Bath & North East Somerset Council

Climate Emergency Study Discussion Pack

September 2019

Anthesis

Contents

Anthesis

Introduction and Context

Introduction

This work is being commissioned by the Sustainability team at Bath and North East Somerset Council.

Aim

The aim of this project is to provide an evidence base to inform the Council's planning in response to the Climate Emergency declaration (14 March 2019), with particular reference to the following aspects of the resolution:

- *Pledge to provide the leadership to enable Bath & North East Somerset to become carbon neutral by 2030.*
- *……. making B&NES Council carbon neutral by 2030.*
- *Launch real two-way engagement with the public to: improve 'carbon literacy' of all citizens and encourage and support leadership on this issue in all sectors of society.*

The resolution also commits us to bringing a report to full Council in mid-September 2019, with an initial response to the Climate Emergency declaration and other commitments, including a first steps action plan, which will be reported on, reviewed and developed annually.

Objectives

To better understand:

- The district's carbon footprint using location and consumption-based approaches;
- The proportion emissions that can be influenced locally, rather than requiring action by central government or other national players;
- What has driven the downward trajectories of Industrial/Commercial and Domestic sector emissions to date;
- Big institution carbon emissions;
- Land use and carbon sequestration potential;
- Potential pathways and options required to better align activities with the climate science and the aim of carbon neutrality by 2030, distinguishing between local action, regional and national action, where possible;
- The Council's own carbon footprint (as opposed to the district as a whole), both direct and supply chain emissions, in order to identify further action on direct emissions and opportunities to reduce supply chain emissions, including calculating what percentage of the district's emissions the Council's own carbon footprint represents;
- Per capita carbon footprints across the B&NES income range in order to be able to inform the public what their likely carbon footprint is and therefore what are likely to be the most relevant actions within different income brackets, within the context of a 'just transition' approach;
- The West of England Energy Study recommendations in order to identify the actions most relevant to B&NES in relation to the two 2030 pathways, including bringing the numbers down to the B&NES level, to inform prioritisation and action planning; and
- Gaps in data where further work is needed.

Introduction and Context

Context

Local and National Policy Drivers

Tackling the climate crisis is a long-standing priority in the UK, reflected in the legally binding target in the 2008 Climate Change Act:

"It is the duty of the Secretary of State to ensure that the net UK carbon account for the year 2050 is at least 80% lower than the 1990 baseline."

In March 2019, B&NES Council passed a Climate Emergency resolution, calling for significant acceleration in the pace of our carbon reduction activities.

Evidence of Need

The Full Council resolution came about as a response to the Intergovernmental Panel on Climate Change (IPCC) special report on the impacts of global warming of 1.5°C above pre-industrial levels, issued in October 2018. The report stated that in order to remain within a 1.5°C increase, governments would have to slash emissions of greenhouse gases by 45% by 2030.

The UN Environment Programme then published their 2018 Emissions Gap Report, which found that the Nationally Determined Contributions, were insufficient to ensure that global warming stays below 1.5°C, and that nations must triple their efforts in order to meet even the previous 2°C target. It also found that global emissions had increased in 2017 after 3 years of stagnation.

A key finding of the report is that: 'Non-state and subnational action plays an important role in delivering national pledges. Emission reduction potential from non-state and subnational action could ultimately be significant, allowing countries to raise ambition'

Research by the Global Carbon Project issued in December 2018 reported that Global carbon emissions are on course to rise by a further 2.7% in 2018, an increase on the rise seen in 2017.

The above evidence makes clear that immediate and drastic action is required to avoid global warming to dangerous levels.

References

- Full Council Motion to declare a Climate Emergency https://democracy.bathnes.gov.uk/mgConvert2PDF.aspx?ID=54982
- IPCC 1.5C Report https://www.ipcc.ch/sr15/
- Emissions Gap Report https://www.unenvironment.org/resources/emissions-gap-report-2018
- https://www.earth-syst-sci-data.net/10/2141/2018/ Global Carbon Project research

Section 1 – District Level Emissions

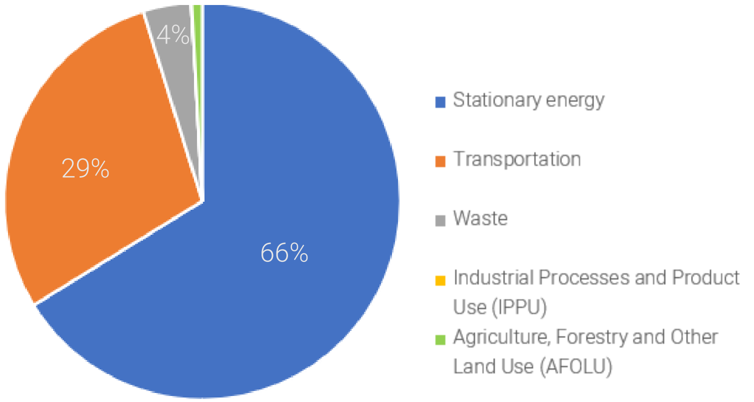
Anthesis

Section 1 – District Level Emissions

Current Profile

The figures and charts presented summarise the emissions relating to the B&NES district emissions. There are two methods used for this estimation; one uses the Anthesis' SCATTER tool, the other uses BEIS local Authority Emissions data. Differences between the two are explored overleaf.

Chart 1: SCATTER Inventory: Direct and Indirect Emissions Summary, tCO_2e



Sector	Direct (Scope 1)	Indirect (Scope 2)	Other (Scope 3)
Stationary energy	277,808	230,000	82,833
Transportation	222,059	-	99,680
Waste	30,268	-	-
Industrial Processes and Product Use (IPPU)	-	-	-
Agriculture, Forestry and Other Land Use (AFOLU)	6,742	-	-
Totals	536,876	230,000	182,513
Direct & Indirect Total	766,876		182,513

Table 1: SCATTER Inventory: Emissions Summary, tCO_2e

Chart 2: SCATTER Inventory: Direct and Indirect Emissions – Sub-sectors, tCO_2e

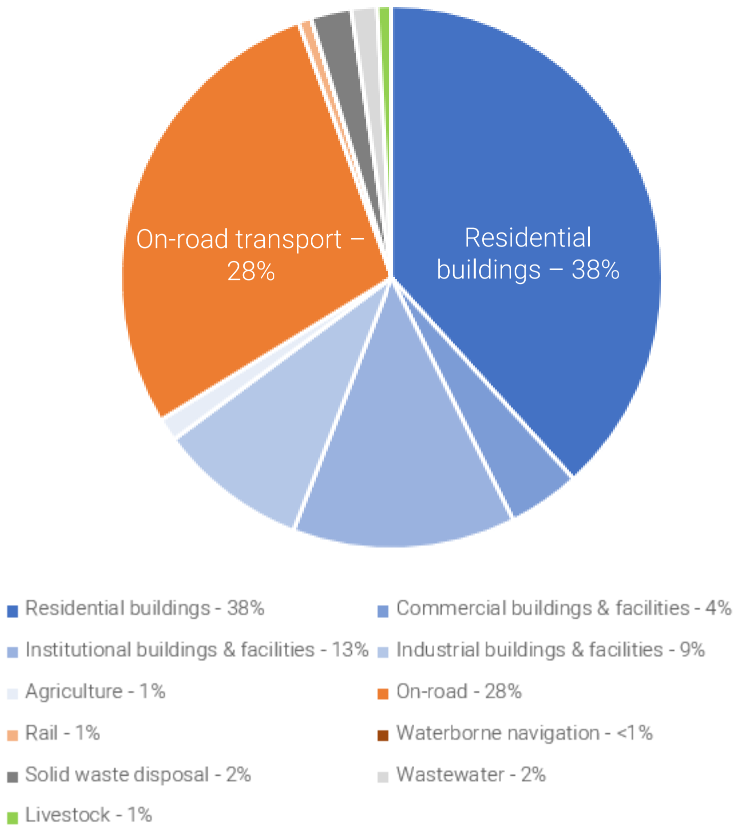
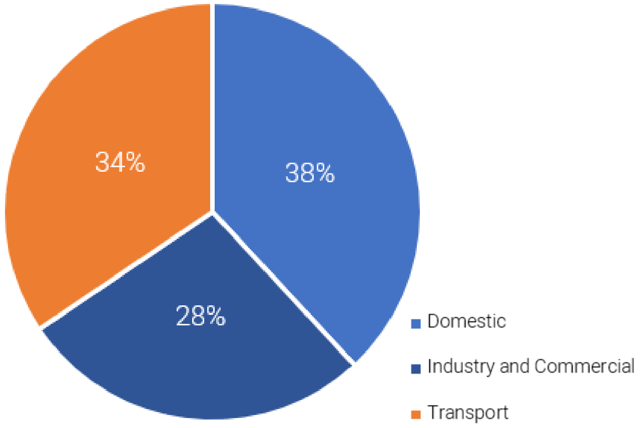


Chart 3: BEIS Local Emissions Summary (Direct and Indirect), tCO_2



Category	2016 (tCO_2)
Domestic	284,608
Industry and Commercial	205,216
Transport	257,383
Land Use, Land Use Change & Forestry (LULUCF)	-8,847
Grand Total	738,360

Table 2: BEIS Local Emissions Summary, tCO_2

Section 1 – District Level Emissions

Current Profile

Frequently asked questions

What do the different emissions categories mean within the SCATTER Inventory?

Direct = GHG emissions from sources located within the Local Authority Boundary (also referred to as Scope 1). For example petrol, diesel or natural gas.

Indirect = GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary (also referred to as Scope 2).

Other = All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary (also referred to as Scope 3). This category is not complete and only shows sub-categories required for CDP / Global Covenant of Mayors reporting. Other Scope 3 emissions are explored (in part) within Sections 2, 3 and 4.An example would be the emissions associated with electricity transmission and distribution (T&D) losses for the region (by sector).

The BEIS Local Emissions Summary does not differentiate between direct/indirect/other (or the various 'scopes'.

What do the different sectors and subsectors represent within the SCATTER Inventory?

- **The Direct Emissions Summary and Subsector categories are aligned with best practice accounting standard:** This is, the World Resource Institute's Global Protocol for Community-Scale Greenhouse Gas Emission Inventories ("GPC"), as accepted by CDP and the Global Covenant of Mayors.
- **The BEIS Local Emissions Summary** represents Local Authority level data published annually by the Department for Business Energy & Industrial Strategy (BEIS).
- **Stationary energy** includes emissions associated with industrial buildings and facilities (e.g. gas & electricity).
- **IPPU** specifically relates to emissions that arise from production of products within the following industries: Iron and steel, Non-ferrous metals, Mineral products, Chemicals. These are derived from DUKES data (1.1-1.3 & 5.1).
- **Waterborne Navigation and Aviation** relate to trips that occur within the region. The figures are derived based on national data (Civil Aviation Authority & Department for Transport) and scaled to the B&NES region.
- **The full methodology available on request:** See http://SCATTERcities.com

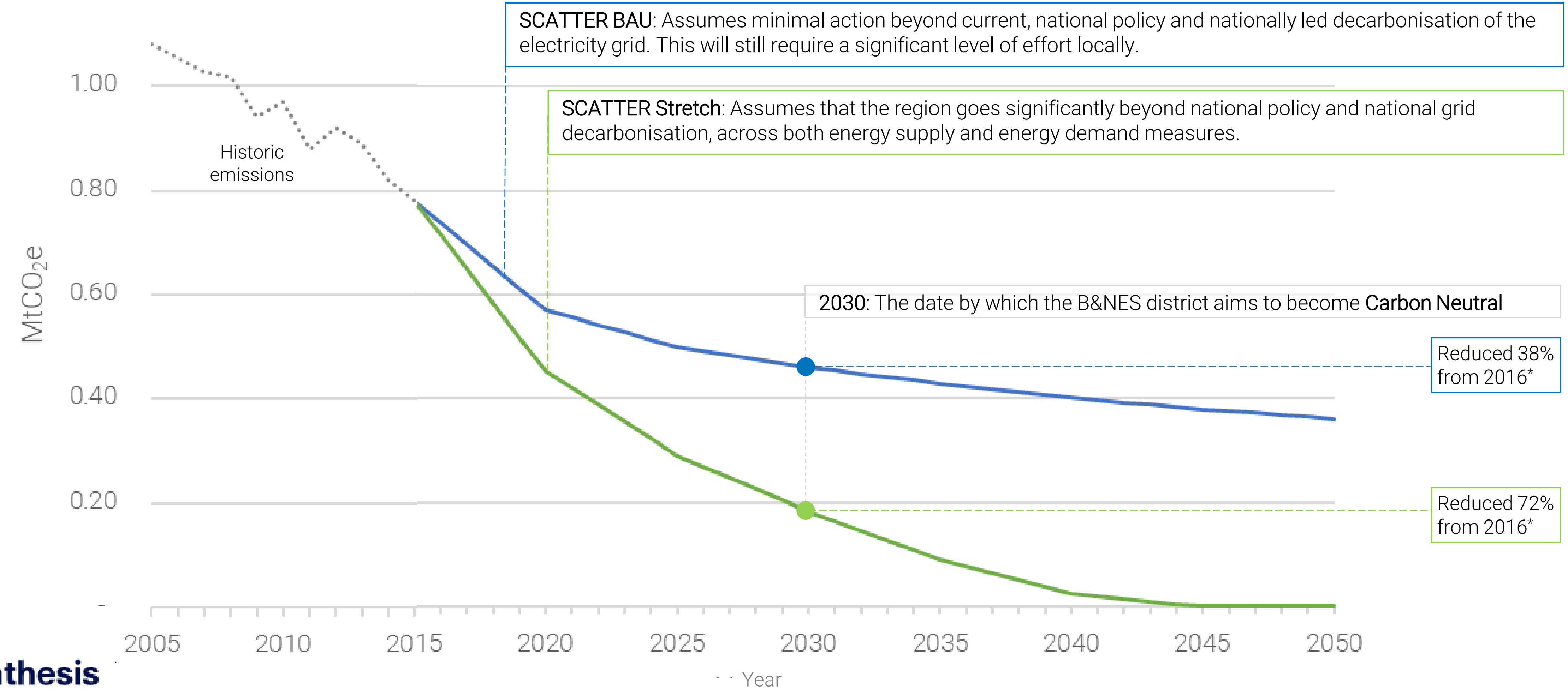
Why does the BEIS summary differ from the SCATTER summary?

- The BEIS summary **represents CO_2 only**; SCATTER also includes emissions factors for other greenhouse gases such as Nitrous Oxide (N_20) and Methane (CH_4). These are reported as a CO_2 'equivalents (e)'.
- The BEIS summary **does not provide scope split**; SCATTER reports emissions by scope 1, 2, and 3 (i.e. direct, indirect or other categories).
- The BEIS **summary categories are not directly consistent or mapped to the BEIS LA fuel data** which is available as a separate data set. SCATTER uses published fuel data and apply current-year emissions factors, whereas the BEIS data calculations scale down national emissions in each transport area. Specifically with regard to road transport, BEIS data splits total emissions across road type; SCATTER uses fuel consumption for on-road transport per LA.
- **Different treatment of 'rural' emissions** i.e. Agriculture, Forestry and Other Land Use (AFOLU) and Land Use, Land Use Change & Forestry (LULUCF) categories are derived from different underlying data sets and have been explored further within section 3 of this report.

Section 1 – District Level Emissions

Future Emissions Trajectories: SCATTER pathways

Chart 4: B&NES Emissions Carbon Budget and Pathways for the District-Wide Energy System, Annotated.

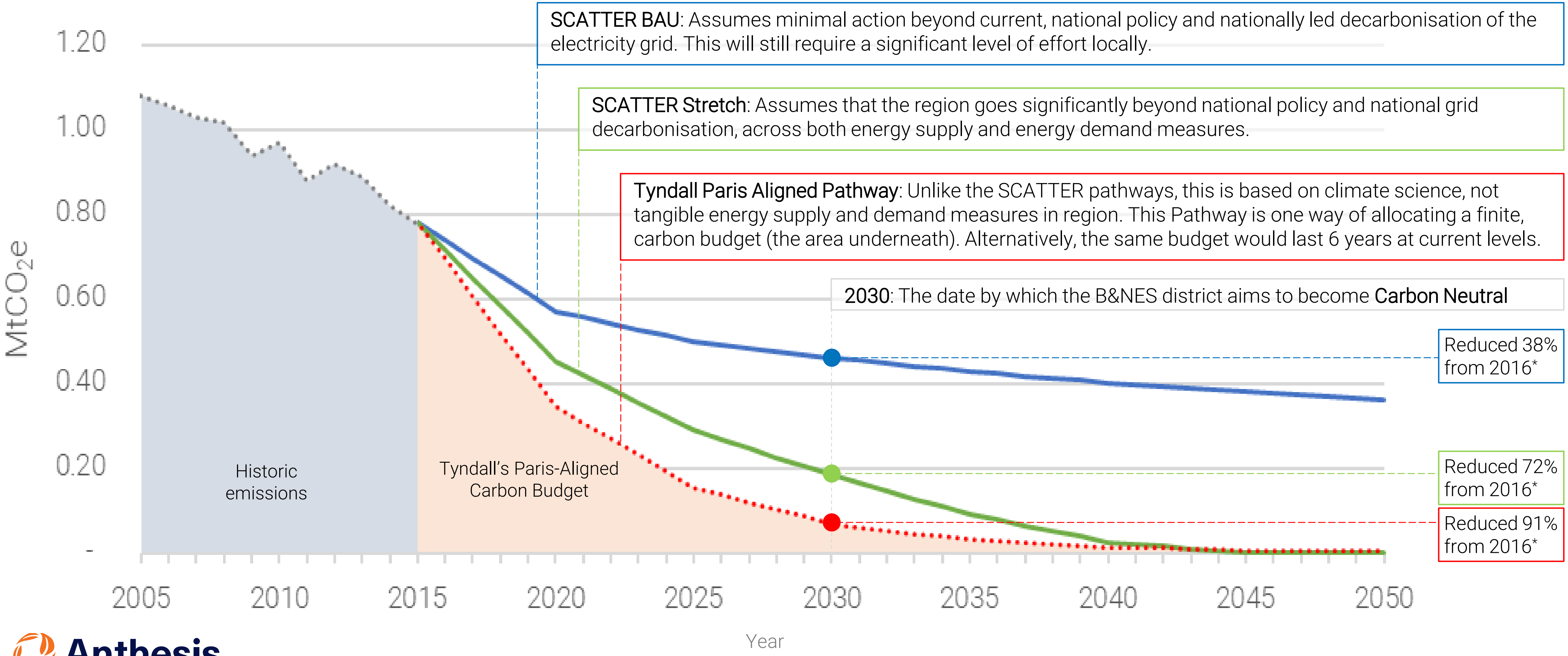


*Local Authority emissions & energy consumption data is published 2 years in arrears. SCATTER Tool operates from 2015 Base year, with adjustments made using 2016 BEIS Local Authority Emissions data

Section 1 – District Level Emissions

Future Emissions Trajectories: SCATTER plus Tyndall Paris - Aligned

Chart 4: B&NES Emissions Carbon Budget and Pathways for the District-Wide Energy System, Annotated.



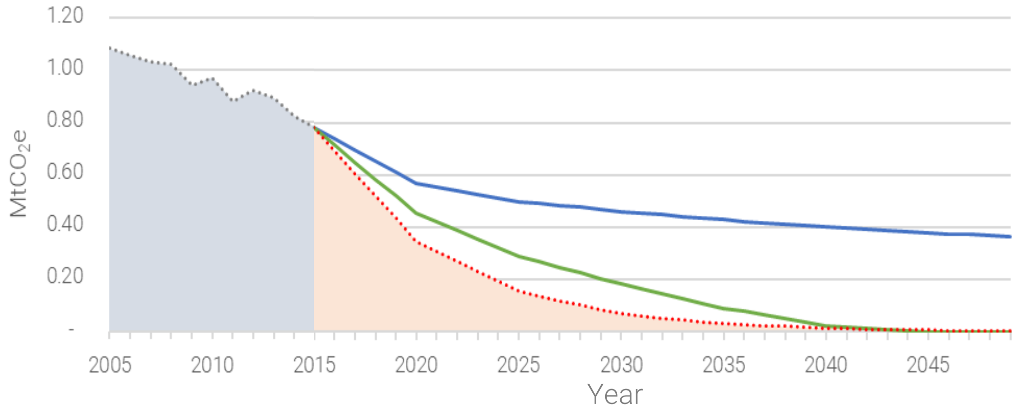
Anthesis

*Local Authority emissions & energy consumption data is published 2 years in arrears. SCATTER Tool operates from 2015 Base year, with adjustments made using 2016 BEIS Local Authority Emissions data

Section 1 – District Level Emissions

Future Emissions Trajectories

Chart 5: B&NES Emissions Carbon Budget and Pathways for the District-Wide Energy System, Not Annotated.



SCATTER "Business as Usual" ('BAU') Pathway – Assumes the selected region doesn't take much action beyond current, national policy and nationally led decarbonisation of the electricity grid.[1]

SCATTER "Stretch" Pathway – Assumes the selected region goes significantly beyond national policy and national grid decarbonisation assumptions, across both energy supply and demand measures. Many assumptions aligned with the legacy DECC 2050 Pathways calculator 'Level 4'. See Appendix 2 for further details.

Tyndall Paris Aligned Budget – The finite, cumulative amount that the region should emit between now and 2050, based on research[2] performed by the Tyndall Centre for Climate Change Research.

Tyndall Paris Aligned Pathway – The yearly totals that must reduce 13% on average each year to keep within budget.

Historic Pathway – Previous emissions totals as reported within the BEIS local authority and regional carbon dioxide emissions data sets.[3]

This graph shows two possible future emissions pathways over time, as modelled by the SCATTER pathways tool. This tool focuses on energy system (fossil fuel consumption) emissions reductions within the B&NES district. The pathways do not represent reductions outside of the B&NES district boundary (see Section 2) or emissions from Land Use, Land Use Change & Forestry (Section 3).

Both Pathways can be compared against the Tyndall Centre for Climate Change Research's Paris Aligned Budget. This is derived from climate science[4] and applies a method for scaling down global carbon emissions budgets that are 'likely' to keep temperature change "well below 2°C and pursuing 1.5°C", to local authority regions. Unlike the SCATTER pathways, this is based on climate science, not tangible energy supply and demand measures in region. The cumulative nature of CO_2 reinforces the need for to take a 'budget' approach, where any annual shortfalls accumulate over time. This Pathway is just one way of allocating a finite, carbon budget (the area underneath the curve). Alternatively, the same budget would last only 6 years if emissions remain at current levels. This highlights the need for urgent action **now**.

Gaps exists between the SCATTER Stretch Pathway and the Tyndall Paris Aligned Pathway / zero carbon at 2030 because modelling assumptions are based on present day evidence & judgment. Such assumptions are not intended to constrain the future ambition to close the gap.

What does 'Carbon Neutral' mean?

'Carbon neutral' or 'net zero' typically means that some carbon/GHG emissions remain but are then 'netted off' or off-set through carbon dioxide removal. Such removal may occur due to Negative Emissions Technologies (NETs) such as biomass energy with carbon capture and storage, or, natural sequestration via means such as afforestation.

B&NES therefore need define the nature and extent of 'offsetting' that is feasible within the Local Authority boundary during the course of this study.

See also, a recent blog by the Tyndall Centre for Climate Change Research on the various related terms that may often get confused or used interchangeably with 'Carbon Neutrality'.

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1 - The BAU carbon intensity of electricity tracks the National Grid Future Energy Scenario (FES) "2 Degrees", 2017), on the basis that this was aligned with the legislated targets at the time the SCATTER tool was developed.
2 - This is based on a method available upon request from c.w.jones@manchester.ac.uk, however the method is broadly comparable with work performed for Sheffield City Council, Greater Manchester Combined Authority and the City of Manchester.
3 - Data is published 2 years in arrears, 2017 published data is represented on the graph as the SCATTER Pathways tool had not been updated at the time of writing. % Reduction figures presented do reflect the 2018 published BEIS data.
4 - IPCC Special Report on 1.5ºC (IPCC SR1.5)

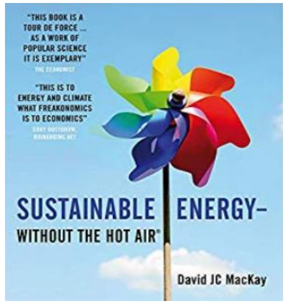
Section 1 – District Level Emissions
Future Emissions Trajectories
About the SCATTER model

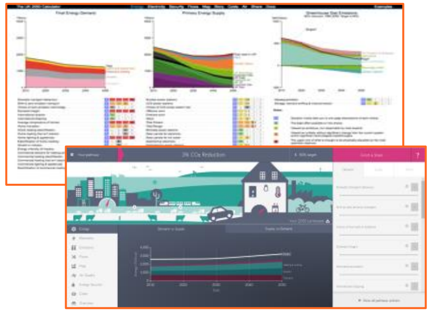
SCATTER is intended to serve as one of many information sources to help users inform their priorities for emissions reduction. Specifically with reference to the forward looking pathways modelling element, it is intended to focus on the 'what' rather than the 'how'. It is important to note that SCATTER does not intend to prescribe certain technologies or policies, and similarly does not intend to discount other methods of arriving at the same outcome, just because they do not feature in the model. The SCATTER pathways serve as 'lines in the sand', and give users an indication of whether they are likely to be on-target or off-target for a carbon neutral trajectory through the adoption of interventions to drive the transition to a low carbon economy.

Naturally, technologies, assumptions and approaches to energy models are evolving all the time, and we would welcome the opportunity to receive feedback and/or collaborate on refinements of SCATTER in the future. Please share any feedback with scatter@anthesisgroup.com.

Basic principals

Sir David MacKay's 'Without Hot Air (2009)" underpins the basis for the pathways modelling. As a scientific advisor to the Department for Energy & Climate Change (DECC), now BEIS, Mackay's work led to the development of the 2050 Pathways calculator. An open source, Microsoft Excel version of this tool was published by DECC which we used as the foundation for SCATTER.





Two key modifications were made by Anthesis:

1) We scaled it down for sub-national regions: Scaling assumptions and localised data sets were built into the tool so that results were representative of cities and local authority regions, rather than the UK as a whole.

2) We pushed ambition further: Technology specifications changes were reviewed and updated where judged to be out of date and constraining ambition. Given that almost a decade had passed since MacKay's publication and the release of the 2050 Pathways tool, we sought the counsel of a technical panel to make these updates. The technical panel comprised subject matter experts from Arup, BEIS, Electricity North West, GMCA, The Business Growth Hub, The Energy Systems Catapult, The Tyndall Centre and Siemens. We also referenced the 2050 Wiki page during the course of the update.

Many other sector specific aspects of modelling treatment and assumptions have required consideration and interpretation as we have applied the model to various cities and local authorities.

Section 1 – District Level Emissions

Future Emissions Trajectories

Supply and Demand

The energy system has two main components; energy supply, and energy demand. In this report, the term 'energy system' relates to energy in the form of solid, liquid and gaseous energy that is used to provide fuel, heat and electricity across buildings, transport and industrial sectors. Energy must be supplied to each of these sectors, in order to meet the demand for energy that the sectors require. Demand drives the amount of supply we need, and actors such as businesses, residents and public services all play a part in contributing to this demand.

Future demand is hard to predict. Recently published analysis within the National Grid's Future Energy Scenarios (FES) 2019 indicates that even under a scenario that meets the UK's net zero by 2050 (Two Degrees), electricity demand still increases. SCATTER's 'Stretch' Pathway on the other hand (consistent with the legacy 2050 Pathways tool), assumes that electricity demand still reduces overall. Factors such as increased electrification of heat and transport are naturally big drivers for the increase, but incentives and opportunities for demand reduction and energy efficiency measures are still significant, and could slow or tip trends in the other direction.

Reducing demand should always come first.

Economically, this usually makes sense, whether at an individual, organisational or district level. For example, energy bills can reduce and at a district level, costs associated with installing new generation assets, new grid connections and grid reinforcement works and be minimised.

Socially, there are benefits if citizens can be better off if they shift to healthier forms of transport just as walking & cycling, or increase efficiency of journeys by car sharing.

Table 3: FES & SCATTER electricity demand assumption comparison

Source	Change in current[1] demand	
	2030	2050
FES Two Degrees (2019)	▲ 5%	▲ 48%
SCATTER "Stretch" Pathway	▼-2%	▼-11%

Environmentally, emissions savings can often be achieved much quicker by implementing various demand side behaviour changes or 'quick win' efficiency measures. This can help safeguard carbon budgets and avoid placing too much reliance on slower, riskier, renewable supply infrastructure to deliver the emissions savings so critically required.

The potential for demand reduction is still huge. The International Energy Agency (IEA) estimated that efficiency measures (i.e. demand side reduction), could contribute 40% towards our emissions targets[2].

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1 - FES: 2018, SCATTER: 2017 levels, electricity demand only.
2 – International Energy Agency, Energy Technology Perspectives, 2017

Section 1 – District Level Emissions

Future Emissions Trajectories

Domestic Buildings

Measure	Current Context	SCATTER Stretch Pathway 2025	2030	2050	Notes
Improved insulation	3,405 ECO measures installed lds) to date[1] 10.9% (8,470) of households are fuel poor[2] 14,500 new homes by 2036[3] 64% of homes are EPC rated D or below (See Appendix 3 for further details) 183 Watts/°C average heat loss per house[4]	66,438 homes have had 'some form' [6] of retrofit 2,554 New build since 2019 to PassivHaus Standard 183 Watts/°C average heat loss per house	66,473 homes have had 'some form'[6] of retrofit 5,090 New build since 2019 to PassivHaus Standard 158 Watts/°C average heat loss per house	66,615 homes have had 'some form'[6] of retrofit 13,000 New build since 2019 to PassivHaus standard 58 Watts/°C average heat loss per house	In the legacy 2050 Pathways tool, national technical potential levels decreased due to assumptions around demolition rates. SCATTER has retained those assumptions. Retrofit rate levels off after an initially much higher rate 2020-2025. Skills capacity is currently a huge challenge in the retrofit market.
Reduction of average temperature	17.3°C is the current average, across the year and all rooms in the house[5]	16.8°C	16.7°C	16.0°C	Reductions may be achieved through better heating controls (i.e. 'Smart thermostats') that zone the heat, as opposed to reducing comfort (which could impact health).

1 & 2 –https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/795930/Detailed_HEE_tables_18_Apr_2019_FINAL.xlsx
Period adjustment made to include 2016 figures, therefore period is 2017-2050 inclusive. 2017 data not available at the time of drafting.
3 - http://www.bathnes.gov.uk/sites/default/files/sitedocuments/Planning-and-Building-Control/Planning-Policy/LP20162036/lp_201636_io_winter_2017.pdf
4- Based on legacy DECC 2050 Pathways Calculator, 2010
5 - Data source: ECUK (2017) Table 3.16: Internal and external temperatures 1970 to 2012
6 –Please refer to Appendix 4 for full list of measures and the implementation timeline– the figures presented here just relate to draft proofing. Other measures including triple glazing, wall, floor and ceiling insulation will be required.

Section 1 – District Level Emissions

Future Emissions Trajectories

Domestic Buildings

Measure	Current Context	SCATTER Stretch Pathway 2025	SCATTER Stretch Pathway 2030	SCATTER Stretch Pathway 2050	Notes
Electrification of heat	69,000 gas meters in B&NES, average 2017 consumption 13,391 kWh[1]. This may imply over 80% of households use gas for heating.[2] 211 domestic Renewable Heat Incentive (RHI) installations from April 2014 to May 2019[3]	26% of heating systems replaced in existing stock	40% of heating systems replaced in existing stock	92% of heating systems replaced in existing stock	Refer to Appendix 5 for further detail on the type of heating technologies assumed.
Estimated carbon saving (from 2018), tCO_2e	Space heating & water measures (insulation, heat demand & heat electrification)	357,000	755,000	3,069,000	Savings are cumulative over the period 2018-2050, relative to 2017.
Appliance & lighting efficiency	Consumption by domestic lighting and appliances in the UK has reduced by 7% (2015 compared to 2018)[4]	15% Energy reduction (from 2015 levels)	23% Energy reduction (from 2015 levels)	65% Energy reduction (from 2015 levels)	
Electrification of cooking	47% Electric (2015) [5]	69% Electric	76% Electric	100% Electric	
Estimated carbon saving (from 2018), tCO_2e	Domestic lighting, appliances, and cooking	437,000	781,000	2,255,000	Savings are cumulative over the period 2018-2050, relative to 2017.

1- Postcodes connected to gas: https://www.gov.uk/government/statistics/postcode-level-gas-statistics-2017-experimental and https://www.doogal.co.uk/AdministrativeAreas.php?district=E06000022
2 – Assuming one meter per household.
3 - https://www.gov.uk/government/statistics/rhi-monthly-deployment-data-may-2019
4 - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/820753/2019_Electrical_Products_Tables.xlsx
5 - BEIS Total sub-national final energy consumption, 2015, Total Domestic Fuel - Allocated according to ECUK proportions

Section 1 – District Level Emissions

Future Emissions Trajectories

Domestic Buildings

UK Case Studies

South West England Retrofits

What: The barriers and enablers for improving domestic building energy use.
Why: To accelerate retrofit market growth.
How: Market analysis to stimulate long term growth.
When: Published 2014.
Barriers: Scaling up, demand and supply, skills capacity and effectiveness.
Enablers: Awareness, interest and supply chain.

Reference Regen SW

Yorkshire Zero Carbon

What: Cross-sector working group to promote zero carbon domestic buildings.
Why: The need for solutions to meet carbon targets .
How: AECB Yorkshire Group strategic planning.
When: Momentum from 2018, visions to 2050.
Barriers: To overcome financial, political and technical challenges.
Enablers: Real-world building energy performance data via low energy building database.

Reference Zero Carbon Yorkshire

Camden Passivhaus

What: Largest residential Passivhaus new build; 345 homes.
Why: Fabric first approach to improve construction and operational sustainability.
How: Scaling up, whilst retaining quality.
When: July 2019
Barriers: Significant forward planning, sign-off prices, planning and phasing.
Enablers: Mainstreaming Passivhaus by 2030, climate resilience.

Reference Passivhaus Trust

Exeter Zero Energy Building Catalyst

What: Innovative programme demonstrating retrofit.
Why: To achieve substantial reduction in energy consumption and carbon emissions.
How: Support 80 enterprises in Devon to engage with new models of retrofit.
When: Runs from 2017 to 2020.
Barriers: Engagement from stakeholders, buy in and education appetite.
Enablers: Energiesprong support to eligible enterprises with technical training courses, tours, toolbox talks and support from supply chain networks.

Reference: Devon County Council

Section 1 – District Level Emissions

Future Emissions Trajectories

Non-Domestic Buildings

Measure	Current Context	SCATTER Stretch Pathway 2025	SCATTER Stretch Pathway 2030	SCATTER Stretch Pathway 2050	Notes
Commercial space heating & cooling	Over 66% of Non-Domestic 'lodgments' are EPC rated D and below.	16% Heating & Cooling reduction	24% Heating & Cooling reduction	49% Heating & Cooling reduction	See Appendix 3 for further details.
Electrification of heat	81% Gas and oil fired boiler (2015)[1]	58% Gas and oil fired boiler	46% Gas and oil fired boiler	0% Gas and oil fired boiler	Refer to Appendix 5 for further detail on the type of heating technologies assumed.
Estimated carbon saving (from 2018), tCO_2e	Space heating & hot water & cooling measures	123,000	252,000	1,020,000	Savings are cumulative over the period 2018-2050, relative to 2017.
Appliances & lighting	Consumption by non-domestic lighting and appliances in the UK has reduced by 2% (2015 compared to 2018)[2]	7% Reduction on 2015 demand	11% Reduction on 2015 demand	25% Reduction on 2015 demand	
Energy used for cooking	24% Electric (2015) [2]	46% Electric	57% Electric	100% Electric	
Estimated carbon saving (from 2018), tCO_2e	Commercial lighting, appliances, and cooking	55,000	99,000	297,000	Savings are cumulative over the period 2018-2050, relative to 2017.

1 - BEIS Total sub-national final energy consumption, 2015, Total Domestic Fuel - Allocated according to ECUK proportions
2 - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/820753/2019_Electrical_Products_Tables.xlsx

Section 1 – District Level Emissions

Future Emissions Trajectories

Non-Domestic Buildings

Local Case Studies

Keynsham Civic Centre

What: Council headquarters aiming to be one of the lowest energy-consuming public buildings nationally.
Why: 'Soft Landings' approach aims to achieve EPC A-rating from the outset of the design.
When: BCO 'Best of the Best' Award 2015, CIBSE Award for 'Project of the Year (Public Use)' 2017.
Barriers: Stringent criteria for achieving EPC A-rating.
Enablers: Design team and contractors committed to two years of aftercare.

Reference Keynsham Civic Centre

Hicks Gate Fire Station

What: First new station built in Avon since 1980.
Why: Equipped with PV panels generating c. 50% of the station's annual energy demand.
When: Operational since April 2016.
Barriers: Significant financial outlay incurred.
Enablers: Constructed as part of the Fire Service's 'Investing for the Future' programme.

Reference Hicks Gate

Section 1 – District Level Emissions

Future Emissions Trajectories

Non-Domestic Buildings

UK Case Studies

Exeter Extra Care

What: First UK Passivhaus Extra Care Home
Why: Low energy healthy building design.
How: Passivhaus for thermal comfort and healthy air.
When: 2019 planning approved.
Barriers: Misconceptions and the need for user education.
Enablers: Future-proofed climate resilient design.

Reference Gale & Snowdon

Swansea Energy Positive Active Classroom

What: Innovate UK funded net positive building.
Why: Energy positive – generating more energy than it annually.
How: Defining zero carbon and a shared roadmap towards net zero.
When: Constructed 2016, results published 2019.
Barriers: Technological and financial feasibility.
Enablers: Unlocking an holistic smart sustainable energy source.

Reference Innovate UK

University of Nottingham Sustainable Buildings

What: A selection of industry leading sustainable university buildings.
Why: As an exemplar university for green development.
How: Brownfield regeneration and low embodied carbon design.
When: 2019 - ongoing
Barriers: Planning permission and detailed supply chain analyses.
Enablers: Low carbon and resourceful building aspirations.

Reference Nottingham

Bedfordshire Sustainable Warehouse

What: Most sustainable warehouse in UK.
Why: Drive energy efficiency and space management.
How: Energy efficient design and space visualisation tech.
When: Accredited 2019
Barriers: Building the business case for green design.
Enablers: Increased control over air, water, noise, light, humidity temperature, occupation and cost control.

Reference KAM

London Bloomberg Office Headquarters

What: World's highest BREEAM-rated office building.
Why: Drive low carbon development and operation.
How: BREEAM as a catalyst for exemplar sustainable design.
When: BREEAM Accredited 2014, opened 2017
Barriers: Turning ideas into successful practice.
Enablers: Client scope for green aspirations and project partners to support the delivery of this aspiration.

Reference BREEAM

Section 1 – District Level Emissions

Future Emissions Trajectories

Transport

Distance reduction and modal shifts bike/walking/mass transport are key to reducing congestion and improving health. These are therefore presented first in priority order over electrification of vehicles in this section (but ultimately all are needed to remain consistent with the SCATTER Stretch Pathway).

Measure	Current Context	SCATTER Stretch Pathway			Notes
		2025	2030	2050	
Distance reduction	Over 50,000 car journeys are made into Bath every day. this may increase by 15% over the next 10 years[1]	17% reduction in passenger-km per person per year	25% reduction in passenger-km per person per year	25% reduction in passenger-km per person per year	
Significant modal shifts	80% of passenger-km's are via the mode of car (2015)	5% Reduction in car travel	7% Reduction in car travel	18% reduction in car travel	Refer to Appendix 6 for further information.
Estimated carbon saving (from 2018), tCO_2e : These measures are interlinked with the type of passenger vehicles remaining on the road. Residual emissions are quantified overleaf.					
Modal shift of freight and increase in efficiency	Within B&NES it is estimated that there are 10,900 LGV and 900 HGV[2] on the road. 71% of Freight emissions in the UK are from road (2015)[3] Class C clean air zone (CAZ) will come into effect in Bath late 2020, charging all higher emission vehicles - except cars - to drive in the city centre.[4]	75% of freight rail travel is diesel 25% of freight rail travel is electric 100% of freight road travel is diesel	63% of freight rail travel is diesel 37% of freight rail travel is electric 100% of freight road travel is diesel	100% of freight rail travel is electric 95% of freight road travel is diesel, 5% is electric	B&NES's Air Quality and Public Health Team are currently exploring aims to further reduce the % of road freight vehicles that are diesel in excess of SCATTER assumptions.
Estimated carbon saving (from 2018), tCO_2e	Freight	117,000	263,000	955,000	Savings are cumulative over the period 2018-2050, relative to 2017.

1 - https://travelwest.info/projects/bath-transportation-package , published 2019
2 - https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01
3 - Department for Transport Statistics - Table TRA3105 Heavy goods vehicle traffic by axle configuration and road category in Great Britain, 2015.
4 - https://www.bathnes.gov.uk/bath-breathes-2021-overview/the-zone-boundary – First published in 2018, however amended several times since.

Section 1 – District Level Emissions

Future Emissions Trajectories

Transport

Transport Glossary
EV - Electric Vehicle
PHEV - Plug-in Hybrid Electric Vehicle
HEV – Hybrid Electric Vehicle

Measure	Current Context	SCATTER Stretch Pathway			Notes
		2025	2030	2050	
Shift to zero carbon cars	37% of all vehicles are diesel[1] Currently 40 Electric Vehicle (EV) charge points across B&NES with 20 more charge points planned through Go Ultra Low West by 2021[2] 547 ULEVs in B&NES in 2019[3]. This is under 1% of the total cars.	51% EV, 13% PHEV, 36% Petrol/Diesel	76% EV, 14% PHEV, 10% Petrol/Diesel	100% EV	Percentages relate to % of passenger km travelled Resources required for EV replacement may be placed under strain if every region (and country) were to make this transition. District impacts and influence over such resource pressure is beyond the scope of this study, however important to acknowledge. For further information, please see: https://www.nhm.ac.uk/discover/news/2019/june/we-need-more-metals-and-elements-reach-uks-greenhouse-goals.html
Shift to zero carbon buses	19 bus operators in B&NES[4] 4,000 buses and coaches[5] 58 low carbon and 2 hybrid buses[6]	51% EV, 31% HEV, 18% Diesel	76% EV, 24% HEV	100% EV	
Estimated carbon saving (from 2018), tCO_2e	Road transport	528,000	1,098,000	3,734,000	Savings are cumulative over the period 2018-2050, relative to 2017.
Passenger rail electrification	Great western mail rail line is part electrified. Passenger timetables introduced electric running from Paddington to Didcot in January 2018[7], and to Swindon and as far west as Bristol Parkway in January 2019.[8]	100% Electrification	100% Electrification	100% Electrification	
Estimated carbon saving (from 2018), tCO_2e	Rail transport	65,000	120,000	344,000	Savings are cumulative over the period 2018-2050, relative to 2017.

1 - https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01
2 - https://www.bathnes.gov.uk/services/parking-and-travel/electric-cars
3- https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01#ultra-low-emissions-vehicles
4 - https://www.gov.uk/government/statistical-data-sets/bus10-number-of-trips-and-information-systems
5 - https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01
6 - https://www.firstgroup.com/about-us/facts-and-stats/case-studies/bristol-green-buses
7 - https://www.gwr.com/about-us/modernising-gwr/electrostar
8 - https://en.wikipedia.org/wiki/21st-century_modernisation_of_the_Great_Western_main_line

Section 1 – District Level Emissions

Future Emissions Trajectories

Transport

Local Case Studies

Go Ultra Low scheme

What: Regional initiative committed to accelerating the purchase of EV.
Why: National scheme aims to inform and promote the savings associated with switching to EV.
When: From 2019 the Go Ultra Low campaign will also be supported by energy providers.
Barriers: Very few charging points compared to traditional petrol stations.
Enablers: £7m initiatives across the South West with plans to double existing networks.

Reference Go Ultra Low

BathBreathes2021

What: Charges for higher emissions vehicles within Bath city centre.
Why: To improve air quality across the whole city.
When: Consultation throughout 2018 and 2019, implementation by November 2020.
Barriers: Local political factors which dictate the zone boundary.
Enablers: Government directives and public support for improving air quality within the city centre.

Reference BreATHe

Section 1 – District Level Emissions

Future Emissions Trajectories

Transport

UK Case Studies

Bristol Green Capital Partnership

What: Vision for the future of travel in Bristol.
Why: To inspire all with their own ideas to shape Bristol's future transport.
How: *The Good Transport Plan* joins the dots as a leading platform.
When: Published 2016, vision to 2037.
Barriers: Affordability, connectivity, low-emissions, heavy vehicles, traffic flow and building on the plan.
Enablers: Sharing ideas, sharing transport, community empowerment, flexible working, improved wellbeing and children's safety.

Reference: The Good Transport Plan

Edinburgh Electric Vehicle Charging Plan

What: Ambitious plan for electric charging infrastructure.
Why: Carbon savings of almost 8,000tCO_2e by 2023
How: £3.3m investment (£2.2m Transport Scotland)
When: Commissioned 2019 for 2023.
Barriers: Governance, accountability, long term validity complexity of options.
Enablers: Emissions and carbon dioxide reductions, rapid electrification of fleet.

Reference: Edinburgh Gov.

London Mayor's Transport Strategy

What: Strategic transformation modelling.
Why: Need for healthy streets, population & job creation.
How: Proposals to reshape transport in London.
When: Published 2018, vision to 2041.
Barriers: Forecasting modes, distance, congestion, speed, utilisation, crowds, emissions and connectivity.
Enablers: Pioneering reference case, optimising network, incremental expansion, new connections, traffic reduction and healthy pay back.

Reference Page 43

Exeter City Futures

What: Roads for the future using an analytical approach.
Why: Need for reliable journeys and resilient roads.
How: Developing a framework for buy in.
When: Published 2018, goal 2025.
Barriers: Sharing goals, building partnerships, defining problems, measuring progress, funding and the action needed for success.
Enablers: Roads for autonomous vehicles, mobility for all, connected-car technology, improving air quality, safe school and living streets.

Reference City Showcase

Chester Smart Travel

What: £4.6m funded to improve accessibility for Chester jobs opportunities.
Why: Previously no joined up transport strategy and action.
How: Stakeholder buy in and app development.
When: Launched 2018.
Barriers: Geographic, demographic, legacy transport network, disconnection.
Enablers: Promotes car sharing, cycling, walking, buses, rail, provides advice on equipment, motivation and cost.

Reference itravelsmart

Section 1 – District Level Emissions

Future Emissions Trajectories

Waste & Industry

Measure	Current Context	SCATTER Stretch Pathway			Notes
		2025	2030	2050	
Waste reduction	72,928 tonnes of household waste was collected in 2018/2019[1] 3% decrease in total household waste from 2016/2017 to 2017/2018 and 3% decrease 2017/2018 to 2018/2019. Fare Share Bath redistribute food to 10 local charities to reduce food waste. 2017/18 B&NES produced less household waste per person than the Local Authority with the highest recycling rate (East Riding): 397.8 kg per person to 499.8 kg per person respectively.	8% decrease in household waste	8% decrease in household waste	22% decrease in household waste	Volume % relate to household waste only. Other categories within SCATTER include Commercial and Industrial waste, Construction & Demolition waste, Sewage Sludge and Landfill Gas. Waste destinations consist of 'recycling' (one category), 'landfill', 'composting', and 'incineration or EfW'. Updates made to the original DECC Pathways Calculator in respect of EU Waste Directive 2035 Targets. Householders must consume less and produce less waste and make full use of services provided. In addition, for B&NES to recycle more, viable markets need to exist.
Increased recycling	58.21% of household waste was sent for reuse, recycling or composting in 2018/2019[1] Current target is 60% reuse, recycling and composting.	65% Household Recycling rate	69% Household Recycling rate	85% Household Recycling rate – exceeding the EU waste directive of 70% by 2035	
Estimated carbon saving (from 2018), tCO_2e	Waste treatment	35,000	92,000	470,000	Savings are cumulative over the period 2018-2050, relative to 2017.

1 - B&NES internal data source.

Section 1 – District Level Emissions

Future Emissions Trajectories

Waste & Industry

Measure	Current Context	SCATTER Stretch Pathway 2025	2030	2050	Notes
Industry efficiency	Deployment of renewable solutions in energy consuming sectors, particularly industry, is still well below the levels needed, and progress in energy efficiency is lagging.(2019)[1]	11% reduction in energy demand	16.5% reduction in energy demand	38.5% reduction in energy demand	
Electrification of industry	35% of industrial energy consumption in 2018 in the UK is electric [2]	41% of industrial processes are electric	44% of industrial processes are electric	66% of industrial processes are electric	
Carbon Capture and Storage (CCS) on industry	UK government is investing £20m in supporting the construction of carbon capture, use and storage technologies at industrial sites across the UK[3]	2% of industrial process CO2 is captured	4% of industrial process CO2 is captured	42% of industrial process CO2 is captured	Note that in the interest of prudence and geographic constraints (CCS opportunities are limited in the B&NES area) and have not been applied to the modelling, but are presented for information purposes. Carbon savings do not include CCS in industry.
Estimated carbon saving (from 2018), tCO_2e	Industrial processes	218,000	373,000	1,005,000	Savings are cumulative over the period 2018-2050, relative to 2017.

Anthesis

1 – https://www.irena.org/DigitalArticles/2019/Apr/-/media/652AE07BBAAC407ABD1D45F6BBA8494B.ashx
2 - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820647/DUKES_1.1.5.xls
3 - https://www.businessgreen.com/bg/news-analysis/3067118/the-time-is-now-government-unveils-plans-for-uks-first-carbon-capture-and-usage-project

Section 1 – District Level Emissions

Future Emissions Trajectories

Waste & Industry

Local Case Studies

GENeco Bio-Bus & Bio-Bug

What: Multi-award winning recycling and renewable energy company.
Why: Improve recycling rates, raise awareness of biofuels.
When: Established in 2009, Bio-Bug first devised in 2010.
Barriers: Over 80% of food waste currently goes to landfill.
Enablers: Gas-to-grid facility is registered with the Green Gas Certification Scheme which supports accurate emissions reporting.

Reference Bio-Bus & Bio-Bug

Share & Repair Bath

What: Library of Things and Repair Café initiative.
Why: Reduces waste, makes better use of resources.
When: Monthly Repair Cafes across four locations in the county.
Barriers: Donation-funded and reliant on volunteer engagement.
Enablers: Strong community links which mobilises bottom-up engagement.

Reference Share and Repair

Anthesis

Section 1 – District Level Emissions

Future Emissions Trajectories

Waste & Industry

UK Case Studies

Bristol Slim My Waste

What: Visual food waste programme e.g. ‘feed my face’.
Why: To divert food waste from black bags to energy creation.
How: 1,000 new brown food waste caddies.
When: Started 2017.
Barriers: Council buy in, measuring results.
Enablers: The trial increased food waste by 87%

Reference [Slim My Waste]

Cambridge Sustainable Waste

What: A cross-sector partnership for sustainable food and waste.
Why: Food poverty, climate change, health, social dislocation.
How: Share challenges, develop practical solutions, drive positive change.
When: Founded 2015, visions to 2030.
Barriers: Getting producers on board, accountability of waste.
Enablers: Collection scheme, training on resource efficiency, promote composting, harvest surplus.

Reference [Sustainable Food Cities]

Loughborough Food Waste Processing

What: Leading innovative solution for food waste.
Why: Significant economic and sustainability benefits.
How: Mechanism for improving reliability of anaerobic digesters.
When: Published 2019.
Barriers: Commercial application in the UK, technology uptake.
Enablers: CO_2 reduction, Unilever tried and tested methodology, improves treatment of difficult waste streams and avoids breakdowns.

Reference [Loughborough University]

London Library of Things

What: A borrowing rather than buying movement.
Why: Avoid carbon, more money, feel better, repair, recycle.
How: Influencing behavioural change via borrowing centres.
When: Founded 2016.
Barriers: Managing rapid growth, retaining values.
Enablers: Investment, technology, social enterprise.

Reference [Library of Things]

Exeter Industrial Strategy

What: Industrial Strategy at city scale.
Why: Local economy need with global investment imperatives.
How: Bold approach to stimulating industrial renaissance through innovation.
When: Published 2016, vision to 2030.
Barriers: Institutional structures, targeted research, methods for financing.
Enablers: Unlock growth potential without subsidy, commercialisation, business support, economic return, lessons learned and fourth industrial revolution..

Reference [City Showcase]

Section 1 – District Level Emissions

Future Emissions Trajectories

Renewable Energy Supply

Current context

Currently, total in-boundary renewable generation represents 4.6% of B&NES total energy demand.

Measure	Current Context	SCATTER Stretch Pathway 2025	2030	2050	Notes
Solar PV	**3.1%** of homes have Solar PV Installed totalling 8MW Installed Capacity[1] (2017) 81 roof-mounted commercial and industrial projects, totalling 2.5 MW of capacity[2] (2017) 0.016TWh total Generated per year[1] (2017)	**45%** of homes + **0.14km²** (26 Football Pitches) on commercial roof space and ground mounted sites[3] 150 MW Installed Capacity 0.16TWh Generated per year	**50%** of homes + **0.62km²** (116 Football Pitches) on commercial roof space and ground mounted sites[3] 210 MW Installed Capacity 0.21TWh Generated per year	**60%** of homes + **2.54km²** (474 Football Pitches) on commercial roof space and ground mounted sites[3] 450 MW Installed Capacity 0.34TWh Generated per year	The B&NES *Renewable Energy Resource Evidence Base Update* (2018)[5] indicated the 'practical potential' of Solar PV was 186MW by 2036. This is over 10% less than the 2030 indicator provided by SCATTER's Stretch Pathway.
Estimated carbon saving (from 2018), tCO_2e	Solar PV	188,664	407,991	1,792,135	Savings are cumulative over the period 2018-2050, relative to 2017.

- Emissions savings are estimated by applying the 2018 national grid factor average of 248g/kWh to the difference between the most recent year's data (2017) generation output and future generation output at each of the yearly milestones (and interim years). We acknowledge that the grid factor is likely to reduce over time, meaning that savings are likely to be materially overstated.
- It is not appropriate to sum any savings presented from renewable supply with savings achieved on the demand side of the energy system, as this is may result in double counting.
- Intervention is critical on the demand side to realise emissions savings from renewable supply. For example, if heating systems are not electrified, then a decarbonised electricity grid will have no impact.

Anthesis

Section 1 – District Level Emissions

Future Emissions Trajectories

Renewable Energy Supply

Measure	Current Context	SCATTER Stretch Pathway 2025	2030	2050	Notes
Onshore wind	4 Turbines installed[1] (2017) 0.1MW Installed Capacity[1] (0.025MW per turbine) (2017) 0.3 GWh Generated per year[1] (2017)	20 Turbines installed 50 MW Installed Capacity (2.5 MW per turbine) 100 GWh Generated per year	28 Turbines installed 70 MW Installed Capacity (2.5 MW per turbine) 150 GWh Generated per year	70 Turbines installed 68 MW Installed Capacity (2.5MW per turbine) 375 GWh Generated per year	The B&NES Renewable Energy Resource Evidence Base Update (2018)[5] indicated the 'practical potential' of Onshore wind was 45MW by 2036. This is over 35% less than the 2030 indicator provided by SCATTER's Stretch Pathway. This report also mentions the use of small turbines – these would be significantly less effective use of land area and would made it much more challenging to achieve the target levels of generation presented by SCATTER.
Estimated carbon saving (from 2018), tCO_2e	Onshore wind	143,467	308,110	1,643,784	Savings are cumulative over the period 2018-2050, relative to 2017.

Section 1 – District Level Emissions

Future Emissions Trajectories

Renewable Energy Supply

Measure	Current Context	SCATTER Stretch Pathway 2025	2030	2050	Notes
Bioenergy supply (heat & electricity)	2 Anaerobic Digestion[1] (AD) Facilities (2017) 2.5 MW Installed Capacity	27 MW Installed Capacity	28 MW Installed Capacity	44 MW Installed Capacity	The B&NES Renewable Energy Resource Evidence Base Update (2018)[5] indicated the 'practical potential' of Biomass CHP was 0.9MW (electricity) and 3MW (heat) by 2036. This is just 3% of the 2030 indicator provided by SCATTER's Stretch Pathway. Installed capacities relate to electricity generation. Biomass can include sewerage gas, landfill gas and waste, as well as AD facilities, and woody biomass. Burning certain types of biomass may present risks such as air quality reduction, competition with food growing, bio-diversity loss and reduction in soil health, so further research would been needed to understand which types are appropriate for the region to develop. Biomass for fuel will also need to be considered in the more in-depth land use study that is recommended in relation to the need to increase the carbon sequestration potential of soil, grassland and trees
Estimated carbon saving (from 2018), tCO_2e	Biomass for electricity	282,290	494,239	1,535,695	Savings are for electricity only are cumulative over the period 2018-2050, relative to 2017. Heat savings are more complex and beyond the scope of this report, however will be factored into the demand side savings presented.

Section 1 – District Level Emissions

Future Emissions Trajectories

Renewable Energy Supply

Measure	Current Context	SCATTER Stretch Pathway 2025	SCATTER Stretch Pathway 2030	SCATTER Stretch Pathway 2050	Notes
Hydro power	6 hydro sites[1] 0.018 GW Installed Capacity (2017) 0.61 GWh Generated per year (2017)	5 MW Installed Capacity 18 GWh Generated per year	7 MW Installed Capacity 23 GWh Generated per year	8 MW Installed Capacity 18 GWh Generated per year	The B&NES *Renewable Energy Resource Evidence Base Update* (2018)[5] indicated the 'practical potential' of Hydro was 0.3MW by 2036. This is over 20 times less than the 2030 indicator provided by SCATTER's Stretch Pathway. SCATTER allocates proportions of National energy potential to regions based on scaling factors such as land use/population, which may give rise to such significant differences. Such differences may still give license to challenge and further explore what the practical potential constraints are, and how ambition may be pushed further.
Estimated carbon saving (from 2018), tCO_2e	Hydro power	28,260	53,415	162,035	Savings are cumulative over the period 2018-2050, relative to 2017.
Storage	To date, there are no large-scale storage projects with a connection agreement in the area. There are no public datasets that record small-scale storage projects so the number of these is unknown.[5]	14MW Peak Power Installed Capacity	20MW Peak Power Installed Capacity	41MW Peak Power Installed Capacity	

1 - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/743822/Renewable_electricity_by_Local_Authority__2014-2017.xlsx
2 - https://www.bathnes.gov.uk/sites/default/files/sitedocuments/Planning-and-Building-Control/Planning-Policy/LP20162036/bnes_renewable_energy_resource_update_report_2018_publication_version.pdf
3 - Method for converting and allocating the SCATTER generated installed capacity (MW) to homes assumes the average installation per domestic installation in the district (3.7kW) will be suitable for up to 60% of households by 2050. This is a judgmental hypothesis to be further tested. The residual area assumes that a 3.7kW installation has an area of 28m2 as per the Energy Savings Trust Guidance:
4- https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766296/Sub-national_electricity_consumption_statistics_2005-2017.xlsx
5 - https://www.bathnes.gov.uk/sites/default/files/sitedocuments/Planning-and-Building-Control/Planning-Policy/LP20162036/bnes_renewable_energy_resource_update_report_2018_publication_version.pdf

Future Emissions Trajectories

Renewable Energy Supply

Local Case Studies

Bath & West Community Energy

What: Locally-focused community benefit society.
Why: Improve share of community-owned renewable energy.
When: Established in 2010.
Barriers: National government legislation has strong influence over project viability.
Enablers: Strong fundraising capabilities and capacity to power 4,000 homes.

Reference BWCE Coop

Chelwood Community Energy

What: Community energy programme with the aim of installing a 5MW solar array.
Why: To provide renewable energy to more than 1,000 local homes.
When: Excess of £2.5m raised in the summer of 2015 towards the project.
Barriers: Removal of FIT and similar schemes have adverse effects on project finance.
Enablers: Local support and improved biodiversity through protection of local habitat.

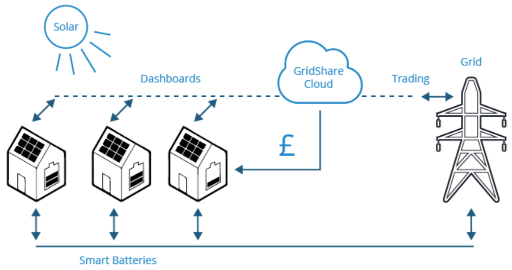
Reference Chelwood

Section 1 – District Level Emissions

Future Emissions Trajectories

Renewable Energy Supply

UK Case Studies



West Sussex Virtual Power Plant

What: PV, battery storage and EVs as a power plant
Why: Benefits of linking power in a smart grid market.
How: Funded GridShare software for energy trading.
When: Development from 2018 (start date pending).
Hidden Costs: Ofgem targeting behind the meter lost revenue.
Enablers: Reducing energy costs by 10%.

Reference Moixa

Kent UK Largest Solar Farm

What: Solar park to power over 91,000 homes.
Why: Secure clean affordable non-subsidised energy.
How: Nationally significant infrastructure project.
When: From 2020.
Barriers: Planning, local resistance, scale.
Enablers: Over £1m of income per year for local authorities.

Reference Cleve Hill

Northamptonshire Solar Storage

What: Solar farm trials innovative solar power with storage battery
Why: Improving the returns from solar annually.
How: An innovative power purchase agreement.
When: Published 2017, vision to 2050.
Barriers: Planning, financing, lack of examples.
Enablers: Commercial appetite to trial and monitor the pilot.

Reference Drax

Milton Keynes Subsidy Free Solar

What: Clayhill, the first UK subsidy free solar farm.
Why: FITs abolished.
How: Utilising strong partnerships, supply chains and reengineering processes..
When: Open 2017.
Hidden Costs: Ofgem targeting behind the meter lost revenue.
Enablers: Unlock carbon emissions reductions, economic growth and drive export-led growth through construction supply chains and innovation pathways.

Reference Anesco

Warrington Entirely Solar

What: First local authority powered entirely by solar.
Why: Energy price control and reduce fuel poverty.
How: Investec funding and Leapfrog impact funding.
When: Development from 2018 (start date pending).
Barriers: Ofgem targeting behind the meter lost revenue.
Enablers: Generating surplus of £150m over 30 years.

Reference Gridserve

Section 1 – District Level Emissions

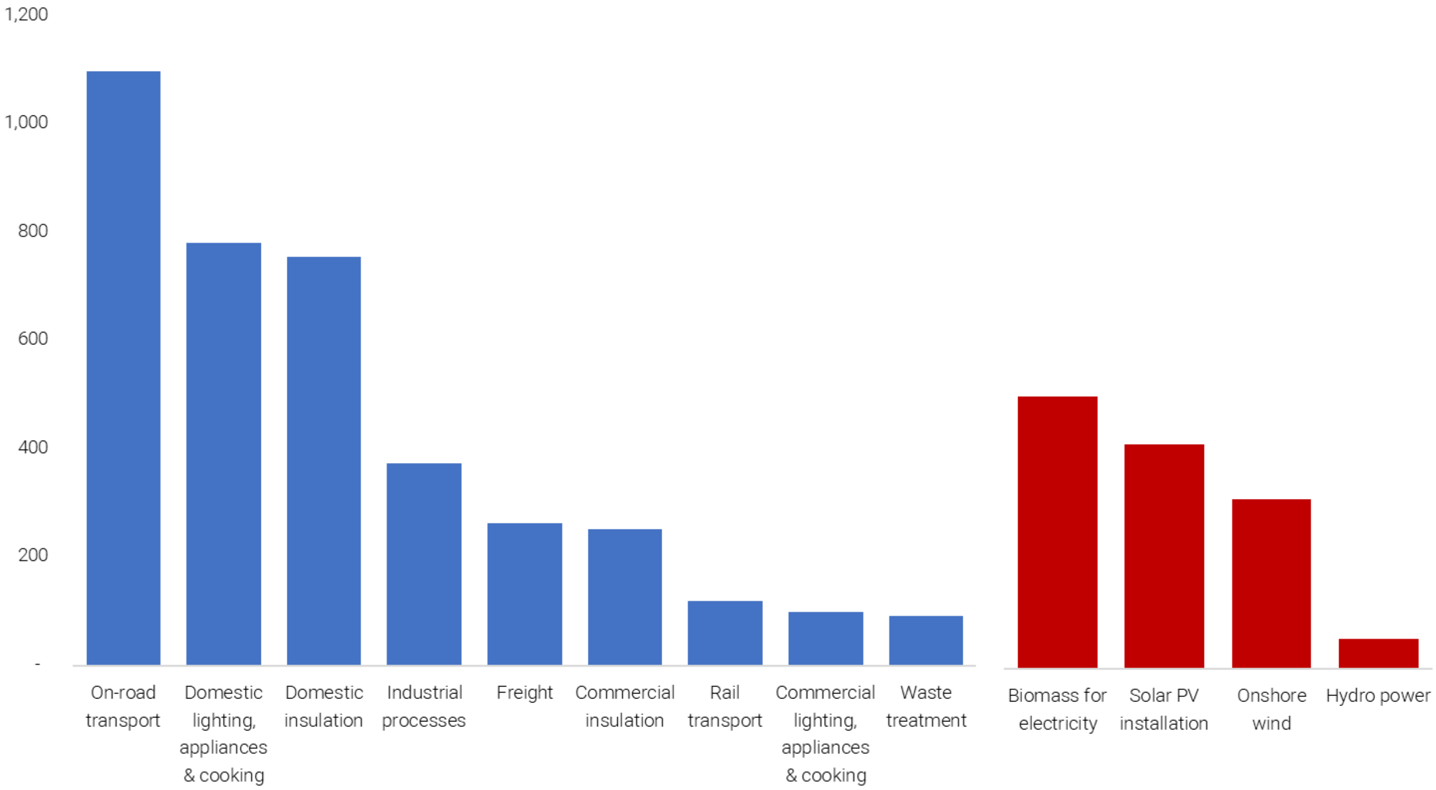
Future Emissions Trajectories

Savings summary

Table 4: Estimated cumulative emissions savings at 2030 ($ktCO_2e$)

Demand Side Measure	Cumulative Savings to 2030 ($ktCO_2e$)
On-road transport	1,098
Domestic lighting, appliances & cooking	781
Domestic insulation	755
Industrial processes	373
Freight	263
Commercial insulation	252
Rail transport	120
Commercial lighting, appliances & cooking	99
Waste treatment	92
Supply Side Measure	**Cumulative Savings to 2030 ($ktCO_2e$)**
Biomass for electricity	494
Solar PV installation	408
Onshore wind	308
Hydro power	53

Chart 6: Estimated cumulative emissions savings at 2030 ($ktCO_2e$)

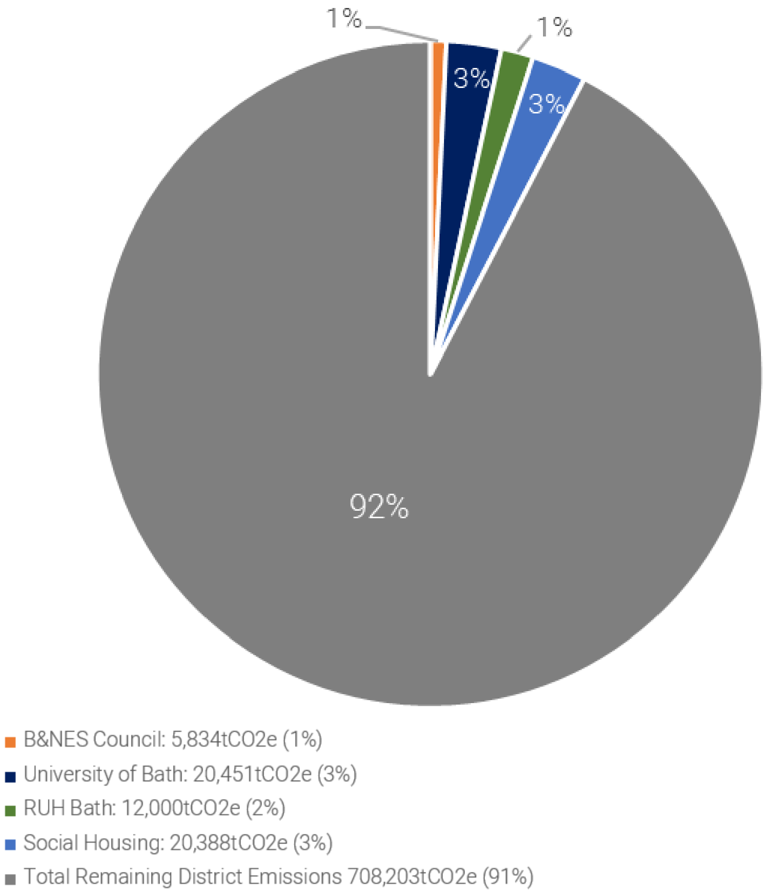


Note: It is not appropriate to sum any savings presented from renewable supply with savings achieved on the demand side of the energy system, as this is may result in double counting. Intervention is critical on the demand side to realise emissions savings from renewable supply. For example, if heating systems are not electrified, then a decarbonised electricity grid will have no impact. Similarly if the grid is not decarbonised, savings from Electric Vehicles will not be as great.

Section 1 – District Level Emissions

Large Emitters

Chart 7: Large emitter's proportion of the B&NES District's direct & indirect emissions



Overview

The chart presented shows a selection of the district's large emitters. Combined, the Council, the University of Bath, the Royal United Hospital and the social housing stock represent approximately 9% of the districts direct & indirect (Scope 1 & 2) emissions.

In order to establish who the districts largest emitters were, various data sets were analysed (i.e. Pollution Inventory, Environment Agency & EU Emissions Trading Scheme), however, as illustrated overleaf, emissions data was not publicly available (specific to the B&NES district), so it was not possible to include on this chart. The organisations shown were identified based knowledge and experience of the district.

Key points that this section has identified:

- The Council cannot do it alone – Their Scope 1 & Scope 2 emissions only represent 2% of the district's emissions. While there may be a much greater proportion of the district's emissions that the Council can still influence (refer to Section 4), this will require a significant amount of collaboration between partners.
- Emissions data transparency is poor – Of the six larger emitters identified outside of the Council, only one (University of Bath) had current emissions data readily available publicly. Good measurement is needed inform and catalyse action, transparency will make it easier for partners to support.

Limitations

The Council's scope 3 emissions (e.g. procurement) has not been mapped on this chart, as it has not been possible to establish the proportion of such emissions that occur within the district boundary. Further data analysis is required in this area.

Notes
- B&NES Council emissions of 5,834 tCO2e refers to the 2018/19 footprint as presented in section 4.
- University of Bath's 20,451 tCO2e was taken from their website and relates to the Scopes 1 & 2 for the year ending 2018.
- Royal University Hospital is estimated at 12,000 tCO2e based on a 2012 proxy identified at: https://www.ruh.nhs.uk/media/documents/2012_04_23_Recycling.pdf
- Social Housing sector – apportioned the total domestic property emissions as estimated via SCATTER (293,585 tCO2e) based on the size of the social housing stock relative to the total stock (c.15%). Current stock assumes the 2017 number of households as 71,743. Social houses assumed as 10,614, based on 2011 on ONS data.
- We acknowledge that more accurate and/or up-to-date information may be available and would welcome any additional resources to help improve estimations.

Section 2 – Consumption-Based Emissions

Anthesis

Section 2 – Consumption-Based Emissions
Overview

Introduction

The C40 Cities define a consumption-based approach as one that captures direct and lifecycle GHG emissions of goods and services (including those from raw materials, manufacture, distribution, retail and disposal) and allocates GHG emissions to the final consumers of those goods and services, rather than to the original producers of those GHG emissions.[1]

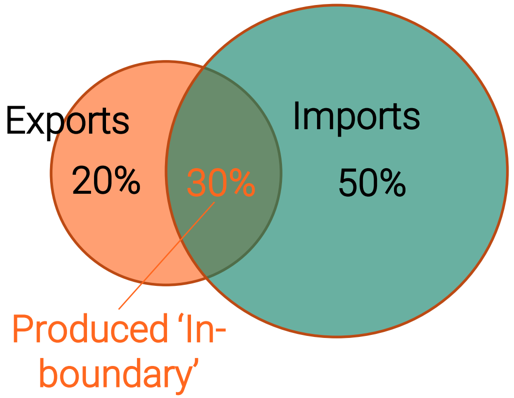
Result

We have estimated consumption-based emissions for the B&NES area. This totalled **1,271,510 tCO_2e.** This is 1.7 times more than the district's direct & indirect location based, 'in boundary' emissions alone (although a proportion of consumption emissions may be double counted here).

Methodology

- Consumption-based emissions are the emissions produced in an area, plus emissions imported (in the form of good or services), minus emissions exported out of an area.

Chart 8: Proportion of emissions from imports, exports and in-boundary production based on the C40 study of 79 cities. [1]



- Traditional carbon accounting methods discount the impact of imported emissions and research suggests that these imports could represent 45% of GHG emissions associated with UK consumption[2]. As such, when used alongside traditional accounting methods, consumption-based emissions can provide a more complete picture of the environmental impact within a country or region.
- A detailed assessment of consumption emissions in the district was beyond the scope of the B&NES study. However, a high-level calculation was performed to provide an estimate of the magnitude, as well as the sectors responsible for consumption-based emissions in the district.
- The methodology used to estimate consumption emissions utilised national datasets for UK consumption emissions over time as researched by Department for Environment, Food and Rural Affairs (DEFRA) and University of Leeds. This data has been split out by 17 Standard Industrial Classification (SIC) categories, which in turn are comprised of 106 activity types. Economic data for Gross Value Added (GVA), researched by the Office for National Statistics has been utilised in the methodology. This is defined as the value of goods or services produced in an area, is also split by the same SIC categories. This GVA data is available both at a national and local authority-level.
- The methodology applied makes an assumption that economic activity and carbon consumption are closely related, enabling the national (UK) consumption-based emissions to be scaled down to a local authority by allocating emissions in the same ratio of the B&NES local authority GVA (for each SIC sector) to UK GVA. This ratio was also broadly consistent with the ratio of B&NES population to the UK population.

1 – https://www.c40.org/researches/consumption-based-emissions
2 - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794557/Consumption_emissions_April19.pdf

Section 2 – Consumption-Based Emissions
Overview

- The results highlight that consumption-based emissions for the B&NES area totalled to 1,271,510 tCO_2e. This is 1.7 times more than the district's direct & indirect location based, 'in boundary' emissions alone (although a proportion of consumption emissions may be double counted here). The trend also shows consumption-based emissions decreased steadily from 2007 which is likely to be due to both efficiency improvements within processes and supply chains as well as the economic recession impacting the volumes of goods and services consumed. The most significant sectors in terms of consumption-emissions are manufacturing, utilities, and mining. The most significant source of demand was identified as households. As a result, improvements in these areas would bring the most material benefit to B&NES's overall impact.
- For further information on national consumption based emissions data, please refer to the following source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794557/Consumption_emissions_April19.pdf
- For further details on SIC categories, please refer to the following source: https://www.ons.gov.uk/economy/grossvalueaddedgva/bulletins/regionalgrossvalueaddedbalanceduk/1998to2016
- The B&NES' proportion of overall UK GVA was calculated (and then sense checked against population).
- The national consumption based emissions footprint was then apportioned based on the unit of local economic output for each sector (in this case, Gross Value Added or GVA). This reflects a key assumption that economic growth and output (GVA) is a good proxy for scaling national consumption-based emissions.

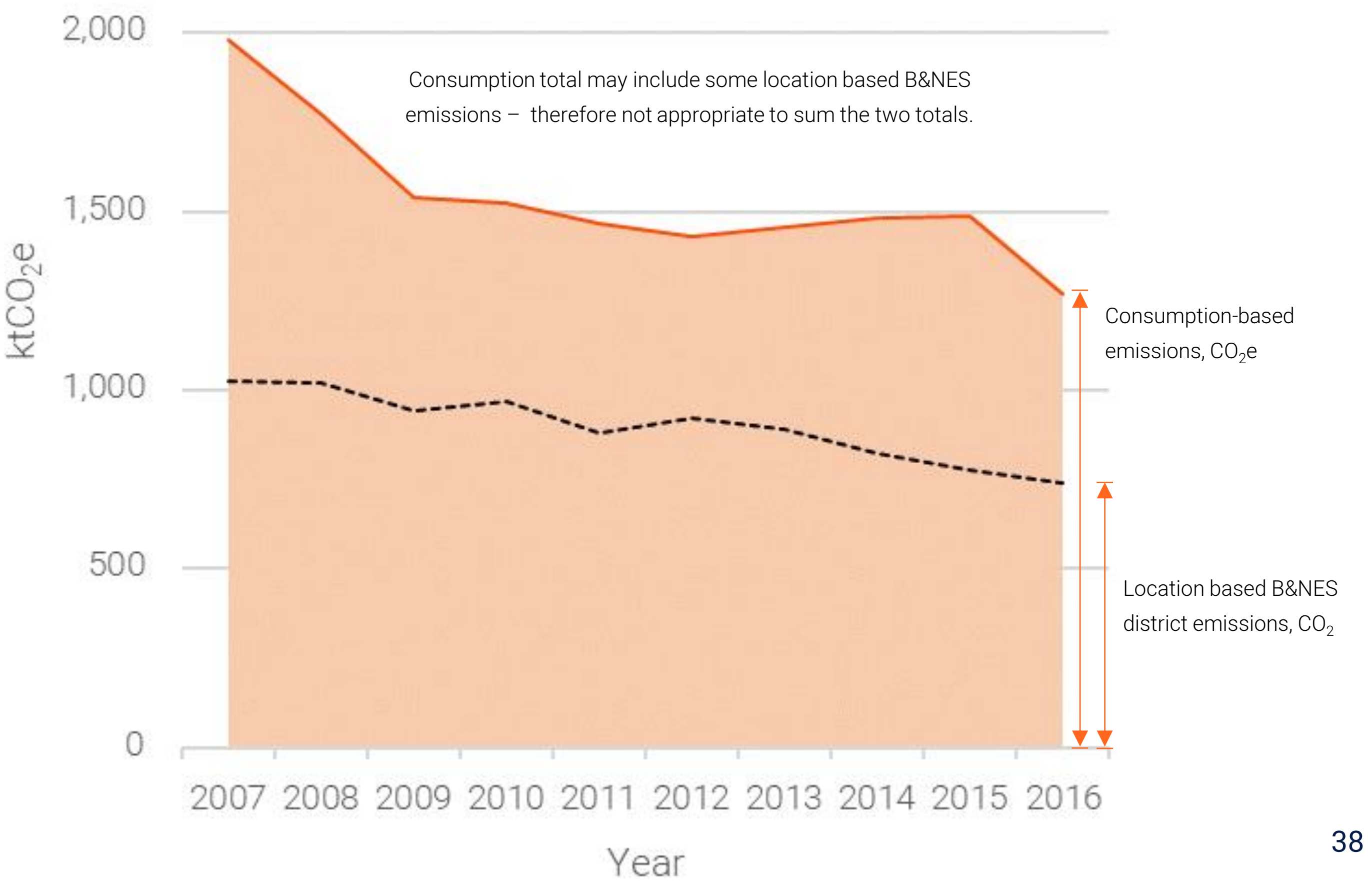
Analysis – By Sector

Relative emissions impacts

Chart 7 shows consumption-based emissions over time, relative to location based district emissions. Note that some of the location based emissions may also be included within the consumption based emissions totals – they are not mutually exclusive and should not be summed together. For example, some goods may be produced and consumed within the B&NES district, e.g. agricultural products.

This shows emissions decreased significantly from a peak in 2007 in light of the economic recession. There has been a general shift across all sectors but most significantly GHG from manufacturing, which decreased by 62% over this period.

Chart 9: How consumption based emissions compare against location based, 'in-boundary' emissions for the B&NES district.



Section 2 – Consumption-Based Emissions
Analysis – By Sector

The table below shows consumption-based emissions over time for the B&NES area, split by SIC category. These have been mapped from national datasets using economic output of B&NES as a proportion of total UK.

Each SIC category relates to emissions released by an industry in order to meet consumer demand (represented by GVA) in the B&NES area.

For example, construction emissions may not all occur directly within the B&NES area. Emissions such as those associated with steel & cement production are likely to have occurred outside of the district boundary, but are still represented within the emissions factor (CO_2e per unit of GVA) allocated to that category.

Table 6: Consumption based emissions estimates for B&NES District 2007-2016, by SIC Sectors.

	Emissions ktCO$_2$e									
SIC Sectors	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Agriculture, mining, electricity, gas, water and waste	656.91	565.13	521.50	469.45	488.35	492.91	564.19	611.30	619.44	515.97
Manufacturing	502.17	412.54	306.40	314.96	288.43	259.01	251.81	246.27	237.64	190.13
Construction	110.14	97.45	84.22	85.74	85.23	83.79	84.28	84.64	92.75	92.05
Wholesale and retail trade; repair of motor vehicles and motorcycles	16.68	14.98	13.23	13.11	12.60	14.36	14.00	13.73	14.90	12.35
Transport and storage	109.73	99.59	90.06	96.81	97.42	88.18	92.13	87.69	88.71	72.50
Accommodation and food services	137.83	124.02	98.68	106.36	95.16	90.38	96.20	95.34	100.43	100.69
Information and communication	31.85	30.78	23.47	28.02	23.85	24.30	29.08	32.71	24.59	25.48
Financial and insurance activities	30.30	30.25	22.81	19.19	20.49	7.96	6.84	5.52	8.64	3.90
Real estate activities	45.39	40.88	31.72	35.61	35.46	34.38	35.82	36.32	35.00	36.22
Professional, scientific and technical activities	11.89	12.06	26.28	26.47	23.35	35.86	31.86	27.88	30.07	16.50
Administrative and support service activities	4.22	4.06	3.53	3.52	3.50	2.56	2.95	2.52	3.00	2.71
Public administration and defence; compulsory social security	141.08	149.12	129.65	128.60	105.59	89.91	48.86	47.92	36.72	33.19
Education	64.24	69.86	63.95	66.46	55.18	58.04	50.72	48.03	46.45	40.86
Human health and social work activities	87.40	93.42	96.38	102.59	106.47	124.03	125.50	121.26	123.23	106.66
Arts, entertainment and recreation	20.06	18.00	16.57	15.98	15.31	14.00	12.46	13.05	12.26	10.27
Other service activities	11.94	11.73	9.66	8.23	7.76	8.98	8.43	8.25	11.39	11.65
Activities of households as employers; undifferentiated goods and services-producing activities of households for own use	0.49	0.69	1.11	0.74	0.60	0.61	0.44	0.48	0.43	0.46
Total	1,982	1,775	1,539	1,522	1,465	1,429	1,456	1,483	1,486	1,272

Sources: UK Office for National Statistics (GVA), DEFRA/University of Leeds. See Appendix 8 for further information.

Section 2 – Consumption-Based Emissions
Analysis – By Sector

The chart below illustrates the significance of the agriculture, mining & utilities sectors for B&NES. Local Authority GVA data was not available for the B&NES district at more granular SIC category sub-sector levels. This shows that the utilities sub-sector (electricity, gas, steam, air conditioning) is still larger than the manufacturing sector overall. Mining & quarrying, water supply and waste management sub-sectors could all displace the human health and social work sector as the 3rd largest sector. Agriculture, forestry and fishing is the smallest of the assumed sub-sector splits, but is still substantial when comparing to against the overall list in Table 5.

Limitations

In order to give a proxy for how the emissions from agriculture, mining and utilities may be further broken down, we have apportioned the B&NES total using national, UK level GVA sub-category data. There is inherently less confidence in this split, as the B&NES GVA may differ from the national at a sub-category level (where local GVA was is in itself a proxy for consumption).

Chart 10: Consumption based emissions estimates for B&NES District 2007-2016, by SIC Sectors.

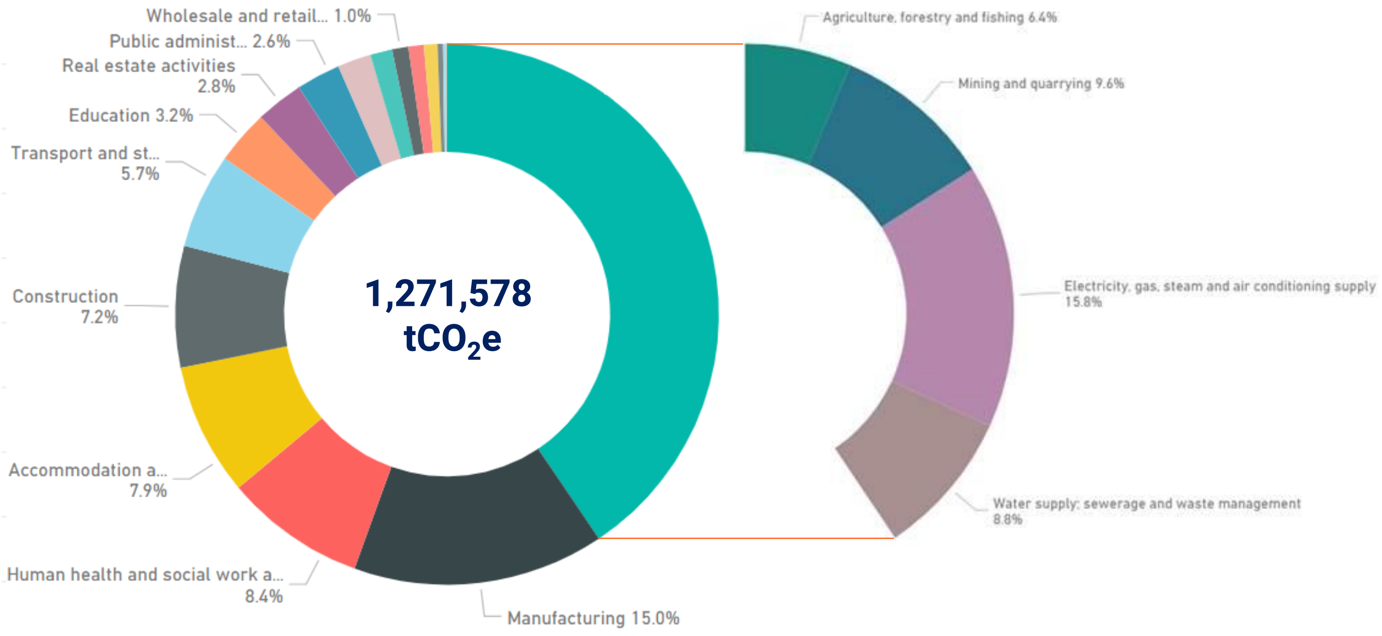


Table 7: Sub-sector estimate for the Agriculture, mining, electricity, gas, water and waste SIC sector.

SIC Code	SIC Category	UK GVA (%)	B&NES 2016 Emissions ($ktCO_2e$)
D	Electricity, gas, steam and air conditioning supply	39%	200.77
B	Mining and quarrying	24%	122.29
E	Water supply; sewerage and waste management	21%	111.48
A	Agriculture, forestry and fishing	16%	81.43
	Agriculture, mining, electricity, gas, water and waste	100%	515.97

Sources: UK Office for National Statistics (GVA), DEFRA/University of Leeds. See Appendix 8 for further information

Section 2 – Consumption-Based Emissions
Analysis – By Final Demand

The national figures can provide a high-level view of what final demand is likely to be in B&NES. However, it should be noted that these figures do not model specific consumption trends or factors present in B&NES, and are simply applying national Final Demand proportions (%) to the 2016 B&NES estimate.

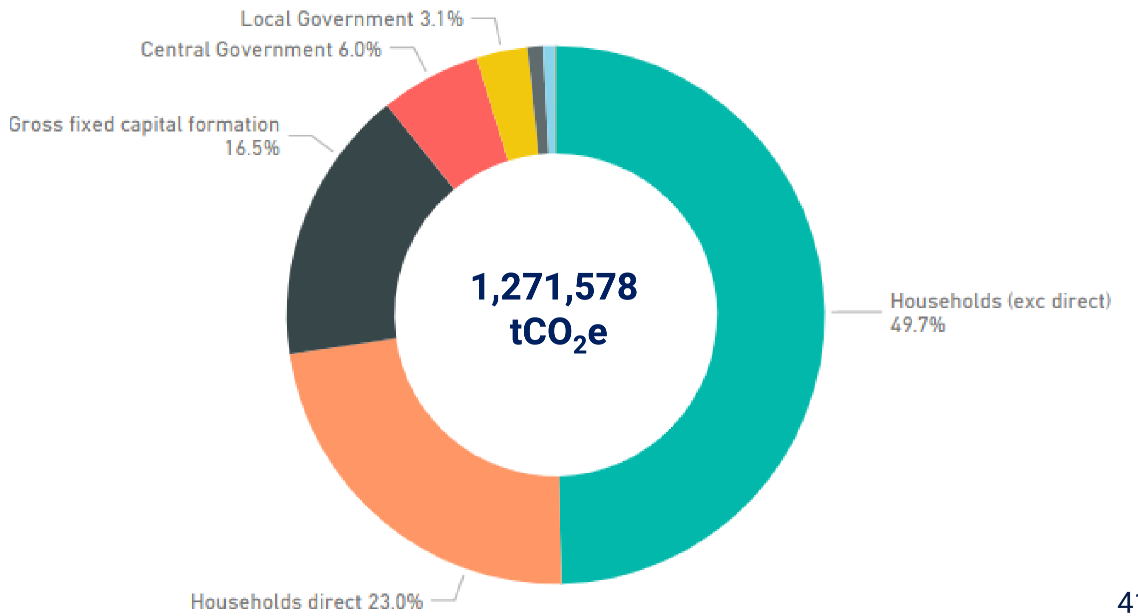
"Household direct" consists of emissions that result directly from household activities, such as using fuels for transport or natural gas for heating (i.e. the fuel is burned within the activity itself). "Households" relates to situations where emissions are released elsewhere (i.e. during the manufacture of a product abroad) but are still driven by the household activity and demand to import. 'Households' direct is a sub-set of 'Households' so should not be counted as additional to' Households'.

For further information on method and categorisation, please see: 2006 GHG - Webarchive.nationalarchives.gov.uk. https://www.oecd-ilibrary.org/docserver/5jlrcm216xkl-en.pdf?expires=1564490143&id=id&accname=guest&checksum=1EC0FC8D2817AFD82D7AC6B177B27934

Table 8: Allocation by Final Demand Category

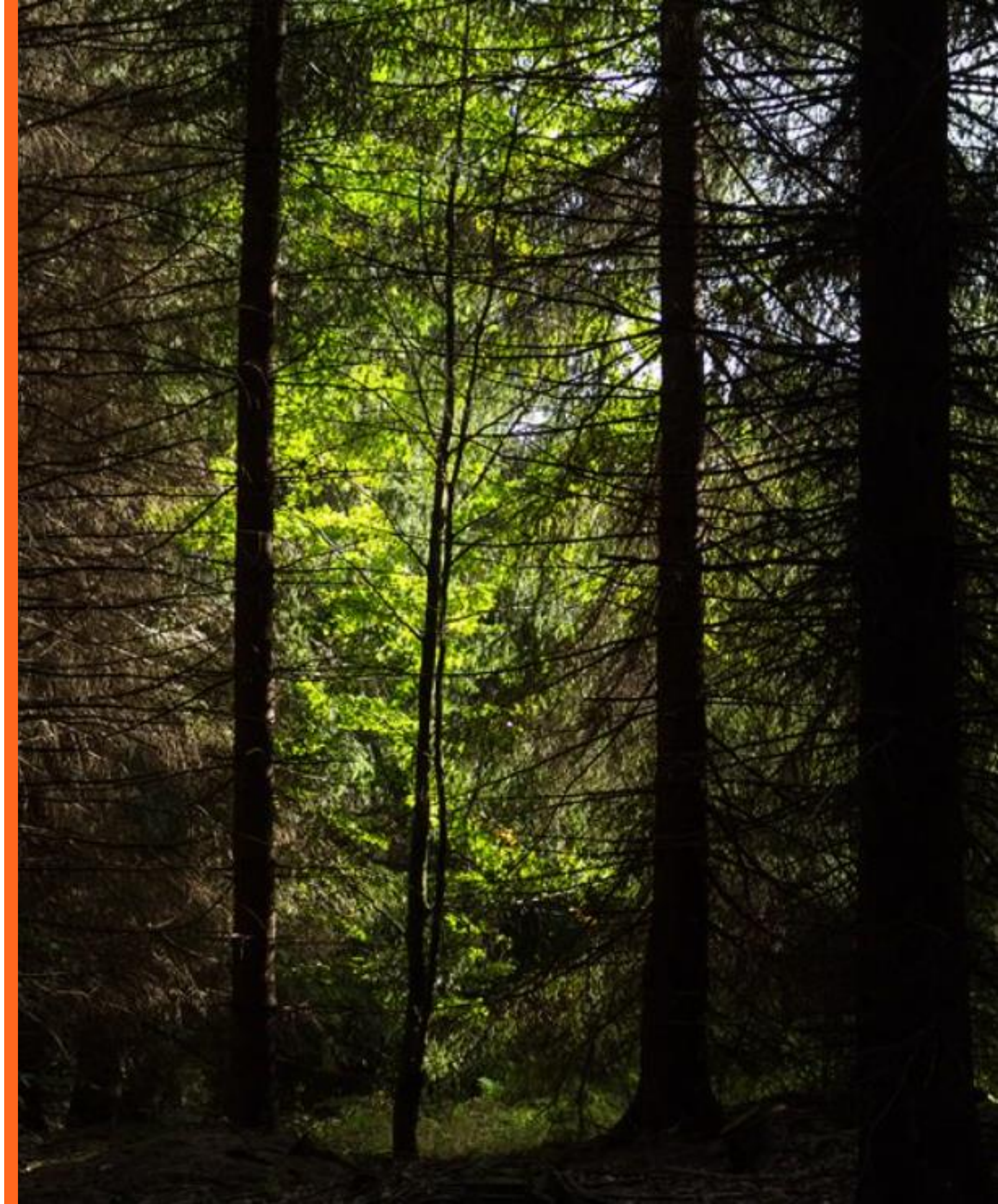
Final Demand Category	tCO_2e	Percentage of total
Households (exc. direct)	631,359	50%
Households direct	292,893	23%
Non-profit institutions serving households	12,077	<1%
Central Government	76,613	6%
Local Government	39,184	3%
Gross fixed capital formation	210,274	17%
Valuables	724	<1%
Changes in inventories	8,454	<1%
Total	1,271,578	100%

Chart 11: Percentage of total consumption by final demand category



Sources: UK Office for National Statistics (GVA), DEFRA/University of Leeds. See Appendix 8 for further information.

Section 3 – Emissions from Agriculture and Land



Anthesis

Section 3 – Emissions From Agriculture and Land

Overview

Context

If global temperature increases are to be limited to 1.5 degrees then the remaining global carbon budget is equivalent to about 10 years' emissions at the current annual global rates[1]. This is underpinned by science and independent of any social or political preferences. Irrespective of how reductions to meet the budget are made, swift and deep cuts to emissions in this sector are imperative.

The recent publication from the Intergovernmental Panel on Climate Change highlights the importance and complexity of Climate Change & Land[2]. Similarly, the UK Committee on Climate Change provides a useful guide on how the UK must act in order to meet its commitments.[3] This includes the actions that may impact agriculture and land, such as eating less meat, cutting food waste, producing food more efficiently and planting more trees.

How the necessary emissions reductions are allocated at a global, national and local level is yet to be determined and is a question for society. However, while there is no "right" way to balance potentially conflicting objectives, it should be noted that climate change is a risk multiplier, exacerbating biodiversity loss and extreme weather to take two examples.

Actions

Avoiding the worst impacts of climate change is complementary to many other objectives. In the context of land use in BNES, there are many co-benefits of taking steps to cut emissions, such as improved water quality by reducing the nitrogen run-off into waterways.

Additionally, biodiversity can be promoted while not affecting (or even enhancing) productivity, through measures such as the improvement of hedgerows and use of buffer strips. Sheep may be grazed in fields of solar panels to keep the grass short; cows may be grazed among trees.

When deciding where and how to make emissions reductions there are many other considerations, including but not limited to:

- Future land stewardship promotions by government;
- Flood management;
- Maintaining landscape character, particularly in the context of the Areas of Outstanding Natural Beauty;
- Maintaining and enhancing biodiversity, including connected habitats;
- Improving animal welfare;
- Balancing food production with land-use management and land-use change;
- Opportunities to work together as a wider region to make the necessary carbon reductions in a way that maximises the co-benefits while minimising potential adverse impacts.

Scope of this study

Following some interim analysis, it was clear that a much more sophisticated study would be required to establish a robust baseline for the district and define key actions. This would require input from various local actors and industry experts. Therefore no further analysis has been performed or included in this report.

Anthesis

1 - https://www.carbonbrief.org/analysis-why-the-ipcc-1-5c-report-expanded-the-carbon-budget
2 - IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems, August 2019
3 - Committee on Climate Change. Land use: Reducing emissions and preparing for climate change.

Section 4 – The Council’s Own Emissions

Anthesis

Section 4 – The Council's Own Emissions

Overview

This chapter presents the emissions generated by the Councils own estate and operations. Emissions data has been prepared in accordance with the World Resource Institute's *Greenhouse Gas Protocol* (2004), using an operational control reporting boundary. Scope 1 emissions relate to natural gas for heating and fuel for owned and controlled vehicles. Scope 2 relates to purchased electricity (location based), Scope 3 emissions include schools, the Council's commercial estate and emissions associated with procurement activities. For a full breakdown and further notes on methodology, please refer to Appendices 7 and 8.

Chart 12: Emissions (tCO_2e) by Scope

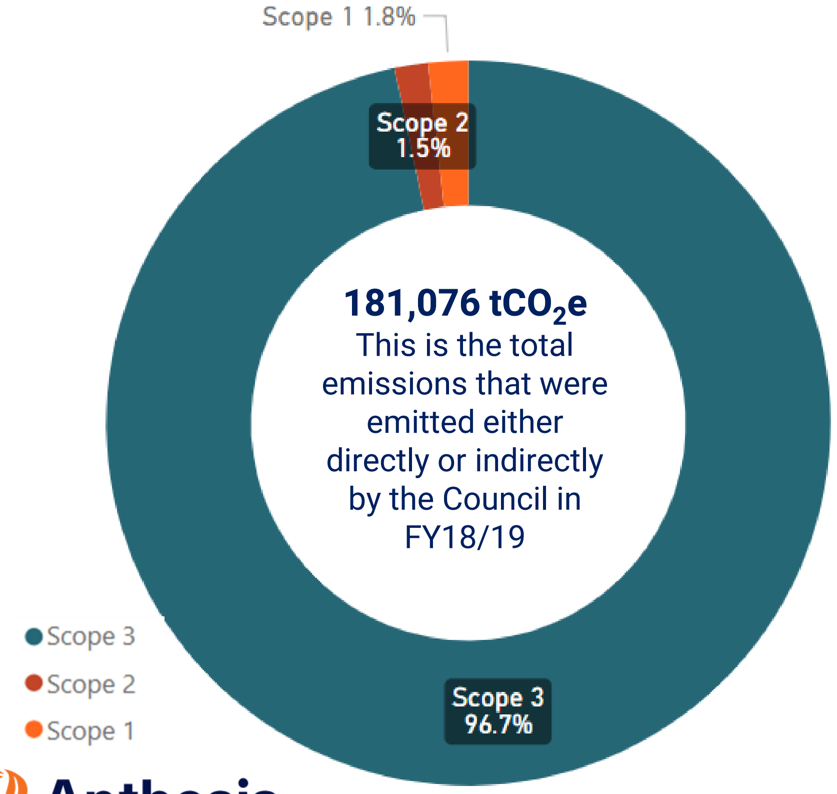
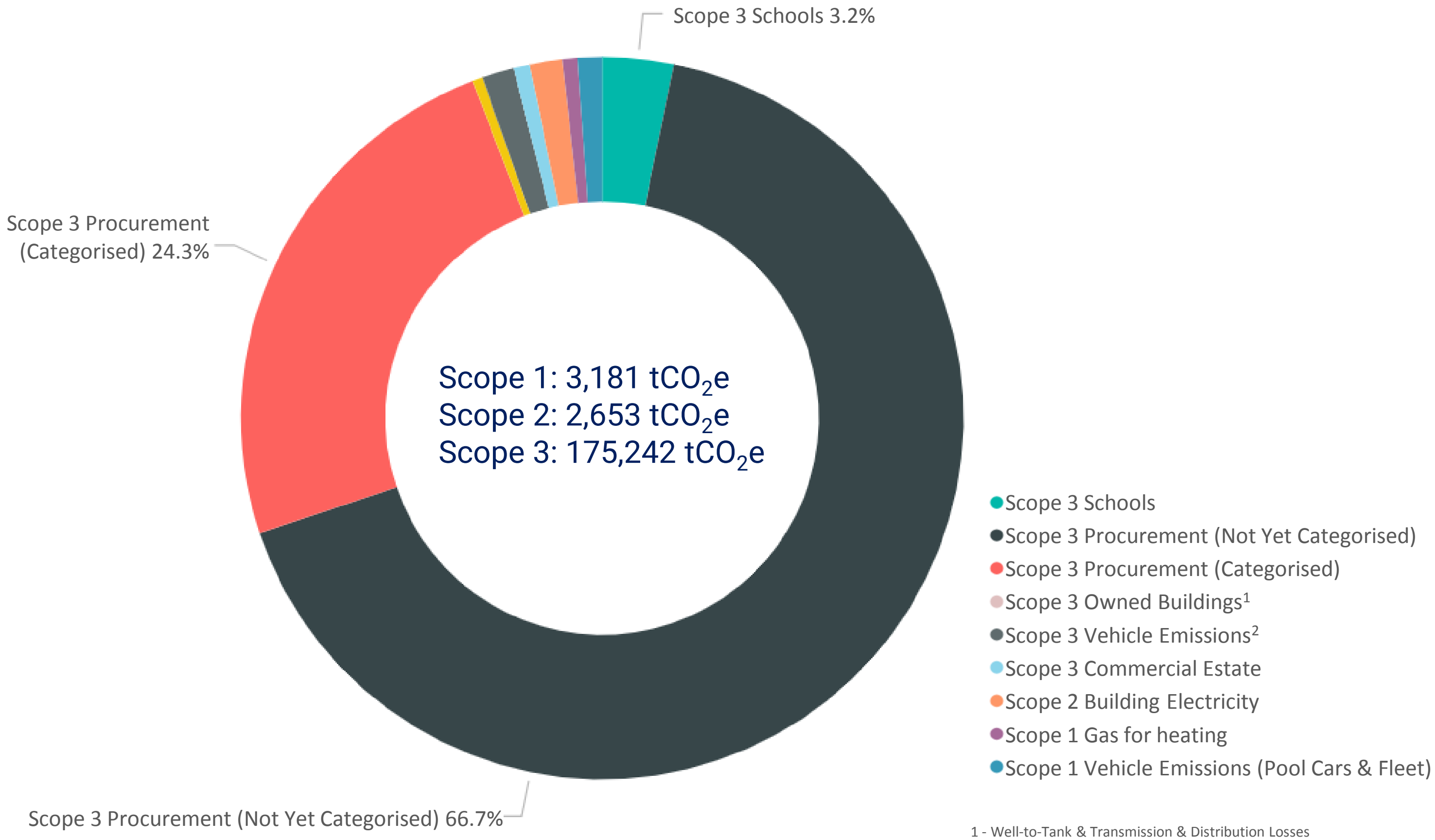


Chart 13: Emissions (tCO_2e) by Scope by sub-category



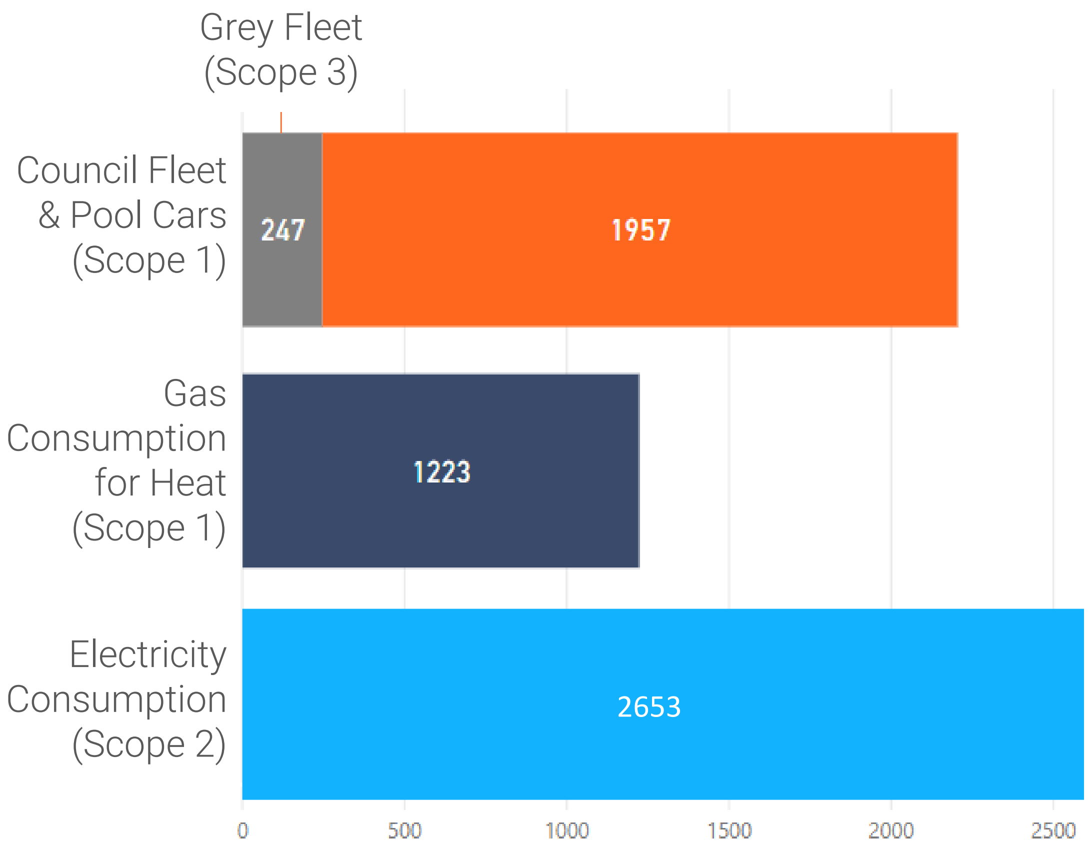
1 - Well-to-Tank & Transmission & Distribution Losses
2 – Staff Commuting & Grey Fleet

Anthesis

Section 4 – The Council's Own Emissions

Emissions Analysis

Chart 14: Emissions source bar-chart comparison (tCO_2e) by Scope

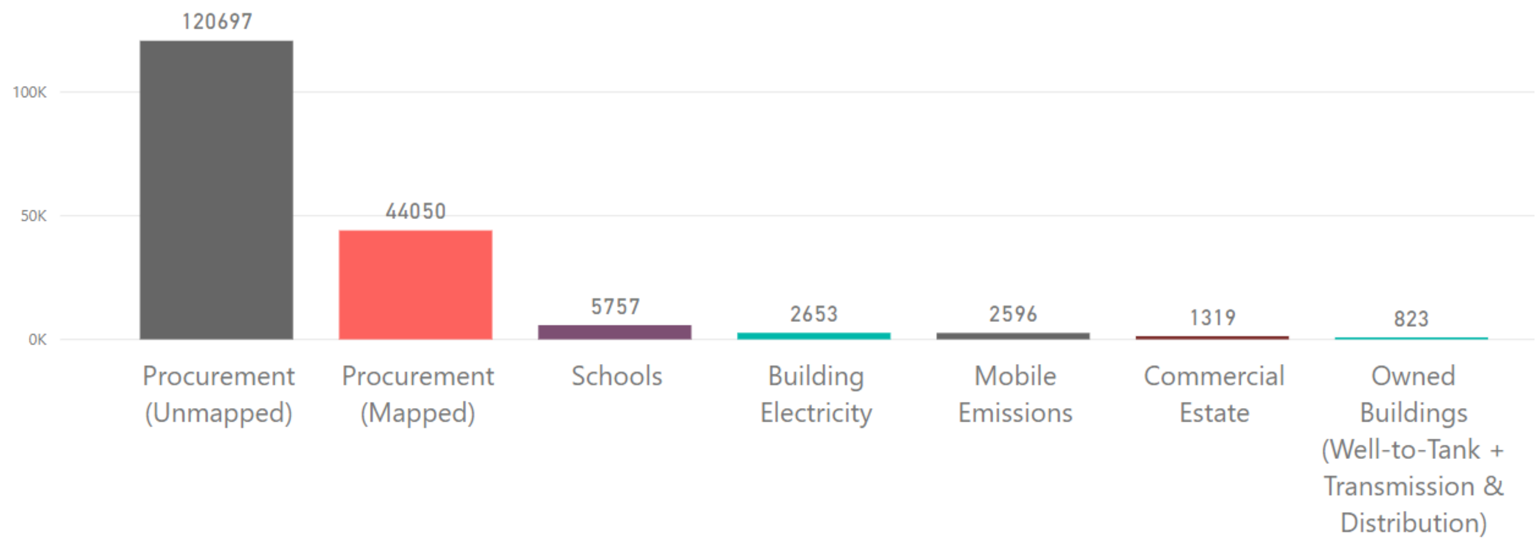


- There are two principal contributions to the Council's direct (Scope 1) emissions; owned & operated building gas consumption (Stationary Energy) and fuel used in the Council's own fleet (Mobile Emissions).
- There is no contribution from building oil consumption.
- The Council's fleet emissions have been estimated by uplifting fuel consumption in the year 15-16 using the number of vehicles owned currently compared with 15-16. Hence, this assumes a constant mileage per vehicle and vehicle type.
- Steps are already being taken to replace ageing cars and vans with newer, more efficient variants.
- Mobile emissions are still significant, and comparable to those from electricity consumed in Council operated buildings. However, they have decreased considerably in recent years through changes to grey fleet and pool cars.
- Electricity Consumption (Scope 2) has also decreased significantly now that schools are no longer under the Council's control.
- Tariff information would enable a market-based emissions to be calculated, whereby the carbon intensity of electricity actually purchased and consumed is represented, rather than just a national average (location based). Implementation of a solar project could then contribute to reduce Scope 2 emissions even further.
- If renewable energy was purchased (from a credible source where additionality could be demonstrated, potentially via Power Purchase Agreement) this may present a 'quick win' for Scope 2 electricity consumption.

Section 4 – The Council's Own Emissions

Indirect Emissions

Chart 15: Scope 2 & 3 emissions source bar-chart comparison (tCO_2e) by category



- Procurement emissions (Scope 3) dominate the indirect emissions totals, even though limitations on the data mean that an exact estimate has not been possible (a significant amount of spend categories could not be mapped/categorised).
- Commercial Estate emissions are likely to be higher. The estimation is based on non-region specific archetypes. Within B&NES, many buildings will be older, listed buildings, which are more likely to have a higher carbon footprint than assumed in this calculation..

Procurement emissions (mapped & un-mapped), follow the same 'Spike Cavell' calculation method as applied by B&NES Council in 2010. This splits procurement spend into the following categories and then applies a carbon dioxide equivalent conversion factor to the spend values in each category.

- Sewage and Refuse
- Utility Supply
- Public admin and defence
- Construction
- Agriculture products
- Mining (stone, sand, clay)
- Legal, consultancy, business services

Procurement data has been split or 'mapped' / 'categorised' into these categories where possible. Where this was not possible the data is referred to as 'un-mapped' / 'not yet categorised' and a weighted average emissions factor across the other categories has been applied.

Section 4 – The Council's Own Emissions

B&NES Council Staff Commuting Analysis

Scope 3 – Employee commuting analysis

Chart 16: % of employees by transport mode

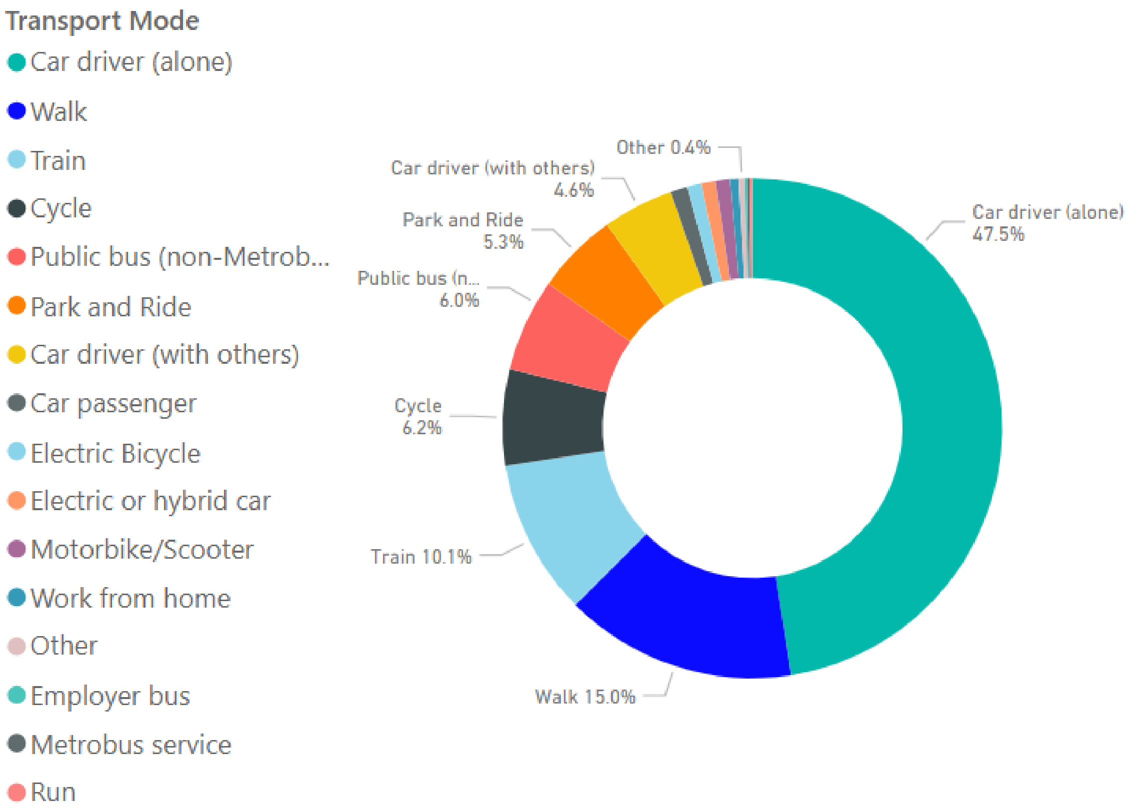
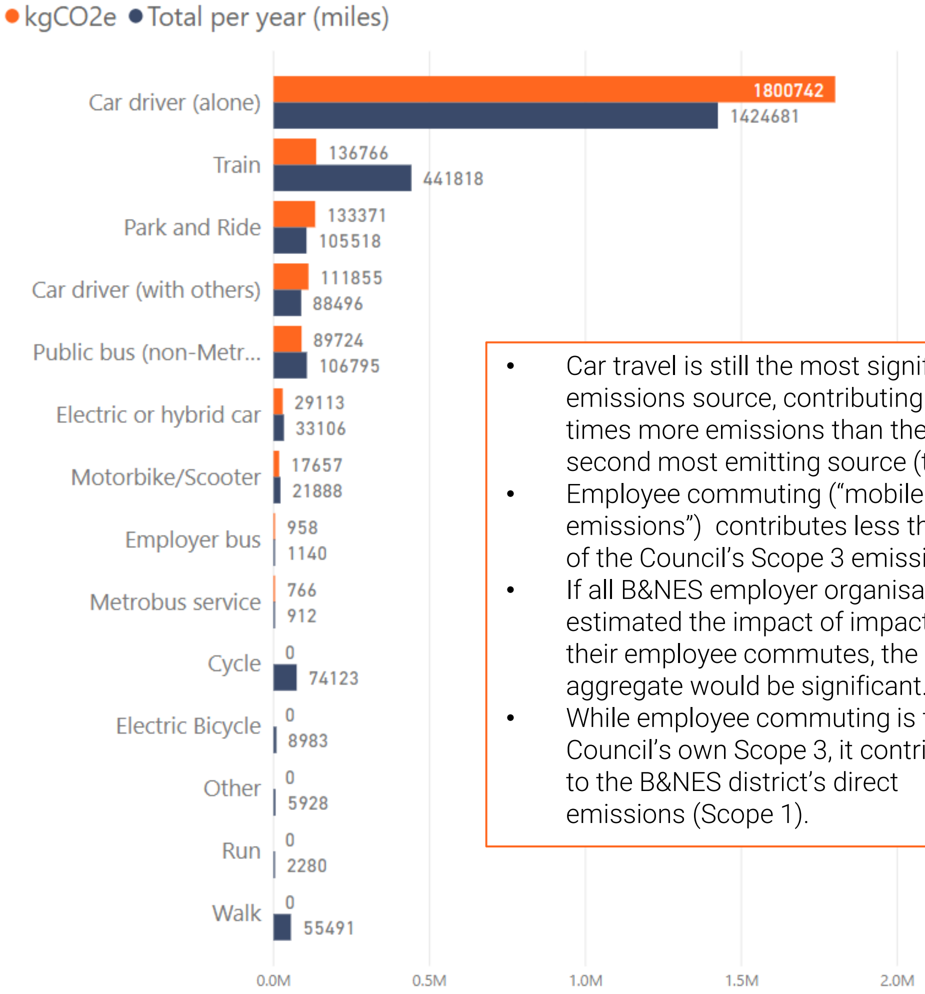


Chart 17: Annual emissions and mileage contribution by mode



- Car travel is still the most significant emissions source, contributing over 10 times more emissions than the second most emitting source (train).
- Employee commuting ("mobile emissions") contributes less than 1% of the Council's Scope 3 emissions.
- If all B&NES employer organisations estimated the impact of impact of their employee commutes, the aggregate would be significant.
- While employee commuting is the Council's own Scope 3, it contributes to the B&NES district's direct emissions (Scope 1).

Source: see Appendix 8

Section 4 – The Council's Own Emissions
Influence

Overview

This chart illustrates that B&NES Council's influence is varied and complex across the different activities that occur within their own operations and also within the district.

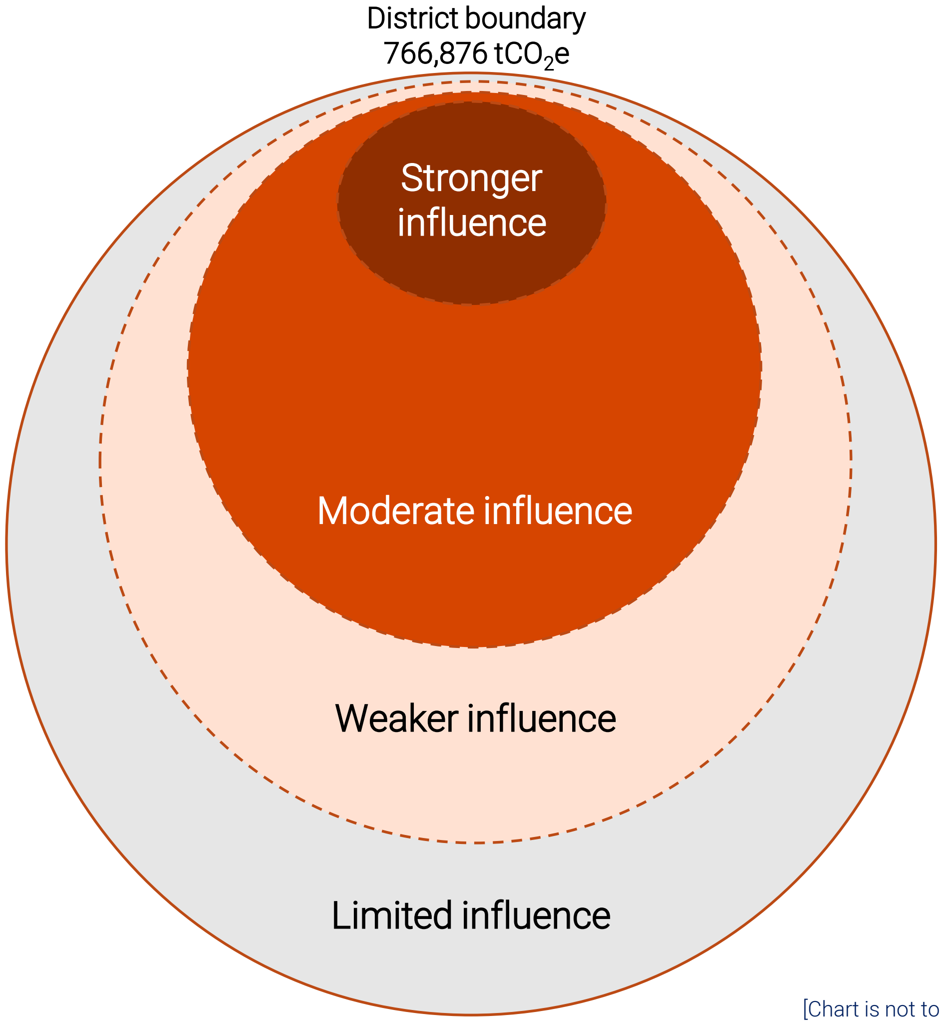
Influence bandings are based on Anthesis' judgment following discussion with officers, and are by no means definitive. The examples that relate to each banding are intended to highlight opportunities for B&NES Council to apply their influence in areas or ways previously not fully explored (e.g. by using 'convening power').

Developing a more robust and detailed list of priority actions will need to follow this initial study.

Influence	Description
Stronger	Emissions sources are directly owned or operationally controlled by B&NES Council.
Moderate	Owners and operators of emissions sources are clearly defined but are not directly owned or operated by the Council. Emissions relate to Council procurement or Council led activities.
Weaker	Emissions sources do not relate to Council owned or operated assets, procurement or Council led activities, however some convening power may exist with specific actors in the district.
Limited	Owners and operators of emissions sources are not clearly defined, influence limited to lobbying central government or trade associations.

Table 9: Influence definitions

Chart 18: Illustrative spheres of influence



[Chart is not to scale]

Section 4 – The Council's Own Emissions

Influence

Stronger influence:
- This primarily relates to owned & controlled buildings & fleet (i.e. 5,834 tCO_2e or less than 1% of the district total).
- Previous initiatives have included
  - Pool car/car share initiatives
  - LED street light replacement
- Future initiatives may include:
  - Procuring 'green' energy
  - Energy company exploration
  - Travel policy review and meeting location optimisation
  - Retrofitting buildings and installing solar on depots
  - Additionally, there may be opportunity to influence and reduce the carbon impacts of wholly Council owned property construction company, ADL.[1]

Moderate influence:
- This primarily relates to the Councils Scope 3 emissions (254,931 tCO_2e[2]), however a large proportion of these emissions (such as procurement) will occur out of the district boundary.
- Previous initiatives have included:
  - Increasing flexibility for employee homeworking
- Future initiatives may include
  - Clean Air Zone implementation
  - Improving procurement policy / data.
  - Commercial estate performance measurement, retrofit (perhaps as part of a void programme) and renewable energy supply to tenants
  - Low carbon requirements for Business Improvement District ('BIDs')
  - Encouraging energy efficiency & procurement opportunities for Schools
  - Reviewing opportunities within waste collection and treatment

Incentive types	
Policy driven	Voluntary driven

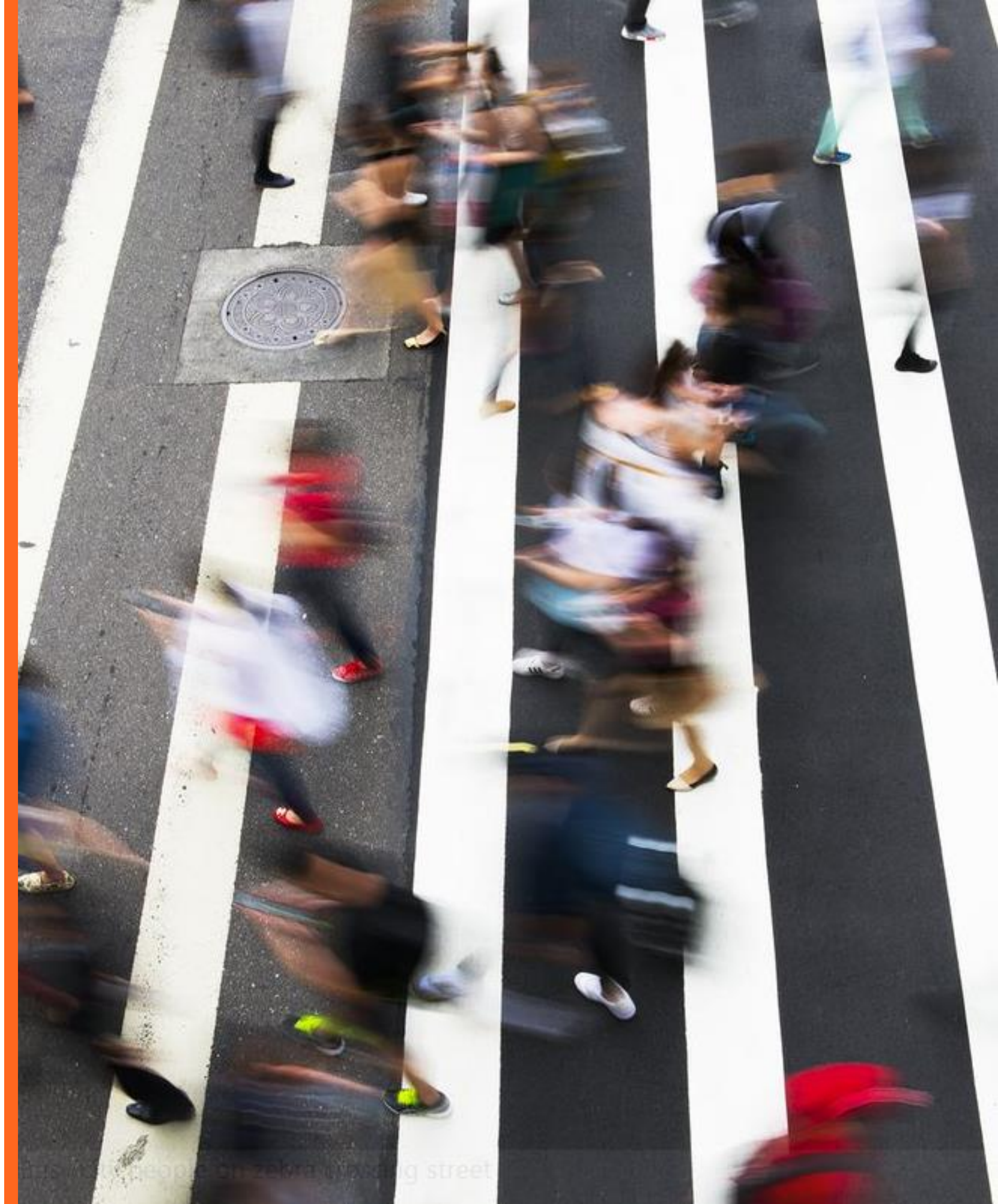
- **Financial**
- **Reputational**
- **Political**
- **Social**
- **Other environmental**

Weaker influence:
- This primarily relates to areas outside of the Councils Scope 3, but still possible to influence.
- Previously initiatives have included:
  - Local organisation partnerships
  - Community renewables schemes
- Future initiatives may include:
  - Refreshed, zero carbon partnerships with local organisations. These may be sector focused and/or may contain stakeholders from public, private, voluntary sectors, Non-Governmental Organisations (NGOs), such as trade associations and activists
  - Resident engagement and initiatives. See Section 5 for further areas that could be explored or used as a basis for action

Limited influence:
- This will relate to activities and decisions that extend beyond the power of B&NES and may require lobbying at a national level.
- Historically, this may relate to:
  - The extent beyond which the Planning Authority can increase energy efficiency standards beyond Part L of the building regulations
  - Permissions granted for Onshore wind generation capacity
  - Incentives and grants available for building more energy efficient social housing
  - Permissions granted by Highways England for measures that may impact roads and transport routes.

Notes:
1 - Aequus Developments Limited
2 - Scope 3 Excludes T&D & WTT losses

Section 5 – Citizen Action



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Section 5 – Citizen Action

Summary - For the full report, please refer to separate document "Citizen Action Report".

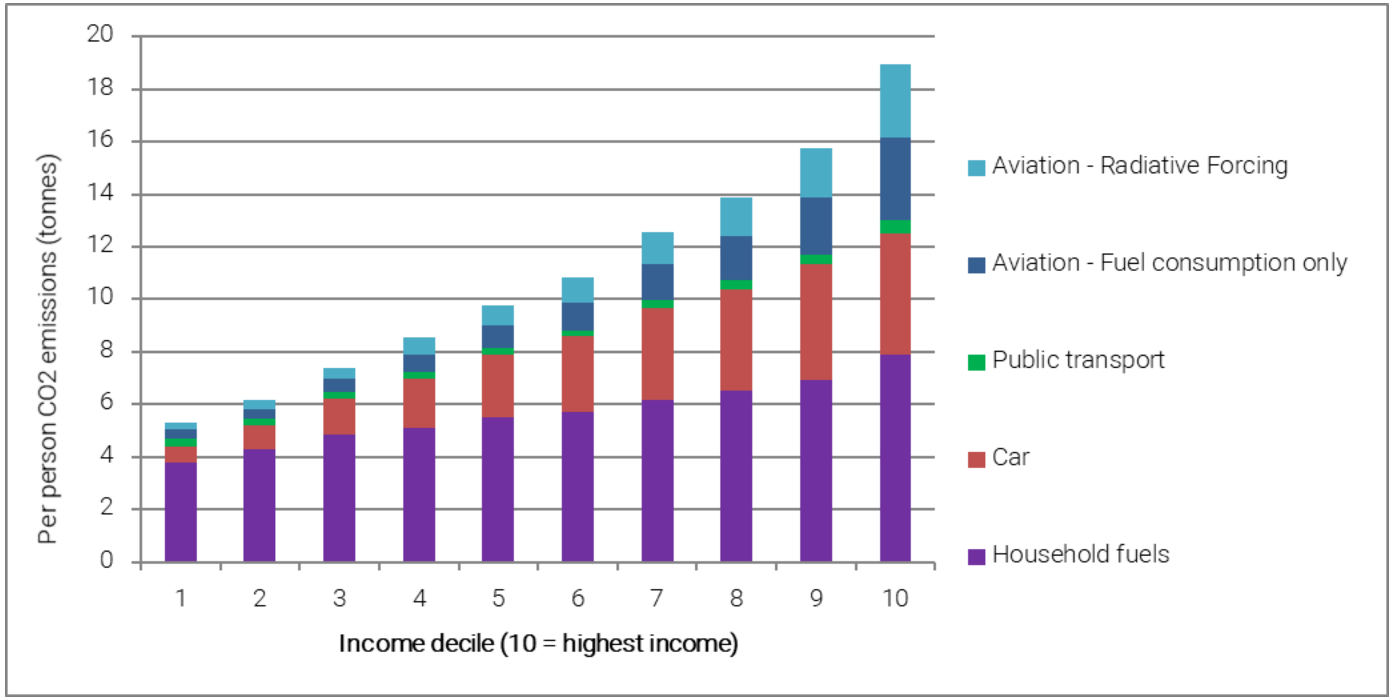
Citizen per capita carbon footprints based on income

Another way to view the area's carbon footprint is to consider the emissions of each citizen. The Centre for Sustainable Energy (CSE) looked at the significant relationship between household carbon footprints and income deciles in three key areas: home energy use; ground transport and air travel.

This analysis aims to inform community and citizen action and work to support the vulnerable and those on a low income. The headline findings presented here are based on national, not local data and derive from a study conducted from 2011-2013. However, the trends are likely to be similar today and in Bath and North East Somerset.

Chart 19 shows that on average across the UK, without counting radiative forcing (see below) the carbon footprint of the wealthiest 10% of households is around 16.14tCO_2/yr and more than three times the 5.03 tCO_2/yr of the least wealthy 10%.

Chart 19: Per person CO_2 emissions by income (UK)



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Section 5 – Citizen Action

Households

Household fuels are the single largest source of carbon emissions overall, and emissions from the wealthiest 10%, at 7.9tCO_2/yr are around double those of the least wealthy 10% at 3.76tCO_2/yr.

To refine the picture on domestic emissions, CSE used a further methodology, the National Household Model (NHM). Rather than looking at assumed household fuel consumption as per Chart 20, the NHM considers housing stock types and energy behaviour across income brackets, e.g. that lower income people tend to under-heat their homes. Chart 21 shows that the results largely correlate with those in Chart 20, with domestic emissions increasing with income. However, this trend was bucked by the least wealthy decile.

CSE suggests that this may in part be due to the disproportionately higher number of households in the lowest decile living in the least energy efficient homes, as shown in Chart 21. For most income deciles, between 7% and 8% of households live in homes rated in Energy Performance Certificate (EPC) bands F and G - the least efficient dwellings. However, for the lowest earning 10% this proportion increases to almost 14%. There is a large difference between the emissions of the highest and lowest EPC band (Chart 22).

District analysis showed the geographic distribution of energy inefficient homes; in parts of Bathwick, Bathavon South, Clutton and Farmborough, Timsbury, and Publow and Whitchurch dwellings rated in bands F and G comprise 31%- 50% of all dwellings.

Chart 20: Emissions by income decile (tonnes of CO2/ yr) using National Housing Model

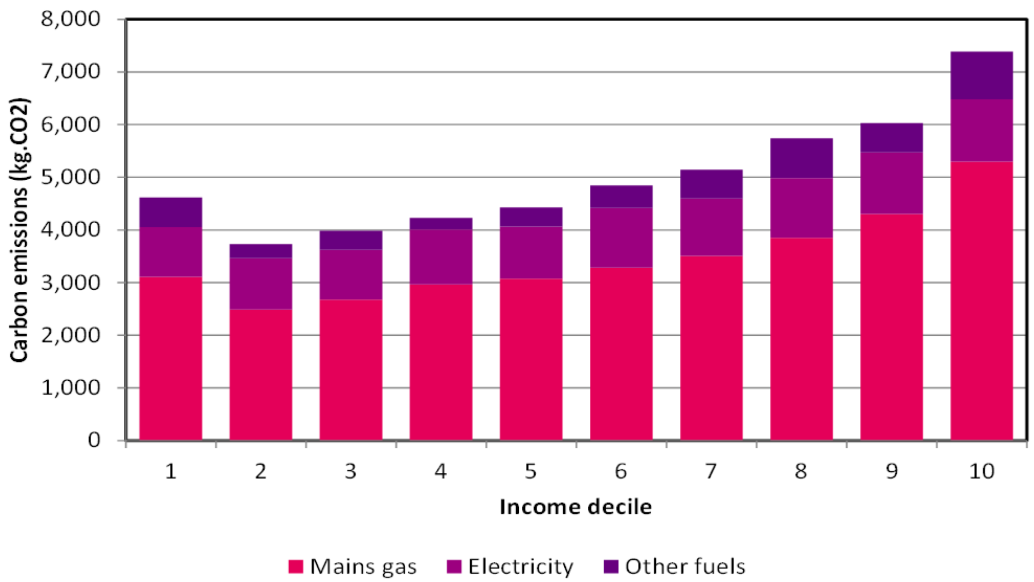


Chart 21: Income decile and % of households in EPC bands F & G.

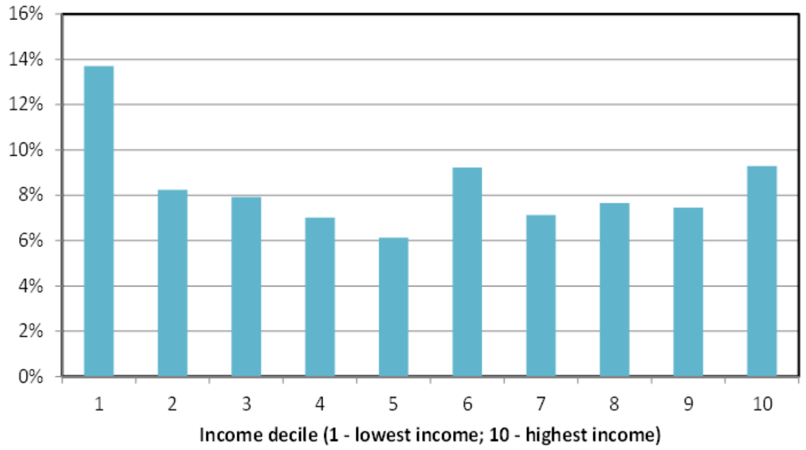
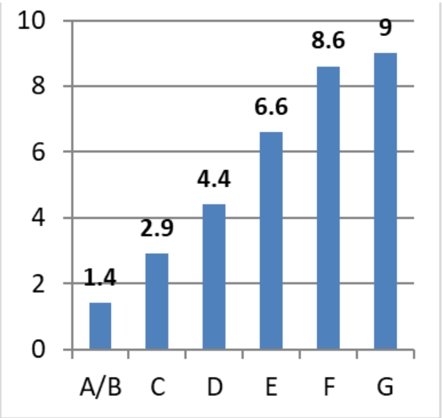


Chart 22: EPC band and emissions



centre for sustainable energy

Section 5 – Citizen Action

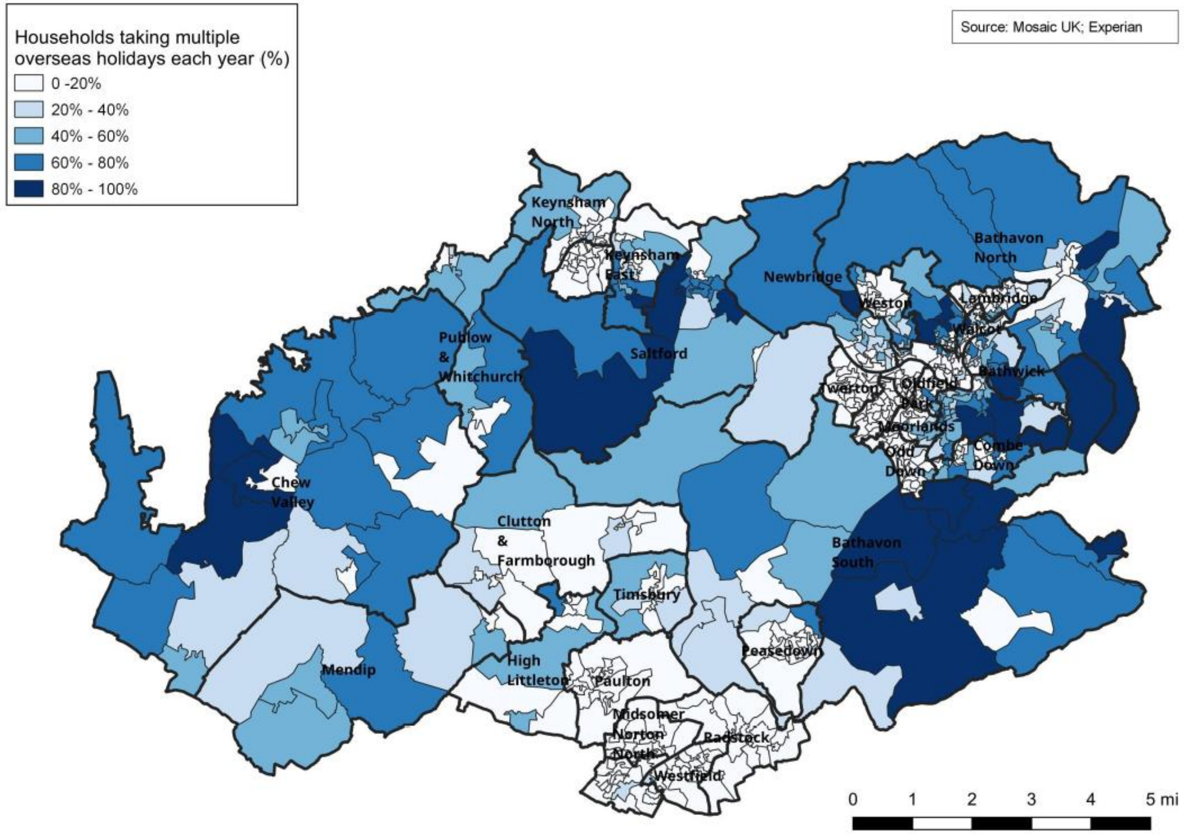
Transport

Transport emissions had the starkest disparity across different levels of income. The wealthiest decile produced more than 7 times the private car emissions than the least wealthy decile. Whilst it was not the intention of this work to produce a major travel study, and it should be read in conjunction with existing research , CSE did illustrate the geographic dimension to car use. Some areas have a high dependency on cars for commuting and there are areas where the average distance travelled to work is less than 10km providing possible scope for shift to lower carbon transport. These areas are more concentrated in the Wards of Southdown, Keynsham South, Westfield, Keynsham North and Odd Down.

The aviation emissions of the wealthiest decile were 10 times those of the least wealthy. CSE considered radiative forcing, whereby water vapour from aeroplane engines acts as a temporary greenhouse gas and may add a further 90% to the impact of CO2 emissions from aviation, although there is significant scientific uncertainty about the magnitude of the effect.

The aviation data presented here is illustrative only. For example, those on higher incomes are more likely to be taking multiple overseas trips and travelling further afield on longer- haul flights, whereas less wealthy households are more likely to be taking fewer trips per year on shorter-haul flights. Therefore this illustration is likely to underestimate the disparity between people on different incomes. Chart 23 shows various wards by frequency of oversees holidays (per household).

Chart 23: Proportion of households taking multiple (more than one) overseas holidays by Census Output Areas (Ward boundaries post-April 2019 also shown)



Appendices

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Appendix 1

Emissions Inventory and Reductions Summary

Sector	Sub-sector	Total tCO2e			
		DIRECT	INDIRECT	OTHER	TOTAL
Stationary energy	Residential buildings	180,811.14	112,774.05	49,364.65	342,949.84
	Commercial buildings & facilities	19,835.17	13,050.56	5,698.14	38,583.87
	Institutional buildings & facilities	36,450.57	65,947.20	16,175.20	118,572.97
	Industrial buildings & facilities	30,158.44	38,228.38	11,594.96	79,981.77
	Agriculture	10,552.23	IE	IE	10,552.23
	Fugitive emissions	0.00	0.00	0.00	0.00
Transportation	On-road	216,109.97	IE	IE	216,109.97
	Rail	5,943.67	IE	IE	5,943.67
	Waterborne navigation	5.04	NO	NO	5.04
	Aviation	0.00	IE	99,680.21	99,680.21
	Off-road	0.00	0.00	IE	0.00
Waste	Solid waste disposal	18,508.25	0.00	NE	18,508.25
	Biological treatment	0.00	0.00	NE	0.00
	Incineration and open burning	0.00	0.00	NE	0.00
	Wastewater	11,759.70	0.00	NE	11,759.70
Industrial Processes and Product Use (IPPU)	Industrial process	0.02	0.00	0.00	0.02
	Product use	0.00	0.00	NE	0.00
Agriculture, Forestry and Other Land Use (AFOLU)	Livestock	6,741.66	0.00	0.00	6,741.66
	Land use	-0.00	0.00	0.00	-0.00
	Other AFOLU	NE	0.00	0.00	0.00
Generation of grid-supplied energy	Electricity-only generation	0.00	0.00	0.00	0.00
	CHP generation	0.00	0.00	0.00	0.00
	Heat/cold generation	0.00	0.00	0.00	0.00
	Local renewable generation	0.00	0.00	0.00	0.00

Table 10 – This is a full export of the 2019 inventory from the SCATTER tool. It is aligned to the reporting requirements of the Global Covenant of Mayors and CDP.

(light green)	= Sources required for BASIC reporting
(grey)	= Non-applicable emission sources
(blue)	= Sources required for BASIC+ reporting
IE	= Included Elsewhere
NE	= Not Estimated
NO	= Not Occurring

Pathway description	Cumulative Total[1] @2050 $MtCO_2e$	% Reduction at 2030	% Reduction at 2050
SCATTER BAU Pathway	16.59	38%	51%
SCATTER Stretch Pathway	7.80	72%	104%
Tyndall Paris Aligned Budget[2]	4.45	91%	99%

Table 11 – This shows the cumulative totals of carbon dioxide based on the various trajectories presented by the SCATTER tool and work performed by the Tyndall Centre for Climate Change Research (obtained by Anthesis during this work).

1 – Period adjustment made to include 2016 figures, therefore period is 2017-2050 inclusive. 2017 data not available at the time of drafting.
2 – Based on 13% Year on Year reductions from for the period 2017 to 2050.

Appendix 2

Summary list of interventions and modification summary

Table 12

Measure	Updated from original Pathways Calculator?
Energy generation & storage	
Onshore wind	N
Biomass power stations	Y
Solar panels for electricity	N
Solar panels for hot water	N
Storage, demand shifting & interconnection	N
Geothermal	N
Hydro	N
CCS	N
Bioenergy sourcing	
Increase in land used to grow crops for bioenergy	Y
Reduction in quantity of waste	N
Increase the proportion of waste recycled	Y
Bioenergy imports	N
Transport	
Reducing distance travelled by individuals	N
Shift to zero emission transport	N
Choice of fuel cell or battery powered zero emission vehicles	N
Freight: Shift to rail and water and low emission HGVs	N

Table 13

Measure	Updated from original Pathways Calculator?
Domestic buildings	
Average temperature of homes	N
Home insulation	Y
Home heating electrification	Y
Home heating that isn't electric	N
Home lighting & appliances	N
Electrification of home cooking	N
Commercial buildings	
Commercial demand for heating and cooling	Y
Commercial heating electrification	Y
Commercial heating that isn't electric	N
Commercial lighting & appliances	N
Electrification of commercial cooking	N
Industrial processes	
Energy intensity of industry	Y

Notes
- Updates flagged do not include scaling to local region – it is assumed that this happened for all measures. They relate to instances where the upper threshold of the ambition has been pushed further(i.e. at Level 4)
- Updates exclude alignment of Level 1 ambition to the National Grid FES (2017)
- Note that bioenergy source did not have material bearing on the model due to assumptions linked to bioenergy shortfalls (i.e. it is assumed that bioenergy would be sourced from outside of region, or another renewable source would be used). Waste assumptions may however drive more sustainable consumption behaviours.

Appendix 3

Domestic & Non-Domestic Energy Performance Certificates (EPCs)

Table 14

	Domestic lodgements	
EPC Rating	Number of domestic Lodgements	% of domestic lodgements
A	105	0.1%
B	5,449	7.2%
C	21,355	28.3%
D	31,880	42.3%
E	13,589	18.0%
F	2,407	3.2%
G	582	0.8%
Not Recorded	1	0.0%
Total Domestic	75,368	100.0%

Table 15

	Non-Domestic lodgements	
EPC Rating	Number of non-domestic Lodgements	% of non-domestic lodgements
A	48	1.7%
A+	0	0.0%
B	213	7.4%
C	707	24.4%
D	771	26.6%
E	530	18.3%
F	257	8.9%
G	370	12.8%
Not Recorded	0	0.0%
Total Non-Domestic	2,896	100.0%

Notes:

- Data Source: Live tables (downloaded July 2019): https://www.gov.uk/government/statistical-data-sets/live-tables-on-energy-performance-of-buildings-certificates
- Lodgements is assumed to represent the same unit as 'household' (for Domestic Buildings) and 'non-domestic buildings' when making comparisons to the analysis in Section one.

Appendix 4

Domestic retrofit measures assumed within SCATTER: Cumulative to 2050

Table 16

Retrofit measure	2015	2020	2025	2030	2035	2040	2045	2050	% of available homes (at 2050 levels)
Solid wall insulation	5,127	8,331	11,535	14,739	17,943	21,147	21,181	21,215	24%
Cavity wall insulation	17,582	24,175	24,175	24,175	24,175	24,175	24,175	24,175	28%
Floor insulation	5,849	9,505	13,161	16,817	20,473	24,129	27,785	31,441	36%
Superglazing	11,630	18,899	26,168	33,436	40,705	47,974	55,243	62,511	72%
Lofts	19,556	27,483	35,411	43,339	51,267	59,195	59,195	59,195	68%
Draughtproofing	40,863	66,402	66,438	66,473	66,509	66,544	66,580	66,615	76%
Total number of homes	75,763	78,122	80,262	82,798	85,174	86,799	86,799	86,799	100%
Average heat loss per home (Watts / °C)	233	208	183	158	133	108	83	58	

Notes:

- This data is included within SCATTER but is not directly linked to the emissions calculation in the model (it was used to inform cost assumptions in the original legacy DECC 2050 Pathways calculator). In the legacy tool, national technical potential levels consider demolition rates.
- The numbers shown are the minimum assumed measures for the Stretch Pathway, as ambition was pushed further than the legacy DECC tool to which this table relates.
- 2050 number of homes is 86,799, derived from non-region specific growth assumptions in Legacy DECC Pathways tool. Broadly aligned with B&NES spatial plan of 14,500 new homes over the period 2016-2036 (SCATTER: 14,140 new homes over the period 2015 to 2035).
- Household is defined as per https://www.gov.uk/guidance/definitions-of-general-housing-terms#household
- The average heat loss per home includes new builds (at PassivHaus standard), which will contribute to lowering the average over time.
- For further detail, please refer to Section D of the DECC 2050 Pathways guidance:

Appendix 5

Domestic & commercial heating and hot water systems assumed within SCATTER

Table 17

Technology penetration						% of households
Heating and hot water systems share, as a % of households						
Code	Technology package	2015	2020	2025	2030	2050
1	Gas boiler (old)	44%	37%	31%	25%	0%
2	Gas boiler (new)	39%	34%	28%	23%	0%
3	Resistive heating	7%	7%	7%	7%	7%
4	Oil-fired boiler	6%	6%	5%	4%	0%
5	Solid-fuel boiler	2%	2%	2%	1%	0%
6	Stirling engine μCHP	-	-	-	-	0%
7	Fuel-cell μCHP	-	-	-	-	0%
8	Air-source heat pump	1%	9%	18%	26%	60%
9	Ground-source heat pump	-	4%	9%	13%	30%
10	Geothermal	-	-	-	-	0%
11	Community scale gas CHP	1%	0%	0%	0%	0%
12	Community scale solid-fuel CHP	-	-	-	-	0%
13	District heating from power stations	-	0%	1%	1%	3%
	Total	100%	100%	100%	100%	100%

Notes:

- Matrix is unchanged from original DECC Pathways Calculator. It is acknowledged newer technologies or fuel sources such as Hydrogen are not reflected in this tool.

Appendix 6
Transport assumptions

Table 18

(i) 2050 mode shares			Pathway (units: % of passenger-km)	
Code	Mode	2015	2050 BAU	2050 Stretch
WALK	Walking	4%	4.4%	4.4%
BIKE	Pedal cycles	1%	0.8%	4.7%
CAR	Cars, Vans, and Motorcycles	80%	80.3%	62.4%
BUS	Buses	5%	5.3%	18.7%
RAIL	Railways	9%	9.1%	9.8%
	Total	100%	100%	100%
	% change - cars		-	22.35%

Table 19

(ii) 2050 occupancies			Ambition level (units: Pax* / vehicle-km) @ 2050	
	Mode	2015	2050 BAU	2050 Stretch
CAR	Cars, Vans, and Motorcycles	1.56	1.56	1.65
BUS	Buses	11.32	11.32	18.00
RAIL	Railways	0.32	0.37	0.42

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*Pax ~ people/persons/occupants

Appendix 7
The Council's own emissions with summary notes

Table 20

Emission Source	2018 (tCO_2e)	Methodology Notes
Scope 1		
Stationary Emissions	1,223	
Building Natural Gas	1,223	*Building energy consumption data multiplied by DEFRA emissions factors ;*
Building Oil	0	*Building energy consumption data multiplied by DEFRA emissions factors*
Mobile Emissions	1,957	
Council-owned Fleet Vehicles	1,944	Vehicle type and fuel used taken from 2015-16 data and extrapolated forward to 2018-19 using data on number of vehicles then multiplied by DEFRA emissions factors.
Pool Cars (EV)	1	Vehicle mileage by type of fuel for 2018-19 used and then multiplied by DEFRA emissions factors.
Pool Cars (Petrol)	13	Vehicle mileage by type of fuel for 2018-19 used and then multiplied by DEFRA emissions factors.
Scope 1 Total	3,181	
Scope 2		
Building Electricity - market based	unknown	
Building Electricity - location based	2,653	*Building energy consumption data multiplied by DEFRA emissions factors*
Scope 2 Total	2,653	
Scope 3		
Commercial Estate	1,319	*Building type and floor area provided then kwh estimated for each fuel using REEB and CIBSE benchmarks*
Schools	5,757	*Building energy consumption data multiplied by DEFRA emissions factors*
Procurement (Supply Chain) - mapped	67,228	*Procurement spend data mapped onto previous analysis by Spikes Cavell (2010) to calculate emissions.*
Procurement (Supply Chain) - unmapped	178,031	*Procurement spend data mapped onto previous analysis by Spikes Cavell (2010) to calculate emissions – weighted average emissions factor used for unmapped.*
Controlled Buildings (WTT + T&D)	823	*Building energy consumption data multiplied by DEFRA emissions factors*
Mobile Emissions	2,596	
Commuting	2,349	*Commuting survey data split by mode of transport and mileage then multiplied by DEFRA emissions factors.*
Grey Fleet	247	Vehicle mileage for 2018-19 used and then multiplied by DEFRA emissions factors – unknown vehicle type
Scope 3 Total	255,754	

Appendix 8
Data Sources

Table 21

Data in Model	Source	Date accessed	Internal reference
Council data; Building Elec	B&NES	01/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved/Copy%20of%20GHG%20Data%202008-09%20to%202017-18.xlsx?d=wedd410828b654bd289d91688c651f3bd&csf=1&e=NUEOZt
Council data; Building Gas	B&NES	01/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved/Copy%20of%20GHG%20Data%202008-09%20to%202017-18.xlsx?d=wedd410828b654bd289d91688c651f3bd&csf=1&e=NUEOZt
Council data; Building Oil	B&NES	01/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved/Copy%20of%20GHG%20Data%202008-09%20to%202017-18.xlsx?d=wedd410828b654bd289d91688c651f3bd&csf=1&e=NUEOZt
Council data; Commuting	B&NES	01/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved%20%26%20Used/B%26NES%20STAFF%20MARCH%202019.xlsx?d=w88cc841c18724c359149efdb889620db&csf=1&e=th4jIM
Council data; Schools	B&NES	01/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved%20%26%20Used/B%26NES%20STAFF%20MARCH%202019.xlsx?d=w88cc841c18724c359149efdb889620db&csf=1&e=th4jIM
Council data; Fleet - Vehicles	B&NES	01/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved%20%26%20Used/Council%20Fleet%20nos.%20April%2015_16.xlsx?d=w60a881cf0e65430e8a17f59acb1c6db4&csf=1&e=it0WZI
Council data; Fleet - Vehicles	B&NES	01/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved%20%26%20Used/Copy%20of%20FLISTA%20MAY%202019.xlsx?d=wf39ddd48da4e462499566bc0e360f773&csf=1&e=Julqvc
Council data; Fleet - Fuel	B&NES	01/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved%20%26%20Used/Council%20Fleet%20nos.%20April%2015_16.xlsx?d=w60a881cf0e65430e8a17f59acb1c6db4&csf=1&e=eEveyq
Council Data; Grey Fleet+Pool	B&NES	01/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved%20%26%20Used/Council%20Staff%20miles_greyfleet%20%26%20pool%20cars.xlsx?d=w15240b59d7df418d83de7672c51278e6&csf=1&e=ryVteC
Procurement Spend	B&NES	05/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved%20%26%20Used/2017-18%20Spend%20Overview.xlsx?d=w761f27f5f96a40ee899f0aeeba54df91&csf=1&e=SovEgf
Procurement Spend	B&NES - Spikes Cavell	04/07/2019	https://anthesisllc.sharepoint.com/:p:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved%20%26%20Used/Spikes%20Cavell%20Template%20v1_02%20B&NES%20Carbon%20v0%201%208%20(16-11-2010).ppt?d=we018cc3b8e254637b3d36eb82c0fdc9d&csf=1&e=S1a5ds
Commercial Estate	B&NES	01/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved%20%26%20Used/Commercial%20Estate%20analysis.xlsx?d=w0edf0059978d4bef9fd63dd01c542b8e&csf=1&e=I55FiG
Commercial Estate	B&NES	01/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/Data%20Recieved%20%26%20Used/Copy%20of%20Carbon%20Calculations%20data%2028062019_SG.xlsx?d=w00ae68fd7ed64576b9a739e5fc8651f9&csf=1&e=HuG9Ps
GVA National/Local Authority	UK Office of National Statistics	07/07/2019	https://www.ons.gov.uk/economy/grossvalueaddedgva/bulletins/regionalgrossvalueaddedbalanceduk/1998to2016
Pollution Inventory	Environment Agency	07/07/2019	https://ea.sharefile.com/d-sec709b63163484f8
UK Emissions by Sector	DEFRA - research by Leeds University	07/07/2019	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794557/Consumption_emissions_April19.pdf
UK Emissions by Sector	DEFRA - research by Leeds University	07/07/2019	https://www.gov.uk/government/statistics/uks-carbon-footprint
Consumption Emissions	Anthesis	14/07/2019	https://anthesisllc.sharepoint.com/:x:/r/sites/external/AnthesisClimateStrategySupport/Shared%20Documents/B&NES_Consumption%20Emissions%20II.xlsx?d=wce54f884508c449eb6dabaa1680ce897&csf=1&e=X3bY8o

Appendix 8
Data Sources (continued)

Data in Model	Source	Date accessed	Internal reference
Land use	Crop Map of England (RPA)	July 2019	https://data.gov.uk/dataset/9b5bb45f-0bef-4b1d-a6f9-9189e29746c2/crop-map-of-england-crome-2017-complete
Livestock numbers	DEFRA	July 2019	https://www.gov.uk/government/statistical-data-sets/structure-of-the-livestock-industry-in-england-at-december
Soil carbon stocks	Countryside Survey (CEH)	July 2019	https://catalogue.ceh.ac.uk/documents/9e4451f8-23d3-40dc-9302-73e30ad3dd76
Net emissions from LULUCF	BEIS	July 2019	UK local authority and regional carbon dioxide emissions national statistics: 2005 to 2017

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