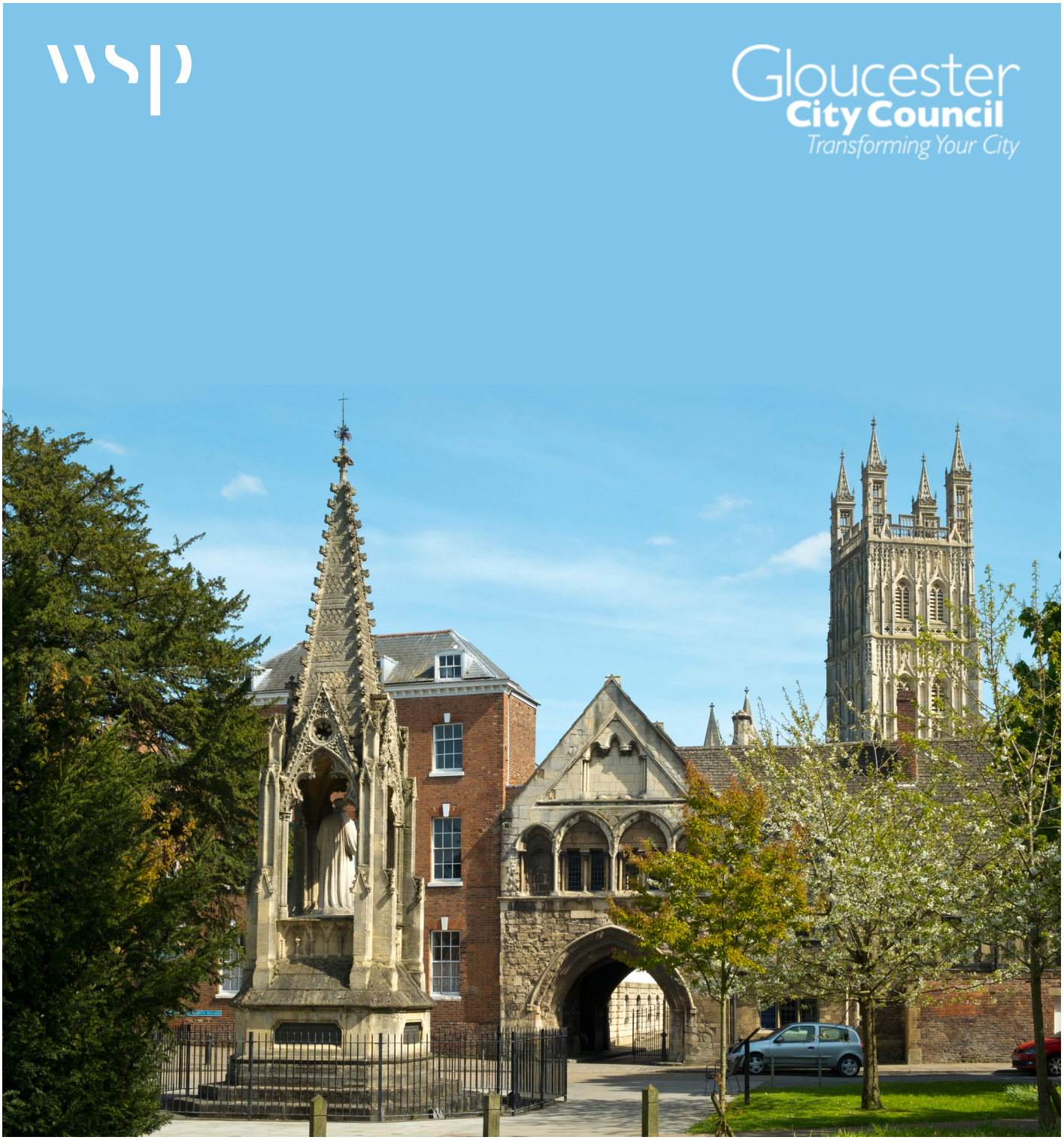

Gloucester Climate Change Strategy (GCCS)

Gloucester City Council

December 2023

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Foreword

Councillor Sebastian Field
Cabinet Member for Environment

As Gloucester City Council Cabinet Member for Environment, I am only too aware of the gravity of the climate crisis, the urgency required to address it, and the appetite of the city's Councillors and residents to see action at both the level of the council and the wider district.

That is why we have committed to delivering Net Zero emissions across the council's functions by 2030 – having brought the target forward five years – and to do everything within the council's powers to achieve carbon neutrality across the wider district by 2045, in line with the findings of the Intergovernmental Panel on Climate Change's 1.5C report.

While the council recognises the scale of the challenge presented by global warming, we also believe the transition to a low carbon society presents huge opportunities to upskill Gloucester's workforce as we transform the energy system, increase the energy efficiency of our buildings, grow the circular economy, and improve local air quality.

By supporting the rollout of electric vehicle charge points across the district, consuming 100% renewable electricity, helping residents to maintain high recycling rates, delivering an ambitious urban greening programme, and through water course naturalisation, Gloucester City Council is already demonstrating its appetite for practical and effective climate action, but we understand that there is so much more we need to do.

This strategy attempts to systematically understand and prioritise Council and wider district emissions and, for the first time, combine this information with decarbonisation pathways and credible approaches to achieving our goals.

Not only does this strategy signal a big step forward in our understanding of local greenhouse gas emissions, it also – in light of the droughts, extreme heat events, flooding, and other signals of global warming that Gloucester is increasingly experiencing – contains a climate risk assessment to help the city prepare for a future in which the climate we have known becomes much less predictable.

And we are taking that leadership role on climate resilience even further as lead council for climate change adaptation on the cross-county body Climate Leadership Gloucestershire. Our mission in that role is to ensure that all districts within the Gloucestershire County Council area are prepared for the climatic changes that existing and future greenhouse gas emissions now make inevitable.

We are aware that, despite the overwhelming scientific consensus on the role of human activity in global warming since the start of the industrial revolution, some residents do not share our view on the urgency of the climate crisis. To those people I say, we will always be led in our decision-making by rigorous science and, irrespective this strategy's strong focus on decarbonisation, this document proposes many approaches – such as investment in green infrastructure – that the academic literature has consistently affirmed can deliver substantial quality of life improvements for the people of Gloucester.

We also understand that, despite the urgency of the climate crisis, the Council's approach must be financially sustainable, which is why all projects pursued as a result of this strategy will be underpinned by strong business cases that seek to reduce costs in the long-term.

We, as a Council, cannot deliver a 'green transition' alone – for that, we need to work with businesses, our ambitious higher education sector, and the people of Gloucester – but we can show leadership by reducing our own carbon footprint, through working with other districts and the county council to increase the impact of these measures, and by improving Gloucester's preparedness to climate change.

This strategy represents a big leap forward in that journey. We hope you will join us on it.

Executive Summary

Gloucester City Council (GCC) is committed to reaching net zero emissions across its own functions by 2030 and working towards net zero emissions across the wider district by 2045.

GCC announced a climate emergency in July 2019, joining over 300 local authorities and councils in England aiming to be carbon neutral 20 years before the national target. Local leadership as well as well as partnerships between central and local government is needed to tackle climate change.

Councils are well placed to support the Government to meet its net zero emissions target by 2050. The Gloucester Climate Change Strategy (GCCS) has been developed for Gloucester District to enable communities, local businesses, and every household to work towards meeting the district's ambitious 2045 net zero target and enhance resilience to the impacts of climate change. The GCCS also provides actions for GCC to achieve net zero emissions by 2030 across its own operations.

This GCCS provides a set of actions across mitigation and adaptation efforts focused on areas of opportunities. By adopting these actions, the associated reduction in emissions will contribute to building a more environmentally, sustainable and resilient Gloucester.

With the proposed energy, transport and waste interventions implemented by 2045, Gloucester could achieve a 76.3% reduction in GHG emissions in the district and a 95% reduction in GHG emissions in Gloucester City Council's own functions by 2030.

By 2045, homes in the District of Gloucester will need to install heating measures for space heating and hot water to achieve the greatest reductions in GHG emissions in the district.

By 2030, installing energy efficiency measures in offices, retail and other types of commercial properties provides significant carbon reduction for the council's own operations.

To achieve net zero emissions goals, carbon removals and offsets would be required. The protection and regeneration of green spaces, ecosystems and biodiversity can provide opportunities for carbon removal to Gloucester District and GCC, in addition to increased well-being.

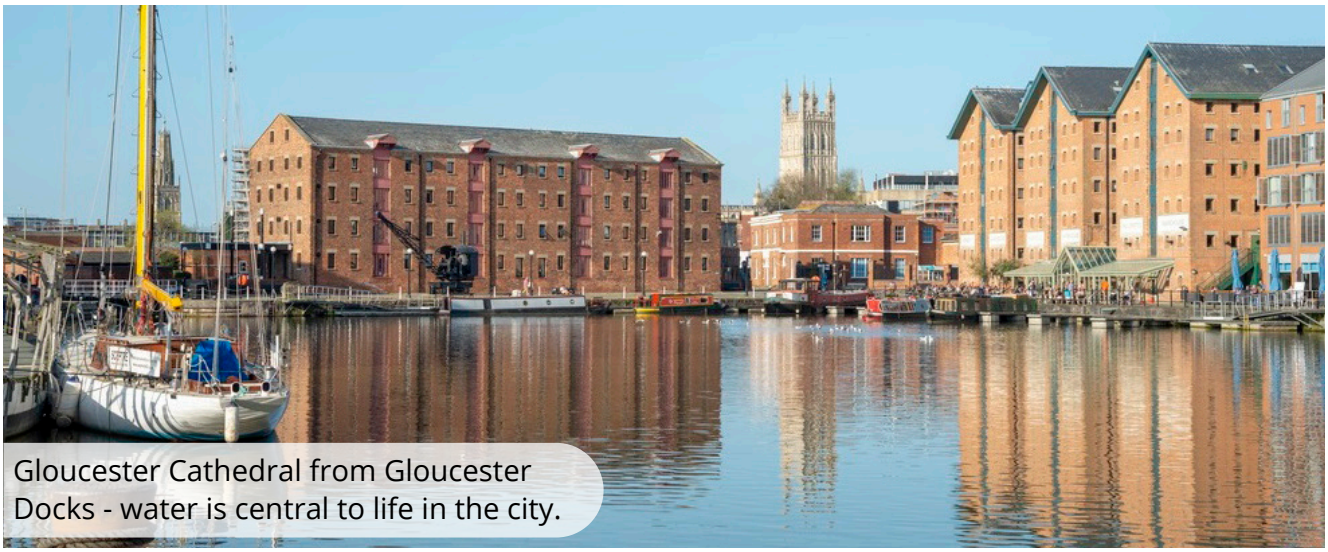
1. Introduction And Context

1.1. Local Context

In 2019, against the backdrop of growing concern about the climate crisis, Gloucester City Council (GCC) declared a climate emergency. In doing so the council committed to reaching net zero emissions across its own functions by 2030 and working towards net zero emissions across the wider district by 2045.

Since 2019, the council has developed a range of sustainability and climate change policy documents. These included the 2022 Green Travel Plan and a 2020 Carbon Baseline for its own functions and the Gloucestershire airport estate, incorporating actions to reduce emissions. In 2020, GCC set out in a report called Tackling Climate Change Roadmap, the actions that the council, its partners and Gloucester citizens can take to achieve the objectives of the Climate Change Emergency resolution as adopted in July 2019. The roadmap provided a broad overview of how the council could achieve its ambition. Climate change is also a key feature in the Gloucester City Plan 2011-2031 which engages with issues such as nature recovery, biodiversity, adaptation to flooding, renewable energy, sustainable neighbourhoods, air quality and transport. Further sustainability commitments can be found within the council's 2022-2024 Plan including promises to continually monitor and annual report on energy use across the council's estate, and to ensure that all capital projects funded by the council are net zero in operation with the ambition to be net carbon zero in construction too.

Through the UK100's Local Power in Action programme and Climate Leadership Gloucestershire, GCC is working collaboratively with local partners to achieve its sustainability goals. In January 2023 the council joined all Gloucestershire local authorities in taking collective action to deliver net zero transport, agreeing to work together on a county-wide project to tackle transport decarbonisation and achieve net zero by 2045. This commitment includes aligning Local Plans and Local Transport Plans with the county's net zero goals, supporting local efforts to create sustainable neighbourhoods and encouraging more active travel. GCC is also part of Climate Leadership Gloucestershire (CLG) which brings together councils and other strategic partners covered by the County Council. At a wider scale Gloucester City Council is a member of the Global Covenant of Mayors (GCoM) and the UK100 Network. See section 6.6 for further information about partnerships.



Gloucester Cathedral from Gloucester Docks - water is central to life in the city.

1.2. National And International

At a national level the UK Government has set a target of achieving net zero emissions across the entire country by 2050 and, under its commitment to the Paris Agreement, has pledged to cut emissions by 68% by 2030. To achieve this the UK government has developed a Net Zero Strategy which sets out policies and proposals for decarbonising all sectors of the UK economy to meet the 2050 target. The Climate Change Act (2008) forms the basis of the country's legally binding net zero target and requires the government to set 'carbon budgets' to act as stepping stones towards 2050.

At a global scale the UN Climate Change Conference Paris Agreement (2015) was the world's first comprehensive climate treaty and commits the majority of the world's governments to addressing climate change. In particular the Agreement aims to limit global temperature increase to below 2 degrees Celsius, while pursuing efforts to limit the increase to 1.5 degrees. The Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report (published between 2021-2023) issued a 'code red', projecting that significant climate-related changes will be felt in all global regions in the coming decades.

The UK Climate Change Risk Assessment (CCRA) sets out the risks and opportunities facing the UK from climate change. It includes summaries and sector-specific briefings that explore climate risks and opportunities across the UK. The CCRA provides the evidence base for the Government's National Adaptation Programmes, the third of which (NAP3) was published in July 2023. The NAP3 sets out a strategic five-year plan to boost resilience and protect communities against climate change risks. Defra has published key documents including Climate Change Adaptation: Policy Information and Good Practice Guidance for Local Government.

The Climate Change Committee (CCC) is an independent statutory body established under the Climate Change Act 2008 which advises the UK and devolved governments on mitigation and adaptation plans. It has called for making resilience to climate change a national priority and advised increasing the pace and ambition of policy development and implementation of climate action.

The Paris Agrement recognises the role of local governments in meeting it's ambitious goal of limiting global warming to 1.5°C. City government networks like the Global Covenant of Mayors for Climate & Energy (GCoM) share a long-term vision of supporting voluntary action to combat climate change in line with the Paris Agreement. While there are currently no statutory targets or mandatory reporting mechanisms for local authorities in England, growing pressure may change this in the coming years. This presents an opportunity for Gloucester City Council to get ahead of the curve, lead by example and achieve its vision of a more environmentally sustainable and resilient Gloucester.

2. Why is a Climate Change Strategy Needed for Gloucester?

2.1. The Purpose of Gloucester Climate Change Strategy (GCCS)

This Gloucester Climate Change Strategy (GCCS) is a tool to ensure that climate and nature are considered in all decision-making and investments and sets out the vision and actions for achieving net zero.

GCC has worked with WSP to develop this GCCS for stakeholders to work towards net zero emissions across the Council's own functions by 2030 and across the wider district by 2045. The GCCS estimates the carbon savings of existing actions and identifies additional interventions required to achieve the net zero goal. In line with GCC's commitments, the decarbonisation interventions outlined within the GCCS primarily focuses on scope 1 and 2 emissions.

As part of the GCCS, WSP also supported GCC with undertaking a Climate Risk and Vulnerability Assessment (CRVA). This Assessment is a tool for identifying and prioritising the council's climate change related risks and tests the effectiveness of existing climate risk management strategies to cope with the predicted effects of climate change.

The Assessment considers baseline climate, climate projections and key climate hazards. It also assesses the risk to vulnerable groups and engages with internal stakeholders to identify potential threats and opportunities.

2.2. Key Drivers

GCC recognises the urgency of climate change and is committed to tackling the climate emergency. The council also recognises its duty to help achieve the UK's legally binding net zero emissions target by 2050 and the Sixth Carbon Budget required under the Climate Change Act. Even though the Act does not include a statutory duty for local authorities, the council has set ambitious climate action targets for the council's own operations and Gloucester District as listed below:

- Meet Gloucester's net zero commitments (net zero emissions across the council's own functions by 2030 and across the wider district by 2045);
- Increase public awareness of climate change; and
- Enable Gloucester, its citizens and biodiversity to adapt to the changes brought about by climate change to ensure the maintenance of a high quality of life.

Flooding in Gloucester, which a warming is projected to intensify.

2.3. Vision and Objectives

The Council Plan 2022-2024 sets out Gloucester City Council's strategic direction over the next three years with a vision for the council, its partners and residents "to build a greener, fairer, better Gloucester." To achieve this, the GCCS identified five sectoral focus areas for which actions will be identified within the objectives:

- **Energy:** Promote energy efficiency, reduce energy consumption, decarbonise heating and increase renewable energy generation in domestic, industrial, and commercial properties in Gloucester District and Gloucester City Council.
- **Transport:** Promote sustainable modes of transport, including hybrid working practices, enable the electrification of transport, while supporting walking and cycling, and improving public and multi-modal transport in Gloucester District and Gloucester City Council.
- **Waste:** Promote the reduction of waste generated and increase recycling rates in Gloucester District and Gloucester City Council.
- **Biodiversity:** To safeguard and create green spaces that enhance biodiversity, facilitate active travel, link neighbourhoods, and protect communities from the impacts of the climate crisis in Gloucester District and Gloucester City Council.
- **Resilience:** Ensure that people, nature, our prosperity, and way of life in Gloucester District and Gloucester City Council are adaptable to a changing climate and strengthen the ability to anticipate and cope and recover from unavoidable impacts.

The GCCS supports GCC to:

- Provide a comprehensive, public-facing, evidence-based Climate Change Strategy aligned with GCC's targets; and
- Increase the resilience of Gloucester to climatic consequences of human-induced global warming.

3. Our Approach to The Gloucester Climate Change Strategy (GCCS)

The Gloucester Climate Change Strategy (GCCS) has been prepared to bring strategic rigour Gloucester City Council's (GCC) commitment to achieving net zero emissions across its own functions and carbon neutrality across the wider district. The Plan has been developed in collaboration with GCC officers who have contributed to:

- **Mitigation – Achieving Net Zero Emissions:** Establishing a baseline for emissions for the district and GCC to identify actions to achieve net zero emissions by 2045 and 2030 respectively.
- **Adaptation – Understanding Vulnerability to Climate Change:** Assessing climate risk and vulnerability to determine actions to improve the GCC's resilience to climate change.

3.1. Mitigation – Achieving Net Zero Emissions

To identify the actions included in the GCCS, GCC councillors and internal stakeholders participated in two workshops to provide information and validate the analysis and results provided by the team at WSP. Figure 3-1 describes our methodology, while the section below describes the approach and baseline emissions for the district and GCC:

- Part 1 – Gloucester District Emissions Baseline
- Part 2 – Gloucester City Council Emissions Baseline

Figure 3-1. The Process of the Climate Mitigation Assessment. Source: WSP

Step 1:

Collecting data to model Gloucester District and Gloucester City Council carbon baseline.

Step 2:

Developing carbon baseline of emissions for Gloucester District and Gloucester City Council carbon baseline and identify and validate key sectors and emissions trends.

Step 3:

Identify areas of opportunity for decarbonisation and existing actions.

Step 4:

Design and validate actions by adjusting the level of efforts with stakeholders and model the path to net zero emissions.

Part 1 - Gloucester District Emissions Baseline

To achieve its goal of net zero emissions across the Gloucester District by 2045, GCC must identify a set of actions and the stakeholders responsible for their delivery. A base year, 2019 , has been identified to measure, monitor, and report the progress towards net zero emissions by 2045. Actions have been identified by estimating baseline carbon emissions for the district for 2019 that considers historical trends since 2005.

A business-as-usual (BAU) scenario was modelled to account for the impact for Gloucester of the implementation of national level policies, plans, and trends, assuming a continuation of the ongoing effort and fulfilment of existing commitments. Even with no further interventions, the BAU scenario represents a significant reduction in emissions, as outlined in policies detailed below. Modelled policies include:

- Domestic Minimum Energy Efficiency Standard (MEES);
- Transport electrification, including ICE (internal combustion engines) sale ban in 2035; and
- Electricity grid decarbonisation.

Gloucester District Historic Carbon Emissions 2005-2019

Carbon emissions have reduced 26% from 2005-2019 as shown in Figure 3-2. In 2019, emissions accounted for 495 KtCO2e. These emissions have been quantified by developing an energy carbon model for Gloucester District based on WSP's local authority tool. The model primarily uses the Department for Energy Security and Net Zero -DESNZ (2021) sub-national total final energy consumption data to characterise the district and understand the total scale of the actions needed to achieve net zero emissions by 2045. The trends observed in Gloucester District historic carbon emissions from 2005 and 2019 include:

- Emissions from gas consumption (43%) are the highest of all fuels, followed by electricity (28%) and petroleum (28%) as shown in Figure 3-2 and Figure 3-3. However, the decarbonisation of the electricity grid has meant that emissions from electricity consumption have declined rapidly, a trend that DESNZ predicts will continue as shown in Treasury Green Book projections.
- In Gloucester, the domestic sector is the dominant energy end use (34%), closely followed by industry (29%), and then transport (24%). The carbon intensity of electricity is now lower than that of gas. In order to meet the District and UK carbon emissions targets, the district must prioritise a shift away from gas use in domestic and commercial buildings, as well as a move to electrifying the transport sector to avoid the use of fossil fuels, such as petrol or diesel.
- Fuel consumption Gloucester is aligned with UK trends. In 2019, in the UK 41% of emissions came from gas, used for heating homes, while petroleum is mostly used in road vehicles similar to Gloucester. While domestic emissions are the highest emitting sector in Gloucester, transport is the highest emitting sector in the UK (27%), followed by energy supply (21%), businesses (17%) and residential sector (15%). Similarly, Gloucester transport and commercial are also a key source of emissions.

Figure 3-2. Gloucester District Carbon Emissions by Fuel Type 2005-2019
Source: WSP with Data from DESNZ

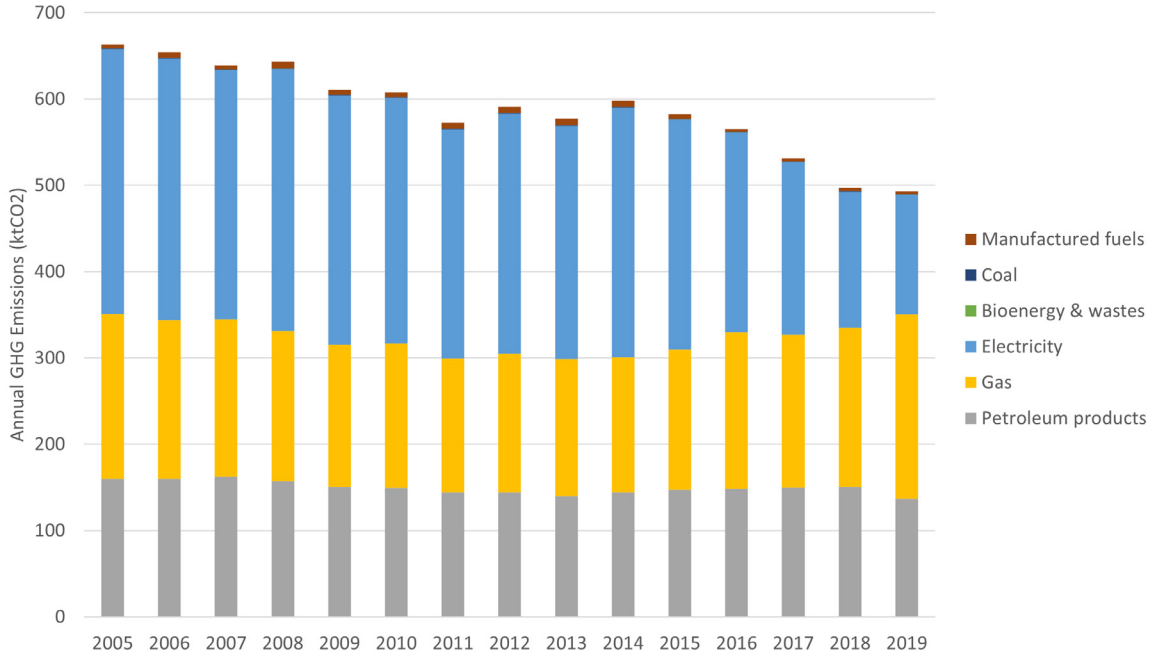
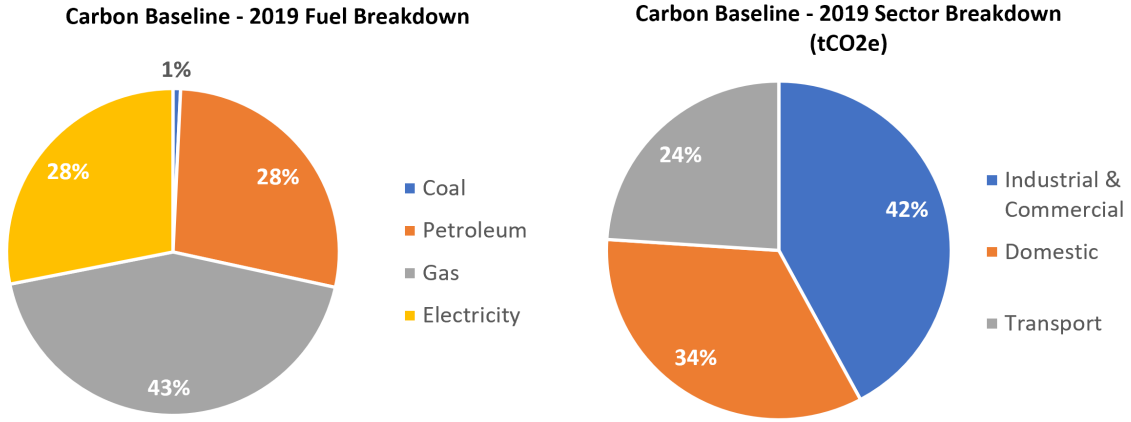


Figure 3-3. Annual Gloucester District Carbon Emissions Splits in 2019.
Source: WSP with Data from DESNZ

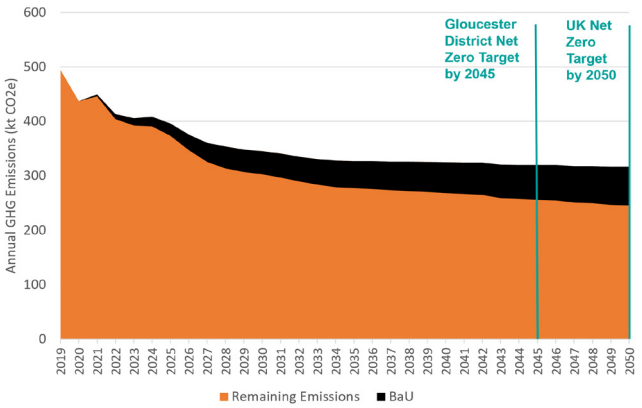


Delivering a Net Zero Carbon Gloucester by 2045

The UK's electricity grid is projected to continue to decarbonise as more renewable energy is connected, as reflected in the 'Business-as-Usual' (BaU) scenario. As a result, further electrification will lower emissions, supporting Gloucester District's ambition of achieving net zero emissions by 2045. However, achieving net zero emissions will not be possible without further action.

Figure 3-4 outlines the carbon emissions trajectory for Gloucester District up to 2050. The black area shows the estimated emission reduction on a BaU scenario. The orange area represents remaining emissions after BaU policies have been modelled.

Figure 3-4. Gloucester District BaU Carbon Emissions for 2017-2050. Source: WSP using DESNZ data for Baseline.



The GCCS response to this is set out later in this report (in Section 4. Achieving Net Zero Emissions) which outlines the actions Gloucester stakeholders will take to achieve the district's net zero emissions target by 2045, in line with the UK's net zero emissions target by 2050. This approach will focus on reducing remaining emissions (light green areas of the above figures), by installing renewable energy-based heating and cooling systems or encouraging active travel, public transport, and EVs for personal travel and commercial freight.

Part 2 – Gloucester City Council Baseline Emissions

Gloucester City Council (GCC) is working towards net zero for its own operations by 2030. This target is aligned with its net zero target by 2045 for Gloucester District. As a signatory of the Global Covenant of Mayors for Climate & Energy (GCoM), GCC is committed to implement policies and undertake actions to limit greenhouse gas emissions and track progress toward the GCoM objectives.

GCC emissions have been estimated by establishing an organisational boundary based upon operational control. This was identified and validated through collaboration and discussions with the GCC Climate Change and Decarbonisation Lead and council officers, and a review of relevant data sources, activities and assets.

The GHG Protocol's Corporate Standard was followed to prepare Gloucester City Council's emissions baseline which has been quantified using a 'calculation' approach, whereby data linked to activities (e.g. litres, tonnes, kWh etc.) is taken and converted to a mass value for GHG emissions using supplier specific and UK Government factors.

All scope 1 and 2 emissions from within the organisational boundary have been included as shown in Table 3-1. However, inclusion of scope 3 emissions is based on level of influence and data availability within Gloucester City Council. Assets owned by the council but leased to tenants or operated by third parties, have been excluded from the GHG baseline. Emissions from the operation of Gloucestershire Airport, partially owned by GCC, are referenced in section 4.7 of this GCCS and previously recommended actions to GCC will be delivered as part of the GCCS. It is anticipated that more Scope 3 emission sources will be included in future years as more data become available; Of the 15 categories included in the Scope 3 Guidance of the Greenhouse Gas Protocol, categories 3, 5 and 7 have been estimated as described in the table below. In the future, emissions from services and goods, downstream assets and investments that could be included in GCC's GHG baseline.

Table 3-1. 2021 Gloucester City Council Baseline Carbon Emissions and Assumptions. Source: WSP

Scope	Category	Description
Scope 1	Gas and Fuel	Direct emissions from company vehicles, generation of electricity and refrigerant gas leaks
Scope 2	Electricity consumption	Purchased electricity for own use
Scope 3	Category 1 – Purchased goods and services	Extraction, production, and transportation of goods and services purchased
Scope 3	Category 3 – Upstream well-to-tank emissions (WTT)	Extraction, refining and transportation of the raw fuel sources prior to their combustion (known as well-to-tank (WTT)).
Scope 3	Category 3 – Transmission and distribution (T&D) losses	Electricity transmission and distribution losses
Scope 3	Category 5 – Waste	Disposal and treatment of waste generated: ▸ Waste data was available for 2021-2022 months, this was assumed to be representative of the 2021 reporting year.
Scope 3	Category 5 – Water	Water consumption and treatment: ▸ Water data was available for 2021-2022 months, this was assumed to be representative of the 2021 reporting year.
Scope 3	Category 7 – Employee homeworking	Home working: ▸ Total number of employees for 2021 provided by GCC; ▸ Assumed 48 working weeks a year (accounting for bank holidays and annual leave); ▸ Assumed 7.5 hours worked per day.
Scope 3	Category 7 – Employee commuting	Employee commuting

Gloucester City Council Baseline Emissions 2021

The baseline year of 2021 was identified as the most recent year for which data was available covering the calendar period from January to December. Total carbon dioxide equivalents (CO2e) emissions in 2021 accounted for 3,381 tCO2e, as set out in Table 3-2.

Insights from GCC baseline emissions in 2021 are illustrated in Figure 3-5 and Table 3-2 and described below:

- Scope 1 emissions accounted for 1,816 tCO2e and represent more than half of all GHG emissions, followed by scope 3 with 28% and scope 2 with 18.3%, as shown in Figure 3-5.
- The biggest source of emissions is the consumption of gas in non-domestic buildings (37.7%), followed by electricity consumption in non-domestic buildings (18.3%) and fuel consumption by the council's vehicle fleet depot (16%).
- For scope 3 emissions, well-to-tank emissions (WTT) are from the extraction, refining and transportation of the fuel consumed by the council's operations, this will be reduced as electricity, gas, and fuel consumption decreases.
- Decarbonisation of the electricity grid by 2030 (and further by 2050) means that emissions will reduce on their own as has already occurred in recent years. However, energy efficiency measures will need to continue to achieve net zero by 2030, by reducing the amount of energy needed by households and businesses, they will also reduce energy bills. These energy efficiency measures include the installation of triple glazing, cavity wall, insulation and energy saving light bulbs.

Figure 3-5. Gloucester City Council Carbon Emissions 2021 Breakdown per Scope and Categories. Source: WSP

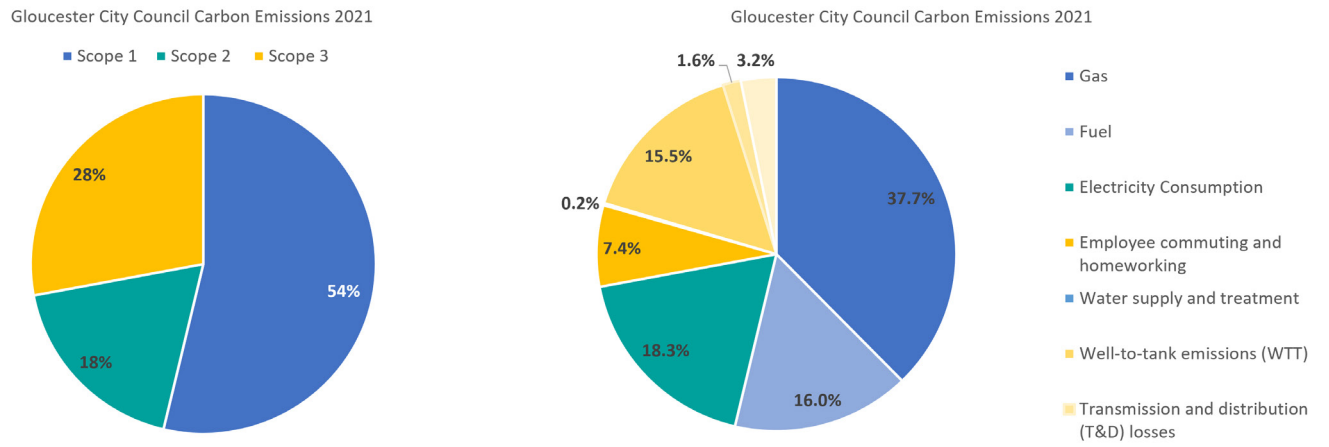


Table 3-2. Outline of GCC Operational Carbon Emissions in 2021. Source: WSP

Reporting Area	Category	2021 Total (tCO2e) (Location Based)	2021 Total (tCO2e) (Market Based)	Totals (tCO2e)
Scope 1	Gas	1,274	1,274	1,816
Scope 1	Fuel	542	542	
Scope 2	Electricity Consumption	620	1,025	620
Scope 3	Employee commuting and homeworking	251	251	868
Scope 3	Water supply and treatment	7	7	
Scope 3	Upstream well-to-tank emissions (WTT)	525	525	
Scope 3	Transmission and distribution (T&D) losses	55	55	
Scope 3	Waste	108	108	
Total		3,381	3,787	3,381

Note: Decimal number rounded to the nearest whole number.

Delivering a Net Zero Carbon Gloucester City Council by 2030

For GCC, net zero by 2030 means limiting the use of fossil fuel across all scopes:

Scope 1:

Heating buildings, ensuring council-owned buildings such as offices, are designed or retrofitted to be low-carbon;

Scope 2:

Electricity use in the council is an important source of emissions, as the grid decarbonises the council can adopt energy efficiency and renewable energy technologies;

Scope 3:

employee commuting, fostering a transition to sustainable transport modes; and

Scope 3:

Influence on the supply chain by requiring their suppliers and contractors to be working towards net zero, for example through sustainable procurement policy.

3.2. Adaptation – Understanding Vulnerability to Climate Change

Climate Risk and Vulnerability Assessment (CRVA)

GCC is aiming for net zero by 2030, and also to create a city that is resilient to climate change impacts. The nature and extent of potential climate change risks and areas of vulnerability for Gloucester have been identified in a Climate Risk and Vulnerability Assessment (CRVA). The assessment was conducted through investigating potential climate hazards, such as heatwaves or storms, the subsequent risks to the city and its community that may occur as a result of those hazards, and existing protections against those risks and hazards. However, the changing climate not only poses risks to the city, its residents and the organisations and businesses that call it home, but also provides opportunities; such as enhancing biodiversity and landscaping, improving health and wellbeing, and providing business opportunities and cost savings through reduced heating bills.

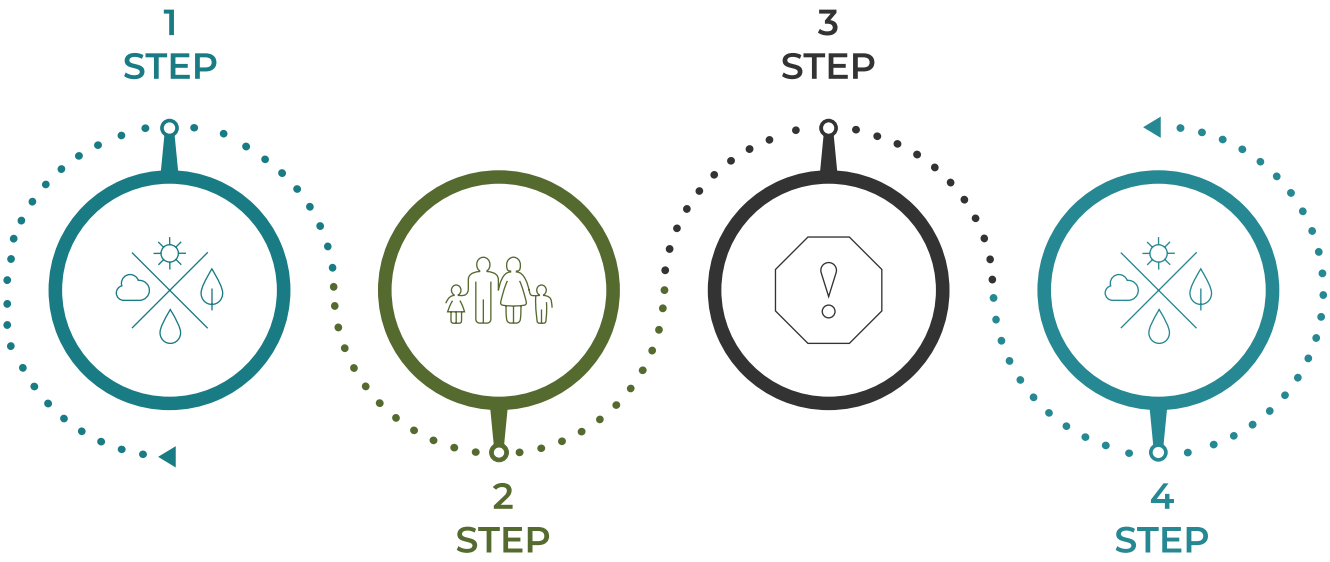
The assessment was undertaken using the latest UK Climate Projections information and indicators (Met Office, 2022) (Arnell, 2021). The risks and opportunities were rated as low, medium, high and very high; in line with the corporate risk matrix and GCoM reporting standards. This was assessed based on the likelihood of the climate hazard occurring and, should the climate hazard occur, what would the impact or disruption look like. The risks and opportunities were grouped into the six themes as outlined in Table 3-3 below.

Table 3-3. Themes and Scope of Council Services* within the Climate Risk and Vulnerability Assessment. Source: WSP

CCRA3 sectors	Theme	Services
Health and Social Care	Community Wellbeing	Safety and crime, health and wellbeing, homelessness, employment, children/ young people, cemeteries, and crematoriums.
Energy, Telecoms and ICT, Transport	Infrastructure (IT, transport, energy)	IT, Transport (parking and roads) and energy
Agriculture and Food	Biodiversity and Environment	Agriculture and green and blue infrastructure
Housing, Business	Housing and Buildings	Corporate and commercial buildings
Water	Waste and Water	Waste, wastewater, bin collections, recycling, and water supply
Business, Cultural Heritage	Culture Leisure and Tourism	Farmers / craft / food markets, museums, heritage sites and assets, theatres, sports facilities, playgrounds, and tourism

*Gloucestershire airport is not included within the CRVA assessment. The CRVA methodology assesses the local authority area, and the airport falls outside of this region. Additionally, as the airport is an investment for GCC, it falls outside the services provided by the council and thus climate risks to the airport will not impact upon the functioning of the council.

Figure 3-6. The Process of the Climate Risk and Vulnerability Assessment. Source: WSP



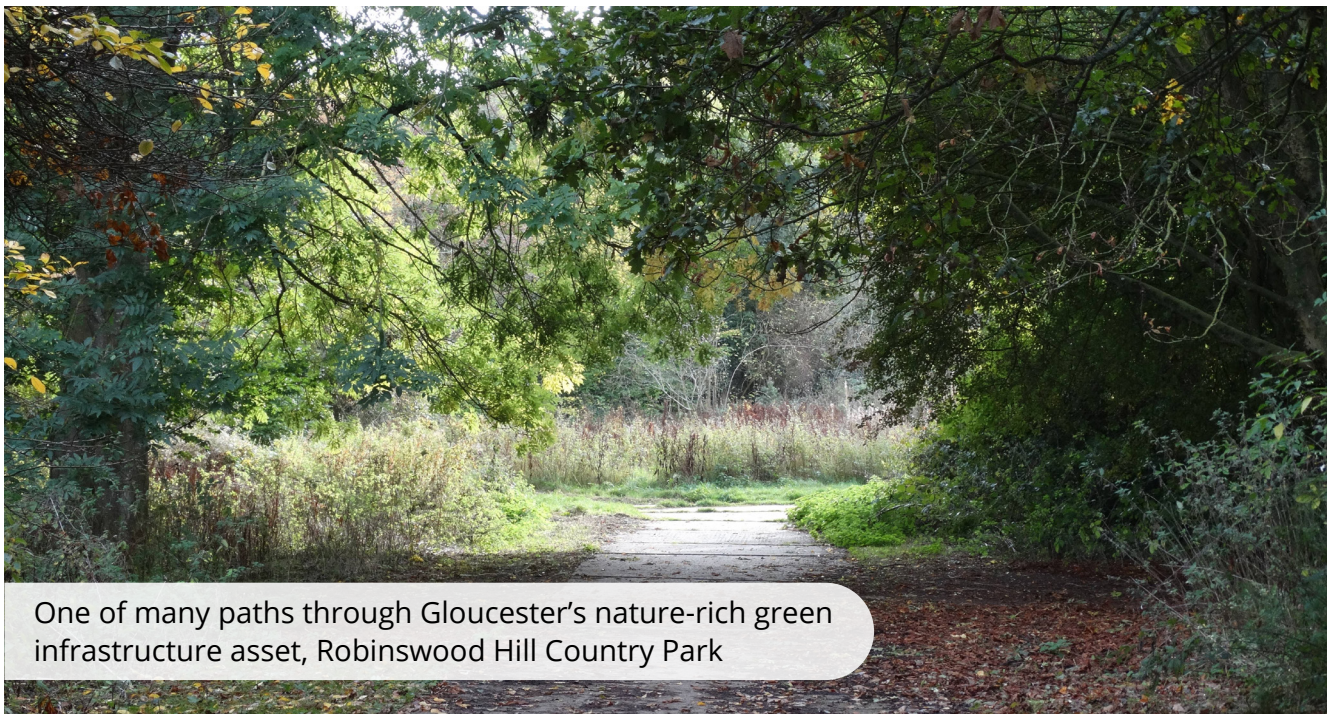
Step 1:
Understanding present day weather, past major climate hazards and future climate change.

Step 2:
Understanding of vulnerable groups.

Step 3:
Identifying potential threats to, and opportunities for, Gloucester City.

Step 4:
Undertaking a Climate Change Risk and Vulnerability assessment and identifying priority climate risks.

Section 5 details further the process and outcomes of the CRVA.



One of many paths through Gloucester's nature-rich green infrastructure asset, Robinswood Hill Country Park

4. Mitigation – Achieving Net Zero Emissions

This section describes the pathway to net zero for Gloucester District and Gloucester City Council, recognising that these are two separate but interrelated pathways. It also covers areas of opportunity for decarbonisation and actions organised around themes of energy, transport, waste and biodiversity.

4.1. Gloucester District Pathway to Net Zero by 2045

To identify a pathway to net zero by 2045 for Gloucester District, the GHG reduction analysis was divided into five areas of opportunities for decarbonisation as described in Figure 4-1 below. Related to this a set of actions has been identified for stakeholders in Gloucester District to implement to achieve the net zero target.

Figure 4-1. Gloucester District areas of opportunity for decarbonisation. Source: WSP

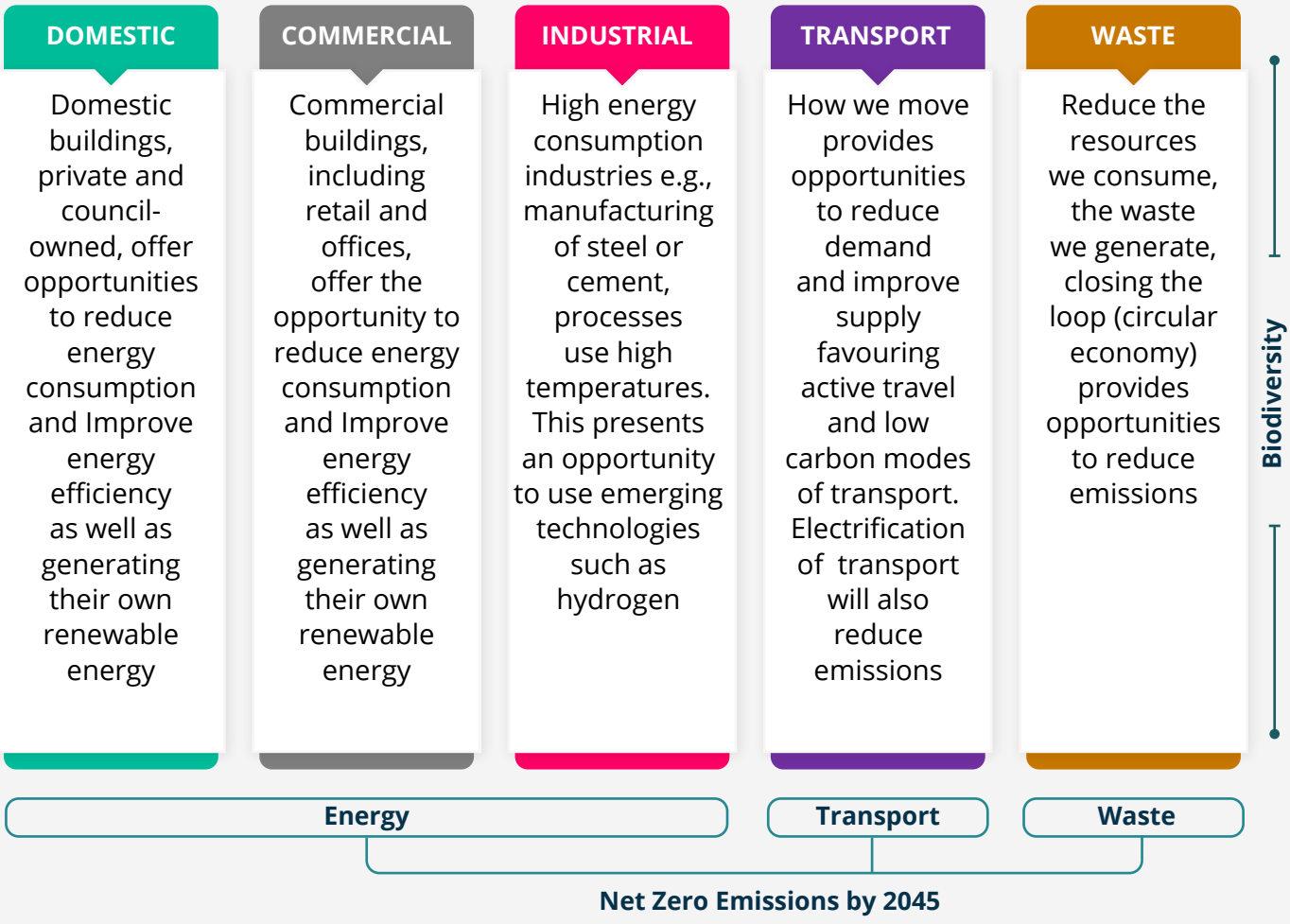
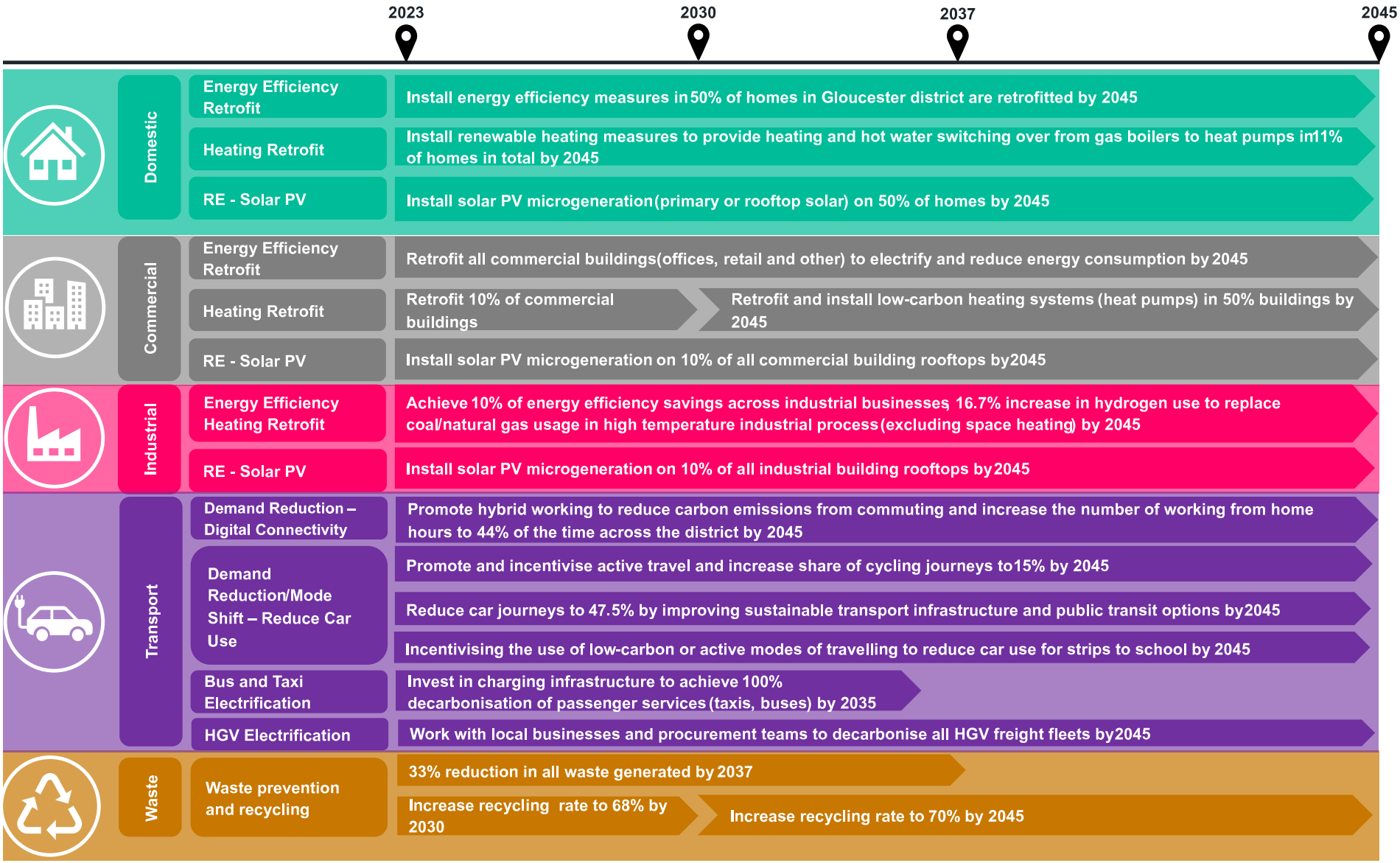


Figure 4-2 presents the actions Gloucester District can take to achieve net zero emissions by 2045, and timeline for delivering decarbonisation across the areas of opportunity. For a detailed breakdown of each action, key stakeholders and potential steps for implementation see Appendix – A – Gloucester District Climate Change Mitigation Actions.

Figure 4-2. Gloucester District roadmap to net zero emissions by 2045. Source: WSP



A short description of each action included in Gloucester District roadmap to net zero emissions by 2045 has been included in the table below as an introduction to Appendix – A.

Table 4-1. High-level description of Gloucester District Mitigation Actions. Source: WSP

Domestic energy efficiency retrofit	Installing energy efficiency measures (where not already present) in half of existing local authority owned dwellings, socially rented and private rented and owned dwellings. The installation of specific measures includes smart meters, smart thermostats, cavity and solid wall insulation, loft insulation, double glazing and other water saving measures, alongside behaviour change. Modelling considers that not all measures will be needed or can be installed in dwellings, a multi-measure approach tailored to each home is suggested.
Domestic heating retrofit	The aim is to achieve heating system retrofits in 11% of homes by 2045 (where not already present). Heat pumps are the low-carbon technology with the highest decarbonisation potential for heating. The modelling assumes the deployment trajectory modelled in the Sixth Carbon Budget report. This trajectory is based on a ban on gas boilers in 2033, and other fuels in 2028, with most installations of heat pumps taking place after 2031. However, central government has introduced an exemption on to the phase out of fossil fuel boilers, including gas, in 2035 for homes struggling to make the switch. While the Boiler Upgrade Grant for households has been increased by 50%.
Domestic solar PV	Installing solar PV in 50% of homes by 2045 can significantly reduce the demand of electricity from the network. Technology is already mature with electricity generation in the short term. A conservative capacity factor of 9.7%, which represents the energy yield of a technology, was employed in the modelling.
Commercial energy efficiency retrofit	The installation of energy efficiency measures in all commercial buildings (where not already present) models the carbon savings from the installation of a range of measures, including building fabric, building controls, energy management systems, lighting installation or building services distribution systems. Their abatement potential has been modelled using BEIS' Building Energy Efficiency Survey.
Commercial heating retrofit	Installing heating system retrofits in 50% of properties by 2045, in line with the equivalent domestic action. Achieving 10% of installations by 2030.This action requires replacing the fossil fuels (natural gas and oil) used for space heating and hot water in retail, offices, hospitality and other commercial buildings.
Commercial solar PV	Installing solar PV in 10% of commercial building rooftops by 2045 (where not already present), would require feasibility and investment to be achieved. However, PVs are a mature and cost-effective technology that provides opportunities to reduce carbon emissions. A conservative capacity factor of 9.7%, which represents the energy yield of a technology, was employed in the modelling.

Industrial energy efficiency and fuel switching	Installing measures in industrial businesses to achieve 10% of energy efficiency measures and 16.7% increase in hydrogen use as alternative to fossil fuels. The 10% energy efficiency savings is an average saving across multiple sectors, including chemicals and food and drinks. The energy efficiency was based on the BEIS Industrial Decarbonisation and Energy Efficiency Roadmaps, carried out by WSP and DNV-GL. Research for the CCC identified that, processes in which hydrogen can play a role are approximately 16.7% (on an energy basis).
Industrial solar PV	Installing solar PV in 10% of industrial buildings by 2045 can significantly reduce the demand of electricity from the network and associated carbon emissions. CCC projections for rooftop solar PV potential by 2050 on a national scale were used to estimate the technically feasible for the industrial sector. Similar to commercial and domestic, a conservative capacity factor of 9.7% was used in the modelling.
Demand Reduction - Digital Connectivity	Promoting hybrid working for people with options to work from home can reduce carbon emissions from commuting. It has been estimated that 44% of the time across the district by 2045, would be feasible based on current arrangements by UK employers requiring 2-3 days to be in the workplace. As the Sixth Carbon Budget Surface Transport report considers, improvements to IT and network connectivity would have to be in place to facilitate the implementation of this action.
Demand Reduction/ Mode Shift – Reduce Car Use	Reducing demand for car travel requires a modal shift towards active travel and public transport, combined with the provision of infrastructure and the introduction of policy measures. The Sixth Carbon Budget Surface Transport report assumes that 14% of journeys can be shifted to active travel (walking and cycling), we have adopted 15% for Gloucester, considering its urban setting. Furthermore, the CCC estimates 34% of car trips could be reduced, with the inclusion of a shift to public transport. Considering Gloucester's current car dependency and potential for active travel, it has been assumed a 47.5% by improving sustainable transport infrastructure and public transit options by 2045. This also considers a reduction in the use of cars for schools' trips. To facilitate mode shift from private motor vehicles to public transport - particularly buses – the City Council will need to actively engagement with the County Council and public transport operators on the possibility of route expansion to under-served neighbourhoods; improved facilities such as shelters at bus stops; and public transport pricing. To facilitate the displacement of short distance private motor vehicle journeys in favour of wheeling, the Council will support kerb-separated cycling infrastructure and engage with the Highways Authority (Gloucestershire County Council) on achieving full compliance with Active Travel England's cycle infrastructure design code (LTN 1/20).

Bus, Taxi and HGV/ HDV (Heavy Duty Vehicle). Electrification	Investing in charging infrastructure to achieve 100% decarbonisation of passenger services (taxis, buses) by 2035. The Sixth Carbon Budget assumes Electric vehicle (EV) technology is developing quickly and they expect uptake of BEVs to grow to between 90-100% of new sales by 2030. However, this could change as the ban on the sale of petrol and diesel vehicles is moved to 2035. The GCCS modelling adopts the CCC's projected pace of public charging infrastructure required in towns and cities as well as long-distance travel. The Sixth Carbon Budget states that decarbonisation of the transport sector will require widespread uptake of zero emission HDVs by 2040 to enable almost full decarbonisation of the fleet by 2050.
Waste prevention and recycling	Reducing waste tonnage by 33% by 2037 compared to 2019 levels and increase recycling to 68% by 2030 achieving 70% by 2045.These targets are aligned with the Sixth Carbon Budget Waste report recommendations; however, these would require significant behaviour changes, with the recycling of commercial and industry waste having the highest potential.
Biodiversity	To safeguard and create green spaces that enhance biodiversity, facilitate active travel, link neighbourhoods, and protect communities from the impacts of the climate crisis. Gloucester City Council's Open Space Strategy (2020-2025) sets out key biodiversity objectives. The council will support Gloucestershire County Council commitment to planting one million trees by 2030.

The impact of the implementation of actions illustrated in Figure 4-2 on Gloucester District baseline emissions is presented in Figure 4-3.

While business-as-Usual (BAU) policies achieve the greatest decarbonisation, which include policies such as transport electrification, including ICE sale ban, that will impact the district, the domestic sector offers the highest decarbonisation potential. This is due to its high consumption of gas for heating and potential decarbonisation through the installation of heat pumps and low carbon heating technologies.

Figure 4-3. Gloucester District Emissions 2019-2050 Graph with actions associated with five identified areas of opportunity. Source: WSP

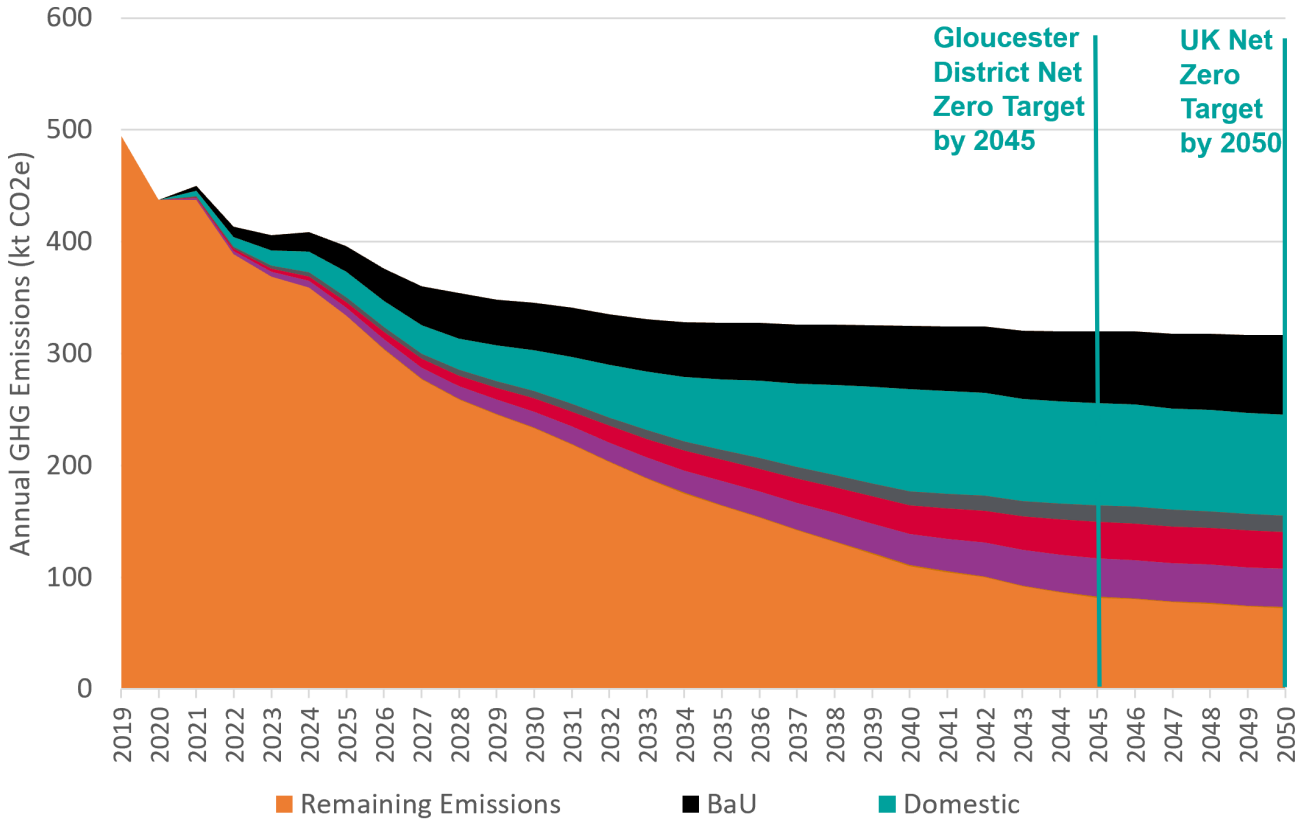


Figure 4-5 illustrates the avoided emissions in Gloucester District in 2045 from the implementation of actions included in the GCCS. Baseline emissions are for the year 2019, as described in section 3.1 to measure progress towards net zero by 2045, the cumulative impact of actions would realise a 76.34% reduction on 2019 GHG emissions levels by 2045.

Residual emissions, shown in Figure 4-5 as total remaining emissions, represents the remaining 23.76% of GHG emissions (128.30 $ktCO_2e$) in Gloucester District. These will have to be removed or offset to achieve net zero emissions by 2045. Following advice from Science Based Targets Initiative, offsets should not be used for more than 10% of Gloucester's emissions: As growth is anticipated in the Gloucester City Plan 2011-2031 an up to 2045, the modelling considers commercial growth as well as additional homes anticipated to be built between 2023-2045.

Figure 4-4. Carbon reduction hierarchy. Source: Columbia University

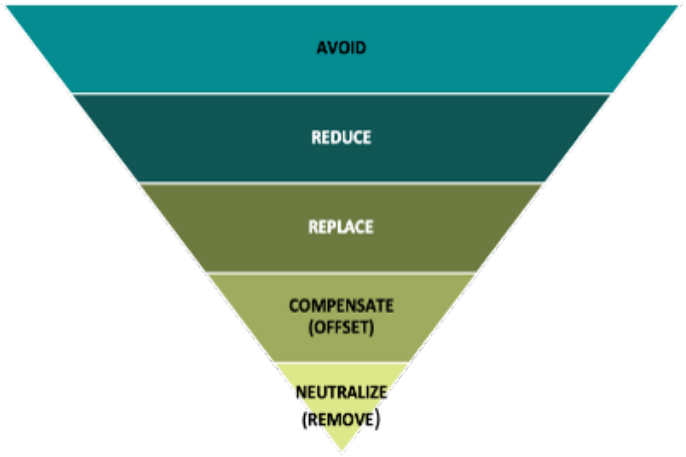
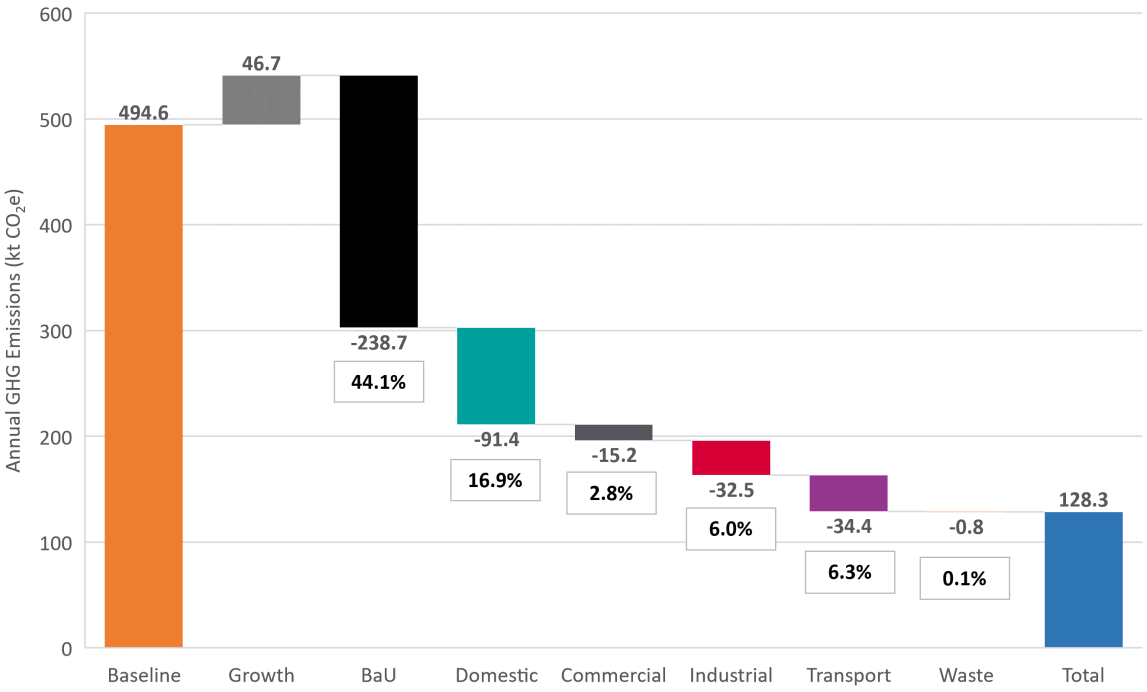


Figure 4-5. Gloucester District emissions 2045 waterfall chart with actions associated with the five identified areas of opportunity. Source: WSP



Carbon removal methods include natural strategies like tree restoration and agricultural soil management; as well as high-tech strategies like direct air capture and enhanced mineralization; and hybrid strategies like enhanced root crops, bioenergy with carbon capture and storage.

Carbon offsets involve compensating for residual emissions and involves the exchange of credits within voluntary markets. A carbon credit is a token representing the avoidance or removal of greenhouse gas emissions, measured in tonnes of carbon dioxide equivalent (tCO2e).

4.2. Gloucester City Council Pathway to Net Zero by 2030

To meet its net zero aspirations GCC has identified four areas of opportunities for decarbonisation as described in Figure 4-6, each with an associated set of actions as set out in Figure 4-7. These opportunities have been identified from the key emitting categories from GCC baseline emissions in 2021, as described in section 3.1, which included gas and electricity in buildings and fuel consumed by GCC's vehicle fleet.

Figure 4-6. Gloucester City Council areas of opportunity for decarbonisation. Source: WSP

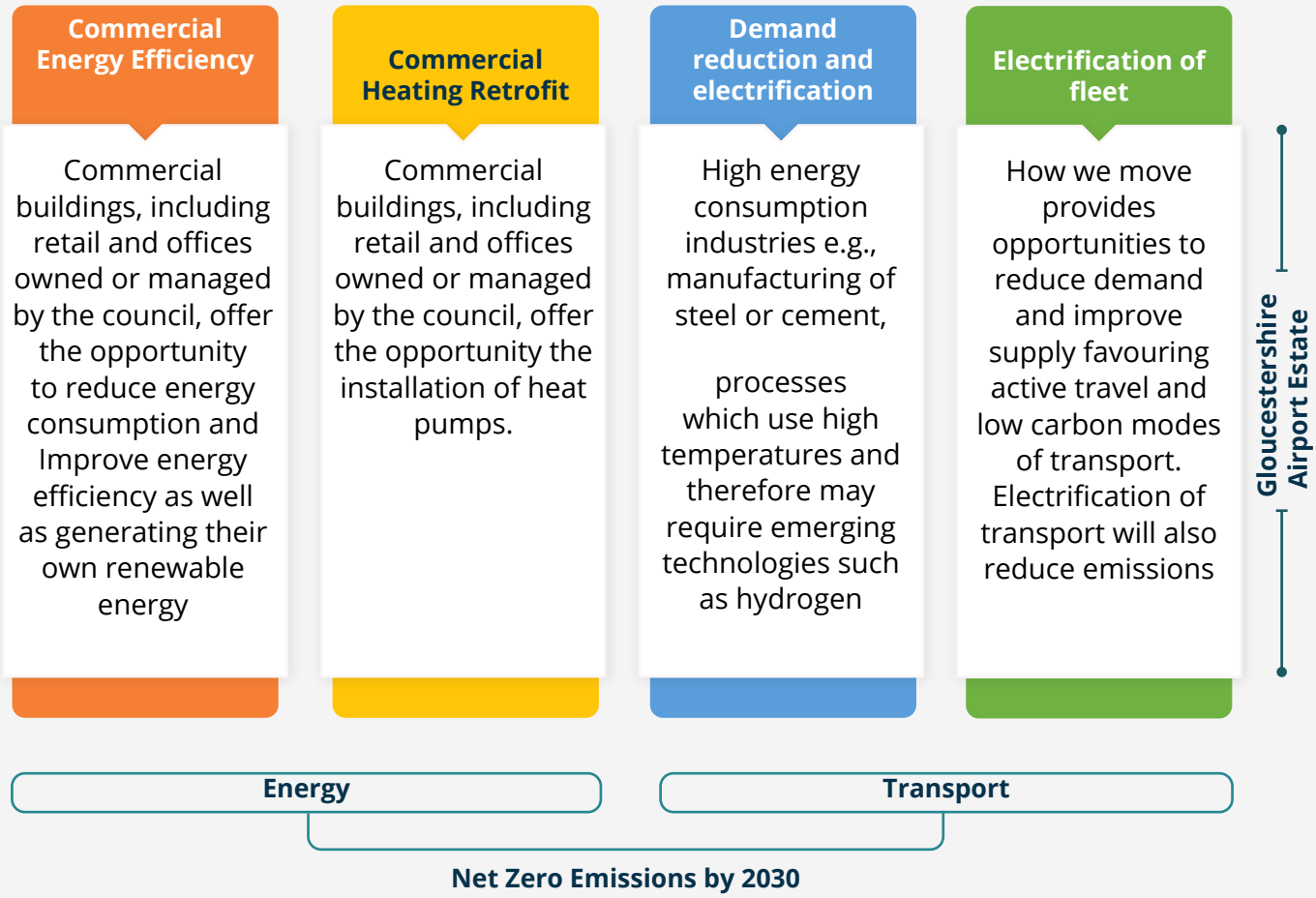
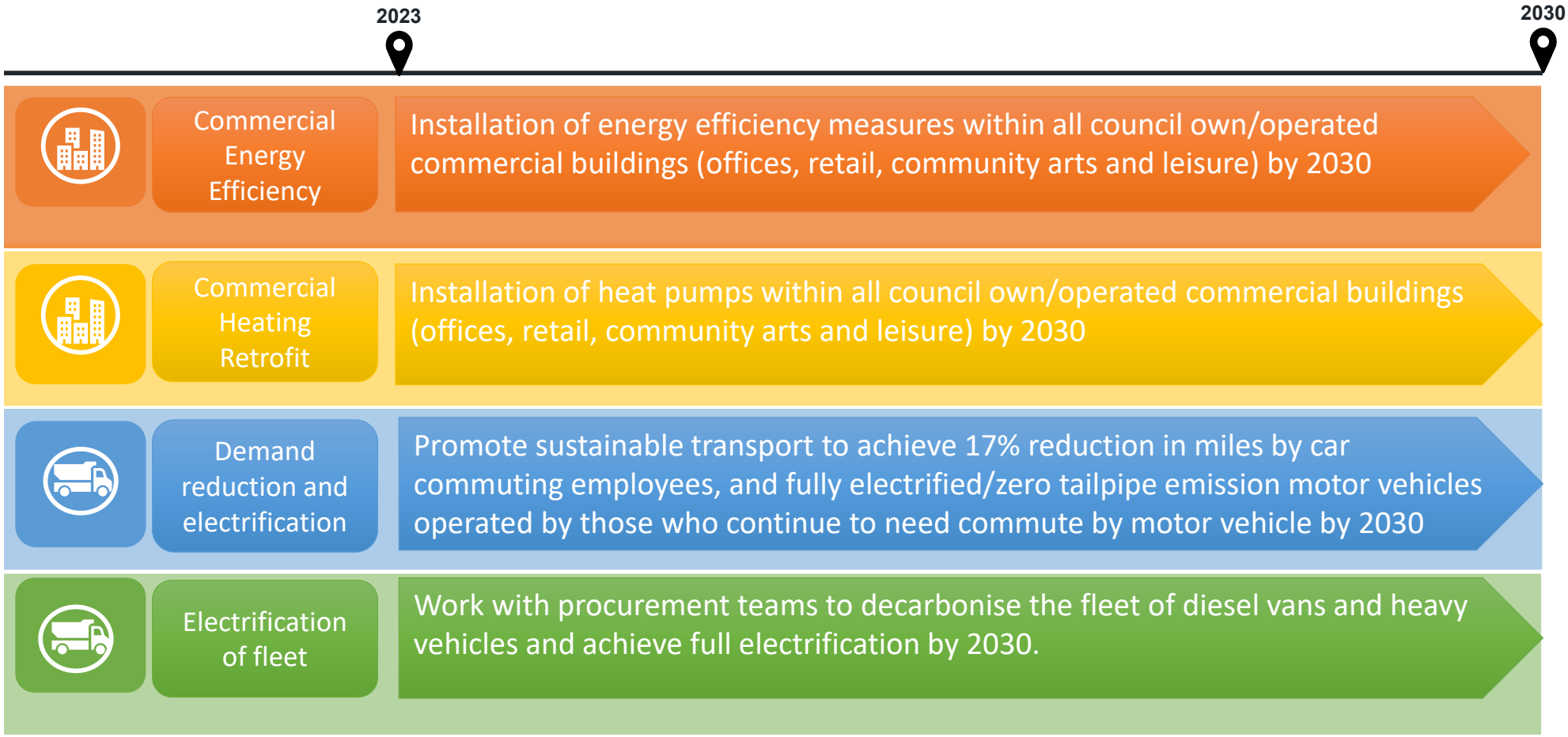


Figure 4-7. Gloucester City Council actions to net zero by 2030. Source: WSP



The net zero pathway set out in Figure 4-8 is based on existing technologies, and as such decarbonisation measures rely on the electrification and the decarbonisation of the grid, which achieves the greatest reduction from 2021 levels.

In addition to savings from grid decarbonisation, the installation of energy efficiency measures in commercial buildings achieves the greatest savings as shown in Figure 4-8. These include the following uses: community, arts and leisure, offices, retail, hospitality, and storage facilities.

Gas consumption in commercial buildings is almost three times that of electricity, which is mostly for space heating. Therefore, the installation of heat pumps will deliver substantial savings followed by the electrification of waste depot fleet, focused on diesel vans and HGVs which make up the majority of council vehicles.

Figure 4-8. Gloucester City Council Emissions 2021-2030 Source: WSP

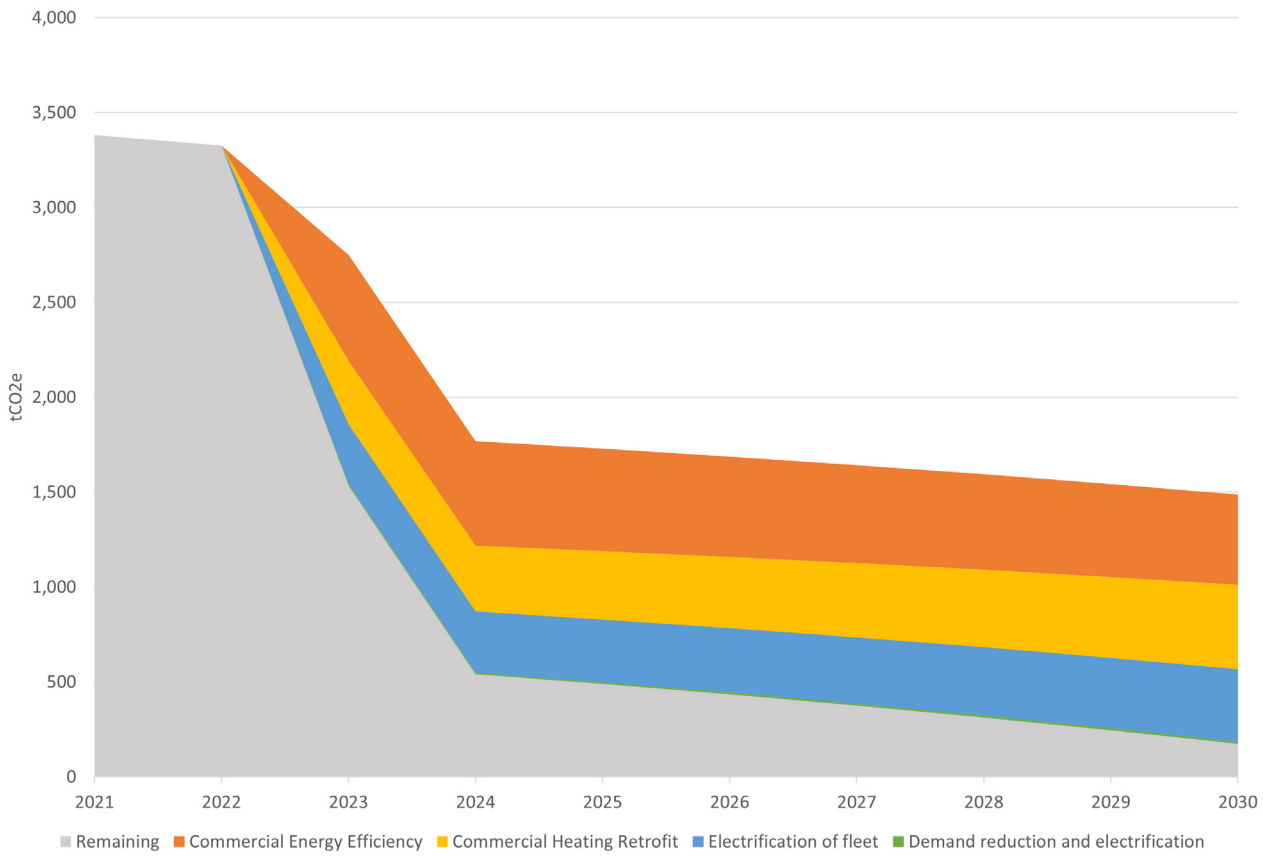
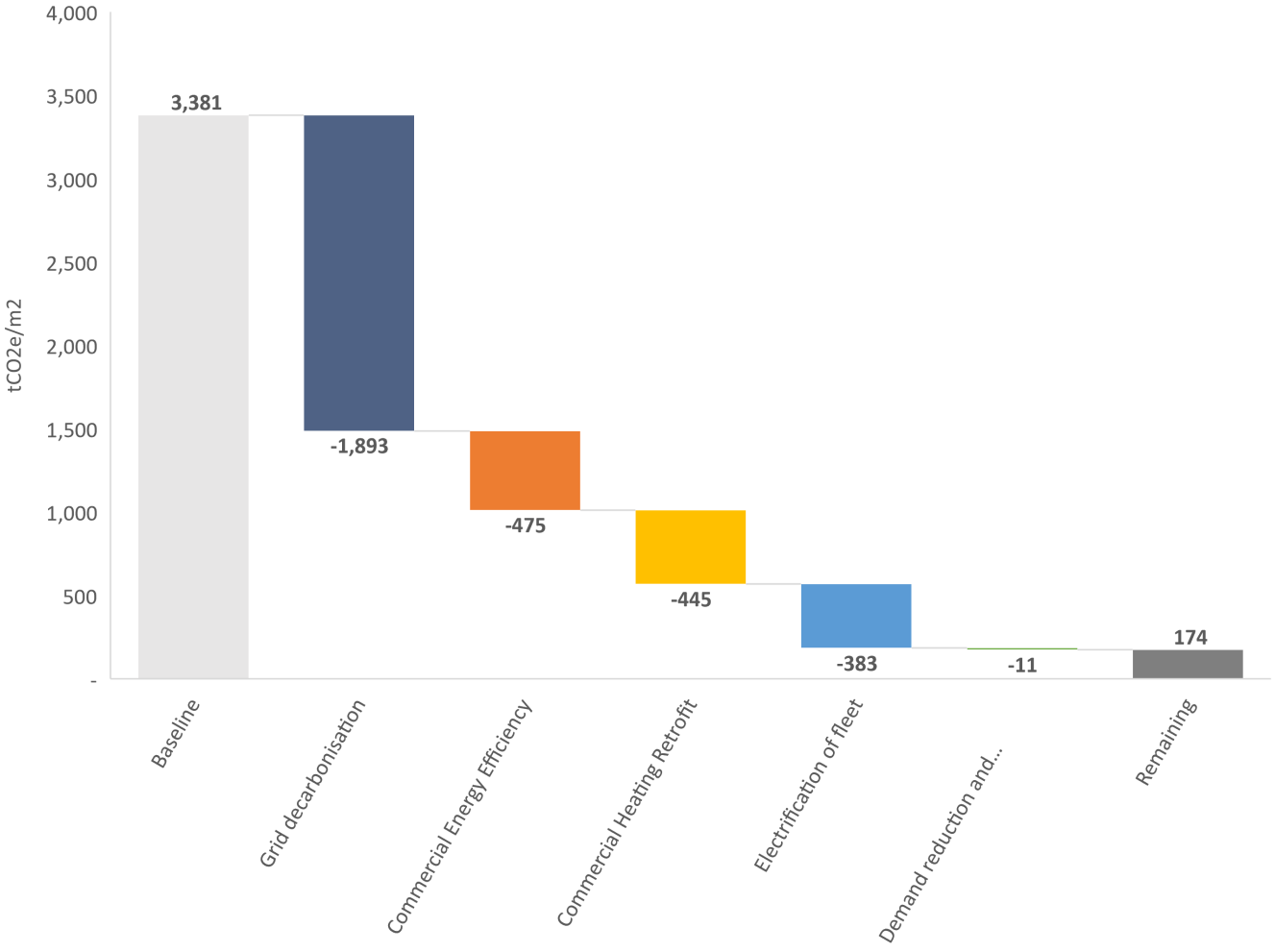


Figure 4-9 illustrates the avoided emissions in GCC's own functions in year 2030 from the implementation of actions included in the GCCS. Baseline emissions are for the year 2021, as described in section 3.1 to measure progress towards net zero by 2030. The implementation of these actions would realise a 95% reduction on 2021 GHG emissions levels by 2030.The 5% remaining emissions will need to be removed or offset by 2030 as recommended for Gloucester District.

Figure 4-9. Gloucester City Council emissions 2030 with actions. Source: WSP



Section 4.3 outlines opportunity areas for decarbonisation for both Gloucester District and GCC's own operations. Since the net zero goals are interrelated and would require the participation of various stakeholders, the actions for the district and GCC are presented together for each opportunity area. Similarly, the evidence used to inform the net zero pathways for the district and the GCC is the same, including central government policy as well as advice from the Climate Change Committee (CCC), city research and peer journals that are relevant to Gloucester District and GCC.

4.3. Area of Opportunity for Action: Energy

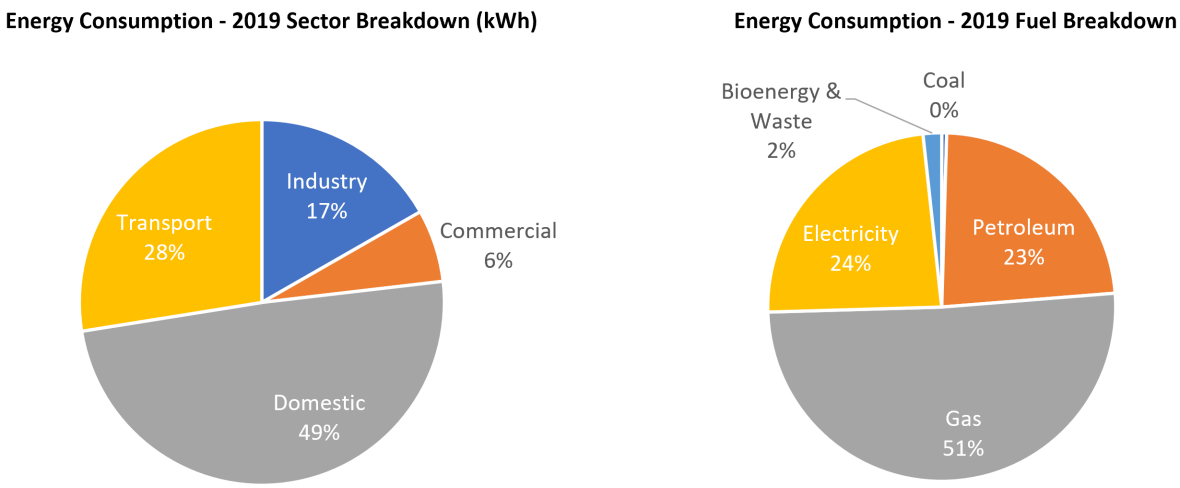
Aim

Promote energy efficiency, reduce energy consumption, decarbonise heating and increase renewable energy generation in domestic, industrial, and commercial properties in Gloucester District and Gloucester City Council.

Energy in Gloucester

In 2019, Gloucester's households, businesses and organisations consumed 2,288.784 kWh in energy. At least 80% of the energy used is from fossil fuel, with almost half of all energy consumption from natural gas. The domestic sector consumed the most energy, followed by industry and transport.

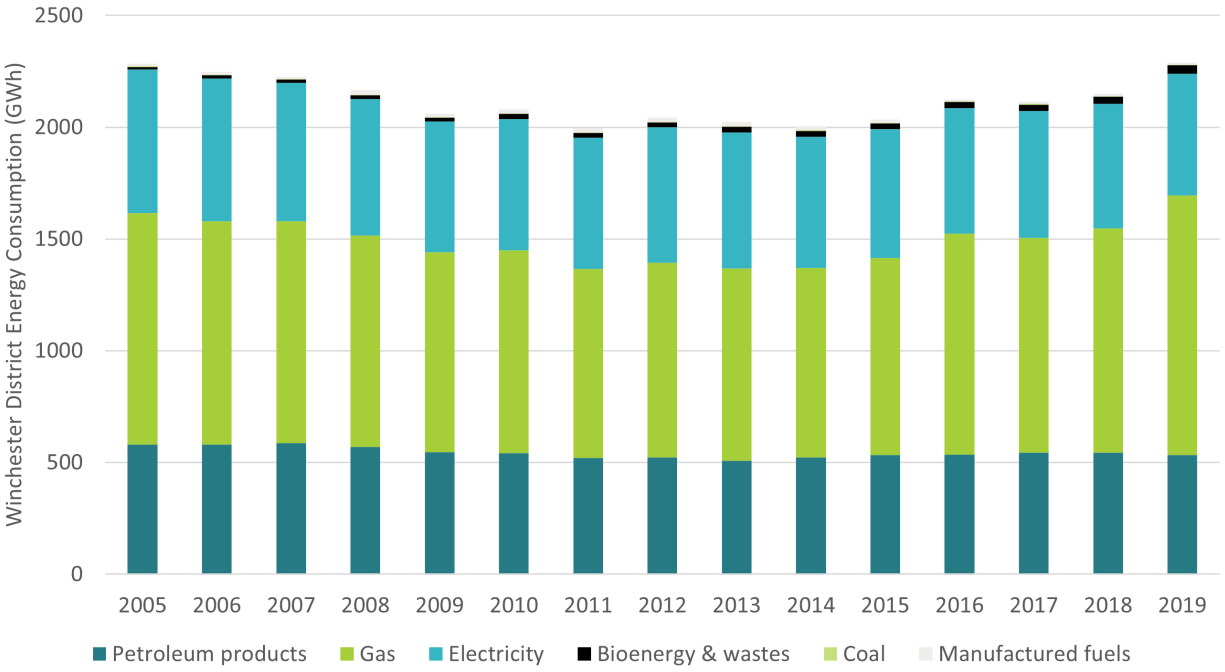
Figure 4-10. Gloucester's Energy Consumption in 2019 by sector and fuel.
Source: WSP with data from DESNZ.



Sector Category	Energy consumption (kwh)	Percentage
Industry	279.4	29%
Commercial	107.1	13%
Domestic	823.4	34%
Transport	459.4	24%

Carbon emissions in Gloucester have reduced since 2005, however energy consumption, has fluctuated over the period from 2005-2019, reducing in early 2010s and increasing in 2019 to return to 2005 levels. Carbon emissions have reduced as a result of decarbonisation of the energy grid, and energy efficiency improvements in buildings as well as a decrease in consumption of coal (50%), manufactured fuels (20%), electricity (15%), and petroleum products (8%) since 2005.

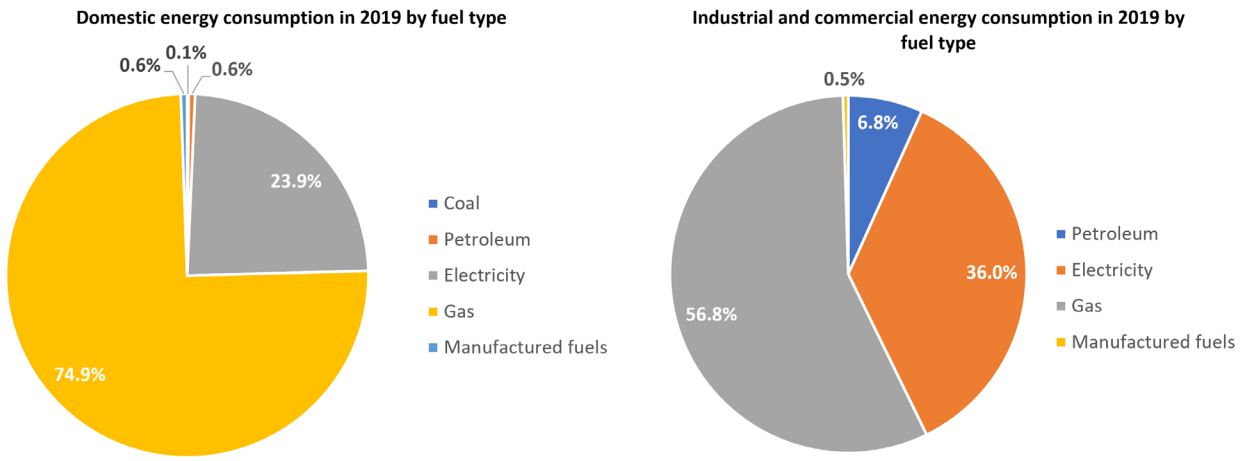
Figure 4-11. Annual Gloucester District Carbon Emissions 2005-2019. Source: WSP with data from DESNZ



Energy in Domestic Buildings

In the domestic sector, gas consumption represents 74.9% of fuel consumption followed by electricity (23.9%), as set out in Figure 4-12. Gas use is mostly for space and water heating, which can be reduced through a combination of energy efficiency measures and low-carbon heat. In 2021, more than half of homes in Gloucester have an Energy Performance Certificate (EPC) rating below C. However, there is potential to influence behavioural change, from planning and design to building net zero homes, in line with the Future Homes Standards, with no boilers installed, as well as the generation of energy from renewable energy sources, for example for solar PV.

Figure 4-12. Domestic, Industrial and Commercial Annual Carbon Dioxide Emissions Splits for Gloucester District in 2019. Source: WSP with data from DESNZ



As part of the actions to achieve net zero, Gloucester District aims to reduce domestic sector emissions by installing energy efficiency measures, heating retrofit and solar PV in homes where these measures are not already implemented.

Gloucester District

Install energy efficiency measures in 50% of homes in Gloucester district are retrofitted by 2045.

Gloucester District

Install renewable heating measures to provide heating and hot water switching over from gas boilers to heat pumps in 11% of homes in total by 2045.

Gloucester District

Install solar PV microgeneration (primary or rooftop solar) on 50% of homes by 2045.

Case Study: The Warm and Well Advice Line

The Warm and Well advice line provides free, impartial, and local home energy advice to households in Gloucestershire. The scheme has been running since 2001. Skilled energy advisers help residents and businesses with a range of issues; from providing advice about simple measures in the house to improve energy efficiency to how to access home improvement grants, such as the Energy Company Obligation (ECO).

It also carries out Green Deal Assessments, including a full technical survey, to produce and EPC certificate. This full assessment looks at fuel bills and energy usage to assess the likely impact of any improvements. The scheme also directs people to a free-to-use online database that can connect residents and businesses with local sustainable energy installers and tradespeople.

For local residents earning less than £31,000 who own or rent an inefficient property the scheme can also provide fully funded insulation and low carbon heating. It has helped to install over 60,000 energy efficiency measures. For more information, Well and Warm have documented some case studies of their work.

Energy in Commercial and Industrial Buildings

Commercial and industry sectors consume almost 43% of energy in Gloucester (see Figure 4-10) and make a major contribution to carbon emissions. Therefore, there is a great potential to engage with businesses to reduce energy usage and carbon footprint. Commercial properties can include retail, offices, hospitality, and other non-domestic buildings.

There is a specific opportunity to improve building energy performance and energy efficiency in commercial buildings owned by, or operated on behalf of, the council to be used as an example of decarbonisation. Similarly, there is the potential to use planning as a means to work closely with businesses to integrate carbon and energy best practices in existing building stock and in new builds.

GCC aims to work closely with local businesses in the district and property managers to install energy efficiency, heating and solar PV measures on commercial and industrial buildings that can benefit from these measures and collaboratively reduce carbon emissions.

The Royal Institute of British Architects (RIBA) has developed an approach to help architects design within a climate conscious trajectory. Its 2030 Climate Challenge provides a stepped approach towards reaching net zero as well as individual targets for embodied and operational carbon, which GCC could use to inform the review of commercial planning applications.

Gloucester District

Retrofit all commercial buildings to electrify and reduce energy consumption by 2045.

Gloucester District

Retrofit and install heat pumps in 50% buildings by 2045.

Gloucester District

Install solar PV on 10% of all commercial building rooftops by 2045.

Gloucester District

Achieve 10% of energy efficiency savings and 16.7% increase in hydrogen use by 2045.

Gloucester District

Install solar PV on 10% of all industrial building rooftops by 2045.

Gloucester City Council

Installation of energy efficiency measures within all council own/ operated commercial buildings by 2030.

Gloucester City Council

Installation of heat pumps within all council own/operated commercial buildings (offices, retail, community arts and leisure) by 2030.

Case Study: Working with Business to Reduce Commercial Energy Consumption

Suntory Beverage & Food BG&I developed a case study for small and medium sized independent convenience stores to implement energy efficiency measures. Cost, time, and uncertainty of where to begin were the key barriers for these businesses. After assessing a Premier in Derbyshire, a range of energy efficiency measures were implemented. These included the installation of LED lighting, replacing old chillers and updating electrical appliances. Recycling initiatives and point-of-sale sustainability measures were used to inspire behaviour change. New stock management practices were adopted to limit van driving hours.

The Energy Saving Trust worked with the store owner to support project management, energy monitoring activities, energy awareness guidance and advice on sustainability and efficiency interventions. After the interventions, the store saved £600 a year – nationwide this could reflect a £28.3m saving for independent convenience retailers. There was also a 12% reduction in electricity consumption. The project highlighted that even small, low-cost interventions can produce positive outcomes.

The Better Buildings Initiative (U.S. Department of Energy) has also produced resource toolkit: Making the Business Case for Energy Efficiency in Commercial Buildings. Cambridge University have also approached this in an academic context: Potential Barriers to Improving Energy Efficiency in Commercial Buildings: The Case of Supermarket Refrigeration.

4.4. Area of Opportunity for Action: Transport

Aim

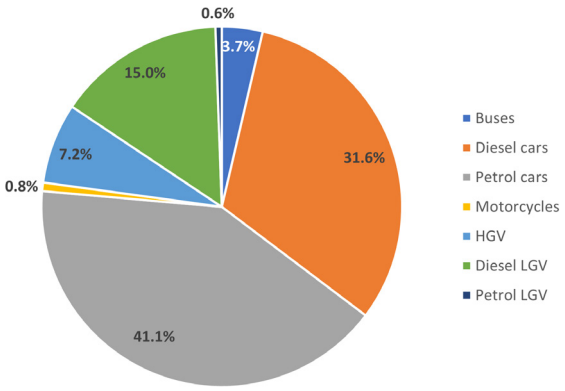
Promote sustainable practices; work with the Local Highways Authority on demand-side measures for reducing excess private motor vehicle use, and deliver demand-side policies within the Council's own powers, such as the recently adopted hybrid working policy; enable the electrification of transport at both the corporate and private level; support walking, cycling and improvements to public and multi-modal transport in Gloucester District and within Gloucester City Council.

Transport in Gloucester

Gloucester is one of Gloucestershire's major urban areas and main economic hub concentrating employment, education, training, and services opportunities for citizens across the county. The district is a net importer of labour, with the workday population rising as a result of in-commuting. Despite offering sustainable travel options, car use continues to be the dominant mode of transport. Continued pressure on the transport network results in delayed journey times and congestion with impacts on public health and wellbeing.

To achieve net zero emissions in Gloucester District and across Gloucester City Council's functions, it is important to reduce tailpipe emissions to near zero. In 2019 (see Figure 4-13), more than 70% of road transport energy consumption was from fossil fuelled passenger cars (diesel and petrol), followed by fossil fuel light good vehicles (LGVs petrol and diesel) with 18%, and heavy good vehicles (HGVs) with 7.2%. Buses and motorcycles have a minor contribution with 3.7% and 0.6% respectively. Therefore, Gloucester District stakeholders will need to work collectively to shift the way people travel, reducing demand for car travel, and decarbonising transport through technological changes.

Figure 4-13. Gloucester District Transport Emissions breakdown in 2019.



The GCCS is aligned with Gloucestershire's Local Transport Plan 2020 – 2041 which sets out the policy areas to reduce tailpipe emissions and objectives as described in Figure 4-14. It defines 'Connecting Places Strategy' areas, the CPS1 - Central Severn Vale includes Cheltenham and Gloucester. Priorities include to complete a strategic cycle route between Gloucester, Cheltenham, and Bishop's Cleeve, increase rail service frequencies and improved journey times to support the expansion of the MetroWest network to Gloucester, provide multi-mode interchanges hubs with sustainable links to key residential and employment areas for onward travel by bus, bicycle or on foot.

Figure 4-14. Gloucestershire's Local Transport Plan 2020 – 2041 objectives. Source: Gloucestershire County Council

LTP Objectives	
Protect and enhance the natural & built environment	**Support sustainable economic growth**
Enable safe and affordable community connectivity	**Improve community health and wellbeing and promote equality of opportunity**

Demand Reduction and Modal Shift

In 2021, 92% of passenger kilometres travelled in Great Britain were made by cars, vans and taxis. The vast majority of trips (94%) are made using private transport, with 68% of people choosing to commute by car. In South West England this is even higher with 76% of commuting trips made by car. A reduction in demand for car travel will reduce GHG emissions in the district and improve congestion and wellbeing. However, this would require behavioural changes and improving public transit options.

Societal changes include factors such as home working. In 2022 commuting is the second most common trip purpose in the UK after shopping. Home-working, local working and internet shopping all offer the potential to reduce the total number of journeys undertaken.

Gloucester City Council employees currently implement an agile working policy with 62% of employees frequently working from home. When not working from home, 50% of employees travel alone, in a fossil fuel motor vehicle, 14% of employees routinely walk/run to site; and 14% of employees use public transport to get to site (7% bus, 7% train). Employees choice of mode travel is motivated by convenience, time, and cost. Improving public transit option, affordability and reliability will have the greatest impact in behavioural change.

With Gloucester City Council leading by example, local businesses and office workers have the potential to adopt the transport decarbonisation hierarchy and to prioritise digital communication where possible. Factors such as increased home-working and local working for those with access to these actions could reduce car travel.

Case Study: Gloucester City Council's Green Travel Plan

The plan provides a route map for reducing surface transport emissions and improving air quality. Through 15 recommendations, including exploring segregated cycle infrastructure and embedding an agile working policy, the project will enable the council's climate action to be even more focused and directed by hard data.

The Green Travel Plan demonstrates both the council's commitment to meaningful action as well as this action being informed by science to address the climate emergency and create a healthier city. 22% of the UK's total emissions are from road transport and so, by 2030, the council will achieve a 17% reduction in miles that officers commute against pre-pandemic levels and vehicles to be zero emission at tailpipe.

The plan quantifies and assesses the per capita surface transport emissions from officers' travel, surveyed their travel habits and barriers to devise the recommendations. The plan encourages home and hybrid working, prohibits domestic air travel, mapped safe, low pollution walking routes, is exploring segregated cycling and will encourage reductions in driving in a fair and reasonable way.

The agile working policy has enabled average annual employee commuting emissions to stand at 185kg CO2e, whereas the national best-case scenario (taking the lowest carbon mode of travel available) is 281kg CO2e. This is popular with staff, who can enjoy greater flexibility and reduces council office costs, enabling greater funds for essential services.

To deliver the transport actions of the GCCS, stakeholders in Gloucestershire will need to work collaboratively to access investment and funding. The Sixth Carbon Budget published by the CCC found that a reduction in private car use can be achieved through investments in infrastructure for active travel as well as improvements to provision and reliability of public transport. This can also be complementary to policy changes such as the Low Traffic Neighbourhoods (LTNs), which have been found to be one of the most effective ways to reduce overall car use in European cities.

Brighton and Norwich have piloted school trip planning, providing travel plans and advice for pupils and their parents, combined with promoting walking, cycling and car sharing achieving a 10% reduction in car use in Norwich. However, changing behaviour requires improving cycling infrastructure and other facilities for users.

Gloucester District

Promote and incentivise active travel and increase share of cycling journeys to 15% by 2045.

Gloucester District

Reduce car journeys to 47.5% though mode shift and provision of infrastructure by 2045.

Gloucester District

Reduce car journeys to 47.5% though mode shift and provision of infrastructure by 2045.

Gloucester District

Incentivising the use of low-carbon or active travel to reduce car use for school trips by 2045.

Gloucester District

Achieve 17% reduction in miles by car commuting employees, and fully electrified/ zero tailpipe emission motor vehicles by remaining vehicles by 2030.

Case Study: Islington Low Traffic Neighbourhood

People friendly streets, or Low Traffic Neighbourhoods (LTNs) are designed to enable people to walk and cycle around their communities more safely. Beginning in the 1970s and growing in popularity in 2020, LTNs use planters, bollards, and other street furniture to direct drivers towards suitable arterial networks and avoid quiet, community streets being turned into shortcuts and rat runs. This can decrease congestion, improve air quality, and enable children to play outside safely. They also facilitate those who would like to use active travel to walk and cycle.

Islington Council installed measures such as bollards and smart cameras to create space for residents to walk, wheel and cycle around their neighbourhoods. These are being trialled for 18 months, with residents' views and feedback being assessed after 12 months before a decision is taken on whether to make the trial period permanent.

Consultations generally showed the popularity of the schemes, with more residents taking up active travel, people feeling safer outside and significant improvements in local air quality.

Zero-Emissions Vehicles

The CCC estates that cars and vans, battery-electric vehicles are now widely available and are likely to become cost-saving by the late-2020s. For HGVs options include battery-electric vehicles, hydrogen fuel-cells and electric road systems. Electric vehicle (EV) technology is developing quickly and the CCC expects uptake of Battery electric vehicles (BEVs) to grow to between 90-100% of new sales by 2030, although this may be subject to change given the Government's recent change of deadline for phasing out the production of new, wholly combustion engine vehicles from 2030 to 2035.

Achieving Gloucester District and GCC net zero targets requires for delivering transport with zero tailpipe emissions including private vehicles, public transport, and freight operations. Gloucestershire County Council is committed to the roll out and encouragement of electric vehicles in Gloucestershire, with the rollout of 1,000 electric vehicle (EV) charging points in Gloucestershire, including sites in Gloucester. This will provide on-street EV charging for those without access to increase EV uptake.

Gloucester City Council

Work with procurement teams to decarbonise the fleet of diesel vans and heavy vehicles and achieve full electrification by 2030.

Gloucester District

Invest in charging infrastructure to achieve 100% decarbonisation of passenger services (taxis, buses) by 2035.

Gloucester District

Work with local businesses and procurement teams to decarbonise all HGV freight fleets by 2045.

4.5. Area of Opportunity for Action: Waste

Aim

Promote the reduction of waste generated and increase recycling rates in Gloucester District.

Waste in Gloucester

Sustainable waste management is a crucial part of meeting local net zero goals, and in supporting the development of a safer, greener society. Effective waste management practices not only reduce the amount of waste sent to landfills but also minimize the environmental impact of waste disposal. By implementing recycling programmes, promoting composting, and encouraging waste reduction strategies, local authorities can significantly reduce greenhouse gas emissions, create jobs, and conserve valuable resources.

By 2027/28 forecasts suggest that Municipal Solid Waste in Gloucestershire will increase to 359,612 tonnes (Gloucestershire Core Waste Strategy 2011). With a growing population the volume of household and business waste, alongside waste from building sites, farms, used cars, electrical equipment, and hospitals, is a critical issue for Gloucester City, and the county as a whole.

In 2022 Gloucester City Council worked to ensure a smooth transition to a new waste management partnership. The Council Plan (2022-2024) sets out three key actions regarding waste:

Deliver a community consultation to get feedback on our plans to increase recycling and reduce waste.

Transition successfully to the new waste partnership by 1st April 2022.

Maintain a minimum recycling level of 45% and develop a waste strategy to enable an increase.

Working in Partnership

Partnership working is a key part of delivering the City's objectives. Gloucester City Council is part of the Gloucestershire Resources and Waste Partnership (GRWP) which provides countywide leadership and a framework for joint working on resources and waste related matters. GRWP members work together to optimise waste management services across the county.

GCC works with the county, and delivery partners to provide a range of waste management services including bins and recycling, street cleaning, fly-tipping, and handling environmental crime and offences. GCC also manages over 100 volunteer litter pickers and has worked with neighbouring local authorities to support the development of the Waste Wizard online platform which helps people manage their waste. The council is also working with Podback to provide a new free recycling service to help people recycle pods (coffee, tea, and hot chocolate) at home

At a county level, climate goals, and to cope with the growing pressure put on waste management systems, Gloucestershire County Council developed **Gloucestershire's Waste Core Strategy (2012-2027).** The strategy sets out how the County Council and its partners are addressing the issue of waste management.

As part of this strategy the county set a target of achieving a recycling rate of 60% by 2020 however, a 2020-21 analysis found that Gloucestershire's recycling rate stood at 50.8%, with a significant amount of recyclable material still being disposed of by residents as residual waste. Further study showed that if all residents recycled as much as they could within the existing waste services the recycling rate would be more than 70%.

To address this, the Gloucestershire Resources and Waste Partnership (GRWP) is implementing a new Gloucestershire Resources and Waste Strategy. The GRWP has committed to developing annual action plans and has set out three key performance measures:

Recycling rate.

The recycling rate (which also includes reuse, composting and anaerobic digestion) has steadily climbed over a number of years although has not yet reached the original strategy target of 60%. We will maintain a target of 60% recycling but recognise that achievement of this will require further step changes in service delivery. In the meantime, the annual action plan will aim to deliver incremental improvement towards this target, with an interim target of 55% by 2026.

Residual waste per household.

This has been reduced significantly in recent years and, excluding 2020/21 when the effects of lockdown and home working skewed the tonnage data, continues on a downwards trend of between 10 and 20kg per household per year. Residual waste targets will therefore be set, reducing 10kg per household per year in line with this trend.

Carbon emissions.

Each partner authority monitors the carbon emissions associated with its activities and we will continue to do this. We will also develop a robust mechanism whereby carbon emissions are targeted for reduction and are embedded as a core aspect in decision making, for example in contract procurements or in operational delivery.

Examples of actions that the GRWP is exploring include:

- The addition of further separate materials collections for recycling, such as soft plastics (e.g., plastic films and bags), where viable.
- The continued encouragement of higher levels of participation in waste reduction, reuse and recycling by residents using behaviour change engagement techniques, with a particular focus on food waste.
- Maintaining a focus on materials quality, adapting services to respond to changing market requirements and the development of a more circular economy.

To achieve net zero emissions by 2045, Gloucester District will continue to work closely with Gloucestershire and existing policy, including the suggested approach by the CCC in the Sixth Carbon Budget Waste report for a balanced net zero pathway, as described in the actions below.

Gloucester District

33% reduction in all waste generated by 2037.

Gloucester District

Increase recycling rate to 68% by 2030 and to 70% by 2045.

Case Study: Making Recycling Work for People In Flats, London

ReLondon is a partnership of the Mayor of London and the London boroughs that aims to improve waste and resource management across the city.

In 2019 ReLondon led work to understand barriers to recycling in flats and enhance recycling rates and effectiveness. To do this the organisation conducted surveys of 132 inner London Peabody housing estates and conducted in-depth ethnographic research involving residents.

Using the insights gathered, ReLondon collaborated with housing providers, local authorities, and waste management organizations to create the 'Flats Recycling Package.' This package comprised a series of improvements to recycling facilities in purpose-built flats. The 'Package' aimed to provide residents with clear information and included a set of changes to recycling arrangements in purpose-built flats that could be implemented and tested to see how effective they were at improving recycling and capture rates.

The 'Package' was rolled out across 12 London housing estates over a span of nine months, concurrently implementing behavioural interventions designed to encourage residents to increase their recycling efforts. It also introduced five behavioural interventions across 10 of the 12 estates, including new signage around rubbish bins, feedback posters and in-home storage solutions for recycling.

The 'Flats Recycling Package' of measures substantially increased the volume and quality of recycling across all 12 estates. The overall capture rate increased by 22%, the recycling rate increased by 26% and the contamination rate decreased by 24% over the nine-month period.

4.6. Area of Opportunity for Action: Biodiversity

Aim

To safeguard and create green spaces that enhance biodiversity, facilitate active travel, link neighbourhoods, and protect communities from the impacts of the climate crisis.

Biodiversity in Gloucester

Biodiversity plays a crucial role in maintaining the health and balance of our ecosystems. Green and blue infrastructure, such as parks, forests, wetlands, and green roofs, not only support local biodiversity but also help to sequester emissions, adapt to climate change, and improve people's physical and mental wellbeing.

The City of Gloucester is home to over 200 areas of public open space including parks, allotments, cemeteries, six nature reserves and two Sites of Special Scientific Interest. With over 14% of the city's total land area made up of publicly accessible green space, the GCC recognises that biodiversity is an important part developing a healthier, more sustainable city.

Between 2014 and 2019 the council added an additional 15 hectares of new open space and over £2million for improvements to existing parks and open spaces across the city. However, the City's growing population (and ongoing projected growth) is putting pressure on local green spaces as demand for housing development increases. In response the council has developed policies to protect most public and private open spaces, as well as guidance to include green spaces in any new developments.

Biodiversity objectives

Gloucester City Council's Open Space Strategy (2020-2025) sets out key biodiversity objectives including:

To develop site improvement plans or site management plans for larger/priority open spaces and those sites with the greatest potential for increasing biodiversity.

Review the council's grounds maintenance contract and identify opportunities for less intensive open space management, to increase biodiversity, sustainability and ensure best use of available resources.

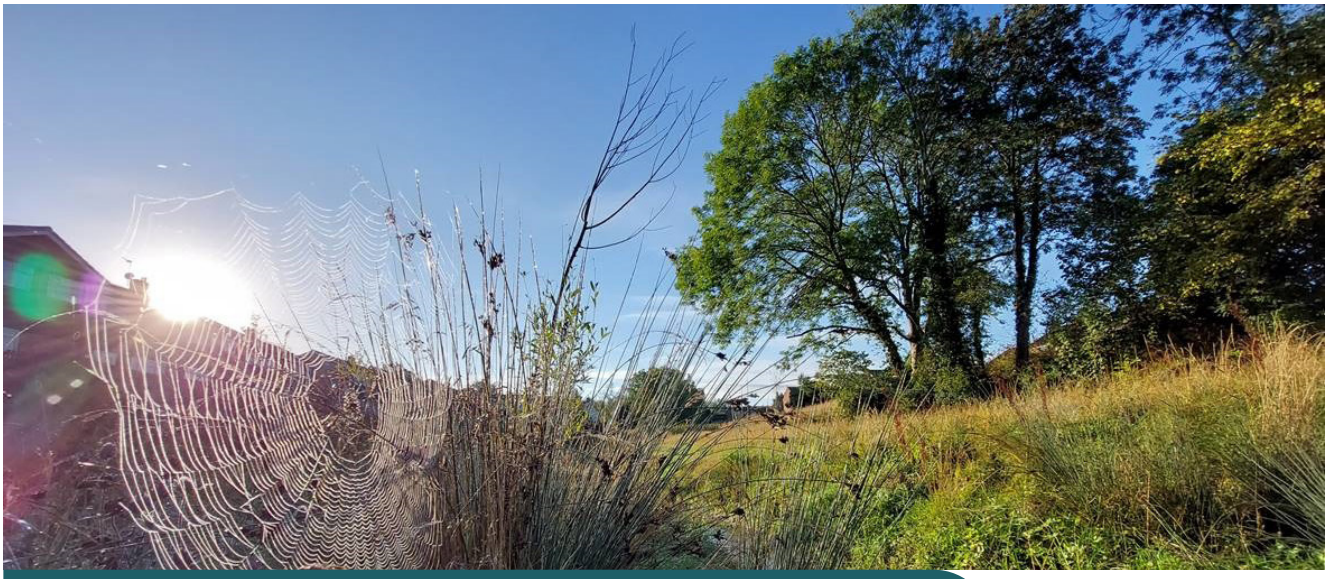
To utilise green space to help mitigate the effects of climate change and biodiversity loss, through habitat creation and management, increased tree planting, water management schemes and other appropriate measures.

To maintain Green Flag status for existing sites and to seek opportunities to increase the number of Green Flag parks in Gloucester.

In addition to the Open Space Strategy the council has developed Gloucester's City Plan (2016-2031) which sets out guidance on a variety of aspects pertaining to green spaces across the City. The Plan sets out strategic objectives around conserving and enhancing the environment, treen and hedge row protection, protecting open spaces, delivering excellent design in new developments, meeting the challenge of climate change, and promoting healthy communities. Key themes within the Plan include:

Enhancing biodiversity

- In England, Biodiversity Net Gain is a planning requirement that mandates developers to improve the natural environment as part of the development process. Local authorities plan an important role in this process through their Planning and development functions. Biodiversity Net Gain became mandatory on February 12, 2024 for major developments and on April 2, 2024 for small sites.
- Development proposals must demonstrate the conservation of biodiversity, in addition to providing net gains appropriate to the ecological network. All new streets must also be tree-lined unless it can be justified otherwise.
- Damage to the natural environment must be avoided or mitigated, and biodiversity offsets could be considered to provide overall net gain. The Severn Vale Nature Recovery Area (NRA) has been identified as an area for biodiversity offsetting as part of achieving biodiversity net gain when development proposals cannot deliver enhancements on site.
- Development which would result in the loss of irreplaceable habitats such as Ancient Woodland, Ancient Trees and veteran trees are not permitted except in exceptional circumstances.



Watercourse renaturalisation at Sudbrook, which has improved biodiversity and increased natural water retention.

Complying with the National Planning Policy Framework (NPPF)

- In accordance with the NPPF, the Local Nature Partnership (LNP) are currently mapping Gloucestershire's ecological network. This includes identifying existing habitat, restoration opportunities, existing connectivity, and the strategic locations for increasing connectivity.
- Biodiversity Net Gain (BNG) is another key part of the NPPF, and the City Council is working with developers to incorporate BNG requirements into ongoing and future activities.

Allotments

- Allotments are key spaces for biodiversity as well as providing a range of other ecological and wellbeing benefits. Existing allotments are protected from redevelopment unless an appropriate alternative provision is made by the developer. The provision of new allotments will be supported where they would meet identified need within a community.

Green infrastructure targets

The importance of green infrastructure in helping to reduce the localised effects of global warming cannot be overstated. Urban tree canopy cover, in particular, helps – via shading, removal of hardstanding, and evapotranspiration – to significantly reduce the propensity, intensity, and duration of extreme heat events, with cascading effects on peak energy demand for cooling and hospital admissions; rainwater gardens and tree pits reduce surface water flooding; and green roofs reduce pressure on the drainage system while enhancing biodiversity.

As part of the City's work to achieve its net zero ambitions Gloucester City council has committed to a programme of tree planting. The council has already collaborated with the Royal Forestry Commission, the Woodland Trust, and Gloucestershire County Council to plant 12,800 new saplings across all 18 of the city's wards, and an additional further 100 large 'standard' specimens will be planted across Gloucester.

At a county level, Gloucestershire County Council has committed to planting one million trees by 2030, a target that aligns with the recommendations of the Gloucestershire Tree Strategy (current total up to 220,396 (2023)).

Case Study:
Linking Neighbourhoods Through Green Infrastructure, Little France Park, Edinburgh.

Little France Park is a peri-urban green corridor that links Edinburgh City Centre to Midlothian. It is approximately 45ha has been created by reclaiming unmanaged grassland. The park is made up of a range of habitats including grassland, hedges, wetland (that has been created as part of a flood alleviation scheme), woodland and moving water courses. It is ecologically diverse and species rich and the site became a nature reserve in 2021.

The park includes a 3km cycle route that links new housing developments with the city and public transport routes. The park is adjacent to some areas of economic deprivation and is an important resource for local people.

4.7. Area of Opportunity: Gloucestershire Airport Estate

Gloucestershire Airport, located at Staverton, is jointly owned by is Gloucester City Council and Cheltenham Borough Council. The analysis below summarises Gloucestershire Airport's carbon baseline emissions for 2019 and actions to reduce emissions (excluding the air fleet).

The airport's emissions have been calcuated based on electricity and fuel consumption (made up of jet fuel, aviation gas (AVGAS), unleaded avgas 91 (UL91), and red diesel). Figure 4-15. Percentage contribution to airport emissions by source (CO2e). Source: CLS Energy Ltd adapted by WSP. shows the relative contribution of each emission source converted into tonnes CO2e. The aviation fuels combined (jet fuel, AVGAS, and UL91) is by far the most significant source, making up almost 99 percent of emissions.

Analysis of the airport's electricity demand only (presented in kilowatt hours (kWh)) shows that consumption is generated from 12 locations. The top four sites (New Hanger and Terminal, Control Tower, SE27, and Gloucester Airport Limited (GAL)) contributing 90% of the the airport's electricity consumption (with the top 3 contributiong 80%) as shown in Table 4 2

Figure 4-15. Percentage contribution to airport emissions by source (CO2e). Source: CLS Energy Ltd adapted by WSP.

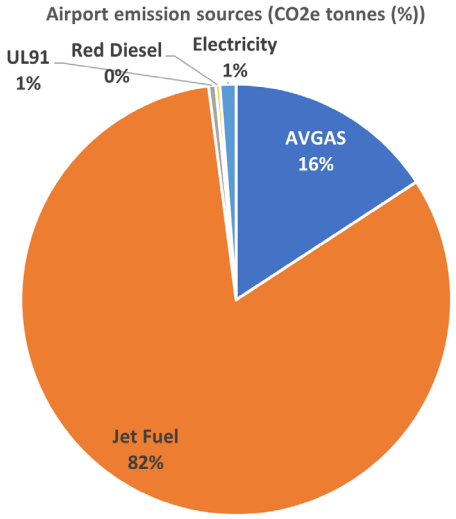


Table 4-2. Electricity Consumption Across Gloucester Airport Buildings. Source: CLS Energy Ltd Adapted by WSP

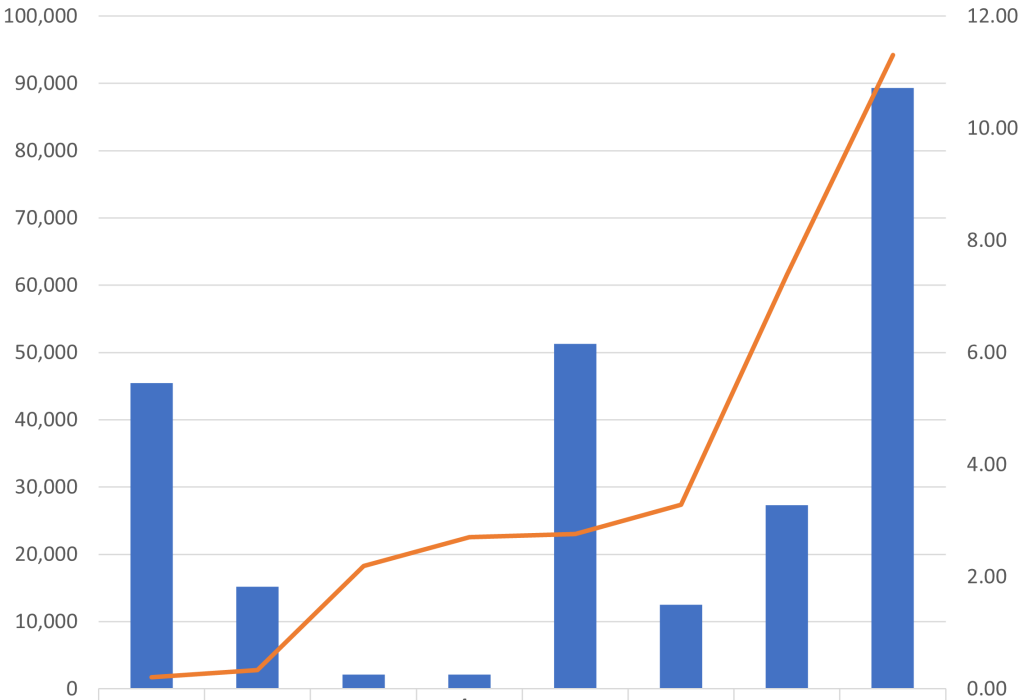
Building	Cost (£/kWh)	Consumption (kWh)	Total (%)
New hanger and terminal	**0.13**	**128,451**	**32.73**
Control tower	**0.12**	**124,876**	**31.82**
SE27	**0.13**	**62,455**	**15.91**
GAL	**0.13**	**35,900**	**9.15**
Pump house east camp	0.13	11,955	3.05
New service sewage pump	0.13	9,170	2.34
SE21 Goodrem Nicholson	0.13	6,034	1.54
SE44 Hangar	0.14	5,092	1.30
Unit 18	0.10	3,914	1.00
Blenheim House	0.13	3,411	0.87
SE20	0.13	946	0.24
Sewage farm	0.13	236	0.06
Total		**392,440**	**100.00**

Actions for Gloucestershire Airport Estate

Actions to reduce emissions have been identified for the airport estate, split between energy efficiency measures and renewable measures, with detail provided in Appendix B – Actions For Gloucestershire Airport Estate.

The impact of the actions has been considered in terms of ability to reduce emissions and the payback period. The payback period represents how long it will take for the initial investment to have repaid itself through profit or financial savings.

Figure 4-16. Energy savings and payback period - energy efficiency actions for Gloucestershire Airport Estate. Source: CLS Energy Ltd adapted by WSP.



	1 - Improved building energy controls	2 - Improved building heating	2 - Reinstatement of server room	4 - Compressor adjustment and control	ME5 - Lighting and Controls	6 - Cavity Wall Insulation	7 - Runway lights to LED	8 - Radiators to ASHPs
Identified Energy Savings Yr 1 (kWh)	45,470	15,197	2,097	2,113	51,284	12,488	27,300	89,307
Payback Period (years)	0.21	0.33	2.19	2.70	2.76	3.28	7.38	11.30

Figure 4-16 shows the combined energy savings and payback period for energy efficency actions. The energy efficiency actions with the greatest impact within the shortest payback period are 1 - Improved building energy controls, 2 - Improved building heating, and 5 - Llighting and controls.

5. Adaptation – Understanding Vulnerability to Climate Change

5.1. Introduction

Recent experiences have demonstrated the impact that a changing climate has on our communities, buildings, infrastructure, businesses, and natural environment. In order to protect ourselves from such impacts, we must first understand how the climate is changing, what the consequences of that will be in terms of the weather, and the threats, or opportunities, this poses to our everyday lives and the council's operations and services.

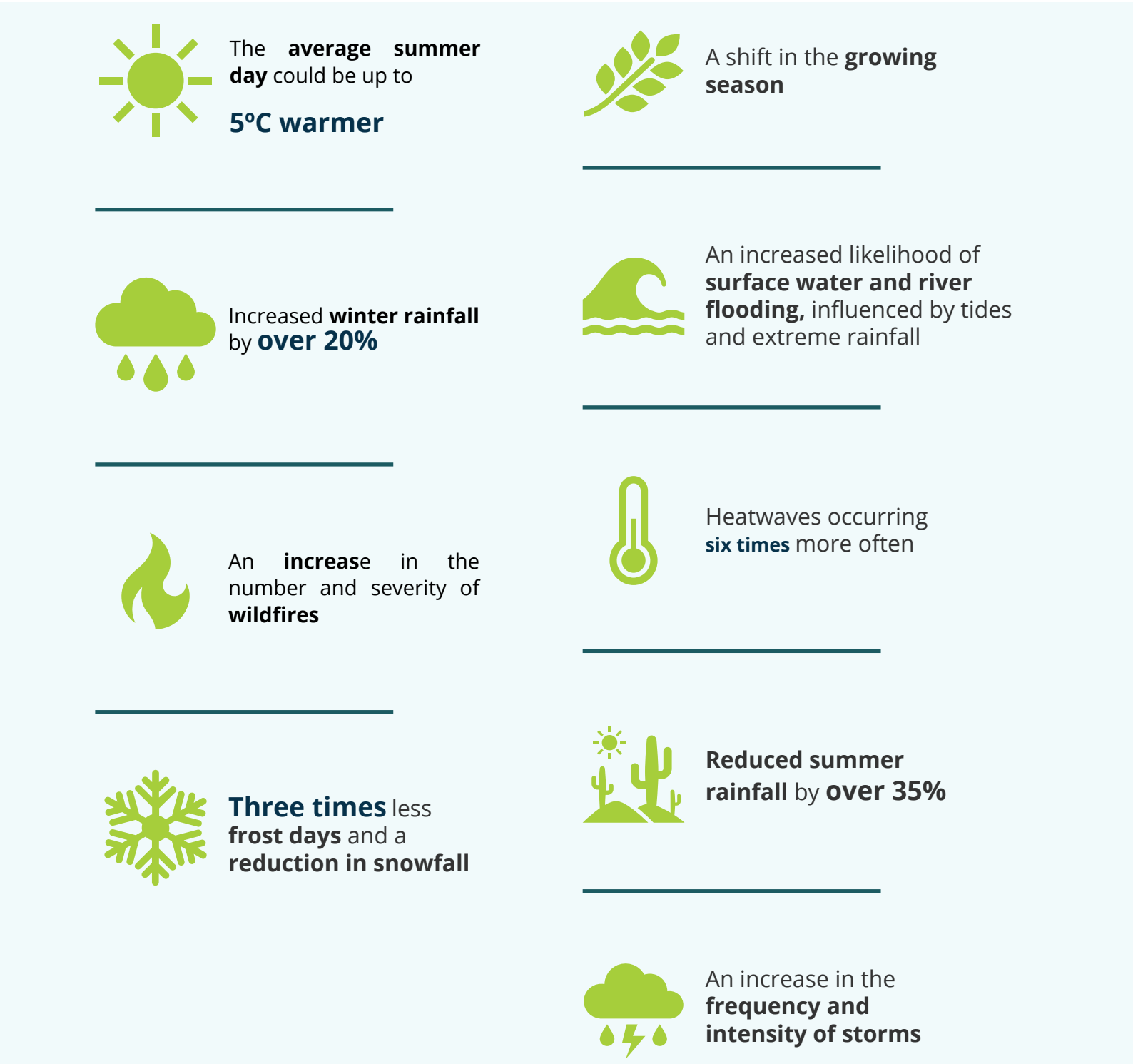
The Global Covenant of Mayors, the world's largest global alliance for city climate leadership, includes a commitment to supporting and enhancing adaptation efforts to increase resilience to adverse climate change impacts. To be able to do so requires the preparation of a Climate Risk and Vulnerability Assessment, to understand the existing and future climate, and the risks or opportunities this may bring, to be able to inform the necessary adaptation efforts.

Figure 5-1. Floodwater being pumped from a property in Gloucester.

5.2. Current and Future Climate

WSP has used the latest UK Climate projections (UKCP18) and related tools to identify projected changes in climate for Gloucester. Projections were identified for the 2030s, 2050s and 2080s. Figure 5-2 indicates that by the 2080s, Gloucester will experience:

Figure 5-2. Future Climate Scenarios for Gloucester. Source: WSP



5.3. Vulnerable Groups

Climate change and extreme weather events threaten our health by affecting not only the weather we experience but also the food we eat, the water we drink and the air we breathe. While climate change can affect anyone, particular members of society are more vulnerable than others. For Gloucester, these include:

Women and girls

Vulnerable to climate change based on biophysical characteristics and gender inequalities. 50.5% of Gloucester's population are women and girls

Elderly

More likely to be increasingly physically, financially, and emotionally at risk to the impact of climate change, largely due to changes in mobility, physiology, and restricted access to resources. 16.7% of Gloucester's population are over 65.

Children and youth

Face disproportionate health effects particularly from heat related impacts as they are dependent on adults to help them adapt in their behaviour and clothing. This can have a detrimental impact on mental health and wellbeing. 19.2% of Gloucester's population are 15 and under.

Marginalised/minority communities

Can be disproportionately affected by climate change. This is generally linked to the vulnerabilities associated with people on lower incomes due to historic and systemic inequalities faced by these communities. Alongside reduced engagement and access to information. 7.7% of Gloucester's populations main language is not English.

Persons with disabilities

Can experience significant levels of vulnerability to changes in climate as a result of limitations presented across local infrastructure and services. 7.4% of Gloucester's population identify themselves as disabled and limited a lot.

Persons with chronic health conditions

Existing medical conditions can make individuals more sensitive to climatic changes, increasing the potential for health impacts and worsening symptoms. 22.4% of Gloucester's population suffer from respiratory conditions, 20.5% with poor mental health, 9.2% with heart disease, and 1.5% with dementia.

Low-income households and unemployed individuals

Those on low income are less able to deal with climate events as they lack the economic or financial capacity to invest in measures to make their homes more resilient e.g., flood insurance. Just over 20% of Gloucester's population are within the most 20% deprived nationally for income deprivation.

Persons living in sub-standard housing

Tenants in the social and private rented sector are likely to have a lower ability to adapt to climate change and extreme weather events compared to homeowners. Reliant on their landlord to ensure that they live in a building which is appropriately insured and retrofitted with appropriate equipment (e.g., air conditioning/heating). In Gloucester, 35% of households are renters.

Outdoor workers

Vulnerable to extreme heat and weather events, impacting their occupational health and safety as well as influencing their line of work. In the Southwest, 134,400 are employed in construction, 75,500 in agriculture, forestry and fishing, and 40,300 in mining, quarrying and utilities.

Frontline workers

Health, education, and emergency service workers become increasingly vulnerable as climate change exacerbates conditions as they have increased exposure to people suffering from climate induced health problems (e.g., vector-borne diseases), as well as an increase in strain on services due to higher demand, subsequently impacting the physical and mental health of frontline workers. In the Southwest, 611,800 workers are employed within health and education.

5.4. Key Risks

As part of the CRVA process, risks were identified across the six themes of Community Wellbeing; Infrastructure (including IT, transport and energy); Biodiversity and Environment; Housing and Buildings; Waste and Water; and Culture, Leisure and Tourism. The risks were identified through an in-depth analysis of documentation provided by GCC, a review of the UK's Third Climate Change Risk Assessment (CCRA3) and stakeholder engagement sessions.

The UK's Third Climate Change Risk Assessment (CCRA3) was used as a foundation to develop the risks applicable to Gloucester. CCRA3 identifies primary risks to health and social care, energy, telecoms and ICT, transport, agriculture and food, housing, business, water, and cultural heritage. This includes, for example, risks to agricultural and forestry productivity, to business locations and infrastructure, to building fabric, to infrastructure networks from cascading failures, to health and wellbeing from high temperatures, to household water supply, to people, communities and buildings from flooding, and risks to infrastructure from subsidence. Therefore, through using these themes and risks as a basis to which the CCRVA could evolve into risks and themes that were distinctive to Gloucester.

Figure 5-3. The Percentage of Overall CRVA Risks per Theme Across All Time Periods (current, 2030s, 2050s and 2080s). Source: WSP

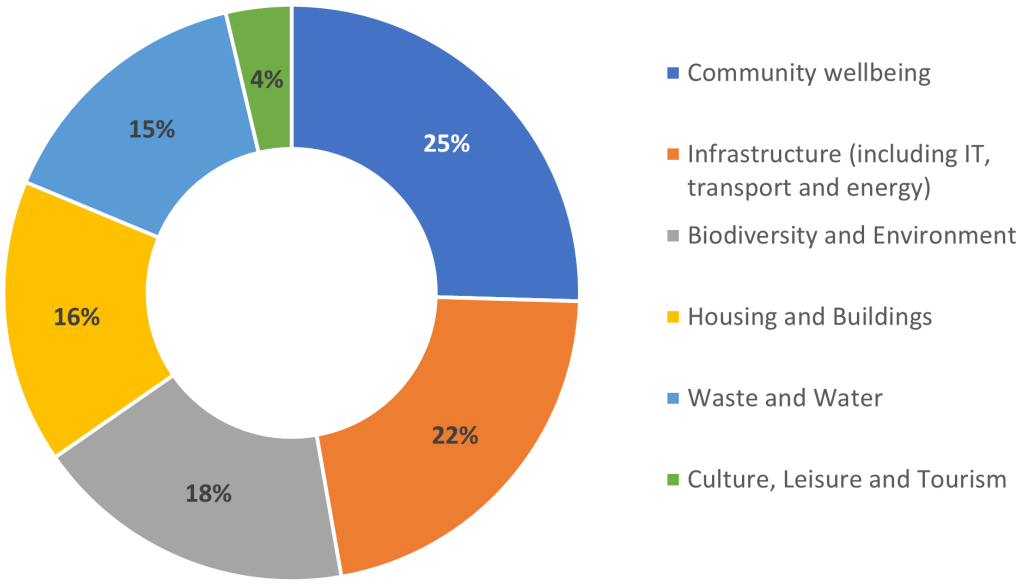


Figure 5-3 shows the percentage breakdown of all risks (low, medium, high and very high) across the themes. 25% of risks fall within the category of Community Wellbeing.

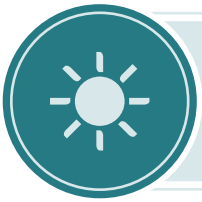
Presented below is a summary of the key findings of priority risks identified during the CRVA process.

Table 5-1. Priority Risk Examples Identified During the CRVA Process. Source: WSP

Theme	Priority Risks
Community Wellbeing	▪ Unsafe working conditions and reduced employee productivity. ▪ Pressure on emergency, education, and health services. ▪ Risks to physical and mental health. ▪ Risk to the homeless. ▪ Inability to travel, leading to isolation, missed medical appointments etc. ▪ Increase in antisocial behaviour and crime. ▪ Issues with deliveries of supplies such as food or medicine. ▪ Forced migration and civil conflict.
Infrastructure (IT, transport, energy)	▪ Damage to infrastructure, such as IT equipment. ▪ Road / rail accidents. ▪ Disruption of transport, including congestion and delays. ▪ Loss of power.
Biodiversity and Environment	▪ Damage to and/or loss of crops. ▪ Increase pressure on water supply. ▪ Damage to young trees, impacting establishment. ▪ Increased tide levels, due to wind and sea level rise, leading to increased risk of flooding. ▪ Increased tree and branch fall. ▪ Increase in pests, pathogens, and invasive species. ▪ Decline in species populations and habitats.
Housing and Buildings	▪ Damage to / flooding of vulnerable assets, such as schools, care homes, children's homes, health centre's etc. ▪ Flooding of homes and businesses. ▪ Increase in risk of subsidence or landslides. ▪ Destruction of homes and businesses due to wildfire or storms. ▪ Displacement of residents. ▪ Risk of mould.
Waste and Water	▪ Introductions of water restrictions ▪ Contamination of water supplies ▪ Reduced efficiency of burning waste ▪ Water supply interruptions ▪ Asset flooding ▪ Strain on street cleaning services
Culture Leisure and Tourism	▪ Increase in public safety concerns regarding health. ▪ Loss of business. ▪ Overheating of outdoor sports facilities. ▪ Increased risk of fire.

5.5. Opportunities

Whilst climate change does pose considerable risks, it also presents opportunities to be benefitted from.



An increase in sunshine leading to an increase in energy generation from solar power can create opportunities for offsetting carbon emissions and creates long-term cost savings.

Warmer winters resulting in reduced household heating can save energy and costs to homeowners.

New business opportunities will arise in areas such as retrofitting, the food and beverage sectors, and outdoor leisure pursuits.

There will be benefits to health and wellbeing, with an increase in outdoor leisure pursuits, and a reduction in cold-related illnesses and lessened symptoms of some conditions.

The local economy will benefit from increased tourism, as a result of an extended tourist season due to warmer, drier weather.

There will be opportunities for new plant, animal or bird species to colonise habitats, and new planting opportunities.

Agriculture and forestry could be boosted by the increased suitability of new and alternative crop and tree species.

5.6. Adaptation Activities

As seen in recent years, climate change and extreme weather events have caused damage to the environment and community. To strengthen the city's resilience to climate change, there is the need to alleviate the impacts that climate change presents, such as those identified in Table 5-1, through adaptation. Climate change adaptation is (IPCC, 2022):

> The process of adjustment to the actual or expected climate and its effects.

Adaptation is important for Gloucester because, despite the fact that the causes of climate change might be global in nature, the effects of climate change are felt locally. As the effects are felt locally, the solutions need to be specific to the local context. To identify these adaptation solutions for Gloucester, a collaborative effort was made by WSP and council officers through exploring existing adaptation measures in place at the local, county and national levels, investigating other council's adaptation measures, and online research. These adaptation measures have been established in response to the CRVA, to mitigate the high and very high risks that were identified, and examples are discussed throughout this section, looking more closely at those actions under community wellbeing, biodiversity and environment, and built environment and services. These themes have been selected as there are multiple overlaps between the adaptation actions from the original six themes.

In establishing the adaptation actions for Gloucester, a number of co-benefits were identified. Co-benefits are valuable because they target multiple objectives and reduce numerous risks through one adaptation action, which also has the benefit of being cost-efficient. Two types of co-benefits were identified, these were direct and cascading. Direct co-benefits simultaneously meet several objectives that enhance climate resilience and the overall environment, society and economy. Cascading co-benefits meet several objectives in succession of one another.

Direct example: Joint Green Infrastructure Strategy

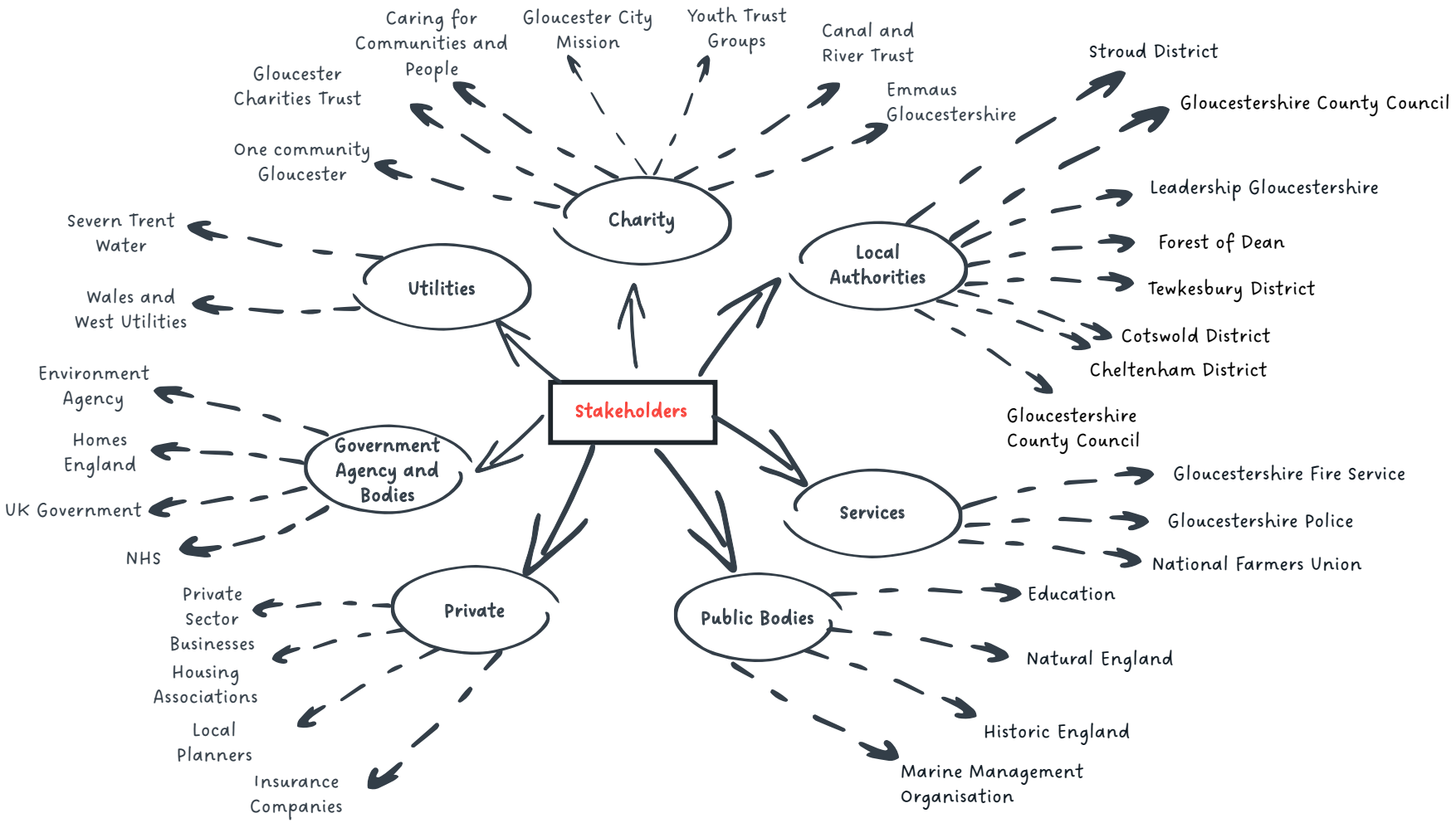
- Reduces flood risk
- Improves biodiversity
- Creates carbon sinks
- Decreases local temperatures
- Provides new habitats
- Improves community

Cascading example: Flood defences

- Reduces disruption
- Reduces insurance claims
- Cost savings
- Reduces damage to assets / residential and commercial buildings
- Reduces impacts to physical and mental health

However, it's important to acknowledge that adaptation is not any specific individuals responsibility. It is a cross-cutting and cross-sectoral issue that is relevant and of interest to a wide range of stakeholders, as identified in Figure 5-4. Their engagement and participation can also greatly support adaptation action. Therefore, it is neccessary to understand who these key stakeholders are for Gloucester as working in partnership allows for a greater pool of knowledge, shared resources and responsibility, has a greater influence and addresses interdependencies between organisations.

Figure 5-4. Gloucester City Council's stakeholders. Source: WSP



The adaptation measures mentioned above are both an example of where multiple organisations can come together, in this instance neighbouring local authorities or GCC and the Environment Agency, and develop adaptation actions that work towards an increasingly climate resilient City in a more effective way.

Case Study: Gloucestershire Local Resilience Forum

Gloucestershire Local Resilience Forum (LRF) is a multi-agency partnership made up of representatives from the emergency services, local authorities, the NHS, the Environment Agency and others.

The Partnership co-ordinates effective and efficient integrated emergency management arrangements within Gloucestershire to prepare your family, business and community for emergencies and disruption.

The LRF carries out a risk assessment to identify the range of risks present in the community, assess the likelihood of their occurrence together with the health, social, economic and environmental impacts that would occur in the event of the risk happening.

The completed risk assessment is used to help prioritise the work they do to ensure emergency preparedness. They subsequently provide advice to help you prepare for cold weather, fires, flooding, storms, extreme heat, power failures, evacuation and more in their 'Are you Ready' booklet. Being prepared can help reduce the effects of extreme weather on your life, reduce the need for support from others and enable you to support the vulnerable members of your community.

Action: Joint Local Plan Update

The Join Strategic Plan is a partnership between Gloucester City Council, Cheltenham Borough Council and Tewkesbury Borough Council, which sets out a strategic planning framework for the three areas.

Since the Joint Core Strategy was adopted in 2017, the councils' have been working towards a review of the plan.

A review of the plan provides the opportunity to develop sustainable construction, biodiversity, flood risk, and green infrastructure policies into a more targeted approach towards adaptation in new developments and communities.

Action: Adaptation Working Group

The newly formed Gloucester Adaptation Working Group is comprised of local stakeholders who will meet on a quarterly basis to discuss climate adaptation in the local area, through a formal governance process.

The Group provides the ideal opportunity to share experiences, knowledge, and funding to work towards co-ordinated goals and targets to improve climate resilience in Gloucester.

Using the CRVA from this report, the Group can establish priority risks to their individual and combined sectors and determine the actions necessary to reduce those risks.

Community Wellbeing

Community wellbeing as a theme brings together a range of areas, including, education and children, physical and mental healthcare, crime, food security, employment, and social care. Ensuring that communities are capable of anticipating, preparing and responding to events, trends, or disturbances related to climate is essential to successfully adapt to climate change. As such, public participation plays such an important role in the effort to adapt to climate change.

Community Based Adaptation (CBA) embodies local community action on climate adaptation initiatives. This may involve participatory learning and problem-solving (including creative trial-and-error approaches), sharing, collaborative planning and local implementation of climate adaptation initiatives.

What can individuals do?

There are many ways to adapt to what is happening and what will happen. Individuals can take some simple measures. It is beneficial to plant or preserve trees at home, opt for vegetative gardens as opposed to hard standing patios or plastic alternatives, this supports cooling of inside temperatures, support natural ecosystems, and provide natural drainage systems. Investing in flood gates or barriers at home if it is prone to flooding and encouraging neighbours to do the same. Using a variety of shading types and fixtures to windows reduces overheating from windows. The most effective type is by using external, fixed shading, for south facing windows deep reveal with horizontal overhangs are most effective and for east/west facing windows vertical moveable shutters/louvres are most effective. Rainwater collection systems such as green roofs, rain gardens or water butts can be used to both reduce localised flood risk and support green spaces during drought periods and in the event of hose pipe bans. Clearing brush might reduce fire hazards. For businesses, start thinking about and planning around possible climate risks, such as hot days that prevent workers from doing outside tasks.

What can Gloucester City Council and the community do?

The loss of urban green space leads to increases in urban heat and flooding, which are amplified by climate change, and can threaten human health, well-being, infrastructure and property. Open and green spaces provide natural cooling of air and surfaces, and support water management in urban areas. Green spaces are an invaluable resource for delivering sustainable urban health to the community and Gloucester City Council Open Space Strategy supports this. Other adaptation actions to support the community include raising awareness and training, working with stakeholders such as fire and rescue and the NHS to support vulnerable community and those directly impacted by extreme weather events and co-designing solutions with communities, as identified on the following page.

Case Study: Gloucester City Council Open Space Strategy

Gloucester's open spaces provide residents and visitors with opportunities for formal and informal recreation, and daily contact with nature. Open spaces provide venues for sports, social events, entertainment, relaxation and celebration. Open spaces are places where people from communities can come together to rest and play. Open spaces also form part of a vital biodiversity network, providing habitat for wildlife and bringing the countryside into the heart of the city. The council has embarked on an exciting programme of biodiversity and habitat improvement schemes aimed at making green spaces even more wildlife friendly. Green spaces also provide areas where natural processes can occur, which is vital in in helping to protect Gloucester City and its residents from the effects of climate change.

The Open Space Strategy aims to utilise green space to help mitigate and reverse the effects of climate change and biodiversity loss, through habitat creation and management, increased tree planting, water management schemes and other appropriate measures, and support the health and wellbeing agenda and help address health inequalities, by improving existing open space facilities in areas of the city where there is a deficit in the provision of open space, and where the scope to provide additional open space is limited.

Action: Awareness Raising

The City Council should work with partners to provide training and workshops for young people focusing on awareness and coping with climate anxiety.

Action: Extreme Weather Follow-Up Scheme

The City Council should establish a follow-up system with the County Council Public Health officer and NHS for victims of flooding, storm damage or wildfires to ensure their wellbeing.

Action: Fire and Rescue Community Wildfire Education Programme

The City Council should work with Gloucestershire Fire and Rescue on public education of wildfire causes and risk.

Action: Community Support for Retrofitting

The City Council should establish a communications plan to encourage residents / businesses to invest in mechanical cooling measures and establish a plan for potential funding to retrofit cooling measures for the most vulnerable.

Action: Climate Café's

A climate café would be a free event held by the Council to discuss climate risk and adaptation with the local community. It can be used to raise the general public's awareness of health-related impacts from climate change and avoidance measures.

Action: Wildlife Trust Projects

The City Council should continue working with the Wildlife Trust on a range of projects with different groups to improve wellbeing, including projects such as Nature Nurtures, Tuffley Rose Garden, Brighter Future, and Nature on your Doorstep.

Action: Overheating Respite Area Creation

The City Council should consider developing outside respite areas (shaded, open to air currents, potentially with moving water) for (particularly vulnerable) people who live in premises at risk of overheating and within large open spaces.

Biodiversity And Environment

The risks associated with biodiversity and environment, such as damage to and/or loss of crops and vegetation, increase in pests, declines in species populations and habitats and so forth are areas which are vital to the functioning of our ecosystem. The environment is also critical to absorbing carbon, reducing local temperatures, managing flood risk, restricting wildfires, enhancing wellbeing, reducing air pollution, and improving biodiversity.

Protecting biodiversity is key to adapting to climate change, as healthy ecosystems are much more resilient and therefore able to maintain the services on which we depend. The loss of biodiversity can lead to an increased risk of wildfire, urban heat extremes, and flooding, as well as having a cascading effect on interdependent species. However, an increase in biodiversity and green space will provide protection against such risks, as with the renaturalisation of watercourses in Gloucester which provides flood risk protection from the river. Actions taken to mitigate the risks to the environment often have many co-benefits, these measures include increasing connectivity of green and blue infrastructure through the Joint Green Infrastructure Strategy, new land management practices, regular vegetation inspections and maintenance, rewilding of landscapes, the creation of tiny projects, and enhancing the natural environment through creating or protecting wildflower meadows, or restricting grass cutting, as identified on the following page.

Case Study: Riparian restoration plus associated habitats

This project is located in an urban area on the Whaddon Brook, adjacent to Holmleigh Park, Gloucester. Prior to the project, the watercourse comprised a straight, concrete lined channel with short utility mown grass banks, offering very little in the way of habitat, biodiversity, and flood resilience.

The concrete base and sides were removed from a 180-metre reach of watercourse with a new, natural channel was created with meanders and a two-stage profile. In areas where there was a risk of bed erosion, stone cobbles were laid. Similarly, where there was a risk of lateral bank erosion, coir rolls, planted with native wetland species, were installed. Gravels were introduced to support fish and invertebrates, and the banks were sown with wildflower seed and native trees were planted.

The changes have allowed for reduced flood risk, an improved habitat for fish, invertebrates, insects, reptiles and small mammals, reconnected waterways, reduced pollution impacts, urban cooling, cost savings, and benefits to mental and physical health through creating a more aesthetically pleasing, nature-orientated space for people to enjoy.

Action: Joint Green Infrastructure Strategy

The Strategy sets out a local interconnected network of green infrastructure for the existing settlements, based around the network of watercourses linking together key strategic GI assets. This should be reviewed, monitored, and updated.

Action: Land Management and Farmer Collaborations

The City Council should work with farmers to support a shift in farmland management and encourage consideration of crop diversification, maintenance plans, and encourage relationships with water suppliers.

Action: Regular vegetation inspections and maintenance

The City Council should carry out regular inspections of vegetation and establish maintenance plans for vegetation, i.e. Watering schedules for newly-planted trees, regular inspection of trees for damage prior to storm events and other extreme weather events.

Action: Rewilding

The City Council should continue to provide support to partners to restore nature and landscapes in rewilding of the region. The delivery partners activities include research and monitoring, as well as practical conservation and awareness-raising.

Action: Tiny Forests

The City Council should establish Tiny Forests, these are dense, fast-growing, native woodlands about the size of a tennis court. Each forest is made up of around 600 trees and provides a biodiversity rich habitat, with low management and maintenance requirements.

Action: Gloucester Urban Green Project

The project has delivered benefits through multiple methods such as, changes to grass cutting regimes and wildflower meadow creation. The asset register and mapping should be made available online for public use and benefits should be monitored.

Built Environment And Services

The built environment and services addresses risks related to housing and buildings, infrastructure, waste and water, and culture, leisure, and tourism. The protection of residents, particularly vulnerable groups such as those with disabilities, people living in sub-standard housing, and low-income households is at the core to supporting resilience in this area, collaboration between the council and its stakeholders is essential, as evidenced below.

Gloucestershire's Local Transport Plan sets out several objectives which support the protection and enhancement of the natural and built environment, encourage sustainable economic growth, enable safe and affordable community connectivity, and improve community health and wellbeing. The Plan aims to reduce air pollution through supporting active travel, reducing congestion, and increasing planting. These measures will also help to improve the health and wellbeing of residents through reduced exposure to pollution and increased physical activity. Indirectly this objective reduces vulnerabilities to climate change. Increased planting is also targeted because of its multiple other benefits which directly decrease risks associated with climate change, including reducing flood risk, reducing local temperatures in heatwaves, protecting habitats, and carbon absorption. Gloucester Nature Park is similar in that there is increased planting and active travel provision, thereby providing the same benefits and climate risk mitigation. Additional actions are identified on the following page.

Case Study: Gloucester Nature Park

Gloucester Nature Park is an exciting new project focused on the area of urban fringe between Gloucester and the River Severn. It will include areas of new woodland, wetland, low carbon energy generation, wildflower meadows and green infrastructure. Accessibility is at the heart of this project:

- **Proximity to the city centre**
- **Increased footpath and cycle path provision**
- **Improved viewpoints and educational opportunities**
- **Opportunities to connect people with nature for the first time.**

So far, 480 people have been directly engaged with the project, through walks and talks, tree planting, and installing access improvements.

Climate resilience is at the heart of this project, including flood mitigation, renewable energy, and reducing the urban heat island effect.

Action: Future Design Standards

The City Council should collaborate on future design standards, such as with DHULC or Homes England, to mitigate climate risks and improve the adaptive capacity of new developments and communities.

Action: Review Locations of Key Infrastructure

The City Council and its stakeholders should review locations of key electrical connections / telecommunications' interfaces / signals / power supply equipment and where possible relocate away from areas likely to be affected by flooding.

Action: Multi-Agency Extreme Weather Plan

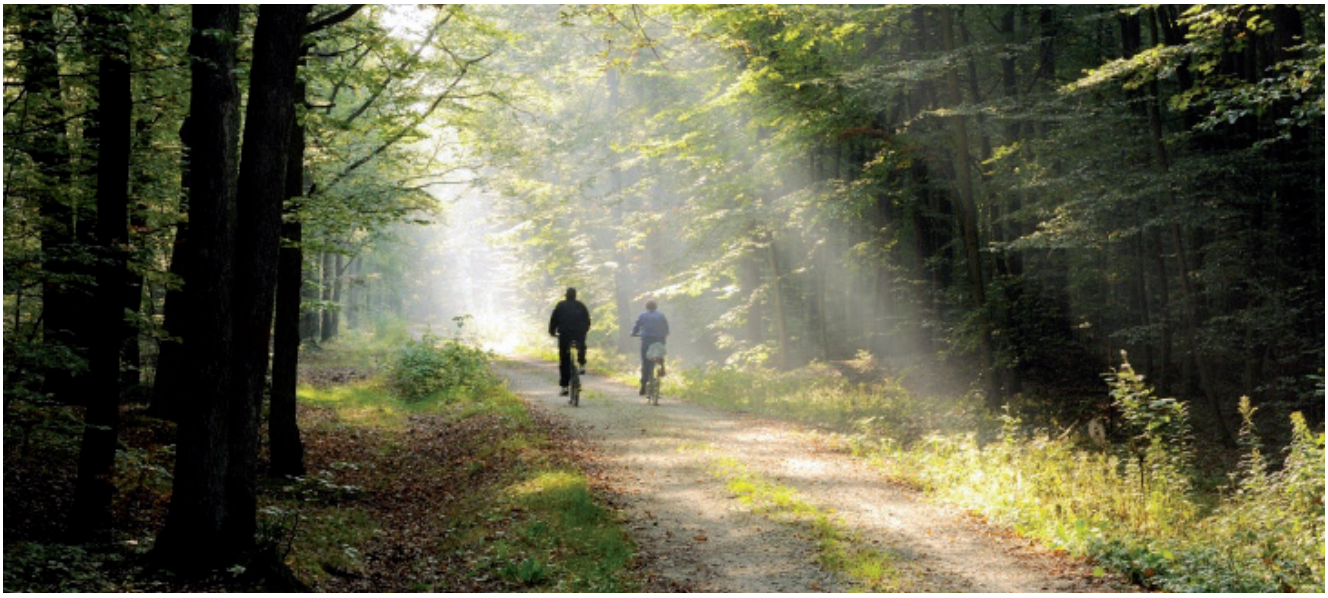
Emergency services are particularly impacted through demand on services to respond to flooding, storm, and heatwave events. Collaboration to alleviate pressure through a multi-agency extreme weather plan with neighbouring services should be considered.

Action: Water Efficiency Measures Installation

The Council should consider the installation of measures such as rainwater harvesting, grey water recycling and others to reduce water demand and use (e.g., low flow taps) in their properties, and encourage uptake of such practices to residents.

Action: Planned and Preventative Maintenance

Alongside stakeholders, the City Council should carry out regular inspections of assets (buildings, vegetation, infrastructure) and ensure planned and preventative maintenance takes place prior to, during and post-extreme weather events to minimise the risk of damage.



6. Delivering Our Climate Change Strategy

This section outlines the framework needed for delivery of the net zero and adaptation goals and supporting Climate Change Strategy, including governance, monitoring and communications of progress towards the goals. It will be developed into the final version of the GCCS draft in September 2023.

Climate action planning ensures successful and responsible climate change mitigation and adaptation in alignment with the community's needs. Gloucester Climate Change Strategy will set out actions to implement climate mitigation, adaptation, and access to sustainable energy strategies to meet net zero targets, as well as specific priority actions, and a timeline. The GCCS provides a holistic, approach to achieve mitigation, adaptation, and other sustainable development goals.

6.1. Governance

The diagram below published in the Climate Change Committee's Sixth Carbon Budget highlights local authorities' leverage and influence through the services they provide. The report notes that while councils face a number of significant barriers to achieving net zero, their leadership role both within their own operations, and in partnership with others, means that local authorities remain at the heart of the climate conversation.

As described in Table 6-1, local authorities have the power to lead on sustainability within their own operations, enable change though policies and partnerships, and inspire communities to take action.

Table 6-1. Gloucester City Council Climate Change Strategy Roles and Influence. Source: WSP

Lead	Enable	Inspire
In the council's operations	Action through programmes, policies, and decisions	Businesses and residents to act
▪ Energy use ▪ Travel ▪ Council estate and land ▪ Procurement	▪ Transport networks ▪ Planning policies ▪ Waste and the circular economy ▪ Green spaces and biodiversity	▪ Helping residents lead more sustainable lives ▪ Providing climate and sustainability education opportunities for all ages ▪ Signposting organisations and individuals to act ▪ Partnering with other anchor and leading organisations to act together

6.2. Monitoring and Reporting Progress

As part of the progress monitoring and reporting approach of this GCCS, GCC would need to define a data collection approach to measure progress against net zero targets using the actions defined in this GCCS. This approach will help the council understand local climate action and its impact, which is crucial to get to net zero by 2030 for its operations and by 2050 for the district.

Data Collection and Performance

For each mitigation action of the GCCS, a deadline for delivery as well as level of effort have been identified to report progress against. GCC has the option to choose yearly targets to measure progress. The council and other Gloucester District stakeholders will need to collect data and information from stakeholders responsible for the delivery of actions. Data quality and accessibility will be key enablers to track progress and increase climate action.

Reporting on Progress

By disclosing annual progress, the council can transparently disclose the data and methodologies used and lessons learned with partners and neighbouring local authorities.

GCoM has a reporting framework with a standardised set of reporting requirements that apply across all GCoM regional covenants, while allowing for regional flexibility. The council will align its annual reporting with reporting to Cabinet Members and GCoM.

6.3. Raising Awareness and Communications

Within Gloucester City Council

The GCCS presents a springboard from which to build capacity and climate literacy across the council. Raising awareness internally is vital for generating buy-in and catalysing action. This may include activities such as:

- Tailored climate literacy training for Councillors and council staff that includes the key findings and recommendations of the GCCS.
- The development of accessible digital and physical communication materials that highlight key findings and next steps for the council.
- Presentation of the GCCS at committee, department, and senior leadership meetings.

With Local Communities and Partners

The climate crisis and the actions taken by local authorities have become important (and sometimes controversial) local issues. For this reason, the council must pro-actively disseminate information, and be prepared to react to questions from external stakeholders. Preparing for this could include:

- Ensuring that councillors and council staff have the knowledge and materials necessary to communicate the GCCS with local external stakeholders.
- Working with partner organisations to disseminate key messages from the GCCS and act on recommendations.
- Using digital channels to distribute information to the public.

Across the District

The causes and impacts of the climate crisis are not limited to local authority boundaries. It is important that the findings from the GCCS are discussed at a county and/or regional level in order to plan effectively. Doing this may include:

- Presenting the GCCS at key partnership meetings such as those held as part of the Climate Leadership Gloucestershire partnership.

6.4. Partnerships for Delivering the GCCS

Partnerships are a vital part of developing and impliementing climate action. Both mitigation and adaptation are issues that transcend local geographies and sectoral boundaries. councils have a key role not only in making their own operations more sustainable but in bringing different stakeholders together to drive holistic and coordinated climate action.

Gloucester City Council works with neighbouring local authorities as well as with central government, industry and local communities to mitigate and adapt to climate change.

With Central Government

In 2022 Gloucester received funding from the UK Shared Prosperity Fund, to be administered locally by the council, and given to schemes that help improve residents' opportunities and quality of life. Fourteen projects were awarded funding including a refill shop and a nature park.

With Neighbouring Local Authorities

At a local level Gloucester is part of Climate Leadership Gloucestershire (CLG) which brings together councils and strategic partners from across the county. The council also works closely with other district authorities across Gloucestershire, South Gloucestershire and other partners on a range of issues including its Affordable Warmth Strategy which aims to improve energy efficiency and its Green Travel Plan.

The council is working with Severn Wye Energy Agency which manages the Warm and Well domestic retrofit programme on behalf of the eight Local Authorities in Gloucestershire and South Gloucestershire.

With Local Communities and Partners

The council has partnered with the Gloucestershire Wildlife Trust to carry out Natural Flood Risk Management in the Twyver Catchment. The project is also receiving support from Stroud District Council and the Environment Agency.

With National and Global Networks

At a global level Gloucester City Council are members of the Global Covenant of Mayors and the UK100 Network.

7. Glossary

Adaptation:

- In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.

Adaptive capacity:

- The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Anthropogenic emissions:

- Emissions of greenhouse gases (GHGs), precursors of GHGs, and aerosols, caused by human activities. These activities include the burning of fossil fuels, deforestation, land use and land use changes (LULUC), livestock production, fertilisation, waste management, and industrial processes.

Biodiversity:

- or biological diversity means the variability among living organisms from all sources including, among other things, terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Business as usual (BAU):

- BAU projections assume that operating practices and policies remain as they are at present.

Carbon dioxide (CO2):

- A naturally occurring gas, CO2 is also a by-product of burning fossil fuels (such as oil, gas and coal), of burning biomass, of land use changes (LUC) and of industrial processes (e.g., cement production). It is the principal anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance.

Carbon neutrality:

- Carbon neutrality means having a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks. Removing carbon oxide from the atmosphere and then storing it is known as carbon sequestration. In order to achieve net zero emissions, all worldwide greenhouse gas (GHG) emissions will have to be counterbalanced by carbon sequestration (European Parliament, 2023).

Carbon offsets:

- A carbon offset is a reduction in emissions of carbon dioxide or other greenhouse gases made in order to compensate for ("offset") an emission made elsewhere.

Carbon sequestration:

- The long-term removal of carbon dioxide (CO2) or other forms of carbon from the atmosphere, with secure storage on climatically significant time scales (decadal to century). The period of storage needs to be known for climate modelling and carbon accounting purposes (European Parliament, 2023)

Carbon sink:

- is any system that absorbs more carbon than it emits. The main natural carbon sinks are soil, forests and oceans. According to estimates, natural sinks remove between 9.5 and 11 gigatonne of CO2 per year. Annual global CO2 emissions reached 37.8 gigatonne in 2021 (European Parliament, 2023).

Climate:

- in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

Climate change:

- refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use.

Climate change risk and vulnerability assessment:

- Risk assessments focus primarily on the projected changes in climatic conditions, inventory of potentially impacted assets, the likelihood of the impact happening and the resulting consequences. Vulnerability assessments emphasise exposure, sensitivity and adaptive capacity of systems, assets and populations. Integrated risk and vulnerability assessments address both the vulnerability to and the impacts of climatic hazards.

Co-benefits:

- The positive effects that a policy or measure aimed at one objective might have on other objectives, thereby increasing the total benefits for society or the environment. Co-benefits are often subject to uncertainty and depend on local circumstances and implementation practices, among other factors.

Decarbonisation:

- Decarbonisation denotes the declining average carbon intensity of primary energy over time.

Enabling mechanisms:

- Enabling mechanisms are management and other approaches that engender execution in accordance with policy and planning intent (Peltz, Eric, et al, 2012).

Greenhouse gases (GHG):

- Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of radiation emitted by the Earth's ocean and land surface, by the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and ozone (O3) are the primary GHGs in the Earth's atmosphere.

Global Convenance of Mayors:

- The Global Convenance of Mayors (GCoM) is the largest global alliance for city climate leadership, built upon the commitment of over 11,500 cities and local governments. GCoM serves cities and local governments by mobilizing and supporting ambitious, measurable, and planned climate and energy action in their communities.

Hazards:

- the potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.

Pathways:

- The temporal evolution of natural and/or human systems towards a future state. Pathway concepts range from sets of quantitative and qualitative scenarios or narratives of potential futures to solution-oriented decision-making processes to achieve desirable societal goals.

Resilience:

- The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation.

Risk:

- The potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain. In the context of the assessment of climate impacts, the term risk is often used to refer to the potential for adverse consequences of a climate-related hazard, or of adaptation or mitigation responses to such a hazard, on lives, livelihoods, health and wellbeing, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Risk results from the interaction of vulnerability (of the affected system), its exposure over time (to the hazard), as well as the (climate-related) hazard and the likelihood of its occurrence

(Climate change) roadmap:

- A climate change roadmap is an ever-evolving document, which seeks to push the agenda for further action on climate change.

Social vulnerability:

- comes about through the interaction of a number of personal, environmental and social factors that affect the way in which climate hazards impact on the well-being of individuals or groups.
- Personal features of the individual such as age and health.
- Environmental characteristics such as the availability of green space or quality of housing.
- Social and institutional context, such as levels of inequality and income, the strength of social networks, the cohesion of neighbourhoods and the day-to-day practices of institutions.

Vulnerability:

- The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Weather:

- Weather refers to short term atmospheric conditions (ranging from days to months).

Definitions taken from IPCC glossary reports unless otherwise stated.

8. Key References

- Climate Adapt. Conducting risk and vulnerability assessments. Available at: https://climate-adapt.eea.europa.eu/en/knowledge/tools/urban-ast/step-2-4/index_html#:~:text=Risk%20assessments%20focus%20primarily%20on,of%20systems%2C%20assets%20and%20populations.

- Climate Change Committee (2020). Local Authorities and the Sixth Carbon Budget. Available at: https://www.theccc.org.uk/publication/local-authorities-and-the-sixth-carbon-budget/ (Accessed 02/08/23)

- Climate Change Committee (2020). Sixth Carbon Budget. Available at Climate Change Committee's Sixth Carbon Budget (Accessed 01/06/23)

- Climate Just. There is an uneven distribution of climate disadvantaged neighbourhoods across the UK. Available online: https://climatejust.org.uk/1-where#:~:text=The%20concept%20of%20vulnerability%20is,the%20impacts%20of%20adverse%20events. (Accessed 02/08/23)

- Edinburgh & Lothians Green Space Trust, Little France Park. Available at: http://www.elgt.org.uk/projects/greenspace-improvements/little-france/

- GCC. (2023) City Plan (2011-2031). Available at: https://www.gloucester.gov.uk/planning-development/planning-policy/adopted-development-plan/ (Accessed: 19/07/2023).

- GCC. (2022) Gloucester City Council Plan 2022-2024. Available at: https://www.gloucester.gov.uk/about-the-council/strategies-plans-policies/council-plan-2022-2024/ (Accessed: 18/07/2023).

- GCC. (2020) Tackling Climate Change Roadmap. Available at: https://democracy.gloucester.gov.uk/ieListDocuments.aspx?CId=129&MId=6627&Ver=4 (Accessed: 19/07/2023).

- Gloucestershire Recycles, Waste Wizard online platform. Available at: https://www.gloucestershirerecycles.com/waste-wizard/

- The Intergovernmental Panel on Climate Change. Available at: https://www.ipcc.ch/ (Accessed 02/08/23)

- The Intergovernmental Panel on Climate Change. (2022) IPCC Sixth Assessment Report (AR6). Available at: https://www.ipcc.ch/assessment-report/ar6/ (Accessed: 01/07/2023).

- Met Office. (2022) UK Climate Projections 2018 (UKCP18) Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index (Accessed: 01/07/2023).

- Nigel Arnell. (2021). The Climate Risk Indicators. Available at: https://uk-cri.org/ (Accessed: 01/07/2023).
- Paula Kuss, Kimberly A. Nicholas. (2022) A dozen effective interventions to reduce car use in European cities: Lessons learned from a meta-analysis and transition management. Case Studies on Transport Policy, Volume 10, Issue 3, 2022, Pages 1494-1513, ISSN 2213-624X, https://doi.org/10.1016/j.cstp.2022.02.001.
- Peltz, E., Robbins, M., & McGovern, G. (2012). Enabling Mechanisms. In Integrating the Department of Defense Supply Chain (pp. 47–54). RAND Corporation. http://www.jstor.org/stable/10.7249/j.ctt1q60t9.13
- ReLondon, Case study – Making recycling work for people in flats. Available at: https://relondon.gov.uk/resources/case-study-the-flats-recycling-package
- UK100. (2023) Press Release: All Gloucestershire's councils unite for collective action to deliver Net Zero transport. Available at: https://www.uk100.org/blog/2023/01/press-release-all-gloucestershires-councils-unite-collective-action-deliver-net-zero (Accessed: 18/07/2023).
- UK Gov. (2021) Net Zero Strategy: Build Back Greener. Available at: https://www.gov.uk/government/publications/net-zero-strategy (Accessed: 17/07/2023).
- UK Gov. (2021) Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/contents (Accessed: 17/07/2023).
- UK Gov. (2022) UK Climate Change Risk Assessment 2022. Available at: https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2022 (Accessed: 10/07/2023).
- UK Gov. (2023) Third National Adaptation Programme. Available at: https://www.gov.uk/government/news/government-sets-out-adaptation-programme-to-tackle-climate-impact#:~:text=The%20UK%20government%20has%20unveiled,as%20flooding%2C%20drought%20and%20heatwaves (Accessed: 17/07/2023).
- UK Gov. (2022) Climate change adaptation: policy information. Available at: https://www.gov.uk/government/publications/climate-change-adaptation-policy-information/climate-change-adaptation-policy-information (Accessed: 01/07/2023).
- UK Gov. (2019) Good Practice Guidance for Local Government. Available at: https://www.adeptnet.org.uk/system/files/documents/Good%20Practice%20Guide%20ADEPT%202019f.pdf (Accessed: 01/07/2023).

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