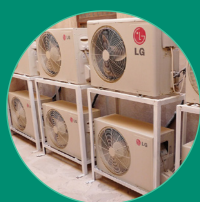
Annual Report 2022

Centre for Energy and the Environment





About SWEEG

The South West Energy and Environment Group (SWEEG) is a collaborative research partnership between public sector organisations in the South West which aims to share information and research on energy and environmental issues in the built environment.

The Centre for Energy and the Environment coordinates and carries out technical research for the group. Research completed by the Centre is disseminated among SWEEG partners. Work of wider interest is published in technical and academic journals. A list of this year's publications can be found at the end of this report. Further details about the Centre and SWEEG are available at www.exeter.ac.uk/cee.

Current SWEEG members

Devon and Cornwall Police
Devon County Council
East Devon District Council
Exeter City Council
Mid Devon District Council
Plymouth City Council
South Hams District and West Devon Borough Councils
Teignbridge District Council
University of Exeter

Organisations wishing to enquire about SWEEG or commission work from the Centre should contact:

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Front cover

Renewable energy technologies such as wind power are key to grid decarbonisation, essential in enabling a transition to net zero carbon emissions as transport and heating of buildings switch from fossil fuels to electricity.

Fullabrook Down wind farm in North Devon was commissioned in 2011. The 22 turbines have a total rated capacity of 66 MW.


Introduction

About the Centre

The Centre for Energy and the Environment has been working with public sector organisations and businesses for over 45 years. Our research has a direct impact on environmental outcomes and policies.

The Centre for Energy and the Environment (the Centre) is a research group within the University of Exeter, and is uniquely placed to provide bespoke research which can help reduce carbon emissions and energy consumption.

Our expertise covers all aspects of the built environment including sustainable building design, efficiency in existing buildings, carbon reduction strategies, adaptation to climate change, renewable and community scale energy, thermal and daylight modelling, acoustic design, transport, waste and all related policy areas.

Research at the Centre ranges from 3 to 5 year Research Council programmes to short applied projects in both the public and private sectors. Staff from the Centre teach within the University and can deliver bespoke continuing professional development training programmes or provide academic supervision for Knowledge Transfer Partnerships with industry.

About the staff

Tony Norton Head of the Centre

A Chemical Engineer with a background in the international energy industry, Tony's experience of economic and commercial issues around energy provision is extensive and includes policy advice to government. Tony's work at the Centre focuses on energy aspects of local planning and the development of combined heat and power schemes and heat networks.

Dan Lash Senior Research Fellow

Dan studied architecture and specialises in low energy building design including natural ventilation, lighting, thermal performance and comfort.

Andrew Mitchell Research Fellow

Andrew qualified as an Environmental Engineer and now specialises in building performance monitoring, acoustics, air quality and transportation.

Andrew Rowson Research Fellow

Andrew is an Engineering Mathematician with a background in construction and engineering. His work is focused on energy technology and policy.

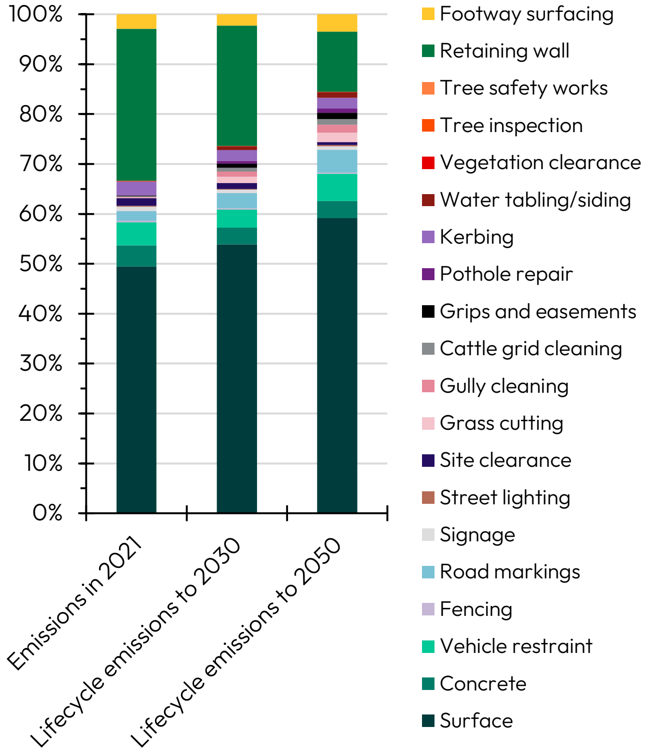
Transport

Carbon footprinting of road maintenance projects

The Centre is developing a carbon calculator to quantify emissions from road maintenance, and is contributing to the development of national reporting standards.

Carbon footprints for local authorities typically reveal that emissions associated with suppliers (classified as Scope 3) make up a significant proportion of the overall impact. Estimates of this impact are often initially based on high-level approaches such as the value of a contract multiplied by a crude sector-wide, spending-based emission factor. Having established that road maintenance was a significant contributor to its carbon footprint, Devon County Council commissioned the Centre to develop a carbon calculator for road maintenance jobs. The aims of the calculator were twofold: firstly, to allow designers to consider carbon emissions in their decision-making, and secondly to enable contractors to feed back live data from ongoing projects via the calculator. The tool covers a wide variety of jobs, such as replacing surfacing, kerbing, barriers, fencing, road markings, signage and lighting, as well as periodic maintenance tasks such as grass cutting, vegetation clearance and gully cleaning.

Road maintenance can give rise to significant carbon emissions. Determining the sources of these emissions helps focus effort to reduce them.



Relative split of carbon emissions for a portfolio of projects over different time periods.

Work this year has included further development of the tool, and participation in a team (including Devon County Council and external contractors) who are together developing web-based data capture forms. The data collected will be processed by algorithms to establish carbon emissions from ongoing road maintenance jobs.

In addition, the Centre has been working with Devon County Council and the Future Highways Research Group to author standards for Scope 3 carbon accounting for the road maintenance sector. The approach being undertaken in Devon was identified as an example of best practice within the sector. Methods utilised in the tool are being included in a framework and methodological approach that can be applied to road maintenance projects across the country.

Carbon projections for Cornwall's Transport Plan

The county's Local Transport Plan (LTP) sets an ambitious target of an 80% reduction in greenhouse gas emissions from transport by 2030 from a 2017 baseline.

Cornwall Council commissioned the Centre to evaluate what measures would be required to meet the 80% reduction target. The first step was to establish current emissions. The quality of emissions data reported by central government at local authority level has improved recently, and now includes greenhouse gases other than carbon dioxide. The contribution made by these gases previously had to be estimated. The latest data indicates that their impact had been moderately under-estimated. Transport emissions fell significantly in 2020 due to the impact of Covid-19 travel restrictions, but the extent to which the reduction will endure remains to be seen.

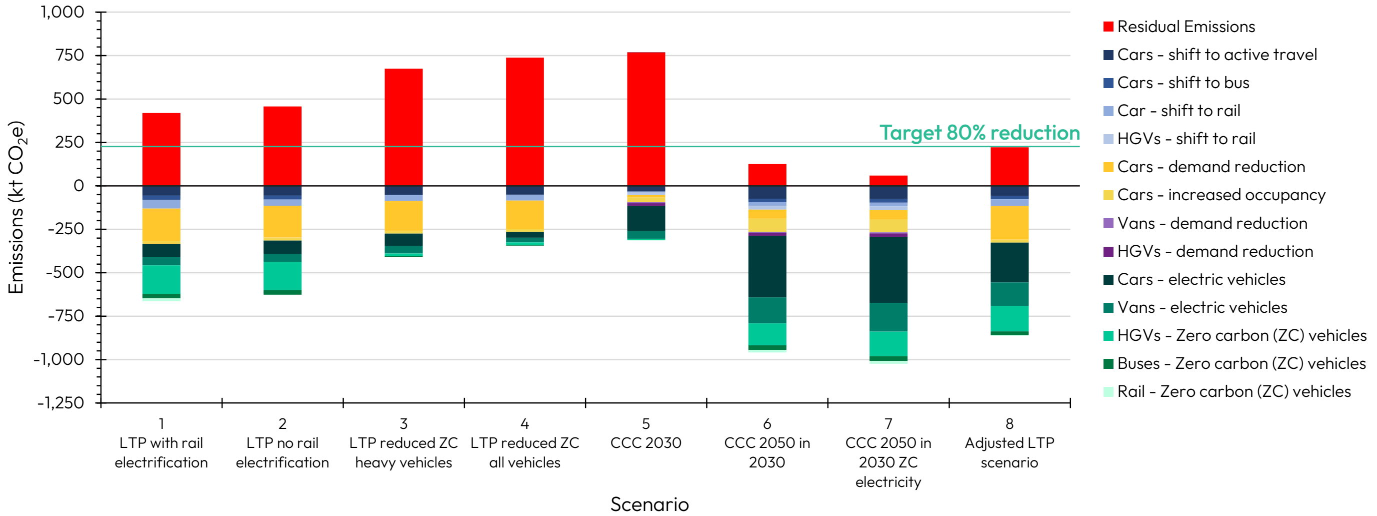
The uptake of electric vehicles has the greatest potential to reduce greenhouse gas emissions. In Cornwall it currently lags behind national and regional trends, although provision of charging points is relatively good.

National decarbonisation plans for the transport sector set out by the Climate Change Committee (CCC) and the Department for Transport were reviewed alongside the Cornwall LTP. Measures included in the LTP mirror those nationally, but lack the detail required to accurately quantify their likely impact on greenhouse gas emissions.

Nine of the twenty policies were identified as having significant potential to reduce emissions. Supporting a transition away from fossil-fuelled vehicles has the greatest potential impact, but is an area where the council's influence is weak. Reducing the embodied carbon of infrastructure provision and maintenance, planning policy and promotion of active travel and public transport were identified as areas where the council has the most direct influence to drive change.

In general, the Cornwall LTP places more emphasis on modal shift and focuses less on vehicle technology than the national plans, reflecting the priorities of a local authority.

The illustrative scenario in the plan was estimated to deliver a reduction in greenhouse gas emissions of about 62%. To achieve an 80% reduction would require both a very high uptake of electric vehicles and a large reduction in car utilisation, for example electric cars forming 85% of the fleet and a 50% reduction in car mileage. Annual performance indicators have been set out to monitor progress towards the emissions reduction target. These include reported emissions, registered ultra low emission vehicles, vehicle mileages and installed charging points.



Residual emissions (red) and avoided emissions (negative) resulting from various packages of transport measures to 2030.

A staff travel calculator for East Devon District Council

A staff travel calculator has been devised to collect data for organisational carbon footprinting and identify potential carbon reduction measures.

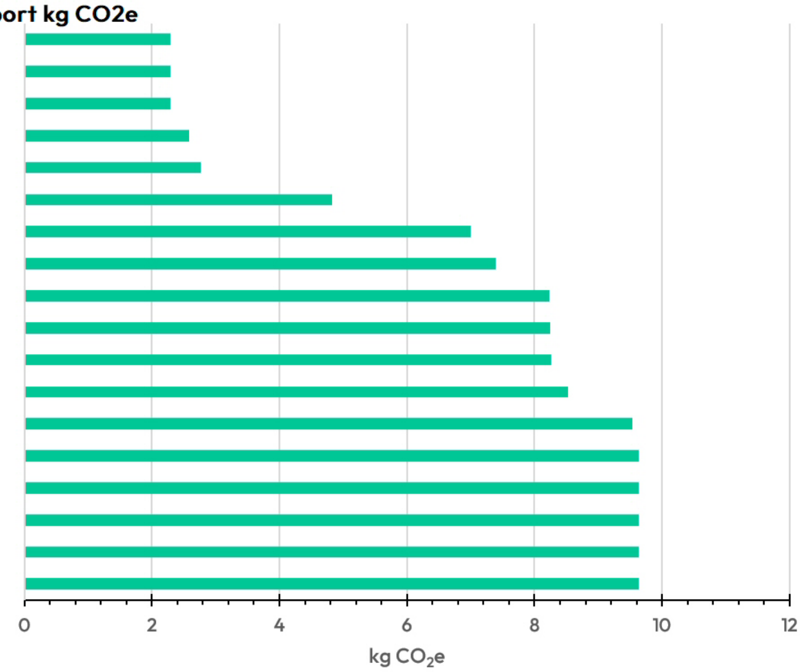
The calculator is provided as a spreadsheet and uses UK government emission factors for use by companies to report their carbon footprint. These factors are combined with information entered by an individual member of staff including details of the vehicles they use, typical weekly patterns of travel for commuting and business mileage, and their position within the organisational structure of the council. Car sharing and use of pool cars are available as options.

The spreadsheet shows the staff member's annual carbon footprint for their transport activity in straightforward charts, giving emissions by journey purpose and vehicle type. Scenarios can then be looked at to determine potential carbon savings from behavioural changes, such as working from home for a certain number of days per week, using pool cars and car sharing.

The Council can collate emissions for groups of staff by importing individual staff data, in bulk, into a master spreadsheet. The collated data are visualised as charts showing overall emissions and emissions by mode of travel, purpose, department and main work site. This information will increase the accuracy of the emissions assessment in the organisation's carbon footprint and offer an enhanced insight into areas that can be targeted to reduce emissions.

The master spreadsheet also incorporates a tool that identifies the optimal location for departmental meetings from eighteen potential sites owned by the council, based on a pre-calculated distance matrix between each of the sites. Options are available to select the levels in the department team structure that will attend, the vehicle type and maximum vehicle occupancy.

Location	Transport kg CO2e
Blackdown House, Honiton	2.29
Camperdown Terrace, Exmouth	2.29
Manstone Depot, Sidmouth	2.29
Dunning Court, Honiton	2.58
Trumps Court, Sidmouth	2.77
Yonder Close, Ottery St. Mary	4.82
Park Close, Woodbury	7.00
Millwey, Axminster	7.38
Clayton House, Littleham	8.23
Palmer House, Exmouth	8.25
Bidmead House, Exmouth	8.26
Broadview, Broadclyst	8.53
Churchill Court, Lympstone	9.54
Exmouth Town Hall, Exmouth	9.64
Lymebourne House, Sidmouth	9.64
Morgan Court, Exmouth	9.64
Albion Court, Exmouth	9.64
Ratcliffe (Burnside), Exmouth	9.64



Calculator output identifying the optimal location for a departmental meeting.

Policy and Planning

Carbon footprinting of local authority activity

Footprints of greenhouse gas emissions produced previously for a number of local authorities have been updated in an annual cycle of reporting.

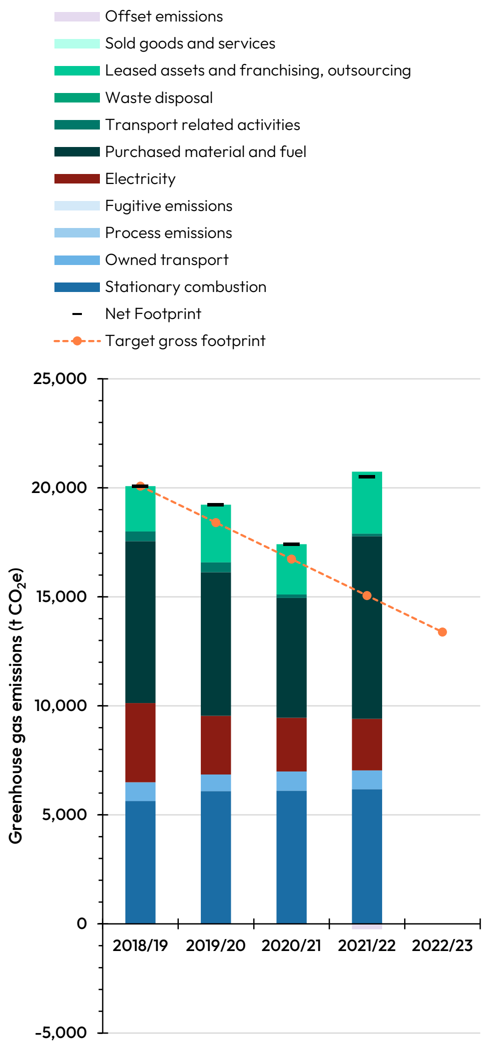
Reporting emissions annually is important because it reveals whether carbon emission reductions are on target to meet declared zero carbon goals. The Centre has continued to produce organisational carbon footprints for several local authorities in the SWEEG partnership. The footprints are produced following the framework set out in the Environmental Reporting Guidelines. This involves classifying emissions as either Scope 1 (direct emissions from the organisation), Scope 2 (energy indirect emissions from the organisation, typically from electricity), and Scope 3 (other indirect emissions). Emissions are further categorised within each scope.

Updating the footprints involved recalculating emissions from the latest activity data and applying the latest emission factors, which reflect the current carbon intensity of each fuel or activity. Opportunities have been taken to improve calculation methods where the quality of available data has improved.

Whilst each organisation is different, there are a number of common themes that are evident from the footprints.

Firstly, where a local authority has a stock of social housing this is likely to be a significant source of emissions. Although local authorities do not directly occupy or operate these buildings, or have access to accurate energy data, they can still improve their energy performance. Moving towards net zero is likely to require higher levels of energy efficiency, for example by improving the thermal insulation of properties and replacing fossil-fuelled heating systems with low carbon heat sources such as air source heat pumps. Hard-to-treat properties such as those with solid external walls cannot be ignored.

The second point of note is that emissions from procured goods and services are always very significant. At present, these emissions are estimated on the basis of financial spend. The amount spent with a supplier is multiplied by an emission factor relating to the sector in which that supplier operates. This is not a very accurate approach and the Centre is actively involved with other groups at the university and with local authorities across the South West region to collectively develop improved methods to quantify and ultimately reduce emissions from supply chains.



An example organisational carbon footprint showing progress against a linear reduction towards a goal of net zero carbon emissions by 2030. Scope 1 emissions are shown in blue, Scope 2 in red and Scope 3 in green.

Exeter City Council's net zero carbon emissions plan

The council has committed to reduce the carbon footprint of its activities to net zero by 2030. Baseline emissions and potential measures have been evaluated.

Exeter City Council declared a Climate Emergency in 2019, with a commitment to achieve net zero greenhouse gas emissions from its own activities by 2030. Direct and indirect activities including supply chain emissions are included in the definition of gross emissions. The subtraction of emissions mitigated by the export of renewable energy and land use change within the council's estate gives its net emissions. The aim is to reduce net emissions to as near zero as practicable by 2030.

Baseline emissions for 2020/21 totalled 52,600 t CO_2e across seven sectors. Assessment of each sector identified a number of potential measures to reduce emissions ranging from straightforward energy efficiency to far more challenging and potentially contentious options to help achieve the net zero ambition.

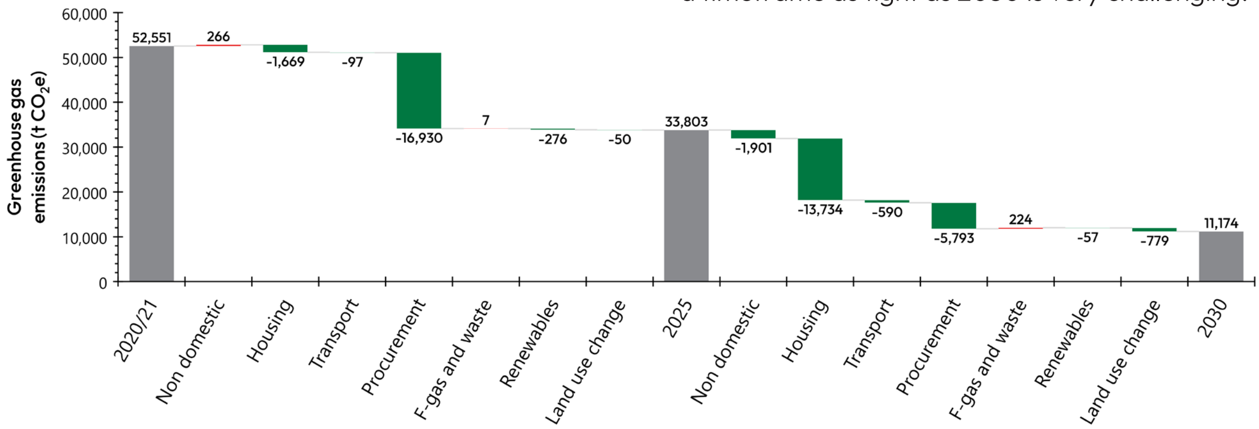
Non-domestic buildings (2,200 t CO_2e) and the council's housing stock (17,300 t CO_2e) would both benefit from decarbonisation of the national electricity grid. The housing stock is already relatively energy-efficient, but would benefit from the installation of heat pumps (saving 9,900 t CO_2e). Non-domestic buildings would benefit significantly from asset rationalisation, energy efficiency and heat decarbonisation but are still anticipated to have associated emissions of 600 t CO_2e in 2030. Emissions of 1,200 t CO_2e would remain for the housing stock. However, the leakage of refrigerants from heat pumps has the potential to increase emissions by 250 t CO_2e.

Transport emissions would benefit most from the adoption of electric vehicles, giving a reduction of 690 t CO_2e. Combined with other measures emissions would fall from 1,100 t CO_2e in 2020/21 to 330 t CO_2e in 2030.

The procurement of goods and services give rise to the bulk of the council's emissions (31,400 t CO_2e). Construction of new buildings is particularly carbon-intensive, with the new St. Sidwell's Point leisure centre being responsible for one-off emissions of 13,200 t CO_2e in 2020/21. Emissions of 9,700 t CO_2e would result in 2030 without this ongoing project and with other improvements in the sector.

The generation of renewable energy and afforestation have the potential to offset 760 t CO_2e and 830 t CO_2e of emissions respectively.

Combining the highly ambitious carbon reduction measures included in the projections indicates potential to reduce net emissions to 11,200 t CO_2e, a reduction from the baseline of 79%. Achieving net zero, whether nationally, locally or organisationally requires action across all sectors; these projections show that delivering net zero in a timeframe as tight as 2030 is very challenging.



Exeter City Council's projected emission for all sectors for 2020, 2025 and 2030.

Monitoring carbon descent in Exeter & Plymouth

Territorial footprints of all emissions arising within each city have been updated and the trajectories compared to the reductions necessary to achieve stated goals.

Exeter and Plymouth city councils have pledged to work towards being carbon neutral by 2030, twenty years in advance of the 2050 national net zero target required under the Climate Change Act and reported on in the Sixth Carbon Budget.

The Centre has provided these councils with carbon footprints for all emissions within the city boundaries, referred to as territorial footprints, for a number of years. These reveal the current level of emissions and historic rates of emission reduction. While there is progress in the power sector, attributable to rapid decarbonisation of grid electricity, locally emissions from the largest sectors—buildings and transport—are not falling at the required rate. These two sectors account for 35% and 22% of Exeter's emissions and 28% and 29% of Plymouth's emissions respectively.

Possible trajectories to achieve the target in each city were considered. Both cities would require annual emission reductions of 11% if emissions are to decline linearly. An alternative decline trajectory was also considered, showing slower reductions in early years compensated for by more rapid reductions in later years.

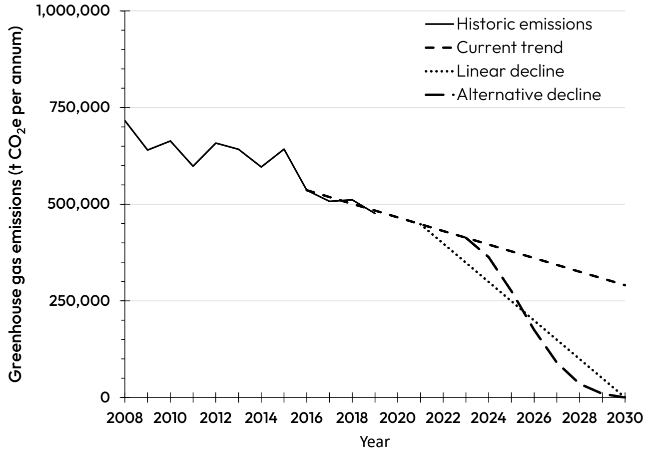
Analysis of each sector identified potential emission reduction measures.

Local renewable energy generation contributes to the decarbonisation of electricity supply, and in urban areas is likely to take the form of roof-mounted photovoltaic panels. Target annual installation rates of 1,240 systems in Exeter and 3,000 in Plymouth are 6 to 10 times historic average rates.

Reduction of emissions from buildings is perhaps the greatest challenge. Analysis of energy performance certificates indicates that 45% to 50% of homes require additional loft insulation, amounting to 2,800 and 6,600 installations per year in Exeter and Plymouth. Solid wall insulation is required in 18% of Exeter's homes (1,500 per year) and 28% of those in Plymouth (3,800 per year). These annual installation figures significantly exceed historic rates. The installation of 4,600 heat pumps per year in Exeter and 8,000 per year in Plymouth is required to decarbonise domestic heating. Non-domestic buildings face similar challenges; 3,100 non-domestic buildings in Exeter and 6,400 in Plymouth have low energy efficiency ratings.

In the transport sector, car mileage needs to fall through modal switch to walking and cycling, to achieve a 17% reduction from 2019 to 2030. Prior to the Covid-19 pandemic the trend was for increased mileage year-on-year. Achieving zero emissions for transport requires the electrification of the vehicle fleet. Encouragingly, electric car and van ownership is increasing exponentially in both cities. Although short-term exponential increases are achievable, uptake would exceed current annual new car registrations in later years. Electric vehicle charging infrastructure needs to grow to support car and van electrification. Targets for larger commercial vehicles have yet to be developed.

Finally, reducing emissions from waste requires increased recycling rates and waste prevention strategies.



Current emissions trends with alternative trajectories to achieve net zero emissions by 2030 in Exeter.

Data processing for carbon emission evaluation work

Evaluating organisational, territorial and project-based carbon emissions requires behind-the-scenes evaluation of complex data sources and reporting protocols.

Territorial footprinting has been simplified this year by the expansion of government datasets to include agricultural emissions from livestock and arable farming (including urea, lime and fertilizer application), and emissions from landfilling waste, wastewater treatment, sewage sludge decomposition, composting and anaerobic digestion. Previously only emissions resulting from fuel consumption had been reported. The dataset now includes emissions of nitrous oxide and methane as well as carbon dioxide; these gases are particularly significant contributors to climate change in the agriculture and waste sectors.

The expanded dataset removes the need to draw on multiple data sources such as agricultural surveys and the National Atmospheric Emissions Inventory, which could previously have led to inconsistencies. Nitrous oxide and methane emissions were previously estimated by the Centre by considering the relative emission factors of a fuel, activity or process; this is no longer necessary.

A contentious issue that arises when reporting the emissions of different greenhouse gases as a single value (CO_2 equivalent, or CO_2e) is the residence time and warming effect of the gas in the atmosphere. Most commonly a time horizon of 100 years is considered. This is similar to the half-life of carbon dioxide and nitrous oxide in the atmosphere. Methane decays much more quickly, with a half-life of about ten years, but it is a more potent greenhouse gas than carbon dioxide, having 28 times as much impact per unit mass over a 100 year horizon, and 84 times as much impact over a 20 year horizon.

Beef and dairy farming in particular are major emitters of methane.

Lobbyists in the agriculture and waste sectors (which emit large quantities of methane) claim that applying a 100 year time horizon unfairly penalises their emissions. The enduring impacts of emissions beyond this time horizon are claimed to be significant for carbon dioxide but negligible for methane. They claim parity between the legacy impact of carbon dioxide emissions from long ago and the impact of ongoing stable methane emissions. Both are said to result in constant atmospheric concentrations of the gas and a corresponding constant long-term climatic impact.

A new reporting method, GWP*, has been proposed to address this claimed inconsistency. A step change in methane emissions is equated to a large, one-off, emission of carbon dioxide. However, this method understates the impact of short-lived pollutants on current rates of global warming as it neglects the lag in climatic response. Although modifications have been proposed to address this, GWP* effectively provides 'grandfathering rights' to existing methane emitters. The method strongly rewards reductions in emission rates, and strongly penalises increases in emission rates. If an area has higher levels of dairy farming than the national average this would be allowed to continue unabated, and any reduction would receive a windfall negative GWP* emission.

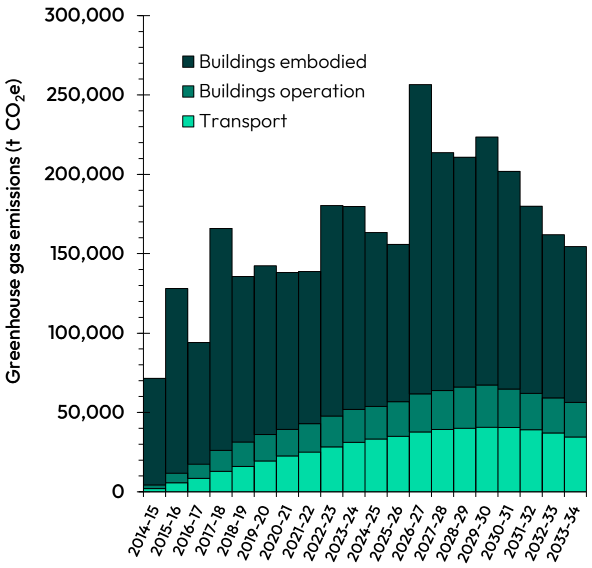
Current reporting ignores the impact of carbon dioxide emissions beyond 100 years. A century is, however, a reasonable timeframe for long-term planning. On this timescale new technologies such as sequestration may become established. Given the urgency of the climate crisis, every possible action needs to be taken to reduce greenhouse gas emissions, rather than asserting rights to continue emitting methane.

Plymouth and South West Devon Joint Local Plan

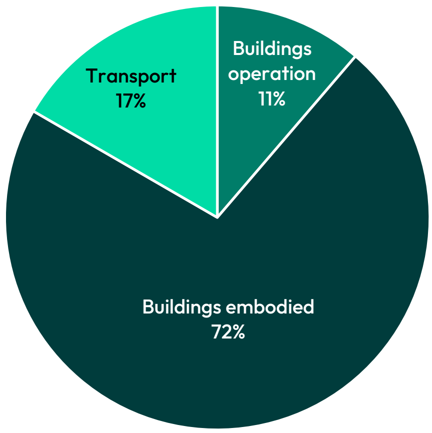
Carbon emissions from residential development have been evaluated, including embodied emissions from materials, and emissions from energy and transport use.

The Joint Local Plan sets a requirement to deliver 26,700 new homes over the 20-year period from 2014/15 to 2033/34. Greenhouse gas emissions are created from the production of building materials used to construct the homes, fuels consumed within the homes once they are occupied, and the use of private cars and public transport by residents. Annual emissions have been estimated based on the number of homes constructed in a given year, and operational emissions from all homes constructed up to that point in time. Future improvements to building regulations, transport policy and electricity decarbonisation were also taken into account.

Total emissions over the 20-year period were estimated to be 3.3 Mt CO_2e, 3.8% of emissions reported for the domestic and transport sectors in 2019. Emissions during construction account for 72% of the total, 11% are from energy consumed within the homes once occupied and 17% are related to transport. Embodied emissions associated with initial construction have been considered, but not lifecycle embodied emissions arising from ongoing use, maintenance or end of life disposal (which would fall outside of the influence of planning policy).



Annual emissions from construction, energy use and transport associated with new homes proposed in the Joint Local Plan.



Split of total emissions arising over the 20-year period.

Emissions per home are expected to be significantly higher for rural dwellings where the average house is larger and residents tend to travel greater distances. Falling in-use emissions per home are assumed in future years and cause total annual emissions from homes built under the Plan to fall from about 2030 onwards, despite the increase in the total number of homes.

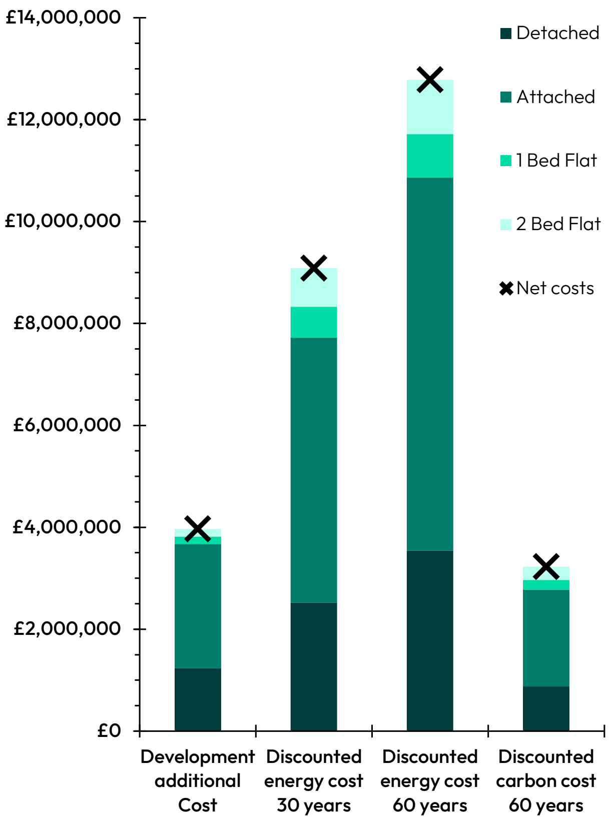
Emissions estimates are inevitably subject to uncertainty. Energy consumption within buildings generally exceeds estimates from established prediction methods used in carbon calculations. For example, the Climate Change Committee state that new build homes lose 50% more heat than they should. This discrepancy has not been taken into account. About 38% of emissions arising due to energy use in the home are from equipment other than fixed heating systems, and are difficult to reduce through legislation. Construction emissions were assumed to remain constant throughout the period of the Plan, due to a lack of policy to drive a reduction in emissions. The dominance of embodied emissions in construction means that improved standards are essential to achieve significant emissions reduction.

Low carbon options for housing developments

A tool was developed to explore the carbon and cost implications of setting different standards for new housing developments in Mid Devon.

Mid Devon District Council declared a climate emergency in 2019 and pledged that the area should be carbon neutral by 2030. As part of its ambition for low carbon new development the Council secured grant funding to develop a low carbon assessment tool for affordable housing developments.

The aim was to learn more about the implementation of low carbon technologies on a challenging site with a view to replicating the results elsewhere. The cost and carbon impact of each technology needed to be understood, as well as its effect on deliverability at scale. The knowledge gained needs to be accessible to council staff.



Sample output from the tool for a scenario with Passivhaus fabric standards and a requirement for a 50% reduction in regulated emissions.

Development Description	
Year of development	2022
Total number of dwellings	1000
% as detached	20%
% as attached	60%
% as 1 bed flat	10%
% as 2 bed flat	10%
Build mix check	OK
Height of buildings with flats	5
Operational Standards	
Building Regulations Minimum Standard	Part L 2021
Fabric Standard	15 kWh/m2.year (Passivhaus)
Gas requirement?	No connection to gas allowed
Carbon standard	Reduce Part L regulated: 50%

Some of the inputs required by the tool.

A tool was created to model potential developments constructed to a range of different building fabric standards and, using a combination of low carbon heating technologies and roof mounted photovoltaic panels, the tool establishes the most cost-effective way of meeting carbon targets on a site.

The tool will be used within the planning application process, and a training session was held for planning officers on its use.

Carbon footprinting of the Cornwall Enterprise Zones

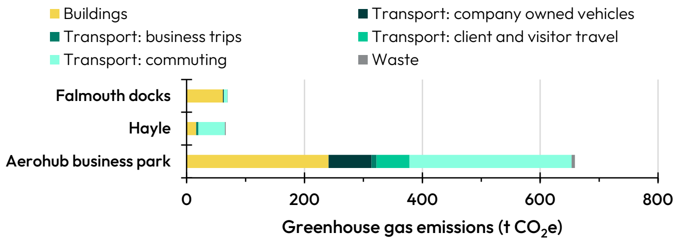
A bespoke assessment framework, data capture and analysis tools were created for the council to calculate the carbon footprint of the Cornwall Enterprise Zones.

The Cornwall and Isles of Scilly Local Enterprise Partnership and Cornwall Council appointed the Centre to carry out a baseline carbon inventory for the three Cornwall Enterprise Zones. The zones are designated areas established to promote business growth in specialist target sectors: marine technology, aerospace and space.

The inventory is to be used as the basis for setting out goals, targets, and approaches to the decarbonisation of the zones. It was collated by combining data held by the building owners with data from an occupant questionnaire to establish emissions across four categories: buildings, transport, refrigerants, and waste.

In 2021, total emissions from the zones were 794 t CO_2e, with 59% of the emissions from transport and 40% from buildings. The remaining 1% was attributable to waste. Emissions from refrigerants have not yet been included due to a lack of data. The Aerohub was responsible for 83% of emissions, Hayle 8% and Falmouth docks 9%. The detailed inventory provided additional breakdowns by sub-category, and on an individual business basis.

The inventory will be updated annually, and a spreadsheet tool was created to ensure consistent calculation in future years, including the automatic processing of returns from the questionnaire that was created as part of the project.

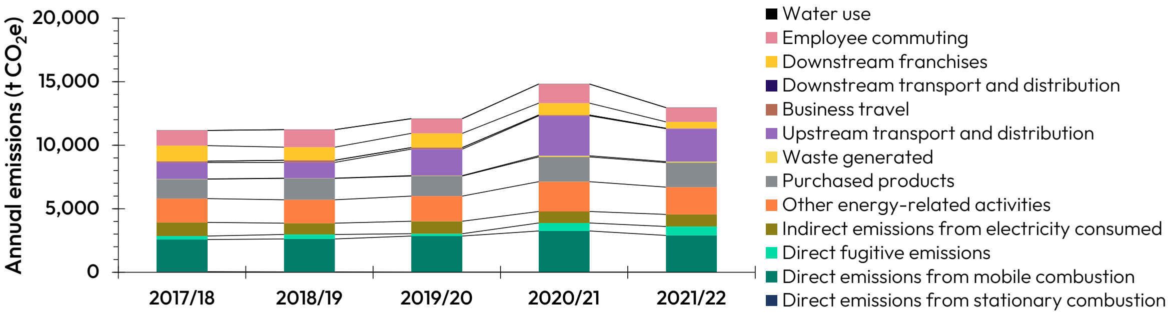


Greenhouse gas emissions in 2021 from each Enterprise Zone.

Carbon footprinting for Riverford Organics

The carbon footprint produced previously for Riverford Organic Farmers Ltd. has been updated, enabling 5 years of progress to be observed.

The footprint is based on the principles of ISO 14064-1. This year's output showed a 13% reduction from the previous year. Emissions from transporting food and people accounted for 69% of the footprint, the use of materials accounted for 15% and electricity consumption was responsible for 9%. Refrigerant leaks contributed 5%.



The carbon footprint for Riverford Organic Farmers Ltd for the past five years.

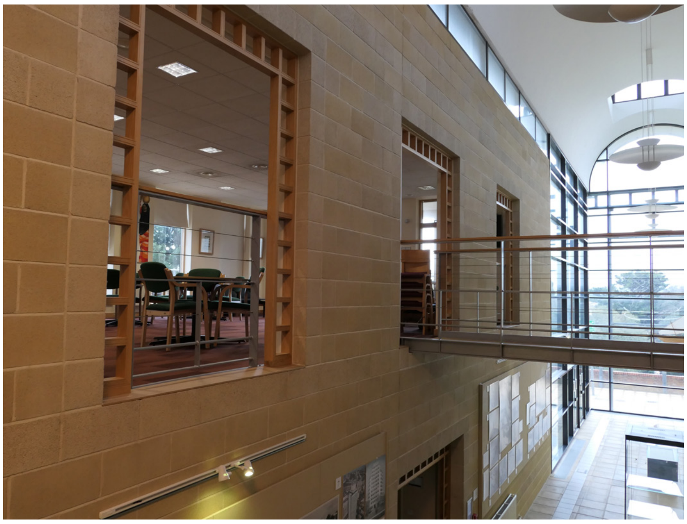
Built environment

Acoustic advice for the University of Exeter

Spaces due for refurbishment in the Institute of Arab and Islamic Studies building were evaluated to ensure that suitable levels of acoustic performance will be achieved.

The building has a double-height atrium space known as The Street, which is open to an adjacent entrance foyer and common room. Measurements confirmed that excessive reverberation is a problem in the building. Reverberation occurs when sound is repeatedly reflected between surfaces rather than being absorbed.

The problem is most acute in the common room. Despite the space having many highly sound absorbent surfaces (carpet, ceiling tiles and upholstered furniture), large openings onto the street allow sound to propagate between the two spaces. Highly sound absorbent surfaces are entirely absent within the street and foyer, and significantly delayed reflected sound re-entering the common room from these adjacent spaces is responsible for the long reverberation time.

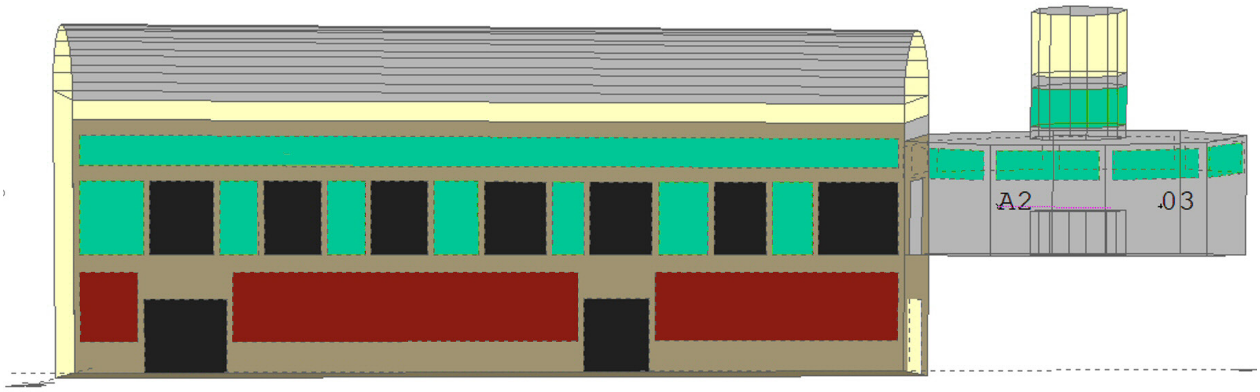


The Street, showing openings into the adjacent common room.

Potential solutions were evaluated using commercial ray tracing software. The geometry of the building is replicated and propagation of sound in the space is modelled mathematically.

One solution would be to glaze the openings between the common room and the street. An alternative would be to add highly sound absorbent surfaces to The Street and foyer in the form of acoustic wall panels and carpeted floor coverings. Placing wall panels on the upper walls of The Street facing the openings into the common room was predicted to be particularly effective.

The library in the building was also evaluated. The acoustics in this space were found to be satisfactory, although plans to provide a door into the street were a potential concern due to noise transfer into the library. Again, reducing the reverberation time of the street would be advantageous, and a minimum sound insulation specification was proposed for the door.



Geometric model of the connected spaces (The Street is on the left and the foyer on the right). Potential locations for sound-absorbent wall panels are shaded green, and existing display boards are shaded red.

Publications

List of publications

Details of documents produced by the Centre this year are shown below. SWEEG members can download documents from centres.exeter.ac.uk/cee/publications/

Internal documents

Number	Title	Author(s)
1001	Wind constraint mapping for Devon	T.A.Mitchell
1002	Electricity monitoring at Chapel Farm, Barnstaple	A.T.Rowson & T.A.Mitchell
1003	Reverberation treatment for the University of Exeter sports park reception	T.A.Mitchell
1004	Acoustic conditions in the proposed University of Exeter Forum Library Digital Maker Space	T.A.Mitchell
1005	Achieving Net Zero for Exeter City Council's corporate carbon footprint by 2030	D.Lash, A.D.S.Norton & A.T.Rowson
1006	Evaluation of the potential of infra red thermography to identify pipe leaks	T.A.Mitchell
1007	Exeter's 2019 greenhouse gas inventory and sector emissions monitoring	T.A.Mitchell & A.D.S.Norton
1008	Acoustic conditions in the Institute of Arab and Islamic Studies building, University of Exeter	T.A.Mitchell
1009	The Development of a low carbon affordable housing development framework assessment tool for new development in Mid Devon	D.Lash
1010	Acoustic advice for The Stage Door, student space in the Alexander building, University of Exeter	T.A.Mitchell
1011	User guides for the East Devon District Council travel carbon calculator	T.A.Mitchell
1013	Electricity monitoring at Cotley Farm, Ottery St. Mary	A.T.Rowson & T.A.Mitchell
1014	Electricity monitoring at Fairfield Farm, Denbury	A.T.Rowson & T.A.Mitchell
1015	Electricity monitoring at Higher Fingle Farm, Cheriton Bishop	A.T.Rowson & T.A.Mitchell
1016	Electricity monitoring at Westcott Farm, Ayshford	A.T.Rowson & T.A.Mitchell
1017	Greenhouse gas inventories for SWEEG: updated methodology for 2020 reporting year	T.A.Mitchell
1018	Territorial greenhouse gas emissions in the SWEEG region in 2020	T.A.Mitchell
1019	Defining a common reporting methodology to produce carbon footprints for the South West police region	D.Lash

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