ECFC	30	2025-30
Corn Exchange	30	2025-30
RAMM	30	2025-30
University fields (Streatham)	2000	2025-30
Water lane II	2600	2025-30
Total	**4,980**	

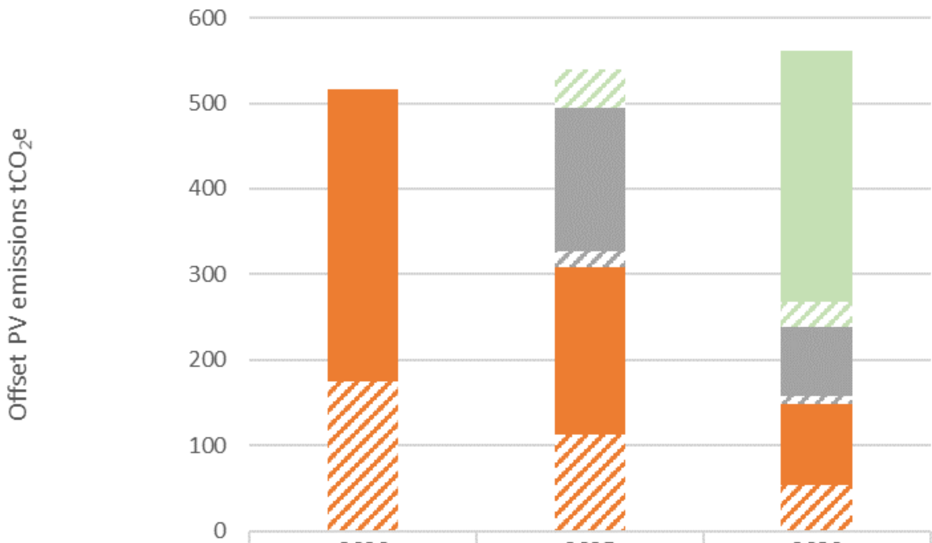
Figure 26 shows the estimated own use and export generation from non-domestic PV to 2030 categorised into existing, under development and future build.



	2020	2025	2030
Future export	0	0	4542
Future own use	0	241	336
Under dev. Export	0	1,248	1,248
Under dev. own use	0	99	99
Existing export	1,459	1,459	1,459
Existing own use	608	608	608

Figure 26: Projections of ECC's current, under development and future non-domestic PV generation

GHG emissions offset through own use and export of non-domestic PV generation is summarised in Figure 27.



	2020	2025	2030
Future export	0	0	293
Future own use	0	45	30
Under dev. Export	0	168	81
Under dev. own use	0	18	9
Existing export	340	196	94
Existing own use	175	112	54

Figure 27: Projections of GHG emissions offset[aa] by non-domestic PV generation

Figure 27 shows the impact of the reduction in the grid emissions factor; the business cases for a 300% increase in total generation in 2030 (from 2020) will deliver a financial benefit, add local energy resilience and a hedge against rising energy prices but results in a limited (9%) increase in total offset emissions.

Generated electricity that is self-consumed in buildings is accounted for by reducing the amount of imported grid electricity. The amount of electricity identified as offset is the net amount exported to the grid from the buildings.

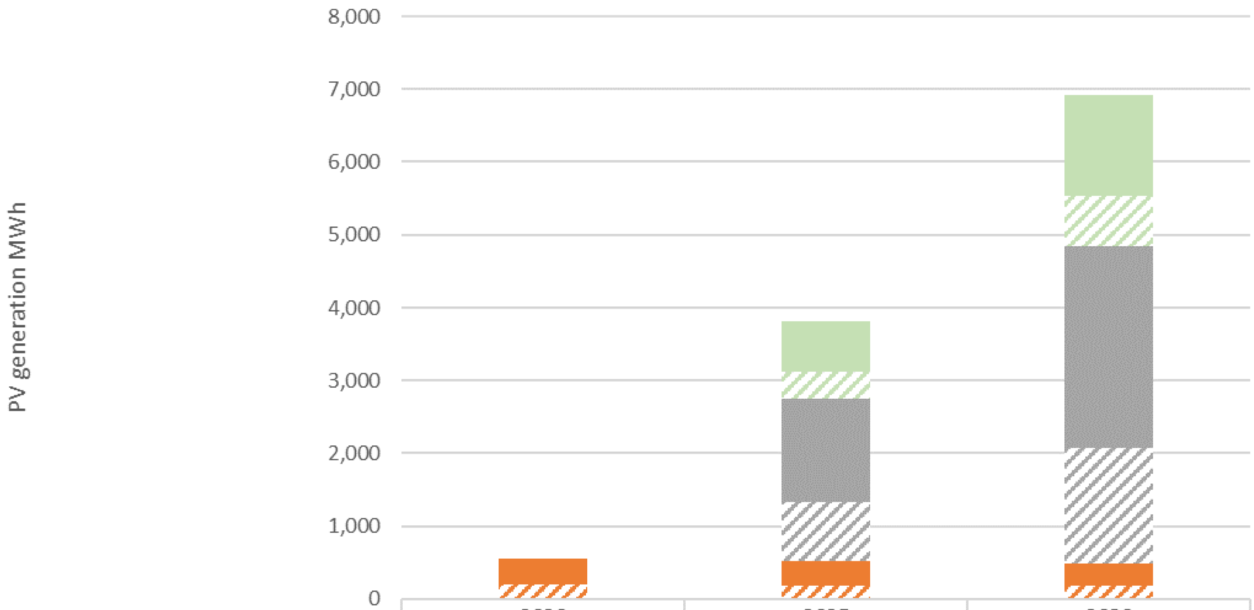
8.3.2 Domestic PV

ECC's housing stock currently has an estimated 296 homes with PV arrays installed. Estimated current generation is 554 GWh of which 199 MWh is self-consumed and 355 MWh exported. The deployment of roof mounted domestic PV to 2025 and 2030 is described in sections 4.3.4 and 4.3.9.

By 2025 the number of existing homes with PV is estimated to grow by 1,193 from 296 properties to 1,498 and by a further 1,193 to 2,682 in 2030. A corresponding proportion of the 1,000 new homes built by 2030 also have PV installations.

Figure 28 shows the estimated own use and export generation from domestic PV to 2030 categorised into current PV on existing homes, future PV on existing homes and future PV on new homes.

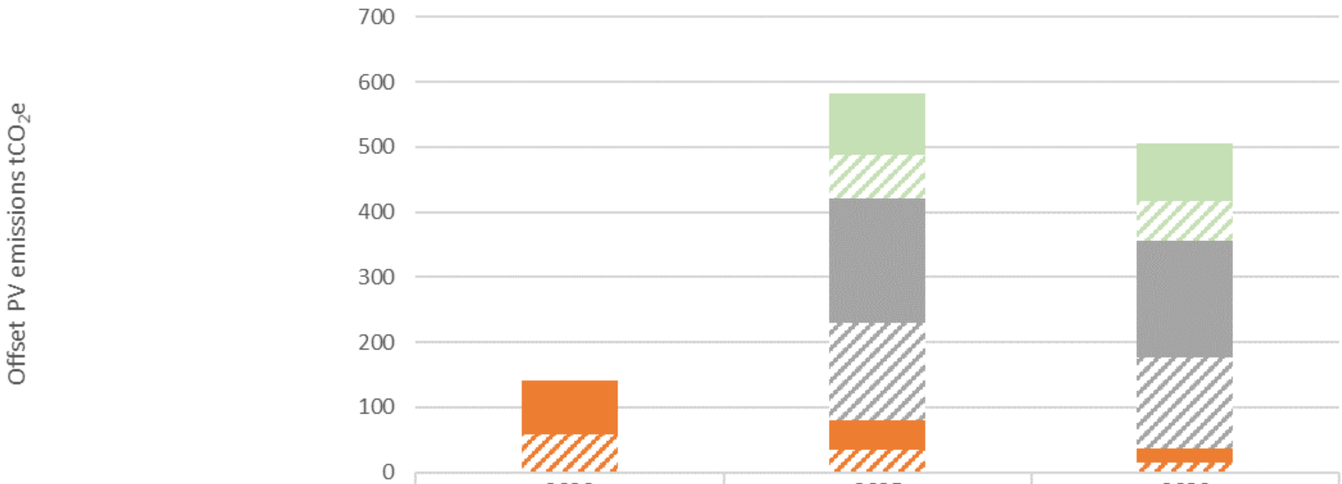
[aa] Note that own use of PV generation is deducted from electricity use and export emissions provide offset credit



	2020	2025	2030
Future PV on new homes export		705	1,371
Future PV on new homes own use		362	704
Future PV on exisintg homes export		1,421	2,771
Future PV on exisiting homes own use		808	1573
Existing homes with PV export	355	336	318
Existing homes with PV own use	199	188	178

Figure 28: Projections of ECC's current and future domestic PV generation

GHG emissions offset through own use and export of domestic PV generation is summarised in Figure 29.



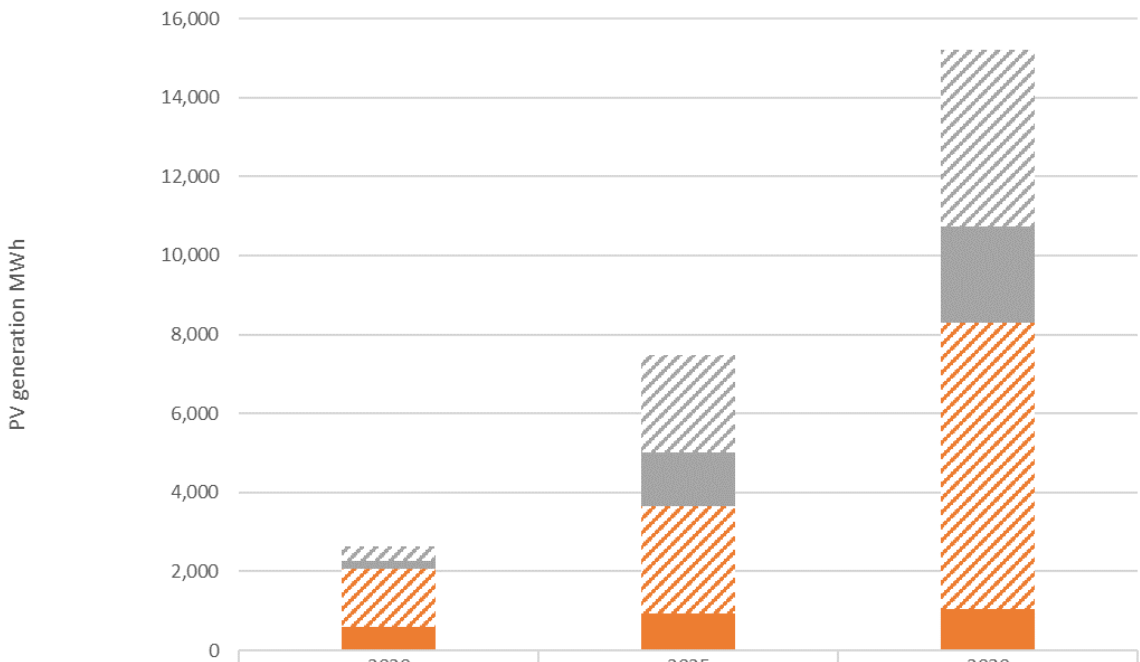
	2020	2025	2030
Future PV on new homes export	0	95	89
Future PV on new homes own use	0	67	63
Future PV on exisintg homes export	0	191	179
Future PV on exisiting homes own use	0	149	140
Existing homes with PV export	83	45	21
Existing homes with PV own use	57	35	16

Figure 29: Projections of GHG emissions offset[bb] by domestic PV generation

[bb] Note that own use of PV generation is deducted from electricity use and export emissions provide offset credit

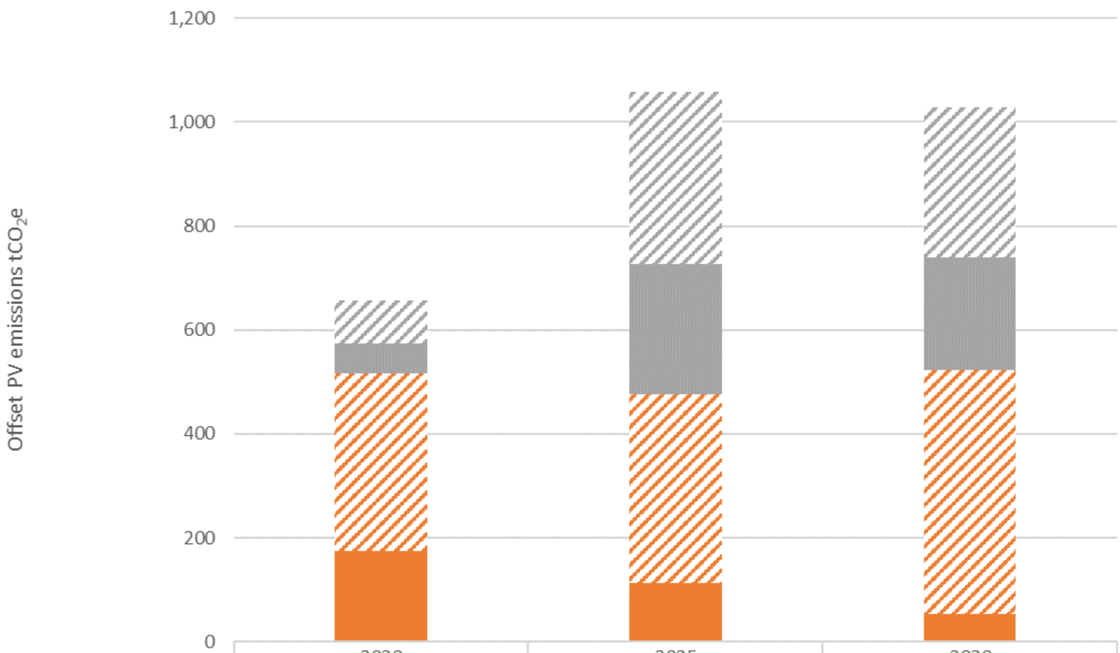
8.3.3 PV summary

Figure 30 and Figure 31 show the generation and emissions offset for all PV, non-domestic and domestic.



	2020	2025	2030
Domestic export	355	2,461	4,460
Domestic own use	199	1,357	2,454
Non-domestic export	1,459	2,707	7,249
Non-domestic own use	608	948	1,043

Figure 30: Projections of non-domestic and domestic PV generation



	2020	2025	2030
Domestic export	83	331	288
Domestic own use	57	251	218
Non-domestic export	340	364	468
Non-domestic own use	175	112	54

Figure 31: Projections of emissions offset[cc] by non-domestic and domestic PV

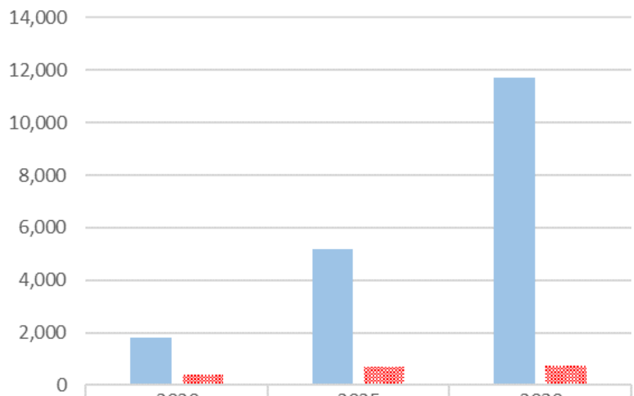
[cc] Note that own use PV generation is deducted from electricity use and export emissions provide offset credit

8.4 Target for 2030

Projections suggest an increase in the reduction in emissions due to the export of renewable energy from -432 to -756 tCO_2e in 2030 (79%). The projections for GHG offsets arising from electricity export from ECC's PV investments are based on:

- The completion of the current Water Lane (1,200 kWp) and Riverside (160 kWp) PV projects
- The commissioning of one export roof mounted project (30 kWp) between 2025 and 2030
- Two further ground mounted projects between 2025 and 2030 totalling 4,600 kWp capacity
- The installation of roof mounted PV on 2,386 additional existing homes and a similar proportion of 1,000 new council homes built between 2020 and 2025.

Figure 32 shows the resulting export PV generation and export offsets. It should be noted that own use PV generation is deducted from electricity consumption.



	2020	2025	2030
PV export MWh	1,814	5,169	11,709
Offset emissions tCO2e	423	699	756

Figure 32 : PV export generation and GHG offset (in MWh and t CO_2e respectively on the same scale)

Export generation rises 545% between 2020 and 2030 whereas offset emissions rise only 79% from 423 t CO_2e to 756 t CO_2e over the same period. This is mostly due to the significant reduction in the projected grid emissions factor. Figure 33 shows projected emissions from ECC PV in 2020, 2025 and 2030.

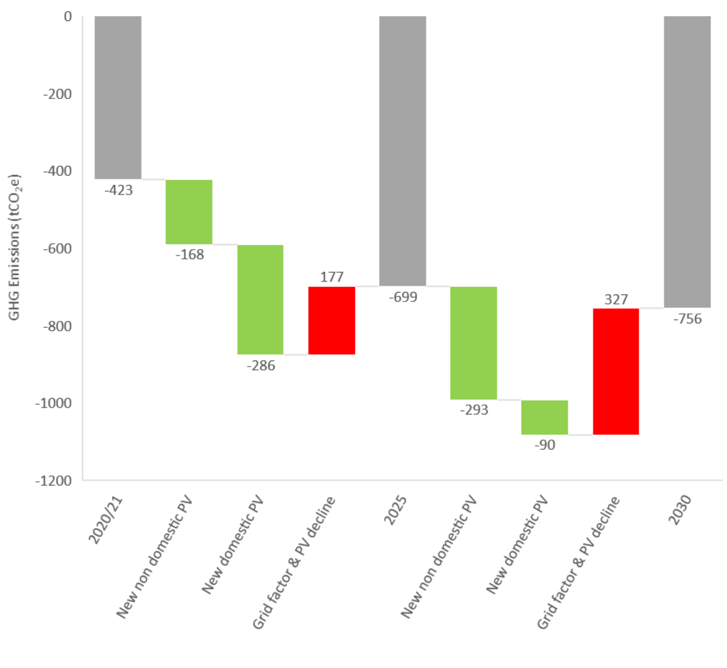


Figure 33: Measures to increase ECC PV export offset emissions to 2025 and 2030

9 Land use change - afforestation

9.1 Detailed sector summary

Land use is not included as part of ECC's footprint as the assumtion is made that the use of ECC's land does not change significanlty from its current use.

ECC owns 162 hectares of greenspace in the city's Valley Parks which are managed by the Devon Wildflfe Trust (see Table 12). In addition the City Council manages other greenspace arround the city. The total area of parks and greenspace is estimated at some 409 ha.

Exeter Valley Park	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
Total	162

Table 12: The areas of Exeter's Valley Parks[dd]

Additional planting creates beneficial land use change (LUC) that the potential to offset the council's GHG emissions. Evaluation of the offset potential is based on data from the Sixth Carbon Budget, which provides GHG savings from planting different types of biomass (see Figure 34).

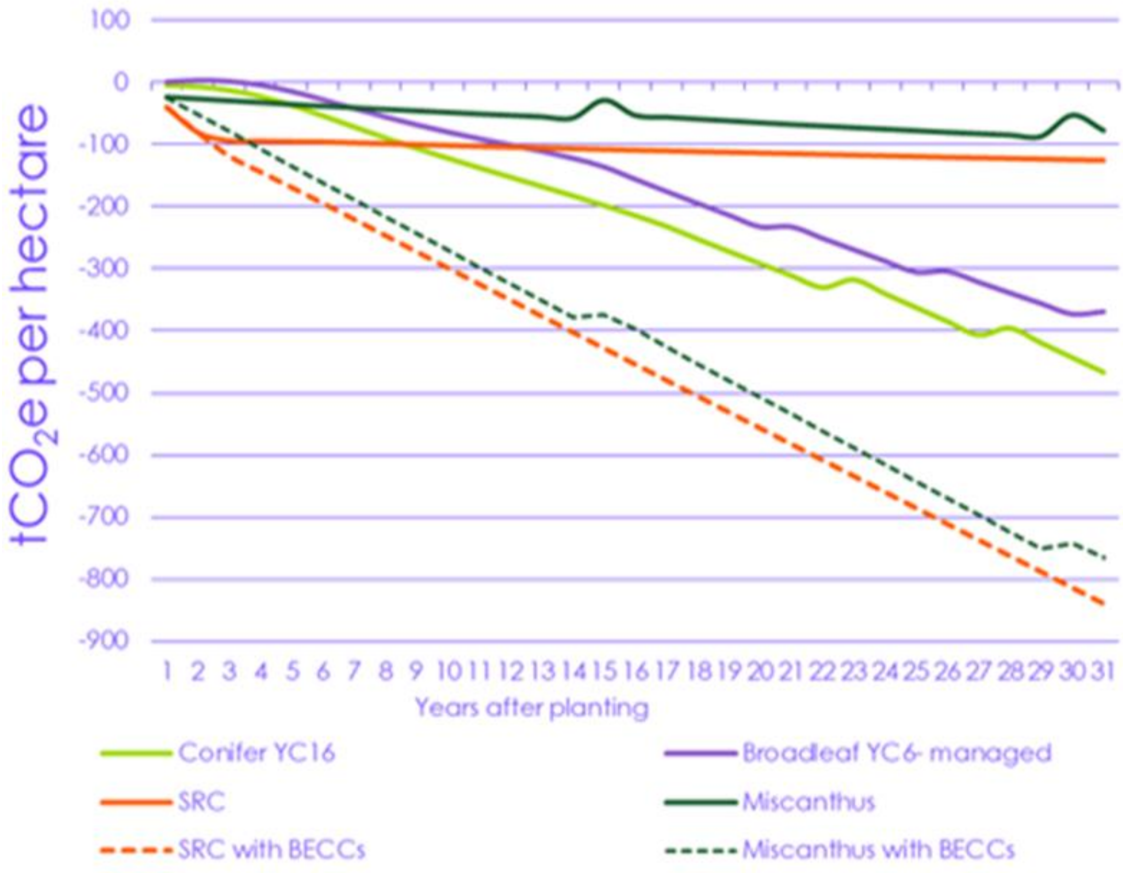


Figure 34 GHG savings from planting different types of biomass (source CCC)

[dd] Source Devon Wildlife Trust

9.2 National policy framework

National policy initiatives for tree planting include:

- The 2016 Woodland Carbon Fund for England, which provides £19 million for woodland planting and maintenance.
- The £640 million Nature for Climate Fund announced in the 2020 budget, part of which will deliver the Government's manifesto commitment to plant 30,000 hectares per year of new woodland in the UK by 2025.
- DEFRA's Woodland Carbon Guarantee scheme, which is designed to increase private sector investment.

9.3 Opportunities

Figure 35 and Figure 36 show the GHG offset achieved from planting different proportions of the 409ha of Valley Parks and greenspace with broadleaf trees and conifers respectively. Planting is assumes to take place evenly over the years between 2022 and 2030.

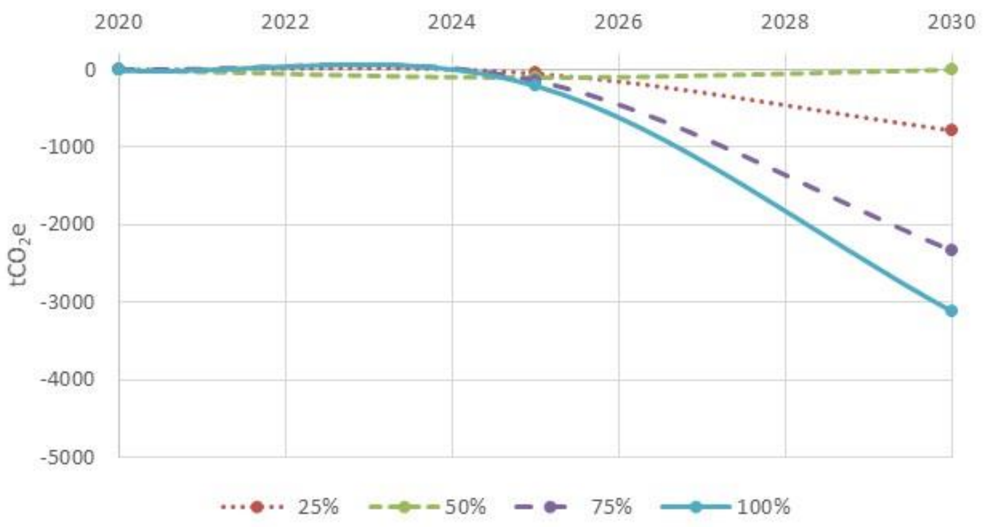


Figure 35: GHG offset from planting varying proportions of Valley Parks and greenspace with broadleaf woodland

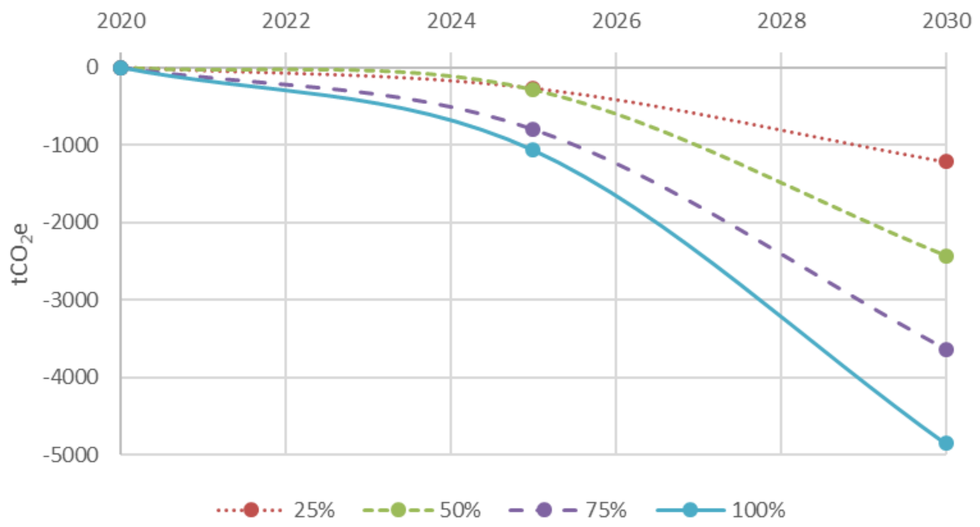


Figure 36: GHG offset from planting varying proportions of Valley Parks and greenspace with conifer woodland

The analysis shows that the if the Valley Parks and greenspace were completely planted with conifers between now and 2030 they have the potential to offset 4,855 t CO2e or 9% of ECC's current emissions.

9.4 Target for 2030

Projections suggest a reduction in the emissions due to afforestation of -829 tCO_2e in 2030. The projections are based on 25% of the area of the Valley Parks and greenspace (102 ha) being planted with broadleaf woodland between 2022 and 2030. A planting density of 2,000 trees/ha means the addition of 205,000 trees by 2030.

Figure 37 shows the projected ECC GHG emissions offset by afforestation in 2002, 2025 and 2030.

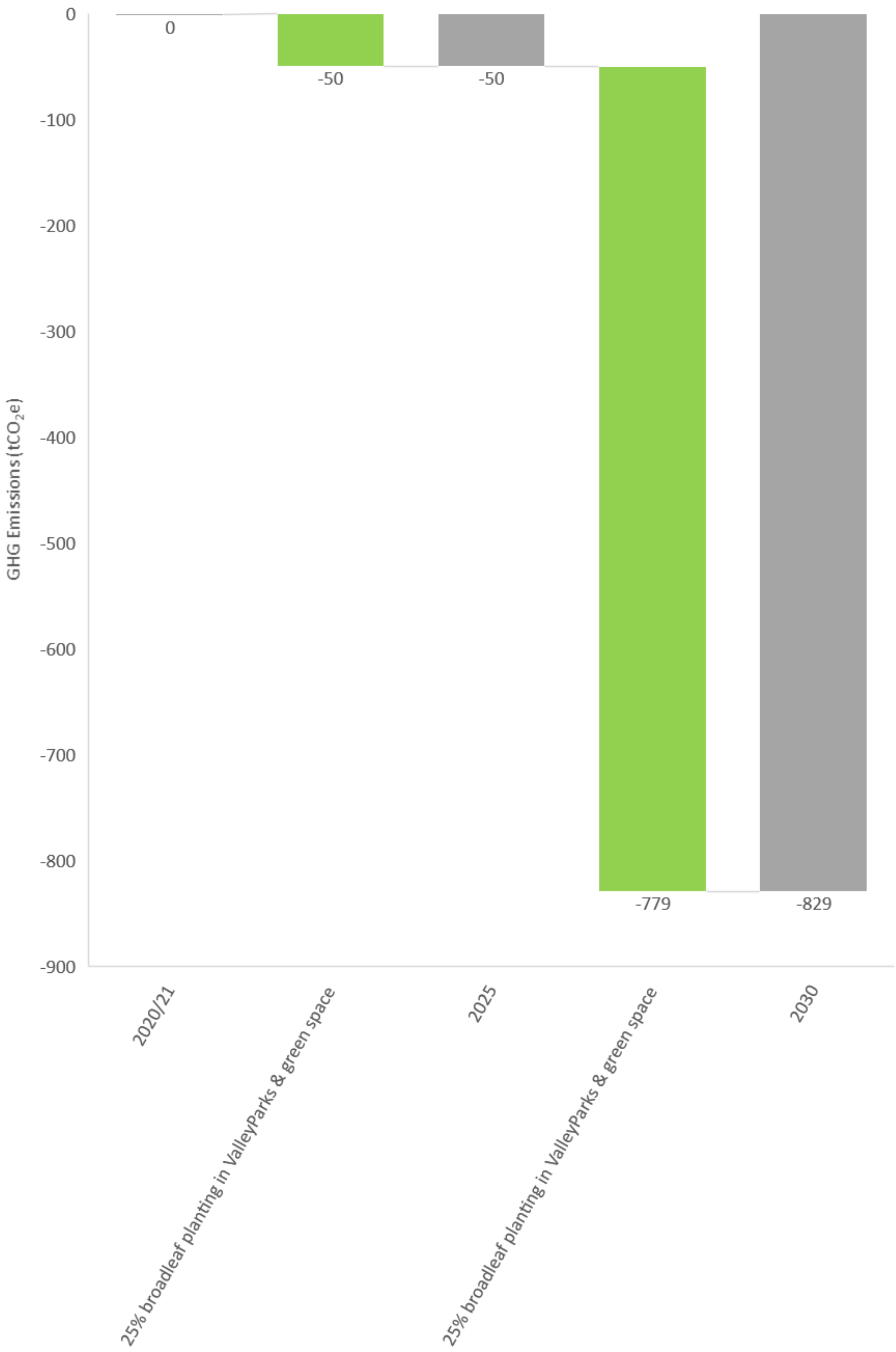


Figure 37: Afforestation measures to offset emissions to 2025 and 2030

10 All sectors

Table 13 gives a summary of ECC's GHG emissions for 2020/21 and projections for 2025 and 2030 across all sectors.

Sector	2020/21 t CO_2e	2025 t CO_2e	2030 t CO_2e	Trend
Non domestic	2,236	2,503	602	
Housing	17,319	15,650	1,916	
Transport	1,018	921	331	
Procurement	32,380	15,450	9,658	
F-gas and waste	21	28	252	
Renewables	-423	-699	-756	
LUC afforestation	0	-50	-829	
Total	52,551	33,803	11,174	

Table 13: Sector emissions projection summary for ECC

Overall, the projections suggest a reduction in emissions from 52,551 to 11,154 tCO_2e in 2030 (79%). Figure 38 shows the projected emissions for all sectors for 2020, 2025 and 2030.

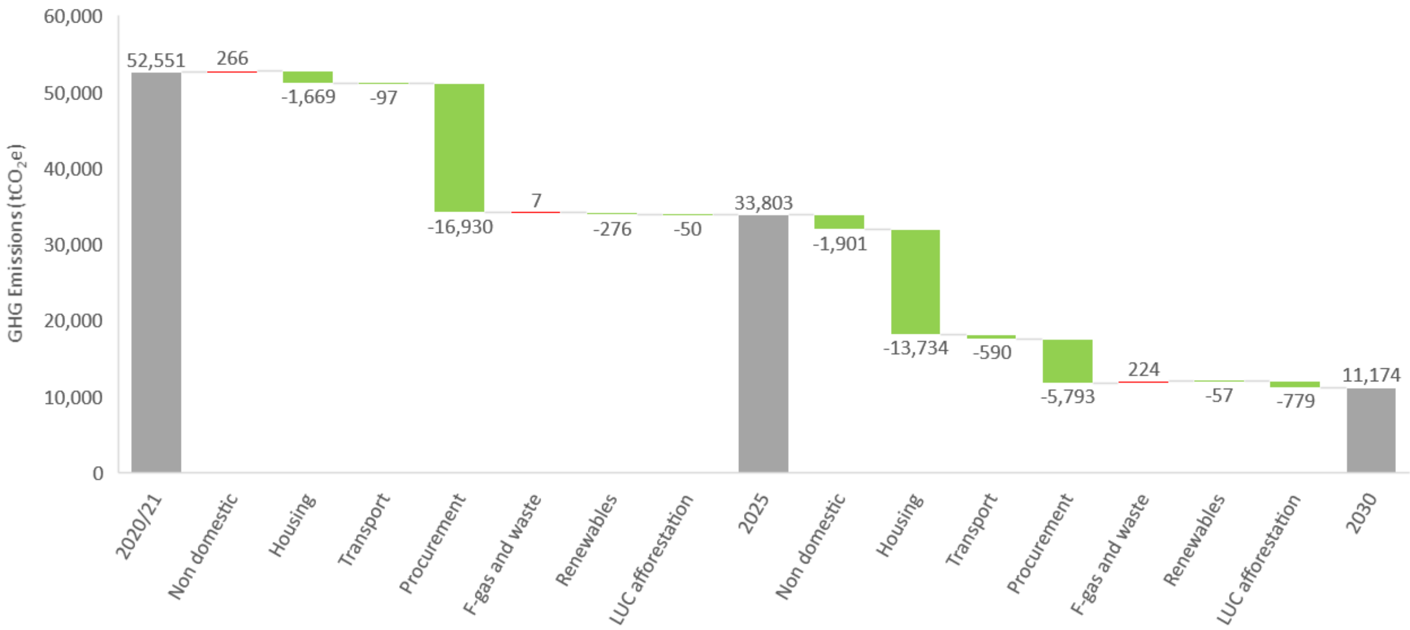


Figure 38: Projected emission for all sectors for 2020, 2025 and 2030

Scope 3 procurement and housing emission dominate. Procurement of goods and services, the sector the council perhaps has least control over, accounts for 61% of emissions in 2020 rising to 76% in 2030[ee]. Housing currently contributes a third of emissions although its share falls to 15% in 2030 due to the implementation of extensive carbon reduction measures across the stock.

The dominance of these sectors must not distract attention from the emissions in other sectors where the Council has the ability to make progress. Figure 39 summarises emissions, in absolute and percentage terms, for all sectors, all sectors less procurement and all sectors less procurement and housing. These graphics highlight, for example, the potential for progress in non-domestic buildings, the contribution of offsets and the challenge of restraining F gas emissions as the number of heat pumps rise.

[ee] Emission percentages in this section exclude offset emission sectors

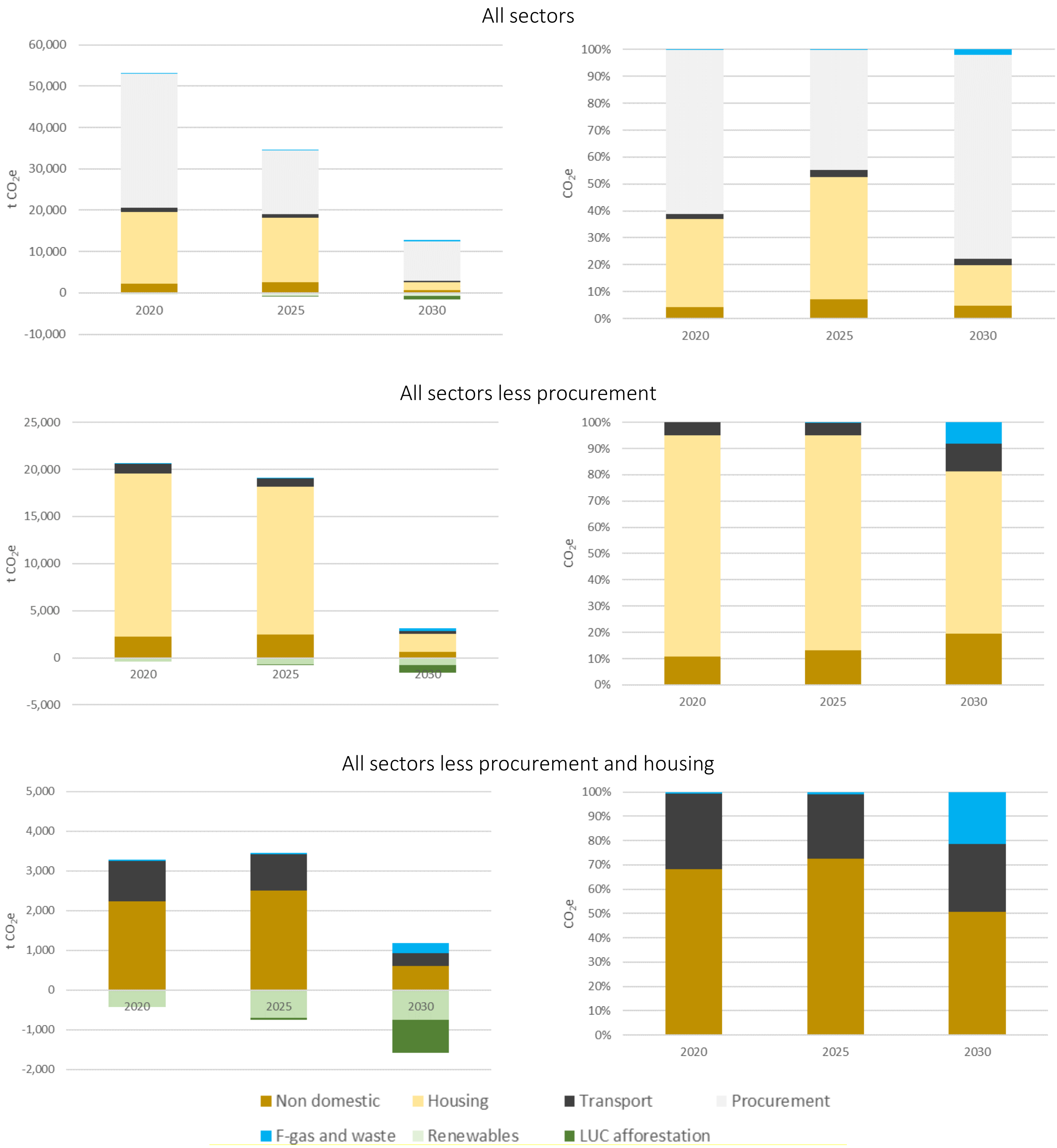


Figure 39: Absolute and percentage GHG emissions by sector for 2020, 2025 and 2030 for all sectors, all sectors less procurement and all sectors less procurement and housing

11 Conclusions

The improved data and detailed methodologies in this study, combined with changes in activity levels, have significantly affected the 2020/21 footprint, particularly indirect (Scope 3) emissions which have risen by over 500% from 2018/19 and are now double direct emissions (Scope 1 and 2).

Indirect emissions from external sources are inevitably those over which ECC has least control and, while it is important to take steps to influence indirect emissions, this should not overly divert attention from reducing direct emissions where the Council is in control.

Direct emissions have fallen 3.7% over 2 years. However, this rate of decline is a sixth of the 11.1% annual reduction needed to meet net zero by 2030.

The combination of highly aggressive carbon reduction measures included in the projections indicate the potential to reduce 2020/21 net emissions from 52,551 t CO_2e to 11,174 t CO_2e a reduction of 79%. Indirect emissions from procurement dominate the residual 2030 emissions (76%). Excluding procurement, residual emissions fall 92% from 20,171 t CO_2e to 1,516 t CO_2e with housing the largest remaining emitter (62%). Offset of residual emissions through the purchase of Pending Issuance Units (PIU) for UK Woodland Carbon Units (see Appendix 3), assuming an average cost of £13.5 per t CO_2e, would cost £151k and £20k respectively. Alternatively, based on the land use change analysis in Section 9, direct coniferous tree planting between now and 2030 of 941 ha or 128 ha respectively achieves these offsets.

Annual assessment of the council's GHG emissions to identify the changes that have taken place each year will enable the evaluation and updating of the actions required to deliver net zero.

Achieving net zero, whether nationally, locally or organisationally requires broad action cross all sectors. The projections for ECC show that delivering net zero in a timeframe as tight as 2030 is challenging.

Appendix 1: Scope 2 (purchased electricity) GHG accounting methods

The method used for calculation Scope 2 (purchased electricity) emissions in this report follows the UK Government Environmental Reporting Guidelines[1] and adopts the GHG Conversion Factors for Company Reporting[2].

The Corporate Accounting and Reporting Standard issued by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI)(see https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf) gives two alternative GHG accounting methods for Scope 2:

Location-based

The location-based method reflects the average emissions intensity of the electricity grids on which energy consumption occurs using grid-average emission factor data (as per the approach adopted in this report). The location-based approach socialises the benefit or renewable energy to all electricity consumers on the grid.

Market-based

The market-based method allows any type of contractual agreement, which ensures the reporting organisation pays for the same amount of renewable electricity as it consumes in a given year, to attribute its electricity emissions to zero. The market-based approach give priority access to renewable energy to those with contracts to acquire it.

To be mutually consistent in a single grid area, such as the UK, the UK grid emissions factor would need to be calculated excluding the renewable energy acquired under market-based agreements. This is not the case and therefore, on a national basis, the emissions reduction from renewables connected to the grid is, to the extent UK organisations are using the market-based method, being taken twice. Consequently, the templates provided in the UK Environmental Reporting Guidelines state that it is mandatory to report location-based Scope 2 emissions. Duplicate market-based reporting is optional.

ECC's electricity supplier provides ring fenced Renewable Energy Guarantee of Origin (REGO) certification for the power it purchases which it states "will not be allocated or counted against any other claim". Using the market based method in the WBSC and WRI standard this would allow ECC to account for its Scope 2 electricity as zero emissions. This could also be show alongside the location-based emissions under the UK guidelines.

A briefing note for the CCC[23] expresses concerns about the market-based method and the use of REGOs. It states that the method does not guarantee that an organisation acquiring renewable energy is actually reducing emissions within the wider system as contracts do not specify that new renewable generation needs to occur as a result of the procurement contract, concluding that "in the UK, there is limited potential for independent procurement to actually lead to new generation" i.e. there is no additionality. On REGOs the document concludes that "the REGO system and, overall, the green tariff system cannot be considered as a support system to drive new renewable generation. For this reason, green tariffs rarely create additionality – meaning, they rarely lead to any decarbonisation of the system."

It should be noted that under the when reporting under Environmental Reporting Guidelines using the market-based method, organisations are restricted in reporting offsets from exported own renewable generation that would have the effect of creating overall negative emissions from electricity.

Appendix 2: Exeter City Council GHG emissions by scope in tonnes CO_2e

Exeter City Council Inventory of GHG Emissions by Scope (tCO2e) | **As % of Gros**

No.	Category	2018/19	2020/21	2018/19 (As % of Gros)	2020/21 (As % of Gros)
SCOPE 1: Direct GHG emissions and removals		**12,541**	**13,139**	**52.1%**	**24.8%**
1. Stationary combustion		*11,863*	*12,352*	*49.3%*	*23.3%*
1	Exeter Arena	24	13	0.1%	0.0%
1	ISCA Centre	57	50	0.2%	0.1%
1	Nothbrook Pool	147	61	0.6%	0.1%
1	Pyramids	272	135	1.1%	0.3%
1	Riverside	121	37	0.5%	0.1%
1	Wonford	31	20	0.1%	0.0%
1	RAMM	257	220	1.1%	0.4%
1	Guildhall	25	22	0.1%	0.0%
1	Civic Centre	78	86	0.3%	0.2%
1	Corn Exchange	64	0	0.3%	0.0%
1	Other Buildings	46	140	0.2%	0.3%
1	Council Owned Homes - gas	10,740	11,535	44.6%	21.8%
1	Council Owned Homes - LPG	0	6	0.0%	0.0%
1	Council Owned Homes - solid fuel	0	26	0.0%	0.0%
2. Owned transport		*678*	*769*	*2.8%*	*1.5%*
2	Car Parking Services	10	3	0.0%	0.0%
2	Cleansing & Fleet Manager Refuse Trucks	451	449	1.9%	0.8%
2	Cleansing & Fleet Manager Other	45	122	0.2%	0.2%
2	Corporate Customer Services	4	0	0.0%	0.0%
2	Housing	11	2	0.0%	0.0%
2	Leisure and Museum Manager	4	1	0.0%	0.0%
2	Patrollers	6	0	0.0%	0.0%
2	Pool Car	9	0	0.0%	0.0%
2	Pool Van Engineering	3	0	0.0%	0.0%
2	Principal EHO	3	0	0.0%	0.0%
2	Public & Green Spaces	128	190	0.5%	0.4%
2	Waterways	4	1	0.0%	0.0%
3. Process emissions		*0*	*0*	*0.0%*	*0.0%*
3	Process emissions	0	0	0.0%	0.0%
4. Fugitive emissions		*0*	*18*	*0.0%*	*0.0%*
4	F gases	0	18	0.0%	0.0%
SCOPE 2: Energy GHG indirect emissions		**5,812**	**4,537**	**24.1%**	**8.6%**
5. Electricity		*5,812*	*4,537*	*24.1%*	*8.6%*
5	Exeter Arena	25	17	0.1%	0.0%
5	ISCA Centre	46	26	0.2%	0.0%
5	Northbrook Golf	1	0	0.0%	0.0%
5	Nothbrook Pool	29	34	0.1%	0.1%
5	Pyramids	123	103	0.5%	0.2%
5	Riverside	144	140	0.6%	0.3%
5	Clifton Hill Sports Centre	0	0	0.0%	0.0%
5	Wonford	26	20	0.1%	0.0%
5	Leisure others	0	5	0.0%	0.0%
5	St Nicholas Priory	60	0	0.2%	0.0%
5	St Georges Market - Corn Exchange	32	12	0.1%	0.0%
5	RAMM	238	161	1.0%	0.3%
5	Civic Centre	153	99	0.6%	0.2%
5	MRF	69	48	0.3%	0.1%
5	Matford Livestock Centre	50	33	0.2%	0.1%
5	Cctv Control Centre	27	0	0.1%	0.0%
5	Oakwood House	24	21	0.1%	0.0%
5	Economy Site Others	34	27	0.1%	0.1%
5	Car Parks	178	113	0.7%	0.2%
5	Facilities Management	39	19	0.2%	0.0%
5	Public conveniences	13	7	0.1%	0.0%
5	Public Realm	20	70	0.1%	0.1%
5	Sheltered Accommodation	95	43	0.4%	0.1%
5	Tenant Services	79	60	0.3%	0.1%
5	UMS Energy	40	33	0.2%	0.1%
5	Council Owned Homes	4,269	3,444	17.7%	6.5%
SCOPE 3: Other indirect GHG emissions		**5,724**	**35,297**	**23.8%**	**66.6%**
6. Purchased material and fuel		*4,316*	*3,664*	*17.9%*	*6.9%*
6	Procured Goods	1,032	804	4.3%	1.5%
6	Well to Tank Emissions fuels	3,284	2,860	13.6%	5.4%
7. Transport related activities		*179*	*32*	*0.7%*	*0.1%*
7	Staff mileage	17	13	0.1%	0.0%
7	Commute by car	106	13	0.4%	0.0%
7	Commute by bus	48	5	0.2%	0.0%
7	Commute by train	8	1	0.0%	0.0%
8. Waste disposal		*0*	*3*	*0.0%*	*0.0%*
8	Paper	0	2	0.0%	0.0%
8	Residual waste	0	1	0.0%	0.0%
9. Leased assets/franchising/outsourcing		*1,218*	*31,576*	*5.1%*	*59.6%*
9	Procured Services	1,218	31,576	5.1%	59.6%
10. Sold goods and services		*11*	*23*	*0.0%*	*0.0%*
10	Electric vehicle charging at Council car parks (kWh)	11	23	0.0%	0.0%
TOTAL GROSS FOOTPRINT (SCOPES 1, 2 and 3)		**24,077**	**52,974**	**100.0%**	**100.0%**
11. Offset emissions		*-363*	*-423*	*-1.5%*	*-0.8%*
11	Civic Centre PV	0	0	0.0%	0.0%
11	Oakwood House PV	-3	-3	0.0%	0.0%
11	Ark PV	0	0	0.0%	0.0%
11	MRF PV	0	0	0.0%	0.0%
11	Belle IslePV	-1	0	0.0%	0.0%
11	RAMMPV	-4	-2	0.0%	0.0%
11	MA Car Park PV	-40	-35	-0.2%	-0.1%
11	JL Car Park PV	-28	-26	-0.1%	0.0%
11	Wat Tyler PV	-3	-3	0.0%	0.0%
11	Climb Centre PV	-5	-4	0.0%	0.0%
11	Livestock Centre PV	-280	-268	-1.2%	-0.5%
11	Council Owned Homes PV	0	-83	0.0%	-0.2%
TOTAL NET FOOTPRINT (SCOPES 1, 2 and 3 and Offsets)		**23,714**	**52,551**	**98.5%**	**99.2%**

Appendix 3: Purchase of carbon offsets

Offsetting can be used where GHG reductions can be achieved more practically or cost effectively from external sources, or where emissions are otherwise unavoidable. However, the effectiveness of carbon offsetting relies on the availability of high quality schemes to reduce carbon emissions.

Definitions of 'Good Quality' criteria for carbon offset projects are provided in Government guidance on environmental reporting[ff] where the following criteria are highlighted:

- **Additionality** – projects must demonstrate that the carbon saving would not have happened without the finance provided by selling credits. This would exclude projects that might be required under legislation or for compliance against legally binding targets.
- **Avoiding leakage** –projects must not cause an increase in carbon emissions elsewhere, the effects of leakage may be experienced either in upstream or downstream emissions and must be accounted for.
- **Permanence** – projects must address the risk of becoming impermanent, the loss of forest through disease or fire for example, would be expected to demonstrate actions to minimise and replace losses.
- **Validation and verification** - independent verification must come from an accredited, independent third party. Those looking to purchase credits should carry out due diligence to check projects are implemented according to the prescribed methodology and monitored to quantify emissions reductions.
- **Timing** – carbon credits should be ex-post i.e. they must only be issued once the emissions reduction has been achieved.
- **Avoiding double counting** – a registry of credits awarded and cancelled must be maintained to avoid double counting, this includes double counting against existing and mandatory targets.
- **Transparency** – registry information should be publicly-available and include project details, quantification methodology, validation and verification procedures, credit ownership and date of retirement of credits.

Carbon Offsets that are Kyoto Protocol Compliant will have met all these criteria, be fully traceable and will have been verified by the United Nations. Examples include the Clean Development Mechanism (CDM)[gg], the Joint Implementation (JI)[hh] and European Union Allowances (EUA) which are traded through the EU Emissions Trading Scheme (EU ETS)[ii].

Carbon credits from Voluntary Emission Reductions (VER) schemes that are not Kyoto Protocol compliant should provide full documentation showing how the above criteria were met. Organisations that provide VER schemes include:

- The Gold Standard[jj], established in 2003 by the World Wildlife Fund (WWF) and other international NGOs to develop projects that reduced carbon emissions while maintaining high levels of environmental integrity and contributing to sustainable development goals
- The Verified Carbon Standard (VCS)[kk] developed by the Climate Group and International Emissions Trading Association (IETA)

Projects offered under the Gold Standard are all based in developing countries and the cost of offsetting each tonne of carbon varies between projects. Community based energy efficiency projects are available at 12 to 25 USD/tonne (8.5 to 17.6 GBP/tonne). These usually consist of cooking stove projects with some biogas and water projects. Other projects are focussed on land use and nature based activities such as community forests, reforestation and biodiversity and cost in the region of 18 to 34 USD/tonne (12.7 to 24.0 GBP/tonne). Renewable energy projects featuring wind, hydroelectric,

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ff www.gov.uk/government/publications/environmental-reporting-guidelines-including-mandatory-greenhouse-gas-emissions-reporting-guidance

gg https://unfccc.int/process-and-meetings/the-kyoto-protocol/mechanisms-under-the-kyoto-protocol/the-clean-development-mechanism

hh https://unfccc.int/process/the-kyoto-protocol/mechanisms/joint-implementation

ii https://ec.europa.eu/clima/policies/ets_en

jj https://www.goldstandard.org/

kk https://verra.org/project/vcs-program/

solar and biomass in India, Brazil, Indonesia and Honduras are 10 to 15 USD/tonne (7.0 to 10.6 GBP/tonne). A single waste management project aimed at plastic recycling in Romania is 47 USD/tonne (33.1 GBP/tonne).

Projects that reduce UK territorial emissions are mostly based around tree planting and woodland and the most established scheme for woodland projects is the Woodland Carbon Code[ll] (although there is an emerging scheme for peatland restoration). Credits from verified projects are referred to as Woodland Carbon Units (WCU) and can be used to report against UK based emissions. It is also possible to purchase a Pending Issuance Unit (PIU) which is the carbon equivalent of a promissory note to deliver a carbon saving in the future. PIUs are based on anticipated carbon sequestration and, as such are not guaranteed, so they cannot be used for official reporting purposes.

[ll] https://woodlandcarboncode.org.uk/

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