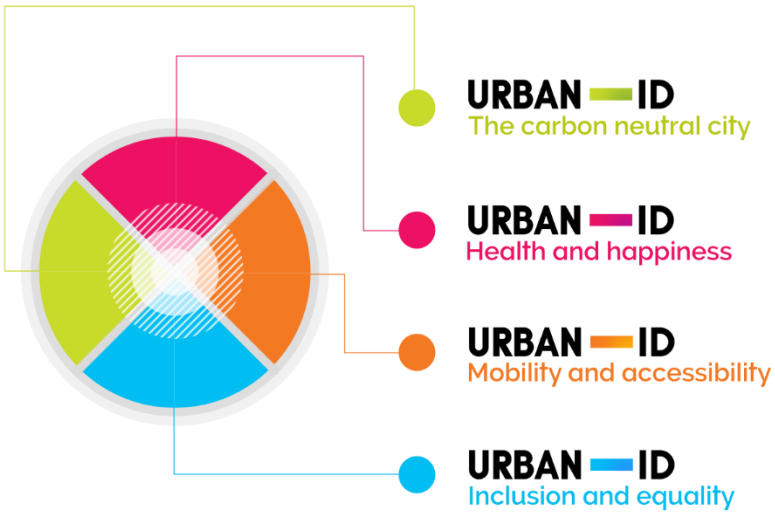


Bristol Urban Integrated Diagnostics Project

Challenge Theme Report: Carbon Neutral City

Report published 28 February 2019

Report Authors

Dr Emily Prestwood, UWE, Bristol; Ian Townsend, Bristol Green Capital Partnership; and Professor James Longhurst, UWE, Bristol.

Acknowledgement

This report comprises a case study for a programme of research entitled the Bristol Urban Integrated Diagnostics Pilot Project funded by the UKRI Urban Living Consortium under Grant Reference EP/P002137/1 2016 -2018.

Disclaimer

The views and recommendations expressed in this report are solely those of the authors.

Contents

Urban ID – Carbon Neutral City: summary

This report presents the key findings of the Carbon Neutral City theme of the Bristol Urban Integrated Diagnostics (Urban ID) pilot project, one of its four themes and five case studies. Urban ID was one of a small number of projects funded by the seven UK Research Councils and Innovate UK's Urban Living Consortium to explore sustainability in city contexts. Urban ID brought together researchers from the two universities in Bristol, representatives of Bristol City Council, South Gloucestershire Council, the Bristol Green Capital Partnership, Bristol Health Partners, community groups and companies to explore and co-create means of diagnosing urban sustainability problems and potential solutions.

The carbon neutral city theme explored four key questions:

- What does 'carbon neutrality' means for the Bristol Urban Area (and what is the Bristol Urban Area) and over what timescale should such a vision be achieved?
- What are the barriers to decarbonisation across the three scopes of carbon emissions (energy use; energy supply; consumption of goods and services)?
- Can Urban ID co-design top-level aims and aspirations for the Bristol Urban Area in relation to carbon neutrality up to 2050?
- Can carbon neutrality for the Bristol Urban Area include 'all embodied carbon' as well as emissions from energy use and supply?

The project team concluded that in order to develop a pathway to carbon neutrality for the Bristol urban area there are several key questions to be addressed:

1) What is the carbon budget for the urban area associated with energy production and use in the city region across different sectors – energy supply, domestic, transport, industrial and commercial?

2) What are the current emissions from scopes 1, 2 and 3 (energy use; energy supply; and consumption of goods and services)?

3) What are the 'business as usual' projections for emissions to 2030 and 2050 and how do these differ from a carbon neutral pathway?

4) What mitigation actions are needed in different sectors to 'zero' the per-capita emissions value and how can carbon budgets assist with this?

5) What is the embedded carbon in goods and services consumed and items purchased in the urban area and is this included in the carbon neutral definition?

6) What level of carbon sequestration is it appropriate to consider to offset any remaining emissions after mitigation actions across sectors?

7) What are the geographical and economic boundaries of the Bristol Urban Area in relation to the carbon neutrality definition?

8) What is the baseline year and what is the end point/target year for the Bristol Urban Area?

The project reveals significant challenges in attempts to design and implement a pathway to a carbon neutral city, but also offers a range of insights and suggestions as to how the above questions might be addressed.

1. Introduction

The Urban Integrated Diagnostic (Urban ID) project developed and demonstrated a 'diagnostic approach' [1] to identify the barriers and challenges that face the Bristol urban area in achieving long-term sustainability. The project was funded by UK Research Councils and Innovate UK, running from June 2016 to March 2018.

The project examined those barriers and challenges through the lenses of four inter-dependent themes: mobility & accessibility; health & happiness; equality & inclusion, and carbon neutral city. It developed a set of tools to support this: participatory research, using co-creation and learning with stakeholders to inform challenges across those themes, in order to create novel solutions.

This approach was developed across five case studies, including one on Bristol Green Capital Partnership as a city-scale environmental sustainability community, by examining available information (e.g. technical reports, data, expert opinion, policy documents) to understand the current situation, and then piloting different co-designed research tools to identify the barriers to sustainable change.

This report summarises the project work on the carbon neutral city theme. It broadly covers the following:

- what a vision of 'carbon neutrality' means for the Bristol urban area (and how this might be defined), and over what timescale this might be achieved;
- barriers to decarbonisation of emissions – across energy use (scope 1), energy supply (scope 2), and energy involved in all goods and services consumed (scope 3, or 'all embodied carbon') – and the merits of an approach that includes the latter; and
- potential to co-design the strategic aspirations for the Bristol urban area in relation to carbon neutrality by 2050.[2]

This is supported by:

- a review of relevant local, regional, national and global policy contexts;
- identification and analysis of available local emissions data; and
- thematic analyses of all five Urban ID case studies, notably the 'city sustainability community' study that focuses on Bristol Green Capital Partnership.

The overall methodological approach to Urban ID and the Carbon Neutral Theme in particular, was designed to be replicable in different contexts to assist the development of carbon management strategies and policies at all levels. Firstly, by enabling

[1] An exploratory approach to identifying structural, organisational and other barriers to a low carbon future
[2] See box * A shifting context: Bristol & other UK cities' carbon neutral ambitions

identification and understanding of the main challenges and where and how they arise, and secondly by facilitating more effective partnership working for achieving a strategic sustainability vision.

*** A shifting context: Bristol & other UK cities' carbon neutral ambitions**

Since the research behind this report was undertaken, the IPCC's report on global warming of 1.5 degrees C was published (2018). This has prompted a number of policy responses:

In October 2018, the UK Government formally requested the Committee on Climate Change to reconsider the national carbon target of 80% by 2050 in the light of the IPCC report. The Committee is expected to update its advice in May 2019.

In November 2018, councillors on Bristol City Council unanimously backed a motion declaring a 'climate emergency' in the city and set out an ambition for the city to become carbon neutral by 2030. The Council is currently considering the scope of this ambition and is due to report back to councillors in mid-2019.

In October 2018, South Gloucestershire Council's Cabinet adopted a new Climate Change Strategy 2018-2023. This covers both climate change mitigation and adaptation.[3] It sets a target of at least an 80% reduction of carbon emissions from a 1990 baseline. The authority reports it has already reduced emissions by 41% compared to 1990 levels of carbon emissions. In order to promote the uptake of renewable sources of energy the Council has set a target for renewables to supply 6% of local energy demand by 2028, increasing to 25% by 2036. Currently 3.6% of local energy demand is supplied from renewable sources.

The Council has also committed to an adaptation strategy to prepare for a changing climate. To support delivery of the strategy five action plans are being developed covering climate resilience, carbon emissions reductions, renewables, new development, and low carbon economy.

Also, in November 2018 Manchester City Council also formally adopted a recommendation in November 2018, to establish a carbon budget that would lead to the city becoming 'zero carbon' by 2038. This covers CO_2 emissions from the city's energy system: gas, electricity and liquid fuels used to power and heat homes and businesses and to transport people around the city.[4]

Several other sub-national units across the UK have now set similar ambitions.

In this report, * has been used to link back to this policy update.

[3] http://www.southglos.gov.uk/environment/climate-change/climate-change-strategy
[4] Tyndall Centre for Climate Research at University of Manchester, https://secure.manchester.gov.uk/news/article/8076/ambitious_climate_change_target_proposed_for_manchester

Defining the carbon neutral city challenge theme

Before the challenges and barriers to low carbon transformation achieving a carbon neutral Bristol urban area can be considered, the concept needs to be clearly defined.

This involves three main questions:

- What do we mean by carbon and by carbon neutrality?
- What do we mean by the Bristol Urban Area? and
- Over what timeframe are we considering reducing carbon to neutrality?

The World Resources Institute (WRI) define neutrality of greenhouse gas (GHG) emissions as "net zero anthropogenic (from human activity) GHG emissions from all sectors". This is achieved primarily by reducing GHG emissions to as close to zero as possible. Then any remaining emissions can be balanced with an equivalent amount of removal of GHGs, such as by 'negative emissions' technologies or sequestration, that is removal from the atmosphere for example by planting trees.[5]

The simplified term 'carbon neutrality' is appropriate in an urban setting, as the majority of GHG emissions in such areas are from carbon dioxide (CO_2) from fossil fuel combustion. Other emissions can be captured through 'CO_2 equivalent' (CO_2e) measures.

The spatial extent of a city or other area that is to be carbon neutral also needs to be defined clearly. This could be in terms of geographic, political – such as a local authority (LA) – or other boundaries, such as the built-up area.

Such boundaries often link to emissions that are at least partially within the control of a given LA. Broadly, LAs in the UK focus on reducing their direct emissions first: those produced from the combustion of fossil fuels within boundary of the LA itself across the housing, transport, industrial and business sectors, and from any energy production and/or supply industry in the area. They may then focus on how to reduce 'indirect' emissions associated with the electricity used in the area that are generated outside the LA's boundaries. This can be achieved by increasing the amount of energy produced locally from renewable sources and by investing in renewable energy supply nationally or internationally.

The Urban ID project focused on the Bristol Urban Area. This covers the Bristol City Council area and that part of Bristol urban area that is in the South Gloucestershire Council area.

While there is no formal carbon reduction target for the Bristol Urban Area, both of the LAs concerned have targets to reduce emissions, so are making their contributions to the UK reaching its national climate change targets.

[5] http://www.wri.org/blog/2015/12/cop21-qa-what-ghg-emissions-neutrality-context-paris-agreement

The current target for emissions reductions in the Bristol City Council area is officially to zero by 2050 against a 2005 baseline.* In late 2018, South Gloucestershire Council adopted a local target in line with the national target, 80% reduction by 2050 against a 1990 baseline.

2. Background

Carbon emissions management at city level

The 2015 Paris climate conference – which happened to take place during Bristol's year as European Green Capital – saw an agreement which formally recognised the role of cities and other urban areas in contributing to national emission reduction targets and taking action on climate change mitigation - reduction of emissions to reduce the rate of climate change - and adaptation - managing the climate change that does occur.

For cities looking to develop a strategy to mitigate climate change, the carbon management hierarchy – initially created by Forum for the Future to inform business climate strategy discussions – is a useful starting point (see Figure 1).

This highlights the need to first avoid carbon intensive activities, then reduce emissions through efficiency improvements, then replace current activity with less carbon intensity activity. Only then is offsetting or sequestering of any emissions not eliminated in the early stages considered (consistent with WRI's GHG emission neutrality definition).

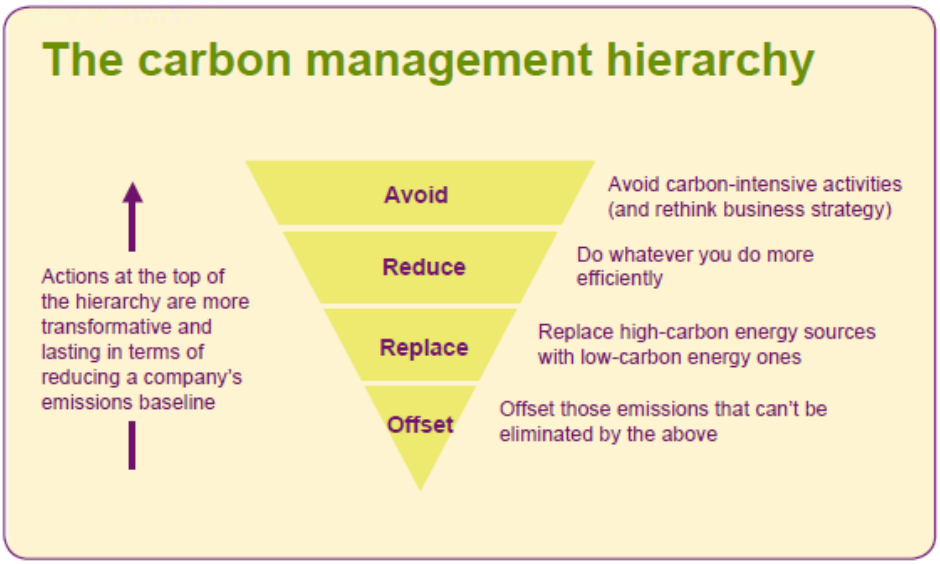


Figure 1: The Carbon management hierarchy (Forum for the Future)

In 2012, the UK Committee on Climate Change (CCC – see below) advised that LAs should develop carbon reduction plans, focusing on reducing emissions they have

some control over.[6] The CCC stopped short of recommending local authority carbon budgets that would have paralleled national requirements under the Climate Change Act (2008).

However, some local authorities are starting to look at how they can build local leadership and capacity to move and monitor progress towards meeting city emission reduction targets, including through setting such budgets.

One such example beyond the Bristol urban area is the Leeds Climate Commission was created in 2017 to provide an independent and authoritative voice on creating a low-carbon, climate-resilient city as the CCC does nationally, including consideration of localised carbon budgets. It brings together key city organisations from the public, private and third sectors to further this aim.

Since 2015's Paris Agreement, cities have been increasingly taking a leadership role on reduction of carbon emissions. Some cities are setting more ambitious targets for emission than their national governments, including Bristol which first pledged to become carbon neutral by 2050 at the Paris conference* – going beyond the UK's current 80% by 2050 target that was at the point of its adoption probably the most ambitious national target in the world.

Cities have also been seen to take action in countries where national leadership has been seen to be lacking. For example, in the US many states and cities have stated their intention to implement the Paris agreement even though the US federal government has announced its intention to withdraw from the agreement in 2020.[7] The US Climate Alliance's member states make up about 36% of the country's population and some 30% of its gross domestic product, and were responsible for around 20% of US carbon dioxide emissions in 2014.[8]

This city-level action is also facilitated by global city organisations such as the Carbon Neutral Cities Alliance, which brings together cities working to cut greenhouse gas emissions by 80 to 100% by 2050 or sooner, and C40 cities' pledge in late 2018.[9]

Measuring cities' carbon emissions

Robust statistics on city-level carbon emissions are vital for progress against reduction targets to be monitored and actions to deliver targets to be appropriately calibrated.

[6] (UK) Committee on Climate Change, *How local authorities can reduce emissions and manage climate risk*v, May 2012
[7] https://www.c40.org/press_releases/one-year-after-trump-decision-to-withdraw-from-paris-agreement-u-s-cities-carry-climate-action-forward
[8] https://www.businessinsider.com/us-states-uphold-paris-agreement-2017-6?r=US&IR=T
[9] https://www.c40.org/other/fossil-fuel-free-streets-declaration

However, attributing emissions to a city or region is more complex than for countries, as there are generally many flows of goods and services in and out of a city or region and often multiply interconnected interdependencies.

Many cities produce inventories of emissions, including for planning and policy purposes. In the absence of binding, verifiable and audited international requirement to produce emissions data at city or region levels, there is no agreed way of measuring carbon emissions at those sub-national levels, as countries are only obliged to report at the national level under the Kyoto protocol.[10]

Internationally, while not universally used, the 'Global Protocol for Community-Scale Greenhouse Gas Emission Inventories' (GPC) is arguably the closest thing to a standard for sub-national emissions measurement.[11] It was developed from two pre-existing approaches.[12] As a joint project between Local Governments for Sustainability (ICLEI), WRI, C40 Cities' Climate Leadership Group, the World Bank, UNEP and the UN, it has extensive recognition as a GHG emission accounting method for cities across the world.

In the EU, the Covenant of Mayors for Climate and Energy supports cities in compiling local emissions inventories as part of their sustainable energy action plans.[13] Broadly based on the IPCC's guidelines, it includes a 'life cycle assessment' approach, so that LAs can calculate Scope 3 emissions from their supply chains.

Another widely-used approach is CarbonN, a global reporting platform for cities, towns and regions to track and report on targets, actions and performance.[14]

In the UK, the Department for Business Energy and Industrial Strategy (BEIS), and previously the Department for Energy and Climate Change, has produced carbon emissions data for local authority areas, regions and devolved administrations since 2005.[15] While some sub-national authorities in the UK use these emissions data to monitor emission reduction progress, there is no formal obligation to do so.[16]

The Urban ID study covers the Bristol urban area which straddles two LAs. In order sensibly to reduce emissions across the area the two LAs will need to agree a common approach, in order to identify a carbon reduction target, timescale and pathway to achievement.

---

[10] https://unfccc.int/process/the-kyoto-protocol
[11] https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities
[12] The International Panel on Climate Change (IPCC) 'Guidelines for National Greenhouse Gas Inventories' (2006) and the World Resources Institute and World Business Council for Sustainable Development's 'GHG Protocol Corporate Accounting and Reporting Standard' (2004)
[13] https://www.covenantofmayors.eu
[14] http://carbonn.org
[15] https://www.gov.uk/government/collections/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics
[16] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/418409/sub_national_emissions_statistics_faq.pdf

Emission scopes and boundaries

As well as determining the boundary to be used for emission reduction targets and strategies for delivering them, cities must also decide what scale of emissions – which 'scopes' as noted above – to include in their 'carbon neutral' definition. These scopes were first defined in the Corporate GHG protocol and then defined at city-scale in the GPC, both mentioned above:

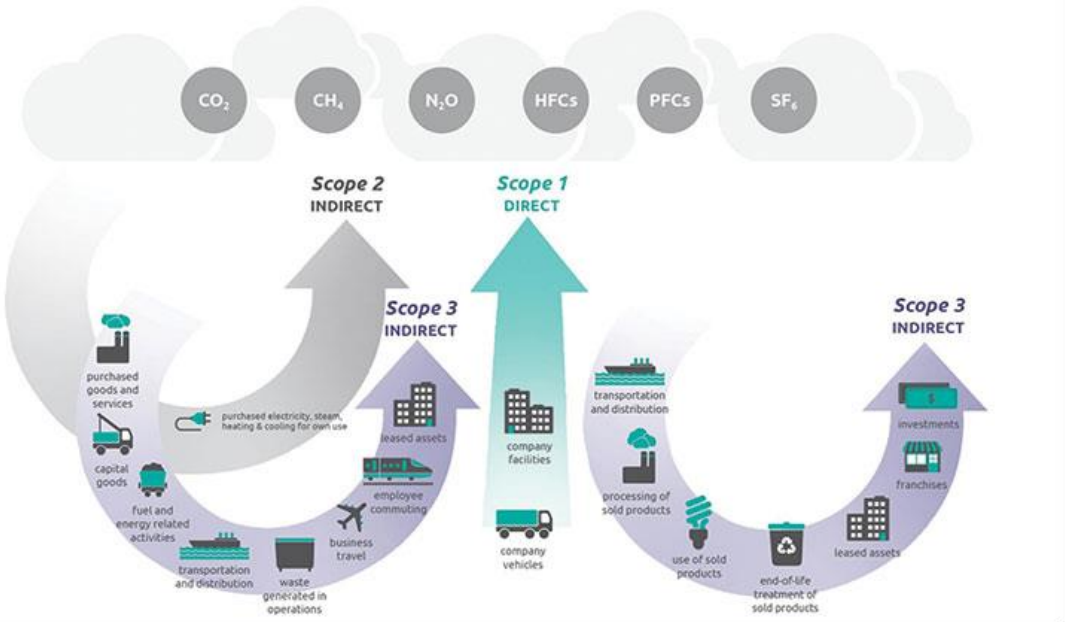


Figure 2 Scope 1, 2 & 3 content as defined by the Greenhouse Gas (GHG) Protocol[17]

Scope	GHG Protocol Definition	GPC city-level definition
1	All 'direct' GHG emissions	GHG emissions from sources located within a city's boundary
2	'Indirect' GHG emissions from consumption of purchased electricity, heat or steam	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within a city's boundary
3	Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities (e.g. transport and distribution losses) not covered in Scope 2, outsourced activities, waste disposal, etc.	All other GHG emissions that occur outside the city boundary as a result of activities taking place within a city's boundary

The academic literature shows that different approaches to emissions footprint measurement include different combinations of these three scopes, with 'direct'

[17] https://ghgprotocol.org/ and footnote 9

approaches focusing on production-based emissions (scopes 1 or 2), whereas economic 'life-cycle based' approaches often also include scope 3 emissions.

Given the close interconnection of cities with their surrounding regions, it is more difficult to define the spatial extent of the inventory, as national emissions inventories do. It is in part for this reason that spatial (direct) measurement approaches based on the IPCC national guidelines usually include only scopes 1 and 2, as these are easier to determine for a city boundary. This means that embedded emissions in imports into and exports from the city are not accounted for in the inventory. However, emission estimates using spatial/direct approaches benefit from greater certainty than estimates that include scope 3 'consumption-based' emissions.[18]

It is important to note that all these approaches estimate rather than directly measure emissions. This involves taking activity data – for example, the annual total distance travelled by road vehicles, or total annual household energy consumption for heating of buildings and hot water – and applying an appropriate emissions factor for different fuel mixes.

Activity and factor data are much more difficult to gather for scope 3 consumption-based emissions, so when they are included in an emission measure the uncertainty is magnified. Nevertheless, there are obvious benefits to including scope 3, such as to ensure city emissions reduction strategies, policies and actions do not focus narrowly on production emissions and so failing to account for the large proportion of a city's emissions (and the actions and behaviours that lead to them) actions.[19]

There are several other issues for cities to consider when compiling emission inventories to support mitigation strategies:

- the ownership and management of 'cross-boundary' emissions and risk of double-counting carbon emissions and/or reductions;
- the baseline year used for assessing progress;
- whether to use national or region/city-specific factors for emission estimates;
- the choice of activity data used in order to allow comparison with other cities and/or to identify areas for action for local policymakers and stakeholders;
- how to balance the need for accurate and complete datasets with available time, resources and analytical expertise.

[18] Kokoni S. & Skea J. (2014), Input-output and life-cycle emissions accounting: applications in the real world, Climate Policy,14, pp 372-396
[19] Millward-Hopkins, J., Gouldson, A., Scott, K., Barrett, J. & Sudmant A. (2017) Uncovering blind spots in urban carbon management: the role of consumption-based carbon accounting in Bristol, UK Regional Environmental Change pp. 1-12

Carbon sequestration

Sequestration in this context means the removal of CO_2 and other GHGs from the atmosphere and its long-term storage in ecosystems for example reforestation.

Carbon sequestration can play a role in achieving a carbon neutrality city. However, the 2015 Paris agreement and WRI's definition of GHG emissions neutrality state that net zero anthropogenic (human-created) GHG emissions from all sectors should be achieved by reducing these as close to zero as possible before considering sequestration.

Carbon capture and storage, either through technology or through sequestration by ecosystems, can be geographically independent. This presents an opportunity for a city to explore sequestration of carbon further afield.

Opportunities for local and remote sequestration can, for example, build on recent work examining the potential for restoration of tropical dry evergreen forests:[20]

The Converging World (TCW) model of averting direct carbon emission by substituting wind turbine generated electricity for carbon intensive power generation sources and through sequestrating in ecosystems is the type of imaginative thinking required to address this issue. TCW's 2.1MW wind turbine installed in Tamil Nadu, India averts approximately 4,000tCO_2e of emissions from conventional fuel sources a year, so some 80,000tCO_2e over the 20-year operational lifetime of the turbine. Reinvesting operating surpluses from the sale of electricity generated into restoration of forests for 20 years, and allowing a 100-year progression to forest climax community, provides 123 hectares of restored forest to sequester carbon. Forest restoration funded from turbine generation surpluses in this way provides a substantial 'multiplier effect' than from sequestration alone. Forest restoration also provides a range of additional ecosystem services, contributing to meeting a number of related UN Sustainable Development Goals.[21]

This suggests that the sequestration of residual carbon emissions through a programme of turbine installation in Tamil Nadu with surpluses dedicated to forest regeneration is a worthy consideration for the Bristol Urban Area.

[20] Everard, M., Longhurst, J.W.S., Pontin, J., Stephenson, W. Brooks, J. and Byrne, M. (In press). Developed-developing world partnerships for sustainable development (3): reducing carbon sequestration uncertainties in south Indian tropical dry evergreen forest. Ecosystem Services 32, pp 173-181

[21] https://sustainabledevelopment.un.org/?menu=1300

3. Policy context

Currently, legally binding targets set under the Climate Change Act (2008) commit the UK to reducing its greenhouse gas emissions by at least 80% by 2050 using a baseline of emissions in 1990. At the time of the Act, coming into force this was considered consistent with limiting the global temperature rise the then target of as little as possible above 2°C.

The UK Government has also adopted interim targets for national greenhouse gas emissions recommended by the Committee on Climate Change (CCC), through legally binding 'carbon budgets'. These are to reduce UK emissions by 35% by 2020, then 50% by 2025 (both also against the 1990 baseline). The CCC is an independent statutory body established under the Climate Change Act to provide expert technical advice, monitor UK's progress on emission reductions, and reports to the UK parliament, rather than the government.

These targets were more ambitious than the EU's interim targets of 20% by 2020 and 40% by 2030, but less so than the EU's 2050 reduction target of 85-95%, again all also against a 1990 baseline. There is an additional '20:20:20' target for increasing the share of energy generated by renewables in the EU to 20% and improving energy efficiency by 20%, both by 2020. More recently, the European Commission has expressed the intention to achieve zero carbon by 2050.[22]

As noted above, the UK produces breakdowns of emissions by LA area, as a subset of its annual national inventory. While UK local authorities have to produce emission statistics, they are free to set their own emission reduction targets if they wish.

Since 2015, LAs in the UK have begun to set their own ambitious targets for carbon emissions reduction.

Bristol City Council: Carbon neutral by 2050*

In 2015, Bristol City Council published *Our Resilient Future: a framework for climate and energy security*, in which Bristol City Council committed to the following targets, against a 2005 baseline (the only sufficiently robust local area figures available):

- reduce energy use 30% by 2020;
- reduce CO_2 emissions by 40% by 2020;
- reduce CO_2 emissions by 80% by 2050.

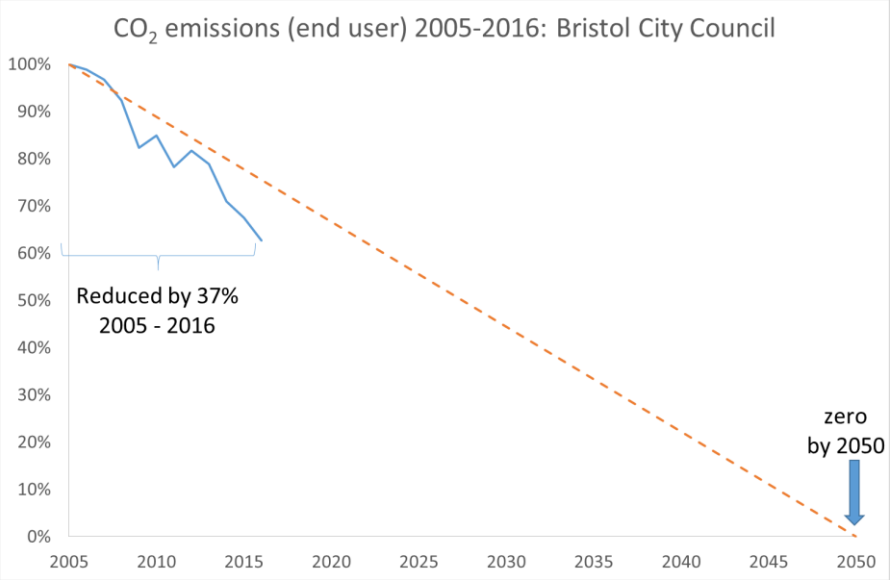
Then, as noted above, the then Mayor of Bristol, George Ferguson, committed to becoming 'carbon neutral' by 2050 in 2015, as part of the city's commitment to the Paris Agreement.

Elected in May 2016, the present Mayor of Bristol, Marvin Rees, reaffirmed this commitment in his election manifesto, pledging that Bristol should run entirely on

[22] https://ec.europa.eu/clima/news/commission-calls-climate-neutral-europe-2050_en

renewable energy by 2050 as part of "the city's journey to becoming carbon neutral by 2050."[23] The Council's *Corporate Strategy 2017-2022* includes "Bristol is carbon neutral by 2050".[24]

Using BEIS LA-level data, Bristol's CO_2 emissions have fallen by 37% since 2005. On a per capita basis, which accounts for an increase in population during this period, emissions are 44% below 2005 levels, going from 6.4 tonnes per person to 3.6 tonnes per person.[25]



However, it should be noted that the changes in emissions since 2005 cannot all be attributed to mitigation actions in the Bristol City Council area. Further analysis would be needed to determine the level of reductions resulting from national policy and action, and/or regional structural and economic shifts.

Emission reductions by different economic sectors suggests a mixed picture, with significant reductions in industry and commercial sectors, less significant reductions in the domestic sector, with transport sector emissions fairly static.

South Gloucestershire Council

South Gloucestershire Council's Climate Change Strategy, incorporating its 'Low Carbon Plan', was formally adopted in April 2013.[26]

[23] https://news.bristol.gov.uk/news/new-mayor-approves-first-major-project-towards-2050-carbon-neutrality-goal
[24] https://www.bristol.gov.uk/documents/20182/1188753/Corporate+Strategy+2017-2022+D5/c545c93f-e8c4-4122-86b8-6f0e054bb12d
[25] Department for Business, Energy and Industrial Strategy, *UK local authority and regional carbon dioxide emissions national statistics: 2005 to 2016*, https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-2016
[26] http://www.southglos.gov.uk/environment/climate-change/climate-change-strategy/

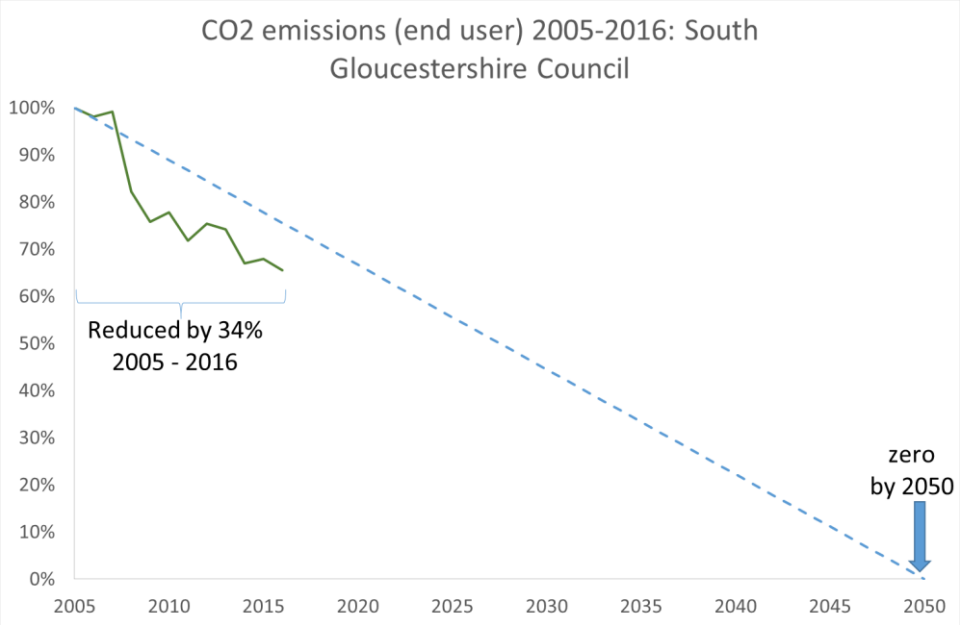
This set a target to reduce CO_2 emissions by 80% by 2050 on a 1990 baseline to 414.6Kt (a reduction of 1,658.7Kt since 1990 and of 1,280.9Kt since 2008), in line with national targets under the Climate Change Act. It also outlined priority actions:

- Low carbon council - reduce carbon emissions across the council estate and operations;
- Low carbon homes - reduce carbon emissions and energy consumption in our homes;
- Low carbon travel - reduce transport energy use and carbon emissions from transport;
- Low carbon economy - promote business resource efficiency and help low carbon and local businesses grow in South Gloucestershire;
- Low carbon energy - enable the development of secure supplies of renewable and low carbon energy; and
- Low carbon communities - support and promote neighbourhood energy planning and community action for low carbon living.

The savings and emissions identified in South Gloucestershire Council's strategy do not match up with BEIS' end-user statistics, perhaps because they only refer to scope 1 emissions and do not include emissions from purchased energy.

The total end-use CO_2 emissions reductions from 2005 to 2016 are shown below against the trend line for reduction to zero emissions by 2050 to allow comparison with Bristol City Council data.

Overall emissions are down 34% compared with 2005, with per capita emissions 40% lower (10.8 tonnes per person to 6.5 tonnes per person). While the reductions are similar to those in the Bristol City Council area, on a per capita basis emissions are starting from a much higher base. An initial examination of the data shows that even though the 276,700 population is lower than that that of Bristol City Council (456,000) the area has much higher emissions from transport – as one might expect between an urban area and a more rural area – it also has similar levels of emissions from industry.



West of England region

The Bristol Urban Area is within the West of England region, which has relatively new regional governance arrangements.

The West of England Combined Authority (WECA) was established in 2017, with an elected mayor chairing the WECA Committee which also includes the leaders of the three constituent local authorities: Bristol City, South Gloucestershire, and Bath & North East Somerset. The WECA mayor and the Committee have a number of powers devolved from central government, focused on transport, housing and planning, and adult education and skills.

While North Somerset Council is not part of WECA, there is a West of England Joint Committee for matters of relevance to all four authorities. The region's Local Enterprise Partnership also covers the same four-authority area.

As regards emissions targets, the draft West of England Joint Spatial Plan – a product of the 4 local authorities in the region – presented a combined CO_2 target of reducing absolute CO_2 emissions by 50% by 2035 from a 2014 baseline.[27]

The Joint Spatial Plan states the commitment of the 4 authorities "to improve energy security, address fuel poverty and to achieve an efficient low carbon economy". Furthermore, the authorities recognise the need to "contribute to and support the increased use and supply of renewable and low carbon energy in line with objectives and provisions of the Climate Change Act 2008".

[27] West of England Councils, Joint Spatial Plan – Publication Document, Nov 2017

A West of England Strategy discussion paper,[28] which set out WECA's initial commitment to climate change mitigation, highlighting that future growth must be more environmentally sustainable and that the region needs to play its part in meeting UK reduction targets. The paper also recognised that the region's "natural assets and economic strength affords us greater responsibility in keeping climate change within recommended limits".

Several strategies or plans relevant to West of England region carbon emissions are currently in development, notably:

- Joint Spatial Plan (currently at planning inspector stage);
- Joint Local Transport Plan (currently out for public consultation;
- West of England Local Industrial Strategy;[29] and
- West of England regional energy strategy (agreed in Feb 2019).[30]

Other UK cities

Other LAs and cities have set emission reduction targets in-line with the national 80% by 2050 target. However, like Bristol, they are free to set carbon emissions targets that go beyond the national target:

Manchester Council

The Manchester Climate Change Strategy 2017-2050, developed in consultation with its citizens sets out its 'Vision 2050':[31]

"Manchester is playing its full part in limiting the impacts of climate change, locally and globally. It is a thriving, zero carbon, zero waste, climate resilient city where all our residents, public, private and third sector organisations are actively contributing to and benefiting from the city's success. We compete and collaborate with cities around the world, ensuring that our collective efforts have limited global average temperature increases to well below 2°C, hopefully to 1.5°C, relative to pre-industrial levels."

In March 2018, Manchester launched a 'UK city-focused low carbon pathway model' called SCATTER (Setting City Area Targets and Trajectories for Emission Reduction). Developed by the Greater Manchester Combined Authority (GMCA), The Tyndall Centre and Anthesis Group, with BEIS funding, the model is intended to support cities in the UK to set emission reduction targets and define pathways.

London

[28] https://www.westofengland-ca.gov.uk/wp-content/uploads/2017/07/West-of-England-Strategy-Discussion-paper.pdf
[29] The LIS evidence base has been published at: https://www.westofengland-ca.gov.uk/ourstrategy/
[30] https://westofengland-ca.moderngov.co.uk/ieListDocuments.aspx?CId=142&MId=259
[31] http://www.manchesterclimate.com/sites/default/files/MCCS%202017-50_0.pdf

The Mayor of London has set a target for London to become zero carbon by 2050.

Around 80% of the city's emissions come from electricity and heating in buildings, and transport. The *London Environment Strategy* sets out a programme of activities to contribute to meeting this target:

- energy efficiency programmes to cut energy use from buildings;
- energy supply programmes to supply more of London's energy locally;
- supporting the use of low carbon hydrogen to power transport and heat and power buildings;
- working with Transport for London to cut energy use from transport and use new technologies to cut emissions;
- measuring the amount of greenhouses gases in London every year through the London Energy & Greenhouse Gas Inventory; and
- increasing jobs and investment into climate change programmes through green economy work.

International city initiatives & targets

Copenhagen has set the most ambitious goal for a capital city: to be carbon neutral by 2025.[32] This is to be achieved through a transition of their energy supply, retrofit of buildings, waste management, public infrastructure and mobility, and other initiatives to support the transition. Copenhagen is collaborating with companies and knowledge institutions to find new solutions to specific challenges of becoming carbon neutral.

The Carbon Neutral Cities Alliance is a collaboration of cities aiming to cut greenhouse gas emissions by 80-100% by 2050 or sooner. The Alliance helps cities in a number of different ways: developing carbon neutrality planning and implementation standards; supporting deep decarbonisation innovations; advancing transformative change in key urban sectors; speaking with a common voice; advancing a "next wave" of carbon neutral cities.

[32] https://international.kk.dk/artikel/carbon-neutral-capital

4 City sustainability community case study

One of the 5 Urban ID case studies (see chapter 5 for more details) focused on Bristol Green Capital Partnership, with the carbon neutral challenge theme explored explicitly across the research activities including a carbon neutral roundtable with city leaders and key stakeholders. A report of the case study noted that engagement with this community on carbon neutrality elicited responses that fell into two broad categories:[33]

- Suggestions of visions, policies and direct actions to decarbonise the Bristol Urban Area; and
- Identification of the wider relationships between a carbon neutral city vision and other aspects of sustainable development in Bristol.

Partnership members had a broad range of knowledge and opinions in relation to carbon neutrality, and a particular focus on energy supply and consumption in the area: indeed, energy is one of the Partnership's five themes.

Climate change and carbon foot-printing were identified by Partnership members as amongst the main issues to address to as one member contact put it, "ensure that sustainability is at the heart of our region's planning".

Participants from the Partnership's membership spoke in the workshop of their organisation's commitments to reducing emissions; their role in encouraging organisations and clients to take up grants and assistance to move towards carbon neutrality, ongoing projects in Bristol to tackle fuel poverty; and workshops for stakeholders on resilience of energy systems.

In terms of identifying the wider relationships between the carbon neutral city theme and the other Urban ID project challenge themes, members recognised the links between health, equality, energy affordability and fuel poverty that could be potentially be addressed by building low carbon homes. Members also recognised the need for improved city and regional planning of the transport system to reduce the city's carbon emissions by increasing cycling and walking infrastructure, reduce congestion by creating decentralise work hubs, and while also addressing air pollution and flooding.

Partnership member organisations also recognised that the boundaries of a 'carbon neutral city' for the Bristol Urban Area extend beyond its geographical boundaries, and that there is a need to consider carbon emissions embedded in resources and energy produced outside the region (scope 3). Case study activities saw a frequent focus on green space and the natural environment, and the relationship between these and all of the challenge themes, including carbon neutral city.

[33] See http://www.urban-id.co.uk/case-studies/bristol-green-capital-partnership/

The Partnership community's collective, broad interest, expertise and understanding of the interdependencies between carbon neutrality, energy, housing, transport, planning, health, the natural environment, air pollution, local business, education and other issues were demonstrated across the research activities. This is therefore a valuable resource for the city and region's policy-makers, businesses and other organisations and communities in terms of identifying and working to ensure interdependencies are recognised in all decision-making and supporting wider learning- and knowledge-sharing on environmental sustainability.

Carbon neutral round-table

As part of the case study. a 'Carbon Neutral Bristol 2050' round-table was co-organised and co-facilitated by the Partnership and the University of West of England in the summer of 2017. This brought in senior stakeholders from Bristol City Council, including the then executive cabinet member for energy and waste, and other key relevant organisations in Bristol. The primary aim of the event was to initiate discussions among key stakeholders around carbon neutral city, and highlight areas of consensus and dissonance. The main elements of the roundtable were:

- "Carbon neutral what?" presentation by UWE, discussing carbon neutrality and zero carbon definitions, emission scopes and data sources;
- a carbon neutral city timeline activity, with breakout groups with attendees developing milestones, achievements, aspirations and ambitions up to 2050;
- a group discussion to explore and prioritise decarbonisation actions up to 2050;
- a group discussion of the importance of a common, shared language for communicating and engaging on carbon neutrality by 2050 to achieve that goal;
- a presentation on the potential role of Bristol Green Capital Partnership and its members, on what they can do to encourage peers and other organisations and through them encourage citizens to engage. [34]

The following sections summarise the key findings from the round-table:

1) Defining carbon neutrality targets for Bristol

Participants recognised the political need for targets, but with the proviso that these should not become the sole focus of dialogue and action: Bristol can and perhaps should go beyond target-setting, although having a target articulates a feeling that 'we need to do something'.

[34] The contents and findings from the roundtable event are reported in a paper presented at the 2018 WIT Air Pollution conference, Prestwood, E., Longhurst, J., Townsend, I., Haines, T. and Tsiarapa, E. (2018) Facilitating stakeholder dialogues on a carbon neutral city: We need to talk about carbon (and air quality). *WIT Transactions on Ecology and the Environment*, 230. pp. 501-510. ISSN 1743-2541

Bristol's carbon neutral by 2050 target refers to scope 1 and 2 emissions (direct emissions and those from purchased electricity). It was proposed that in future scope 3 (those embedded in goods and service) should not be ignored, so as to avoid off-loading consumption-based emissions on to, for example, developing countries and the 'fossilisation' of business-as-usual approaches. The city should consider itself as part of a larger system and therefore include emissions from production outside the city.

The high level of uncertainty attached to quantification of scope 3 emissions was acknowledged, but it was thought that accounting would become easier in the future, with emerging methodologies, such as in London.[35]

Focusing on scope 1 and 2 emissions would however make it easier to talk about and to quantify co-benefits of carbon emission reduction, in particular, improved air quality and to communicate the local, national and global context of emission scopes and targets to business and other organisations, and citizens.

2) Bristol as a global leader city

The role of Bristol as a city leader was discussed and the question of what the city's various actors including civil society organisations can do to recover or maintain (depending on one's perspective) its position as an environmental sustainability and decarbonisation leader.

A number of suggestions were made as to how Bristol can engage the wider city in transforming to carbon neutrality and be a leader in the UK and worldwide:

- promote procurement best practice that includes embedded (scope 3) carbon emissions;
- lead the UK's core cities on low-carbon benchmarking, building on Bristol's existing leadership on the low carbon portfolio in that group;
- set new standards for cities by generating more of its own energy, developing a sharing economy and energy democracy, and being independent; and
- developing a set of baseline design principles, which should be considered in all city plans and strategies.

The 'short-sightedness' of city and regional planning was identified as an area that needs to change to ensure the strategies Bristol is setting now contribute to future change, and do not set this back: avoiding a 'here and now' approach that preserves current barriers and issues. New and smart technology development in Bristol (and other cities) needs to be appraised and socially and politically managed to avoid unintended detrimental impacts.

[35] www.london.gov.uk/sites/default/files/assessing_londons_indirect_carbon_emissions_2010_2014.pdf

For example, growth in the electric vehicle market in the city might seem inevitable, but this should be considered in planning and policy to ensure it is not prioritised over walking and cycling infrastructure. The emerging 'One City Plan' was also highlighted as an opportunity for Bristol to lead the way on a future focused, co-produced city planning process with carbon neutrality at its heart.[36]

3) Engaging with carbon neutrality

The meaning of the term 'carbon neutrality' in the Bristol context was discussed at the round-table and its complexity as a term identified as a clear barrier to engaging businesses and communities across the city. Even among Partnership member organisations 'carbon neutrality' was not a term in common use.

To engage the city on transforming to a carbon neutral city, city leaders and key stakeholders needed to consider how they are fertilising the ground they are seeking to develop policy about. A space in the city needed to be created to enable discussions about carbon neutrality, what it means, and to explore the interconnected issues of how we live and work in the future work to provide meaning and context to the term 'carbon neutral'.

This means that to engage the business community, for example, the city needs to describe and talk about carbon neutrality in a way that is compatible with their objectives in using familiar language. 'Carbon conversations' also need to be linked to quality of life, business outputs and co-benefits of action with a recognised economic cost such as improved air quality and health.

To be engaging, conversations should be based on a narrative of hope of achieving something better such as a 'clean energy city'. Conversations need to include tangible effects of moving to a carbon neutral city rather than focusing on concepts such as scopes and accounting. One participant noted: "Avoiding a bad thing is a motivator, but achieving something better is a stronger motivator."

Energy and carbon conversations with different stakeholders often ask what they are going to do, but never ask people what they want to do. There is an assumption often made by academics and politicians that people and organisations do not need to know about details and should be happy to defer to experts.

Part of making carbon neutrality more meaningful and tangible to a range of communities should be co-designing technological and organisational solutions in focus groups and at 'open door' events that explore how technologies work.

In addition, engagement on policy design should be improved, increased and democratised to reach different communities (through businesses and other

[36] The One City Plan was published in Jan 2019 (www.bristolonecity.com) along with *Our Future, an Environmental Sustainability Vision for Bristol*, which includes a specific action on carbon neutrality*: http://bristolgreencapital.org/bristol-green-capital-partnership-launches-future-vision-environmentally-sustainable-bristol

organisations) to reach beyond the parts of the city that are already engaged on climate change mitigation.

4) Bristol Green Capital Partnership's role

The Partnership was seen to have a key role to play in creating and increasing space for organisations to engage with the city's carbon neutrality agenda – building on its independence from the LA in order to open up city conversations and action towards carbon neutrality (with appropriate resources to do so).

The Partnership can, and does, create opportunities for specialists to debate and engage with other members to explore questions and come up with solutions for moving towards a carbon neutral city. It can also showcase good practice and develop further processes for demonstrating and discussing members' ongoing activities that are contributing to the transition to a carbon neutral city.

To enable the Partnership to take on this carbon neutrality leadership role in the city a carbon neutrality strategy for Bristol needs to be developed and implemented. In communicating the 'bigger picture', carbon neutrality needs to be linked with issues that may be of more immediate concern, such as employment, air quality, social inclusion and fuel poverty. This would help the setting of carbon neutral targets and strategies and be meaningful and tangible to all parts of the city.

Engaging stakeholders

Analysis of the outputs of the roundtable and wider Urban ID project leads to a set of guidelines for facilitating stakeholder engagement on carbon neutrality:

1) ask stakeholders how they want to live and work in the future (visioning), rather than present them with a predetermined picture of a carbon neutral city;

2) include specialists from other areas, such as health and wellbeing, and natural environment, as well as those with knowledge of energy supply and energy use;

3) when referring to emission scopes or presenting carbon or air pollution data, identify meaningful and tangible impacts that locate these data sources in a real world and relevant context for different people, communities and businesses;

4) align stakeholder engagement sessions with 'open door' events to showcase innovation – both of technological and social/organisational forms; and

5) set out an inclusive process for continued engagement, learning-and knowledge-sharing to follow on from stakeholder dialogue sessions.

Summary of the Round Table

The round-table identified the challenges in defining carbon neutrality for Bristol in terms of boundaries, emission scopes and timescales.

Attendees did not reach a consensus on which emission scopes should be included in a carbon neutral definition for Bristol though a majority agreed the target should focus on scopes 1 and 2 with the boundaries aligning with the city's control of and responsibility for emissions. A minority of participants argued for inclusion of scope 3 emission in targets to avoid dumping and business as usual patterns.

Carbon neutrality targets are a political necessity, but it was agreed that the language of emissions scopes was not helpful for engaging citizens, businesses and organisations. Targets need to be framed within a real-world context that links to impacts and benefits more meaningful to different communities such as improved air quality or quality of life.

The Partnership has a significant and continuing role in creating the space in the city for organisations to come together to act, learn and talk about a carbon neutral city and what this means. They can do this by continuing to bring their members together co-create and showcase good practice, and share their work, progress and knowledge with the wider Bristol Urban Area. The Partnership could also help formalise a process in the city of bringing member organisations and citizens together to co-design technological or social governance solutions, or put on 'open door' allowing interested people to see how different technologies work. This would clearly require funding and support.

The Partnership brings together people from organisations and businesses working on different but interconnected economic, environmental, social and health and wellbeing issues in cities, to fully analyse carbon neutrality and what it means, through boundary spanning communication and collaboration. These groups should start with the question of 'how do we want to live and work in the future' to co-produce a hopeful vision for the future.

At the same time, there is a need to utilise the specialism of Partnership members to help develop a quantified and measurable strategy for how Bristol becomes a carbon neutral city and to build a better, empirical understanding of carbon neutrality. This strategy must necessarily focus on emission scopes and boundaries initially but should also quantify physical, financial, meaningful impacts for businesses, organisations and citizens rather than presenting ideas and concepts that rely on hard to understand terms such as low-carbon or energy efficient.

Finally, the Partnership and the City should not shy away from talking about carbon neutrality, providing it develops appropriate methods of framing conversations so that they have meaning for the range of different communities in the city.

5. Learnings from the other 4 case studies

The Urban ID project created diagnostic tools to identify barriers and challenges to sustainable transformation in the Bristol Urban Area, using a combination of the following data collection/analysis approaches:

1. Drawing on appropriate existing data and identifying missing data and sources.
2. Interdependency mapping exercises and documentation/analysis of the outcomes.
3. Use of participatory/creative approaches and documentation/analysis of the outcomes.
4. Narrative interviews with a range of different actors associated with different case study.
5. Completion of learning profiles with different actors engaged with the project, where possible.

These were developed across five case study areas. The findings from four of those case studies related to the carbon neutral city challenge theme are described and summarised in this section. The fifth is examined in more detail separately above.

Across case studies, a set of integrated questions were developed for each challenge theme, to be considered in research activities. For the carbon neutral city theme, these were:

Spatial and temporal boundaries:	1) What is my/our definition of the Bristol urban area? Is it where I/we live, work or travel? Where we are active? 2) How long will it take before we have a carbon neutral/sustainable city?
Knowledge & understanding:	3) What is my/our personal experience of climate change versus what is my/our understanding of the science/statistics of climate change? 4) How do I/we feel about a carbon neutral city?
Agency & power:	5) Can I/we make a difference and act to reduce emissions? 6) Am I/are we empowered or able to act on climate change?
Willingness to act:	7) Do I/we want to take action to reduce emission or do the perceived sacrifices outweigh the perceived benefits? 8) What is my/our motivation to act? 9) Will other people/organisations take action?

Staple Hill

This case study primarily focussed on Urban ID's 'health and happiness' theme. Older people were identified as a key group to focus on though quantitative data and site visits.

During this engagement with the community, issues relating to the 'inclusion and equality' and 'mobility and accessibility' themes were the focus of discussion. The

research team leading this case study noted that ‘carbon neutrality’ did not arise in interviews as spontaneously as it did in the other themes, and was not as explicitly linked to those themes.in the minds of the participants.

They considered carbon neutrality to be less obviously linked to older people. However, the greater car dependency of the elderly was identified as a potential link, and the carbon neutral city theme was also linked with health and happiness as the Staple Hill area was seen by research participants as an accessible, walkable neighbourhood. This carbon neutral city finding was common across many of the case studies.

Innovative housing case study

‘Carbon neutrality’ did not arise spontaneously in interviews with community members in this case study and that it was not raised by researchers as a follow up must be considered a missed opportunity. The case study researchers recognised that ‘sustainability is of concern to housing’ and ‘buildings are responsible for a fair degree of greenhouse gas emissions’.

The case study researchers noted that “construction of buildings is not the major cause of emissions, but rather their phase of use; a building may release 80-90% of its total emissions during this time (UNEP, 2010). This period of use relates to everyday choices and habits. With this in mind, the notion of a carbon neutral city is bound to people’s behaviour in the city as well as the materials from which the city is built”. Though this is undoubtedly true, any pathway to a ‘carbon neutral city’ is highly likely to require the design and construction of new low and zero carbon buildings that enable low carbon choices, along with and extensive retrofit of the existing building stock. The links between carbon neutrality and innovative housing may therefore be stronger than considered in the case study.

East Bristol case study: Bristol to Bath Railway Path (BBRP)

This case study examined promotion of walking and cycling in the area, and the need for improved cycling infrastructure across the city. These actions would result in reduced carbon emissions from car, bus and train transport systems in Bristol and so help achieve a carbon neutral city.

The case study researchers concluded that the challenge themes were sometimes insufficient for understanding and identifying key trends in the community’s usage of the BBRP and their aspirations. For example, wildlife and biodiversity and a key reason for valuing the path, but these issues were not represented by any of the four project challenge themes.

Another important issue for this case study was the perception of better air quality on the path, as well as the impact that wider usage of the path could have on reducing vehicle emissions and improving air quality in East Bristol and on emissions of carbon.

Metrobus

Reducing carbon emissions and contributing to a lower carbon city was identified as a specific objective of the Metrobus case study:

“To reduce carbon emissions, by extending the choice of transport modes, providing a rapid and reliable alternative to car use, and encouraging a shift to more sustainable travel patterns”.

Therefore, this case study more explicitly considered the carbon neutral city theme through the promotion of public transport use, and increased opportunities for walking and cycling interchanges enabled by the Metrobus project.

In workshops, the case study also considered how the spatial boundaries of a ‘MetroBus community’ might be in practice. It also considers the visions, hopes and expectations community members have in terms of the future of transport in Bristol and how it relates to their own lives (accessibility, health and wellbeing) and wider issues (e.g. air pollution, carbon emissions).

Cross-study analysis

The learning from four of the Urban ID case studies described here highlights a significant barrier to a city’s transformation to a carbon neutral city.

Other than in the Metrobus case study, ‘carbon neutrality’ and climate change mitigation did not arise spontaneously in engagement. As the Bristol Urban Area becoming carbon neutral will require concerted action from everybody, this is a potential concern.

However, the various different communities involved demonstrated interest in issues closely interlinked with carbon neutrality, e.g. innovative housing design, efficient and accessible transport, air quality and the natural environment.

This suggests a need to engage communities in conversations on carbon neutrality that refer to more tangible and meaningful impacts of actions to reduce emissions. It also raises some areas to be considered in the Urban ID diagnostics tools, as lack of spontaneous engagement with or knowledge of carbon neutrality and its associated terminology should not be accepted or interpreted as evidence that people are not interested in this issue. Instead, explicit and meaningful engagement with citizens and organisations is needed properly to diagnose the barriers to transformation in relation to this challenge theme.

6. Conclusions and recommendations

What next?

This report's introduction set out four broad questions to be considered:

- **What does 'carbon neutrality' means for the Bristol Urban Area (and what is the Bristol Urban Area) and over what timescale should such a vision be achieved?**

While there was no consensus in the Urban ID project on what carbon neutrality means for Bristol, a majority at the roundtable felt the focus should be on scopes 1 and 2 because of the relative ease of quantifying co-benefits and the higher uncertainty and difficulties of measuring scope 3 emissions.

The emissions data presented for Bristol City Council and South Gloucestershire Council demonstrates progress so far (acknowledging that there are issues with these data), and the scale of further reductions required. While significant reductions have been achieved to date, deeper analysis is needed to assess the scale of the challenge of reducing them to near zero with recognition that some reductions so far may have been 'low-hanging fruit' or due to structural economic change in the UK as a whole, rather than specific local action.

As the Bristol Urban Area is spread across two local authority areas it is difficult to see how carbon neutrality can be achieved in one LA without collaboration with the other. There is also likely to be an important role for regional West of England governance structures.

Achieving carbon neutrality will be challenging, whatever the timescale. To develop and set in motion a strategy for becoming a carbon neutral city almost certainly requires carbon budgets to be set at local level as they are nationally, and for these to be implemented as a matter of urgency.

These should clearly define the steps needed to achieve emission reductions in each sector: domestic, transport, industrial and commercial. They should also be based on a suitable accounting methodology.

- **What are the barriers to decarbonisation across three scopes of carbon emissions (energy use; energy supply; consumption of goods and services)?**

Technically and logistically, there are many barriers to decarbonisation of energy use and energy supply in urban areas. There is a large body of academic, policy and practice literature and analysis identifying these barriers in the UK context and the main actions to be taken.

In brief, these are: decarbonisation of heating and cooling in all buildings, decarbonisation of all public and private transport within the city boundaries across modes, decarbonisation of industrial/commercial processes, and decarbonisation of the region's energy supply and purchased energy (mainly electricity). There are significant barriers to each of these. For example, the need to:

- retrofit the existing domestic and commercial building stock to make it sufficiently 'energy efficient' for a switch away from gas and other fossil fuels for heating and cooling to renewable technologies;
- incentivise citizens and business to replace their existing vehicles with zero-emission vehicles in an equitable way;
- fund a zero-emissions transport system;
- identify suitable renewable energy sources to power potentially energy intensive industrial processes; and
- manage increasing local electricity demand and intermittent renewable supply in the current centralised energy supply sector in the UK.

In addition, this project has identified barriers to engaging the city and taking meaningful action:

- people do not often spontaneously engage with carbon neutrality and related terms: conversations need to be framed in a relatable, real-world context;
- co-designing a hopeful vision for the future is more likely to engage people on the journey needed than presented a fixed view of how the future should be;
- a 'here and now' approach, short-termism in planning and policy, fossilises current barriers and issues; and
- a lack of appraisal and control of new and smart technological development can lead to unintended detrimental impacts in the future.

To define carbon budgets and develop a strategy for becoming a carbon neutral city, Bristol will need to develop a comprehensive understanding of the economic, technical, logistical, political and social barriers to transformation. This will require a mixture of actions:

- review of existing literature and analysis to build a knowledge base and understanding of the barriers to decarbonisation;
- engagement with different communities to understand the barriers (and potential solutions) in a local context; and
- identification and development of expertise in the city to overcome these barriers.

- **Can we co-design top-level aims and aspirations for the Bristol Urban Area in relation to carbon neutrality up to 2050?***

This report identifies the need to talk about carbon neutrality with different communities, with a real-world framing of what it means that is relevant to them and to ask the question: 'how do we want to live and work in the future?'

This question can provide the starting point for co-designing a set of aims and ambitions for the city that provide a framework for defining carbon budgets and a strategy for a carbon neutral transition.

That question should be fully explored in relation to carbon neutrality to define a set of sub-questions. For example:

- How do we want to heat our homes?
- What do we want our homes to be like?
- How do we want to travel to work and where do we want to work?
- Do we want to be independent of the national energy supply industry?
- What industry and businesses do we want in the area?

- **Can the Bristol Urban Area consider a more radical approach where carbon neutrality includes 'all embodied carbon' as well as emissions from energy use and supply?**

There is interest in including scope 3 (embedded) emissions in carbon neutrality targets for the Bristol Urban Area as a way to avoid business-as-usual approaches that maintain current consumption patterns and off-load emissions to producer countries.

Taking a more radical approach such as this could see Bristol benefit from acknowledging and advertising its role as a city that sees itself as part of a global system. It would see Bristol taking a leadership role nationally and internationally in developing methodologies for accounting for embedded emissions in cities and best practice guidance for decarbonising procurement.

Bristol should consider a more radical approach but must also acknowledge that decarbonising our energy use and supply will be a significant challenge in itself, even with a target date of 2050.* Including all 'embodied carbon' in a definition of carbon neutrality increases the risk of failing to become carbon neutral. In addition, it may also increase the challenge of engaging different communities with the transition to carbon neutrality if emission reductions cannot be adequately framed within in a local geographic context.

Key questions

Developing a strategy for how Bristol can become carbon neutral requires the following questions to be answered:

1) Is the Bristol Urban Area the best geographical area in which to set a carbon target? Might the West of England Combined Authority boundary or that of the Local Economic Partnership be a better scale for the appropriate area for target setting and implementation management?

2) What are the current emissions associated with energy production and use in the city region across different sectors – energy supply, domestic, transport, industrial and commercial?

3) What are the current emissions from scopes 1, 2 and 3?

4) What are the 'business as usual' projections for emissions to 2030 and 2050?

5) What mitigation actions are needed in different sectors to 'zero' the per-capita emissions value and how carbon budgets assist with this?

6) What are environmental equality implications that need to be considered in the implementation of policies to address the above, to ensure a 'just transition'?

7) What is the embedded carbon in goods and services we consume and items we purchase, and is this included in the carbon neutral definition?

8) What level of carbon sequestration is it appropriate to consider to off-set any remaining emissions after mitigation actions across sectors?

9) What is the baseline year and what is the end point year (end point) for a target?

Appendix

Urban ID Challenge Theme integrated research questions[37]

Carbon neutrality

Spatial and temporal boundaries:	• What is my/our definition of the Bristol urban area? Is it where I/we live, work or travel? Where we are active? • How long will it take before we have a carbon neutral/sustainable city?
Knowledge & understanding:	• What is my/our personal experience of climate change versus what is my/our understanding of the science/statistics of climate change? • How do I/we feel about a carbon neutral city?
Agency & power:	• Can I/we make a difference and act to reduce emissions? • Am I/are we empowered or able to act on climate change.
Willingness to act:	• Do I/we want to take action to reduce emission or do the perceived sacrifices outweigh the perceived benefits? • What is my/our motivation to act? • Will other people/organisations take action?

Health and happiness

Knowledge & understanding:	• How would you define happiness? (What is your understanding of personal happiness?) • What about health? How would you define a healthy person?
Agency & power:	• Can I/we make a difference and to our own happiness? Alternatively, is it determined by outside factors? • What are they main things that you can/could do to improve your happiness? • What about health? Do you think you can make a difference to your own health? Alternatively, is it determined by outside factors? • What are the main things that you can/could do to improve your health?
Willingness to act:	• Do I/we want to take action to improve our own happiness? • Do I/we want to take action to improve my own health? • What is my/our motivation to act? • Do you feel other people/organisations need to take action to improve your happiness? • Do you feel other people/organisations need to take action to improve your health?

[37] http://www.urban-id.co.uk/

Mobility and accessibility

Knowledge & understanding:	• How do people define a good transport experience? • Do people regard transport and accessibility as important to their lives? • Do people know what different transport options are available to them? Do they know how to use these options?
Agency & power:	• How much choice do people have in how and when they travel? • How much power do people perceive transport authorities and providers to have over the transport choices they have and the services that are available? • Can people access everything they need using the transport options they have? • How free should people be to choose how they travel?
Willingness to act:	• How willing are people to change their travel habits? • What factors influence people's willingness to change their travel habits? • Is integration of different transport modes important in enabling change?

Inclusion and Equality

Knowledge & understanding:	• How would you define or envisage an equal society? • What do you think constitutes an inclusive experience/ environment / community?
Agency & power:	• Can I/ we make a difference to the development of inclusive and equal societies? • How much do you think you can do to ensure equal engagement with Bristol's goods and services? • How much do you think can be done to engender greater equality within and between segregated communities in Bristol? • What are the main things that could be done to support equality?
Willingness to act:	• How willing are people to encourage equal opportunities in employment, goods and services in Bristol? • Do you feel other people / organisations need to take action to improve the inclusivity and equality in Bristol? • Do you feel you can act to improve the inclusivity and equality of Bristol?

Descriptions of the other Urban ID challenge themes

Health and Happiness

Bristol is already considered to be a happy place. Recently, the Happy City Index (happycity.org.uk) found Bristol to be the happiest of nine core cities in England. This index takes into account a range of factors including work, health, education, place and community. However, evidence suggests that happiness is not evenly distributed across Bristol. The health and happiness challenge theme explores what is stopping Bristol from bridging the gap

between the city's present reality and the desire, of policy makers, other stakeholders and communities, to see a healthy, happy population. It seeks to address potential reductions in health and happiness inequalities.

Key concerns:

- Significant difference in life expectancy between adjacent wards (e.g. Henleaze and Southmead are separated by only a few streets, and yet there is a difference in the life expectancy in the two areas of around 9.5 years)
- Challenging the mental model that sees the city as serving the economy, rather than as a city that is served by its economy.
- Explore how happiness, not economic productivity, is the best indicator of a society's provision for wellbeing and quality of life.

Mobility and Accessibility

The mobility and accessibility challenge theme focuses on the effectiveness (in sustainable mobility terms) of the movement of people and goods and the ability of people to reach different services. Measures to improve mobility and accessibility in urban areas may include sustainable mobility polices (such as walking and cycling, high-efficiency motorized modes and also avoiding the need to travel). The theme links to the other themes in a number of ways, through enhancing public health through active mobility (cycling and walking), enabling social inclusion, and minimising greenhouse gas emissions.

Key concerns:

- Environmental and economic costs: congestion with consequences for travel time cost, air pollution and noise pollution have become serious issues in the last few decades.
- High car use in Bristol due to purpose-designed road network and the wider car dependence of society
- Need to enhance the accessibility of the transport system by ensuring people have the skills (cycling, driving) and information (online, signage in the streets) and the economic means (fare levels) to use it
- People who walk and cycle can feel unsafe sharing space with other vehicles and the threat of collisions creates a perception of danger when travelling on foot or by bike.

Inclusion and Equality

The inclusion and equality theme focuses on fostering greater social cohesion within and between community networks. This involves developing citizens' sense of belonging; enhancing inclusiveness to the city (including its organisations and services); and ensuring an equal representation of citizens in private and public decision-making.

Key concerns:

- High levels of ethnic and social segregation in Bristol.
- Differentials in health outcomes (difference of 10 years of life expectancy between the best and worst wards in the city), crime prevention and the quality of the local environment.
- Disparities in attainment within the education system.
- Uneven engagement with and provision of Bristol's goods and services.