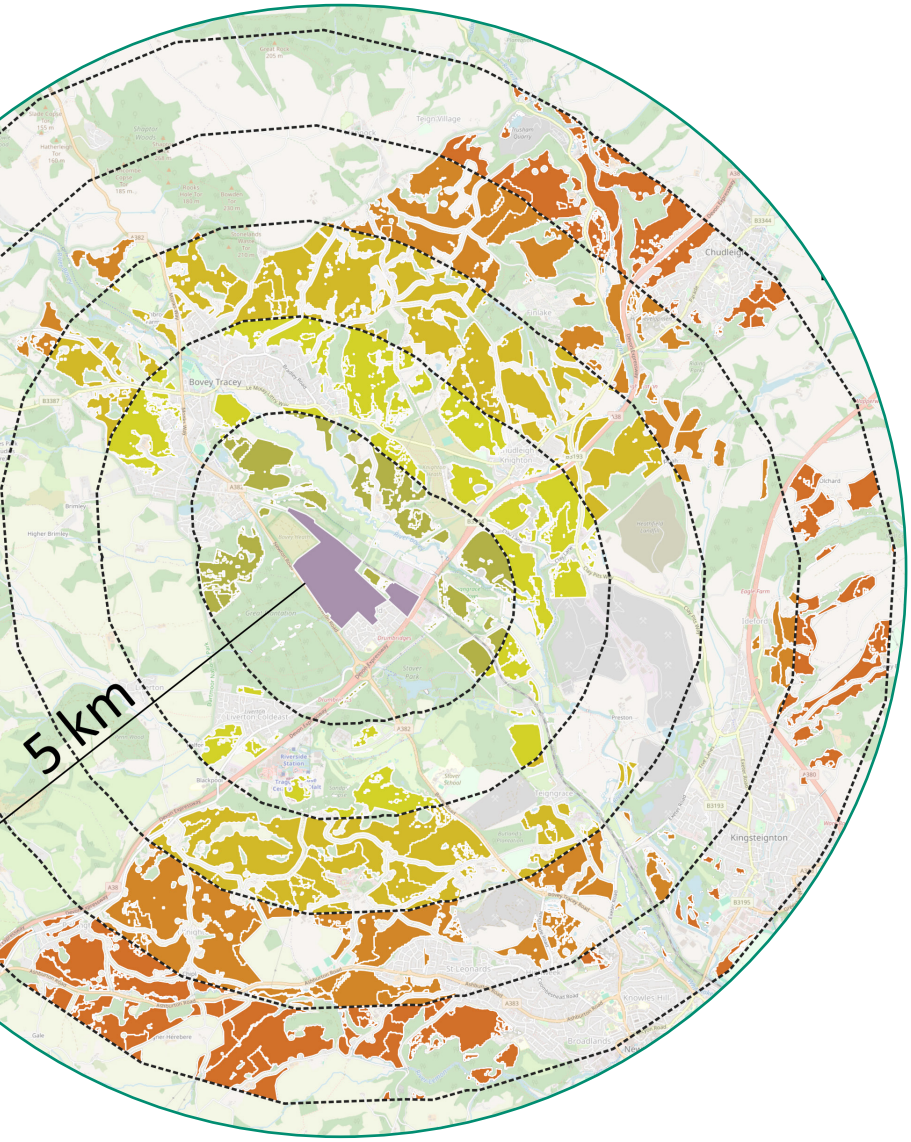


Annual Report 2024

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

The SWEEG partnership was formed in the 1970s and continues to research and share information on energy, emissions and environmental issues in the built environment.

The Centre for Energy and the Environment at the University of Exeter coordinates and carries out technical research on behalf of SWEEG members. Research completed by the Centre is disseminated among SWEEG partners, while work of wider interest may be published in technical and academic journals.

A list of publications produced for SWEEG over the past year can be found at the end of this report. More information about the Centre and SWEEG research is available on the University of Exeter website 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 & West Devon Borough Councils
Teignbridge District Council
University of Exeter

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

The Centre for Energy and the Environment
University of Exeter
Hope Hall
Prince of Wales Road
Exeter EX4 4PL

Tel: 01392 724141

Web: www.exeter.ac.uk/cee

Contents

Front cover
An analysis of the potential for ground-mounted solar photovoltaic arrays around the Heathfield Industrial Estate (see page 8).

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.

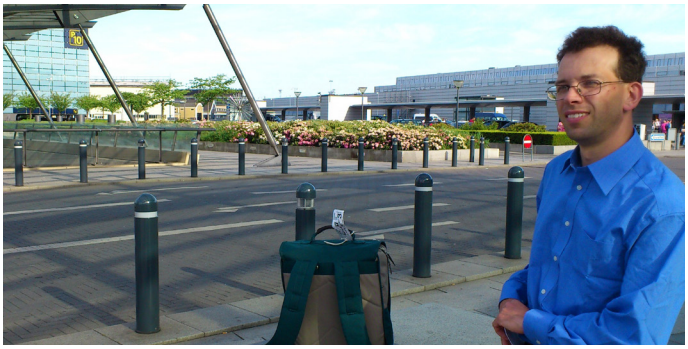
The Centre for Energy and the Environment (the Centre) is a research group within the University of Exeter and is uniquely placed to provide bespoke research to help reduce energy consumption and carbon emissions.

2024 has seen significant changes to staffing at the Centre.

A successful recruitment process, supported by SWEEG members, resulted in the appointment of three Graduate Research Assistants. Each has a first class degree and brings new skills to the Centre.

Isabel Brown has a degree in Climate Change from the University of East Anglia and experience in the transport sector. Ethan Feaver is a Chemist from University College London and has undertaken air quality studies. Ray Rubia Rankin has a degree in Ecological and Environmental Sciences from the University of Edinburgh and has experience using GIS. All three are already making important contributions to work at the Centre.

Andrew Mitchell has left the University after 26 years at the Centre. Andrew has been an incredibly able and productive member of the team, leading the Centre's field work in acoustics and onsite data collection. His skills are wide ranging, from databases and programming to GIS, electronics and much more. His contribution to SWEEG and the Centre has been immense. We wish him well wherever he chooses to deploy his talents next.



Andrew about to board a train from Copenhagen to Växjö in Sweden over the Øresund Bridge in 2012.

Current staff

Tony Norton Head of the Centre
A Chemical Engineer with a background in the international energy industry, Tony's work focuses on energy aspects of local planning and the development of heat networks.

Dan Lash Senior Research Fellow
Dan studied architecture and specialises in low energy building design including ventilation, lighting & comfort. Dan also leads the Centre's work on carbon footprinting.

Andrew Rowson Research Fellow
Andrew is an Engineering Mathematician with experience in construction. He is involved in strategic energy modelling, technologies, planning and policies.

Isabel Brown Research Assistant
Isabel's background is in climate change and has recently worked on transport decarbonisation, adaption planning policy and solar resource assessment and mapping.

Ethan Feaver Research Assistant
Ethan is an environmental chemist with experience in air and water pollution monitoring. His recent work has focused on the built environment and PV technology.

Ray Rubia Rankin Research Assistant
Ray is an ecologist with experience in environmental data analysis and GIS. His work currently focuses on land use change, territorial footprinting, and PV modelling.

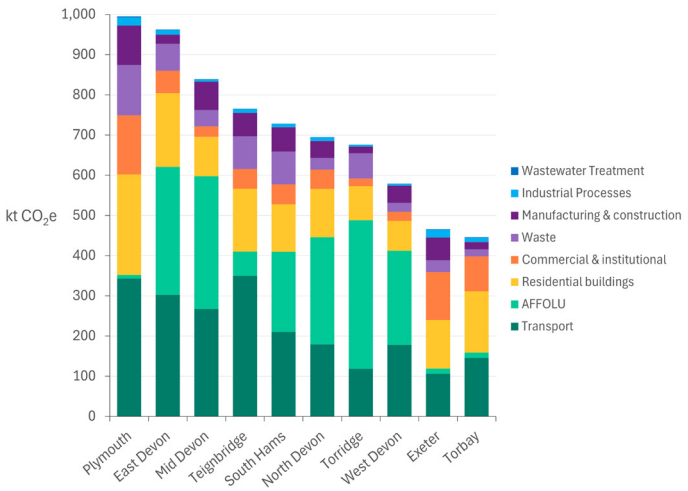
Territorial footprinting

Local authority territorial footprints

The Centre continues to support local authorities' Climate Emergency responses by providing annual updates to territorial carbon footprints and carbon descent progress reports.

The Centre continues to provide territorial footprints for Devon and Cornwall, including district and unitary authorities. The analysis of greenhouse gas emissions is derived from data reported by central government, except for the waste sector where government figures are based on recorded waste arisings, rather than the location of disposal facilities. Instead, the Centre uses point source data from the National Atmospheric Emissions Inventory (NAEI) which are supplemented with carbon emissions reported directly by South West Water.

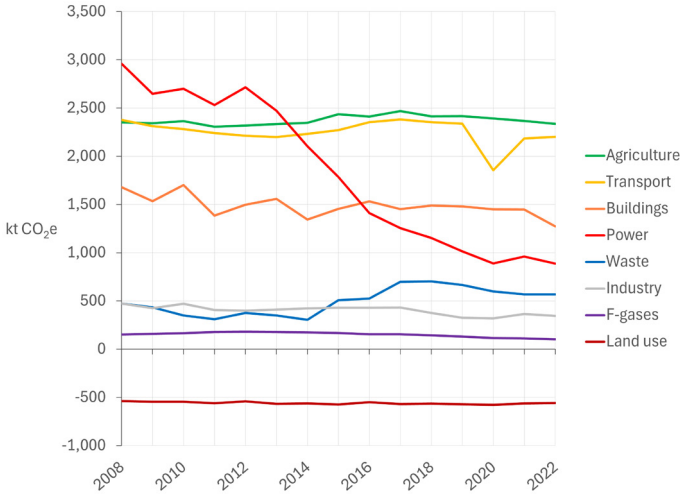
Emissions sources vary considerably across Devon demonstrating the differences between rural and urban areas. Transport emissions tend to be relatively higher in rural districts where emissions from agriculture and land use are also significant. As might be expected, emissions from residential and non-domestic buildings are dominant sources in urban centres.



Greenhouse gas emissions by sector in Devon districts, Plymouth and Torbay in 2022, highlighting the relative dominance of emissions from transport, buildings and agriculture across different parts of Devon.

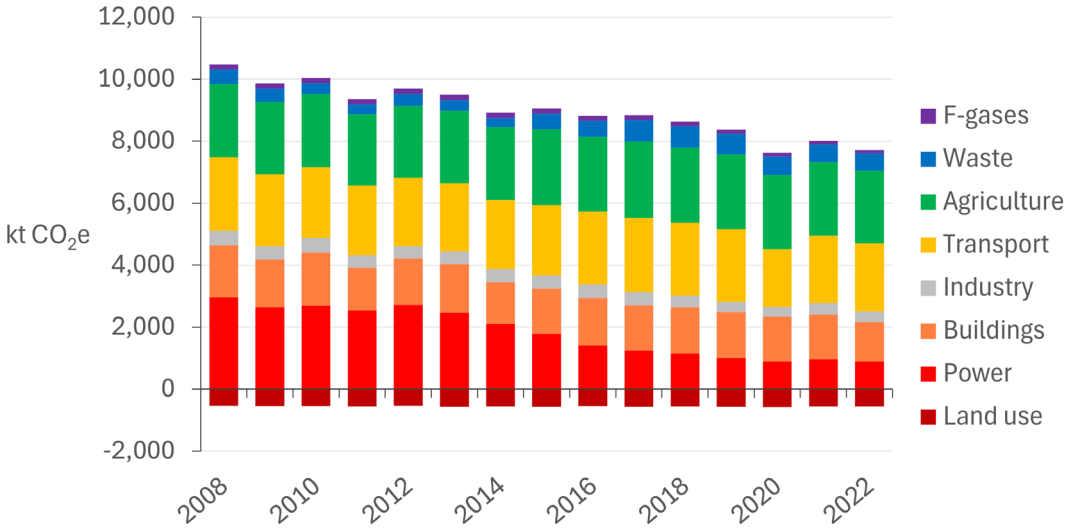
Looking at trends by sector, post COVID-19 transport emissions show a near complete bounce back by 2022 as remote working gives way to commuting. Emissions from buildings show a decline from 2021, this is likely to be a response to the surge in energy prices and more general increases in the cost of living. Hopefully, the reduction is at least in part due to investment in longer lasting energy efficiency measures and shifts in behaviour to enable building emissions to continue to fall, as opposed to just foregoing comfort.

The power sector which has underpinned emissions reduction across the UK for many years through the increased capacity and penetration of renewable energy, has resumed a downward trend in 2022 after an unexpected increase in 2021. In the waste and industry sectors there have only been small changes in emissions between 2021 and 2022.



Greenhouse gas emissions in Devon, Plymouth and Torbay by sector from 2008 to 2022 showing the bounce back in transport emissions, the dip in emissions from buildings and the reliance on emissions reduction in the power sector.

Overall, there is some evidence that emission trends have resumed their downward trajectory in 2022 after the immediate bounce back from COVID-19 in 2021. However, outside the power sector historic emissions reductions continue to be inadequate and are likely to jeopardise both local and national emissions reduction targets. The transport and buildings sectors in particular need to contribute more ahead of the more difficult to decarbonise sectors such as industry, agriculture and waste.

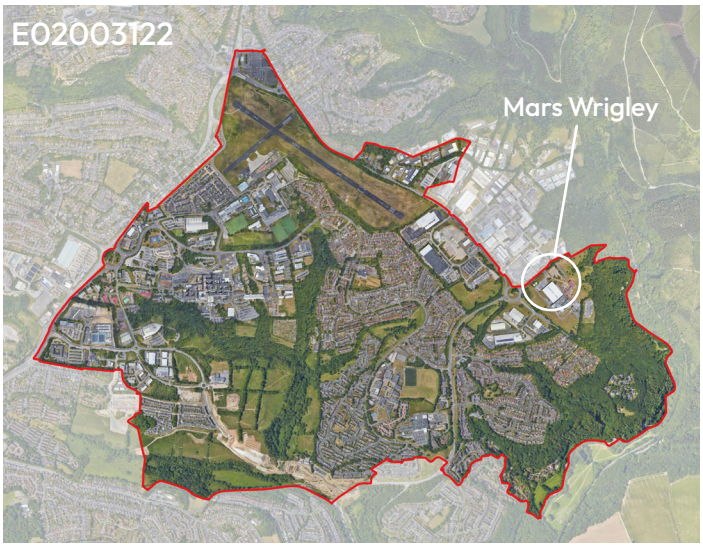


Total emissions in Devon, Plymouth and Torbay between 2008 and 2022 broken down by sector. Post-Covid total emissions appear to have resumed a downward trajectory, although emissions reduction from non-power transport and buildings will be required to meet emission targets.

A separate study was carried out to review the extent to which industrial emissions in Plymouth could be analysed given the granularity of available data.

The industrial sector in Plymouth comprises 12% of the city's emissions with 1% from large industry and the remainder from general industry. A deeper dive into the sector was deemed important to be able to develop strategies for industrial emissions reduction across the city. The focus was on reducing Scope 1 emissions because the electricity grid is decarbonising in line with government policies and predictions, and therefore Scope 2 emissions will contribute relatively less over time. The NAEI identifies two sites contributing 11% and 2% of the total 132 tCO_2e Scope 1 emissions leaving around 87% unidentified.

Non-domestic gas consumption is available at the level of middle layer super output area (MSOA) and identifies areas such as Estover and Coypool with high levels of gas usage. Use of fuel oils represents a significant part of Plymouth's Scope 1 emissions (53%) and is therefore a priority for decarbonisation, but data is only available for the city as a whole. The findings will help focus further analysis which is likely to require engagement of businesses in the city with a view to sharing data and supporting efforts to decarbonise.



MSOAs in Plymouth with the highest gas consumption include E02003122 (Estover Industrial Estate and part of Roborough). and E02003140 (Valley Road Industrial Estate, SWW and Coypool/Princess Yachts).

Other carbon footprinting

Carbon footprinting of events

There are no established standards to determine emissions from events, let alone those simple enough for organisers to implement themselves. The Centre worked with East Devon District Council to produce a method and develop a tool to address this.

A range of festivals and events occur across East Devon each year. These are variously organised by East Devon District Council (EDDC), parish and town councils, and other organisations, or combinations thereof. At present, there is no common approach for organisers to estimate the carbon emissions of an event. Although events vary in size and scope, in most cases there is no budget for formal greenhouse gas (GHG) emissions assessments. Event organisers need a common framework and simple supporting tools to enable them to undertake emissions assessments.

The Centre has created a framework and tool to enable EDDC to develop event carbon footprints with scope to apply the methods more widely.

The Exmouth Festival is a free annual festival for the arts that takes place across the town each summer. The festival was used to trial the framework and tool with the aim of enabling the organisers to assess the emissions sources and take actionable measures to reduce them at the planning stage for the upcoming event and for events in subsequent years.

Emissions categories in the GHG Protocol were mapped to five overarching categories for events: heat and power, transport, goods and services bought by the festival, visitor purchases, and waste.

For each category, data sources and calculation methods were incorporated into the tool allowing a user to easily select available data from a predefined list. They could then enter a single value to capture the activity e.g. kWh of energy, distance and mode of travel for attendees.

The results from the tool are displayed in tables and charts which break down emissions by categories in absolute terms and on a per person basis. Another feature enables comparisons to be made between options within a single event or for the same event across different years. Ease of use ensures that assessments are more likely to take place at the planning stage while positive action still remains a possibility.

Having been successfully trialled in Exmouth, the tool is now being used by Plymouth City Council for its annual British Fireworks Championships. This has demonstrated that the tool also enables events across the region to be compared using a common approach and that it gives potential for shared learning.

This sheet displays headline results for main category and main + sub-category both in total absolute emissions (tCO2e), and per event visitor (kgCO2e/person).

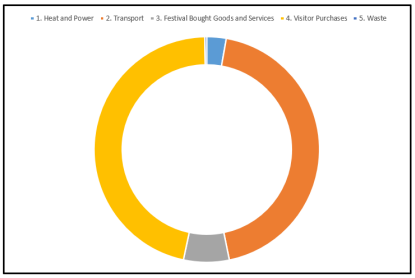
The results are shown as summary tables, and graphs, for the event. Detailed breakdowns by item are provided in the detailed results page, and the comparison page can be used to compare years, scenarios, and events.

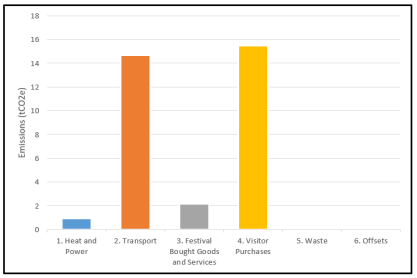
Results for Main Categories

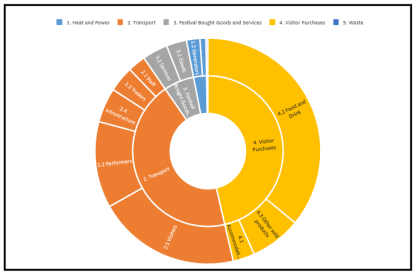
Main Category	tCO2e	kgCO2e/ person	%
1. Heat and Power	0.9	0.1	3%
2. Transport	14.7	2.1	44%
3. Festival Bought Goods and Services	2.2	0.3	7%
4. Visitor Purchases	15.5	2.2	46%
5. Waste	0.1	0.0	0%
6. Offsets	0.0	0.0	0%
TOTALS	**33.3**	**4.8**	100%

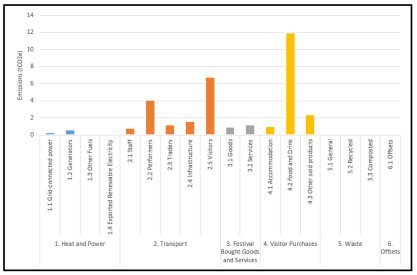
Results for Main and Sub Categories

Main Category	Sub-Category	tCO2e	kgCO2e/ person	%
1. Heat and Power	1.1 Grid-connected power	0.3	0.0	1%
	1.2 Generators	0.6	0.1	2%
	1.3 Other Fuels	0.0	0.0	0%
	1.4 Exported Renewable Electricity	0.0	0.0	0%
2. Transport	2.1 Staff	0.9	0.1	3%
	2.2 Performers	4.1	0.6	12%
	2.3 Traders	1.2	0.2	4%
	2.4 Infrastructure	1.6	0.2	5%
	2.5 Visitors	6.8	1.0	20%
3. Festival Bought Goods and Services	3.1 Goods	1.0	0.1	3%
	3.2 Services	1.2	0.2	4%
4. Visitor Purchases	4.1 Accommodation	1.0	0.1	3%
	4.2 Food and Drink	12.0	1.7	36%
	4.3 Other sold products	2.4	0.3	7%
5. Waste	5.1 General	0.0	0.0	0%
	5.2 Recycled	0.1	0.0	0%
	5.3 Composted	0.0	0.0	0%
6. Offsets	6.1 Offsets	0.0	0.0	0%
TOTALS		**33.3**	**4.8**	100%









The event GHG emissions tool gives a thorough breakdown of emissions by category, allowing organisers to easily assess and compare the carbon footprint of different events or the same event over time.

Carbon impact of new road construction

The Centre continues to undertake research into the impact of new road construction by modelling the A382 as part of the DfT funded Live Labs project.

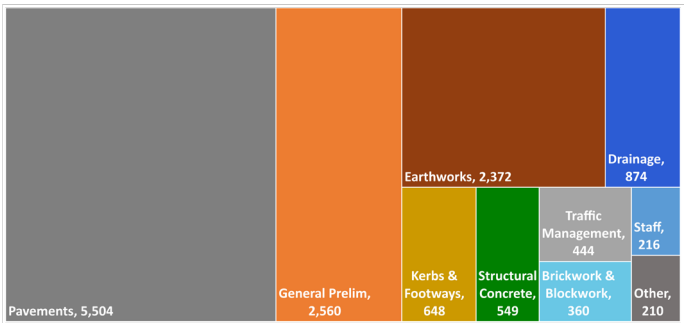
Research on the Live Labs projects has involved producing innovative tools and standards that are in the process of being incorporated into national guidance for the sector.

The Centre has been collaborating with Devon County Council (DCC) for several years to assess and mitigate the carbon impact of its road network. The partnership began with the creation of a tool that allows road designers to estimate the environmental impact of various construction and maintenance activities on the road infrastructure. Through ongoing collaboration with DCC and developers, the Centre has improved these capabilities by producing a data capture tool designed to record live data from on-site operations. Additionally, the Centre has contributed to national standards by co-authoring the Carbon Calculation and Accounting Standard alongside the Future Highways Research Group (FHRG). This provides guidelines and methodologies for accurately measuring and accounting for carbon emissions within the highways sector.

A focus of the Centre's recent work with DCC and its framework contractor, Milestone, is to development and implement a 'carbon negative' A382 road close to Newton Abbot. Funded by the Department for Transport, as part of the Live Labs competition, this initiative aims to create a sustainable model for road construction with minimal or negative carbon impact. So far, the project has integrated previously developed models with an advanced estimator created by Milestone. This estimator provides a highly detailed model capable of calculating carbon emissions and financial costs across a range of innovative options and combined scenarios. These options encompass various aspects of road construction and operation, including materials, construction techniques, biodiversity, operational strategies, and carbon offsetting measures. Each option is modelled as a unique scenario, allowing for adjustments such as changes to material types and quantities, efficiencies gained through redesigns, or alternative fuel and process choices.

A key challenge for the project has been how to keep the baseline design model up to date in light of evolving innovation scenarios. To address this, a spreadsheet-based model has been created that allows changes to the baseline demand to automatically update across different scenarios, minimising abortive work and keeping the analysis accurate.

Another major development in the tool's capabilities includes its ability to account for different stages in a road's lifecycle: the initial construction phase (upfront), the operational phase (in-use) and the end of life. The initial focus of the model has been on upfront emissions, labelled 'Module A,' while an additional calculator for capturing emissions during use, 'Module B,' is under development which ultimately will be incorporated into an overall model for the scheme. A key challenge for the project is obtaining reliable information from suppliers on the emissions of their products. To support this a data hierarchy has been established to prioritise data from Environmental Performance Declaration (EPDs) certificates.



Initial forecasted emission sources from A382 construction.

Organisational footprints

Carbon footprinting for local authorities

The Centre works extensively with Local Authorities and other partners to produce organisational greenhouse gas inventories, including annual updates and detailed carbon descent analysis involving engagement with staff across organisations.

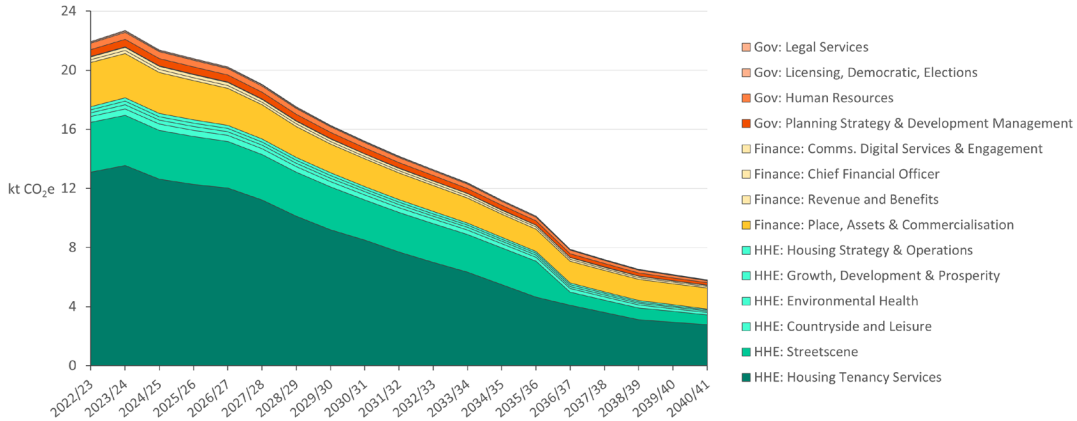
The Centre has continued producing organisational carbon footprints for several local authorities in the SWEEG partnership. This includes Devon County Council, East Devon District Council, Exeter City Council, Mid Devon District Council, and Plymouth City Council. Carbon footprinting has also been undertaken for the five police forces in the South West, Dartmoor National Park Authority, and Treveth – a housing development company that works in partnership with Cornwall Council.

The footprints for the authorities have previously been produced by the Centre 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), and sub-categories within these. The updates to the footprints involved recalculating emissions within the inventory and refining calculation methods where the quality of data has improved in the intervening period.

Calculations are carried out within a spreadsheet tool that the Centre has improved to provide additional functionality. For example, emissions can now be classified by alternative organisation-specific categories and sub-categories such as buildings or transport but can also be aligned more closely with departmental operations. Alternative classifications have been found to be a useful tool for identifying specific areas for emissions reduction and in the management of their implementation.

As well as undertaking annual inventories for previous years, the Centre has been working with partners to project emissions into the future in line with organisational trajectories. Work undertaken with East Devon District Council saw separate meetings held with staff from 14 different departments with the aim of identifying planned and potential activities that might contribute to overall emissions reduction across the organisation. Wider climate change related activities, for example around adaptation, were also discussed. From these sessions, an action plan was developed, and combined with national projections, such as the decarbonisation of the electricity grid and the uptake of electric vehicles, to estimate an emissions pathway in each year to 2030. The discussions were detailed enabling more granular reporting of emissions by department or by category.

The Centre is also exploring alternative approaches to setting decarbonisation targets, including the Science Based Targets Initiative (SBTi) which is helping to develop targets that align with climate science and meet requirements in the Paris Agreement.



Projected emissions for East Devon District Council to 2040 broken down by department. Decarbonisation measures were identified by considering wider national trends alongside detailed discussions with staff.

Policy and planning

Local plan advice

The Centre continues to work with Local Authorities to produce guidance and evidence to support the development of local plan documents. This involves technical analysis, non-expert summaries and support at local planning examinations.

Exeter City Council (ECC) is producing a local plan – the Exeter Plan – covering development in Exeter to 2040. Part of this process is considering what standards to adopt in planning policy with regard to climate change. The Centre worked with ECC to develop a variety of sound climate related policies which deliver positive impacts.

To support the process at the outset, the Centre created a primer for councillors and the public to demystify the often-complex relationship between building regulations and planning guidance.

Several policy options were investigated for inclusion in the Exeter Plan. These included setting a formal date for the adoption of Future Home Standard equivalent targets, specific requirements regarding photovoltaic panels, embodied carbon, consideration of larger standalone renewable energy technologies, and adaptation to climate change.

Setting operational targets for carbon emissions is a complex area both from a technical and viability perspective and is set against the evolution of national policy over time. Although much delayed from the 2016 zero carbon homes ambition, the adoption of the Future Homes Standard is likely to mean that fossil fuel heating systems are no longer installed in new homes.

As standards for operational performance are improved through the Building Regulations, embodied emissions during the construction phase now provide an opportunity for the local planning process to have a significant positive impact on reducing emissions from new development. The Centre worked with ECC to explore potential standards that could be adopted by the Exeter Plan to calculate the upfront emissions from new development. In addition, a checklist was created for local planning officers to help assess delivery of the prospective policy.

Support on adaptation policy included undertaking research of similar policies elsewhere and how these might feed into the wording of the policy for Exeter.

Background material developed for the policy includes holistic measures to reduce overheating in buildings through orientation, air tightness, passive ventilation, shading, reflective surfaces, green infrastructure and heat refuges. Flood risk is addressed by green roofs, permeable pavements, rainwater harvesting and several property-based interventions. Advice on integrating biodiversity into the built environment and adapting to reduced water availability is also provided together with the retrofit of renewable energy technologies with a particular focus on roof mounted solar photovoltaic panels.

In addition to helping develop policy and the underlying evidence base, the Centre also supports local authorities through the examination of their local plans. In September 2024, the Centre provided technical support to Teignbridge District Council at the examination of its local plan on policies relating to operational emissions, construction standards and renewable energy.

Policy CC6: Embodied Carbon – Delivery Checklist

Task	Completed	Notes
EMBODIED CARBON ASSESSMENT		
1. Has an embodied carbon assessment been submitted with the application? *If not, application should not be validated*		
2. Has the assessment been completed by a suitably qualified assessor?		
3. Does the assessment method conform to BS EN 15978-1? *e.g., RICS or London Plan Guidance (see report for guidance on appropriate methodology, data sources, data quality, scope, software tools, reporting, etc.)*		
DEMONSTRATING ADEQUATE STEPS TAKEN TO REDUCE EMBODIED CARBON		
1. Has a clear report providing quantitative demonstration of embodied carbon reduction efforts been submitted?		
2. Does this report include a baseline and optimised assessment? *If not, is there an alternative methodology thoroughly explained and accompanied by data illustrating carbon reductions*		
3. Are the following emission reduction measures covered: - Reuse of buildings - Efficient building design *(e.g., considers spatial efficiency, reuses/renovates existing structures, reviews loadings, reduces material quantities, considers material efficiency and longevity)* - Low carbon material (*Prioritises the use of low-carbon, renewable, bio-based, locally sourced and reused/recycled materials from responsible sources)* - Reusability of material for future builds *(e.g., designed for easy disassembly, durable and flexible materials that can be used at end-of-life)* *The suitably qualified assessor undertaking the embodied carbon assessment will be able to advise further on what steps are most suitable for reducing impact for the specific development proposed*		
4. Does the report include an approach to monitor and ensure the constructed building achieves the estimated embodied carbon?		

Providing planning officers with this checklist ensures that minimising embodied carbon is discussed throughout the planning stages of construction projects.

Renewable heat and power

Renewable energy resource assessment

An early-stage assessment has been made of energy demand on the Heathfield Industrial Estate along with a resource assessment of solar photovoltaic (PV) electricity generation.

The Heathfield Industrial Estate lies between Newton Abbot and Bovey Tracy close to the A38 Devon expressway, it is home to about 200 businesses.

Devon County Council in partnership with Teignbridge District Council is exploring the potential to decarbonise Heathfield Industrial Estate.

Data suggests that gas consumption on the estate has declined by an order of magnitude since 2013, due to the closure of British Ceramic Tile in 2018/19. Current consumption is below the average across Teignbridge and the estate now appears to have few, if any, heat intensive industries.

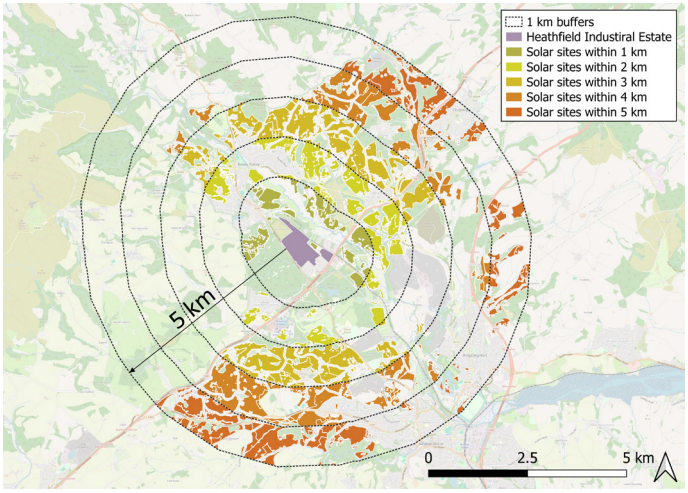
Half hourly electricity data is only available at a district level making it difficult to draw conclusions about electricity consumption. Secondary substation data suggests consumption is in the order of 12 GWh and provides context for the PV assessment. Meanwhile upstream grid constraints are likely to prevent significant PV export to the grid which suggests that private wire connections will be needed to develop PV at scale.

A constraint mapping exercise highlighted areas with the technical potential for ground mounted PV at distances of up to 5 km from the estate. The areas identified have an estimated theoretical capacity of 871 MW which could generate 915 GWh annually, far exceeding total demand. Within 1 km, generation potential is 65 GWh per year and twelve more specific areas could generate 16 GWh, exceeding overall electricity demand on the estate. Areas closest to the estate offer the highest rates of return, due largely to the length of the private wire connection. This effect is less pronounced on larger arrays which maintain higher returns further from the estate.

Ground mounted PV around Heathfield is likely to be economically viable and the selected areas could supply a significant proportion of the estate's electricity demand, with sufficient scope for expansion should electricity demand increase over time.

Analysis of roof space across the estate show that 399 roof faces are potentially suitable for PV (approximately 23% of the total ground area), These roofs could accommodate around 60,000 standard panels, producing 12 GWh of electricity annually.

Although PV output can be intermittent and generation does not always match patterns of demand, energy storage and smart technologies, which incentivise load shifting, mean that the technology could make a significant contribution to energy use across the estate.



Mapping the technical potential of areas within 5 km of the Heathfield industrial estate for ground mounted PV arrays.

Heat decarbonisation planning

The Centre worked with East Devon District Council to formulate a Heat Decarbonisation Plan for the authority's non-domestic buildings. The plan identifies priority buildings for future funding.

A Heat Decarbonisation Plan is a prerequisite for applying for the feasibility stage funding from the Low Carbon Skills Fund. East Devon District Council's (EEDC) estate has a variety of buildings ranging from toilets to swimming pools.

Although a relatively small part of overall emissions, direct (Scope 1) GHG emissions from its non-domestic buildings are among those the Council has most control over, making these a priority for action.

Leisure buildings are the dominant source of emissions (89%) making them the initial strategic focus as they offer the largest carbon savings and have significant social and economic co-benefits.

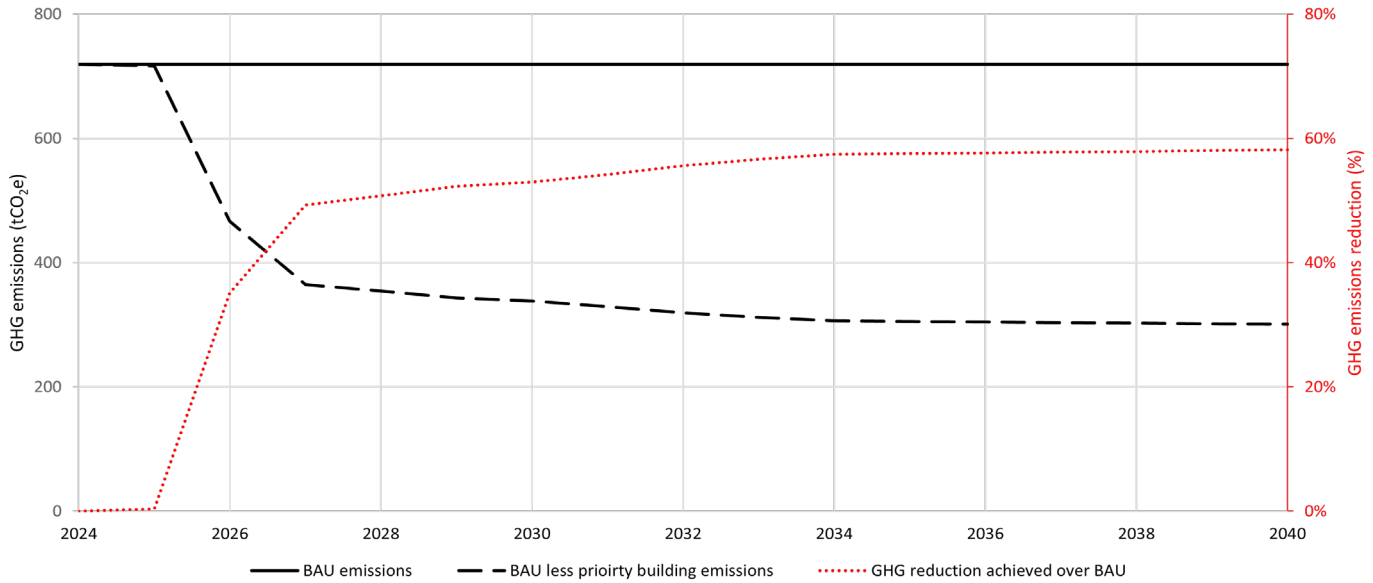
EDDC's non-domestic buildings consume 3,908 MWh of energy for heating, and this generates GHG emissions of 719 tCO_2e. Replacing all fossil fuel boilers with air source heat pumps (ASHPs) when boilers reach 15 years old would theoretically result in a 96% reduction in GHG emissions across the portfolio.

In the short/medium term the non-domestic building estate is looking to initiate projects that enable it to play its part in achieving the Council's reduction trajectory.

The leisure centres in Exmouth and Honiton are the highest emission buildings and combined are responsible for 60% of emissions. Both have gas boilers over 10 years old. Operational considerations also favour the prioritisation of a smaller building in Exmouth for heating replacement – the Withycombe Raleigh Common Changing Rooms. Heating system replacement in these buildings reduces GHG emissions in 2030 by 53% (from 719 tCO_2e to 223 tCO_2e).

The Energy Systems Catapult Interventions Estimator suggests that capital costs for fabric improvement and ASHPs in the three priority buildings will total £840,000. However, the economic evaluation shows that the interventions will not be economic for EDDC to install without financial support.

Undertaking decarbonisation in these community spaces will show the Council's determination to meet its commitment to decarbonise and, as an anchor institution, provide inspiration and leadership to organisations and residents across the district.



Decarbonising three of EDDC's non-domestic buildings makes a substantial contribution to reducing the organisational carbon footprint.

Research highlights

Land-based carbon stocks and fluxes

The Centre worked with Devon County Council to assess methodologies to quantify land-based carbon stores and greenhouse gas fluxes for use in designing sustainable land management strategies.

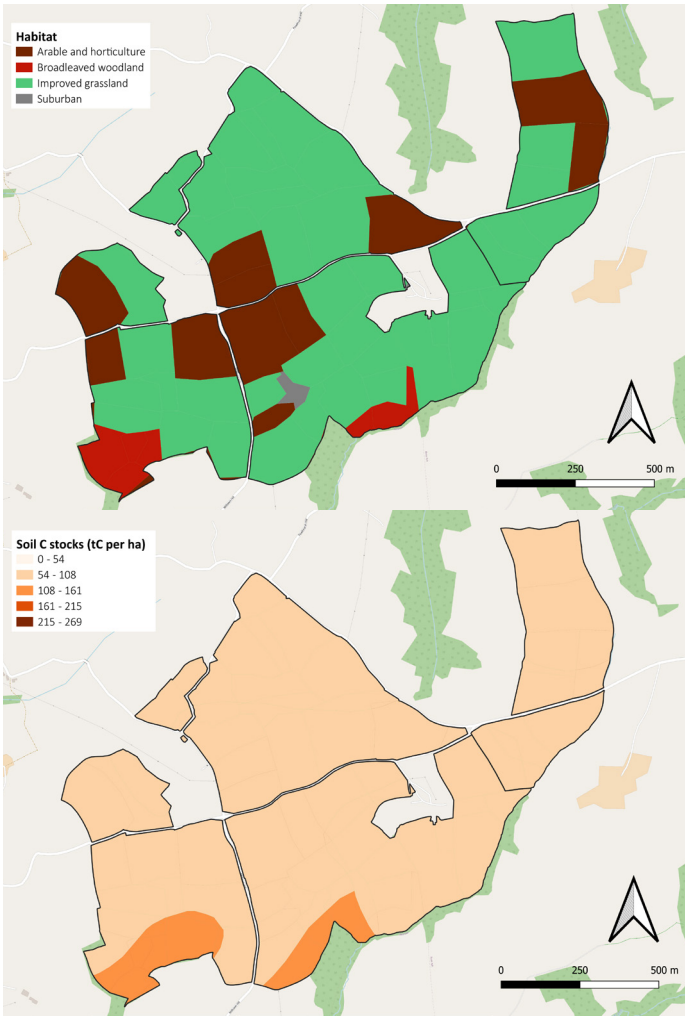
The rise in land sector greenhouse gas (GHG) emissions due to agricultural intensification is threatening to disrupt climate systems and ecosystem functioning worldwide. The Centre assessed two methodologies by applying them to Devon County Council's (DCC) undeveloped estate to quantify its land-based carbon stores and greenhouse gas fluxes.

The methods use GIS mapping software combined with statistical analysis on RStudio to estimate soil and biomass GHG emissions and carbon stores by habitat and land use. The Centre used data from spatial datasets on habitat cover, and a compilation of habitat-specific literature data on soil and biomass carbon stocks and GHG flux densities and compared these with a spatial dataset on soil carbon stocks developed by Cranfield University.

There is between 274 to 890 ktC stored in DCC's undeveloped land and its annual land-based GHG fluxes are between 3,225 tCO_2e and -7,735 tCO_2e. Estimates varied greatly depending on the degree of land quality assumed, underscoring the need for effective ecosystem planning strategies to enhance the habitat quality of managed land. Commonly used sustainable land management strategies include reducing or eliminating tillage, effective water management, growing cover crops, ratooning and increasing the biodiversity of tree, grass and crop species.

Carbon stores and GHG fluxes are highest in the improved grassland habitat and the county farm land use, due to their persistence across DCC's undeveloped land. However, stocks and flux densities are highest in woodland habitats and the country park land use. This finding demonstrates the potential to increase land carbon stores and GHG sequestration on DCC's land by favouring these carbon-rich habitats.

Both quantification methods yielded broadly similar conclusions despite some discrepancies in the estimates, illustrating the suitability of these approaches for land managers in identifying areas with the highest emissions mitigation capacity. The



Example of habitat types and soil organic carbon stocks on a DCC land parcel.

maps derived from the analysis demonstrate the carbon stock values of different habitats and the potential impacts of climate-smart management strategies.

Future work needs to focus on improving data quality and quantifying additional land sector emission sources to provide more accurate estimates. This empirical evidence will help to identify the optimal suite of management practices to mitigate land sector GHG emissions that will build and protect current land carbon stores.

Biochar properties and applications

Devon County Council asked the Centre to review the potential of biochar as a means of sequestering carbon and reducing emissions. Environmental benefits however can vary and biochar applications need to be considered with care.

Biochar can be made from different feedstocks including woody and straw-like materials, as well as agricultural residues. Other sources include those derived from sewage sludge and animal wastes including manures and poultry litter.

Most biochar is produced through pyrolysis, a process where organic materials are heated in an oxygen depleted environment, at temperatures ranging from 250-1000°C. Instead of being combusted, volatile elements (largely oxygen and hydrogen) are vaporised and captured as synthetic gas (syngas) or condensed into tars and oils. Direct substitution for fossil fuels is not possible without further refining.

The solid, carbon-rich residue is called char, or biochar, and is more stable than the organic carbon in the raw feedstock, decomposing over periods of tens to hundreds of years. Biochar has a range of uses; application to soils can increase water resilience, reduce fertilizer use and improve crop yields. In the cement and steel industries biochar can partially replace coal/coke and aggregates (bio-concrete). The high surface area and porous structures combine with electrochemical properties to give biochars strong adsorptive properties which can be utilised in filtering and decontamination applications.

Biochar appears to provide a number of options for reducing emissions and sequestering carbon, however, the properties of individual biochars vary considerably. Feedstock, pyrolysis temperature and retention time all affect real-world performance. Application to some soil types or crops can yield negative results, while complex material properties often require the adaptation of existing processes.

Production emissions can also be variable. Small and mobile plants have few options for energy recovery or capturing flue gases, and while greater efficiency is possible for industrial scale pyrolysis plants, technical and economic complexity are increased significantly.

Supply chain emissions therefore are dependent on a range of factors, to the point where the reduction of greenhouse gases cannot be taken for granted. The environmental credentials of biochar applications should therefore be considered on a case-by-case basis. The introduction of biochar standards helps to reduce product uncertainty, but the controllability of production parameters and consistency of feedstock can remain a challenge. Existing life cycle assessments (LCAs) may follow agreed standards but suffer from arbitrarily chosen scopes and boundaries which make it difficult to generalise results.

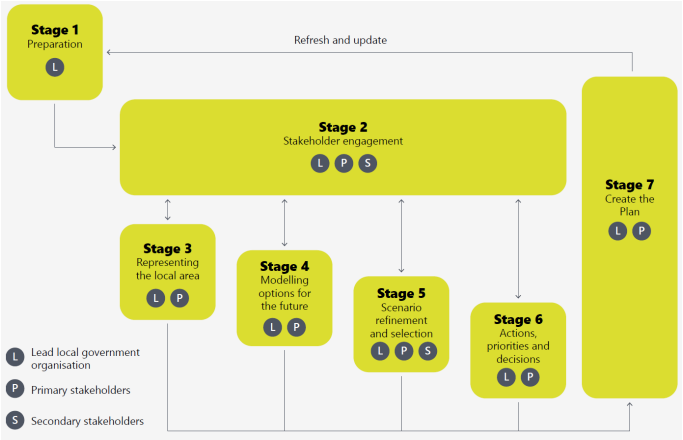
A Royal Society report on greenhouse gas removals suggests that the impact of biochar emissions ranges between -1500 kgCO2e and 160 kgCO2e per dry tonne of feedstock. Common success factors for emissions reduction are likely to include the use of waste feedstocks, energy recovery during production and substituting out high carbon alternatives. Understanding the carbon implications of biochar applications ultimately requires detailed LCAs, taking account of the individual biochar properties and counterfactuals.

The Intergovernmental Panel on Climate Change (IPCC) and the Climate Change Committee (CCC) acknowledge the potential of biochar as a negative emissions technology (NET), but the lack of field trials and the wide range of reported outcomes have meant that confidence in its potential role is currently low.

Local area energy planning

Local authorities are widely seen as key drivers of national plans for net zero yet a range of overlapping initiatives mean that roles and responsibilities across central and local government are far from clear.

Many authorities have declared Climate Emergencies or made other commitments to reduce emissions. However, developing credible plans for achieving local carbon targets requires consensus building across the public and private sectors. Energy masterplanning is seen as an important step in realising net zero ambitions. Guidance has been provided by the Energy Systems Catapult (ESC) to formalise the process.



Energy Systems Catapult guidance describing the seven stages for developing a Local Area Energy Plan.

Local Area Energy Plans (LAEPs) require a 'whole systems' approach supported by a robust technical evidence base. This includes appreciation of non-technical factors and a thorough process of engagement to ensure local interests are represented, together with a credible plan for governance and delivery. The Centre has been providing input to the Devon Energy Planning Group and is providing quality assurance for the Cornwall and Isles of Scilly LAEP.

In Wales, LAEPs are a statutory requirement and are supported by central funding. These enable individual LAEPs to contribute to the National Energy Plan. In Scotland, Local Heat and Energy Efficiency Strategies (LHEES) are also statutory (and funded) but are focused specifically on decarbonising heat in homes and buildings.

In England funding has been provided for LAEP pilots through competitive tenders, but with no statutory obligation many authorities are left considering how best to prioritise their capacity and funds.

While the ESC guidance provides a useful framework, the amount of effort and expertise required to develop a LAEP is considerable, and most authorities have therefore engaged consultants to undertake the work. The guidance alone however is not sufficiently concise to define contractual outputs and authorities should therefore expect to be active participants in the LAEP process to ensure they get the required outputs.

The commitment to LAEPs is complicated by parallel energy planning initiatives from central government. A national heat mapping methodology will be applied to determine Heat Network Zones (HNZs), areas where heat networks provide the lowest cost option for decarbonised heat. Local refinement will be carried out (or overseen) by local authorities who will have powers to force connections to networks. The second consultation on HNZs ended in February but the response, including details of funding, has yet to be issued.

Meanwhile Ofgem has consulted on Regional Energy Strategic Plans (RESP) where another 'whole system' approach will be applied to the energy distribution system, potentially mirroring much of what is being done in LAEPs. Local authorities' participation in the RESP will be voluntary, as Ofgem believes it will be in the local authorities' interest to engage in strategic network developments. Governance is envisaged through regional Strategic Boards comprising network operators and local government alongside relevant local actors. Decisions on funding and resources however, have been deferred to central government.

The role of local authorities in delivering net zero has been highlighted as 'critical' by the National Audit Office, Climate Change Committee and in the 'Mission Zero' (Skidmore) review. At the same time, clear direction from central government on responsibilities and priorities is currently absent which risks the duplication of effort and the collective response to net zero being uncoordinated.

Publications

List of publications

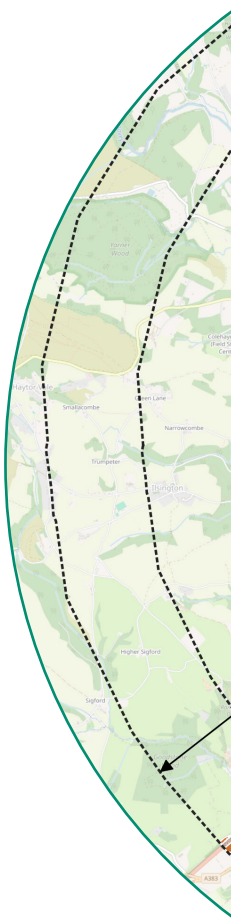
Documents produced by the Centre this year.

Internal documents

Number	Title	Author(s)
1024	Water Lane smart grid and storage project: Summative assessment report	T A Mitchell
1027	Teignbridge District Council: Planning evidence review for draft policy CC2	A Norton
1029	Evaluation of the case for electrification of the refuse collection vehicle fleet in Exeter	T A Mitchell
1032	Calculations of greenhouse gas emissions from road users for the A382 major road network improvements project	D Lash
1034	House type cost uplift figures for policy CC2	A Norton
1042	Plymouth's greenhouse gas reporting 2023	T A Mitchell, A Norton
1043	Exeter City Council's carbon footprint 2022/23	D Lash
1044	A common framework for producing carbon footprints for events and festivals in East Devon	D Lash
1045	Exmouth Festival 2023 carbon footprint	D Lash
1048	Calculations of greenhouse gas emissions from road users for the A382 major road network improvements project: Updated traffic models	D Lash
1049	East Devon District Council non-domestic heat decarbonisation plan strategy stage	D Lash, A Norton
1050	A Review of Software Options for Calculating Lifecycle Carbon Emissions in Construction Projects	D Lash
1051	An assessment of energy use and greenhouse gas emissions at the Heathfield Industrial Estate	A Norton
1052	East Devon District Council's carbon footprint 2022/23 and projecting emissions to 2040	D Lash, A Norton
1055	Mid Devon District Council's organisational carbon footprint 2023/24	D Lash
1056	Delivering Policy CC6: Embodied carbon	R Rubia Rankin
1057	Avon and Somerset Police's carbon footprint 2023/24	D Lash
1058	Devon and Cornwall Police's carbon footprint 2023/24	D Lash
1059	Dorset Police's carbon footprint 2023/24	D Lash
1060	Gloucestershire Police's carbon footprint 2023/24	D Lash
1061	Wiltshire Police's carbon footprint 2023/24	D Lash
1062	A review of the Devon Carbon Plan monitoring indicators	I Brown, E Feaver, A Rowson
1063	Exeter's greenhouse gas reporting 2024	R Rubia Rankin
1064	Greenhouse gas inventories for SWEEG: Updated methodology for 2022 reporting year	R Rubia Rankin
1065	Plymouth's greenhouse gas reporting 2024	R Rubia Rankin
1066	An assessment of ground mounted solar PV around the Heathfield Industrial Estate	I Brown, A Norton
1067	Heathfield rooftop PV assessment	E Feaver, A Rowson
1069	University of Exeter Science-Based Target for the reduction of greenhouse gas emissions	D Lash
1070	Delivering Policy CC7: Development that is adaptive and resilient to climate change	I Brown
1071	Assessment of a methodology to quantify land carbon stores and land-based greenhouse gas emissions	R Rubia Rankin

Briefing papers

Number	Title	Author(s)
110	A review of biochar production, properties and applications	A Rowson



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Published November 2024