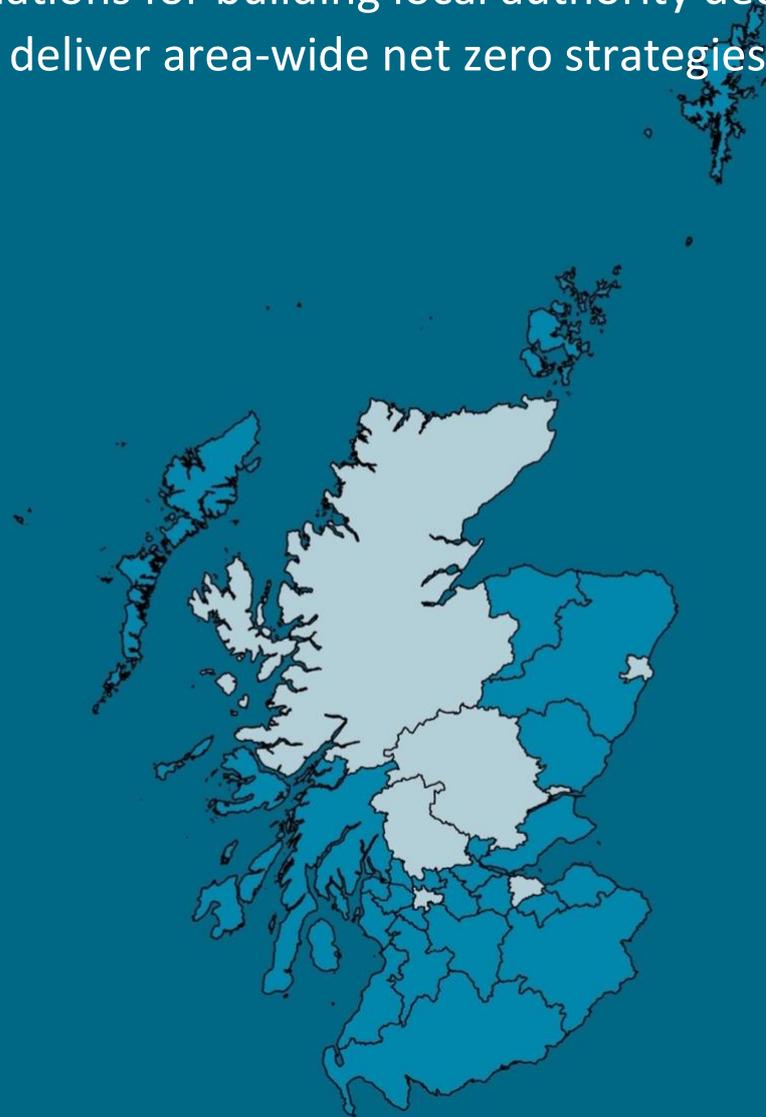


# Carbon Scenario Tool Pathfinder Project:

Recommendations for building local authority decision-making capability to deliver area-wide net zero strategies



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# Contents

Executive Summary	1
List of Abbreviations	5
Glossary	6
1. Introduction	9
1.1 Meeting Scotland’s Climate Commitments	9
1.2 Adopting Area-wide Approaches	9
1.3 Development of the CST pathfinder project	10
1.4 Aim and Objectives of this project	11
1.5 Report Outline	11
2. The context around area-wide action by Scottish cities	12
2.1 Introduction	12
2.2 Relationship between different types of footprints	12
2.3 Area-wide footprinting in the literature	12
2.4 The solution proliferation	13
2.5 The relationship between area-wide emissions and Local Heat and Energy Efficiency Strategies (LHEES)	13
2.6 Area-wide emissions in Scottish local authorities	14
2.7 A brief history of climate change activity within Scottish Local Authorities	15
2.8 What area-wide targets have the seven cities set?	16
2.9 The increasing challenge of emissions reductions	16
3. Aligning LHEES and area-wide net zero tools	18
3.1 Introduction	18
3.2 Methodology	18
3.3 What key points can be pulled out of the LHEES pilots	18
3.4 Where do LHEES and area-wide approaches requirements align?	19
3.5 Where is there discrepancy between LHEES and area-wide approaches?	20
3.6 Evidence of integration between LHEES and area-wide Climate Plans	21
3.7 How LHEES and area-wide action might integrate in the future	22
3.8 Conclusions about aligning LHEES and area-wide requirements	24
4. Tool requirements to plan, meet and monitor area-wide net zero targets	24
4.1 Introduction	24
4.2 Methodology	24
4.3 Functional requirements	25
4.4 Calculating the area-wide footprint	25
4.5 Estimating the Business as Usual	25

4.6	Producing scenarios and reduction pathways, actions for reducing carbon and detailed project carbon costing	26
4.7	Usability requirements	27
4.8	Conclusions about requirements	27
5.	Solutions scan	28
5.1	Introduction	28
5.2	Methodology	28
5.3	Results from Rapid phase 1 assessment	28
5.4	Results from detailed phase 2 assessment	30
5.5	Details of the three top scoring tools	30
5.5.1	ClimateOS	30
5.5.2	Carbon Scenario Tool	31
5.5.3	Net Zero Navigator	31
5.6	Conclusions about solutions	32
6.	Data approaches and requirements	33
6.1	Introduction	33
6.2	Methodology	33
6.3	Data Types	33
6.4	The data dichotomy	34
6.5	The sheer quantity of data	35
6.6	Dataset complexity and delay	35
6.7	Conclusions about data	36
7.	Capabilities and Capacity within cities	37
7.1	Introduction	37
7.2	The context for area-wide climate change data and decision-making within Local Authorities	37
7.3	Current capacity within Local Authorities	38
7.4	Current capability within Local Authorities	38
7.5	Conclusions on capability and capacity	39
8.	Recommendations	40
8.1	Introduction	40
8.2	Summary of recommendations	40
9.	References	50
	Appendix A: Precise target wording	55
	Appendix B: Assessment criteria for evaluating area-wide net zero tools	57
	Appendix C: Workshop findings according to ISM themes	62
	Appendix D: Emotional themes from the three phases of the LHEES pilot	66

# Executive Summary

## Project Aims

The Carbon Scenario Tool (CST) pathfinder project was designed to help identify the approaches, tools and resources required to develop a standardised approach for incorporating climate change implications into decision making for net zero., in line with local climate targets and helping cities play a leadership role in achieving Scotland's target of net zero greenhouse gas emissions by 2045.

The key aims of the project were to:

- Understand the context of area-wide climate action in Scotland
- Compare Local Heat and Energy Efficiency Strategy (LHEES) and area-wide net zero action to identify synergies
- Define the requirements of cities for approaches to plan, implement and monitor area-wide net zero targets
- Evaluate area-wide tools to support city strategies for emissions reduction and identify solutions that meet requirements
- Make recommendations for consistent, effective, and efficient use of area-wide emissions data
- Understand current and future capabilities and capacity within cities to deliver net zero climate action

The project has produced a set of recommendations for Scottish Government, local authorities, supporting organisations such as ECCI, SSN and the Improvement Service, and the wider public and private sector. These are designed to support area-wide net zero climate action and the delivery of local and national net zero targets.

## Context

City authorities across Scotland have taken the lead in setting area-wide targets to reduce city emissions, some with ambitious deadlines ahead of Scotland's national net zero target. These targets go beyond their own organisational footprints to tackle territorial emissions within the local authority boundary. This represents a huge step change in not only the size and complexity of the problem but also the requirement for partnership working with the organisations and individuals who have direct control over these emissions. This in turn requires a coordination and stimulation role by cities, who need both effective data and tools to evidence and enable this decision-making, and the skills and resources to implement action at a pace consistent with the local and national targets.

## Background

This project originates from a partnership between the City of Edinburgh Council (CEC) and Edinburgh Climate Change Institute (ECCI) to embed a tool to support decision-making for climate action. The potential to support wider capability and capacity building for net zero targets across city authorities led to the partnership with Scottish Cities Alliance (SCA). The project has been funded by the Scottish Government, with the aim of supporting integration and accelerating adoption of Local Heat and Energy Efficiency Strategies (LHEES).

## Approach

The CST team engaged extensively with local authority staff and other key stakeholders through a series of workshops and one-to-one interviews and analysed the data context by identifying and assessing current area-wide tools and associated datasets. The team appraised current area-wide tools and data against our compiled criteria of city requirements to inform our recommendations.

## Key Findings

Tackling climate change on an area-wide basis is a complex challenge requiring commitment to change across all city stakeholders. City authorities are still shaping their role in driving down territorial emissions and understanding their requirements to deliver this. Our project identifies key areas to address in embedding climate impact into city decision-making consistently and effectively across Scotland's city authorities:

- **Area-wide Tools:** several solutions are available for assessing and tracking area-wide climate emissions and actions. City authorities currently make individual decisions on which, if any, they choose to adopt. We find that planning, delivery, and action would be more effective by implementing a consistent approach and adoption of the same tool across Scotland.
- **Local Authority Requirements:** we have captured an initial set of requirements where all local authorities need effective data to support decision-making for net zero. Core functional requirements are:
  - Calculate an area-wide baseline footprint for the local authority area
  - Estimate business as usual scenarios for comparison
  - Produce scenarios and reduction pathways from cumulative or alternative action groups
  - Highlight key actions for emissions reduction
  - Produce detailed project carbon costing to support decision making

In addition, the data needs to be in a system that is easy to use, supports multiple users and produces compelling visual outputs for internal and external communication.

- **Data Availability:** we find that data is used inconsistently between geographies and tools, there is limited local resolution, and that current national datasets have a publishing delay which reduces their decision-making value. Multiple datasets require officers to spend too much time gathering and preparing data when value should come from analysing and presenting data to inform decisions.
- **Data Consistency:** a lack of consistency on everything from terminology, boundaries and approaches to data currently impedes collective understanding and shared progress.
- **LHEES Alignment:** LHEES focuses on ensuring local authorities have a long-term plan for decarbonising heat in buildings and improving energy efficiency across an entire local authority area. Heat and energy use in buildings represents a significant proportion, and complex component, of area-wide emissions. Thus, LHEES and area-wide emissions strategies share the same aim of decarbonisation, bringing a clear focus on priority areas, delivery approaches, and sequencing of programmes, measures, and actions. To avoid duplication and support integration, consideration needs to be given to how LHEES and area-wide net zeros are aligned through standards for net zero buildings, datasets, tools and plans.

- **Capability and Capacity:** local government alone does not have sufficient visibility or resources in all the areas required to respond to the challenge of achieving net zero. A large amount of time is devoted to producing a baseline dataset, monitoring progress, and producing action plans, and this leaves insufficient resources for coordinating implementation, tracking impact and improving delivery. Officers often feel fearful of the data demands that are made of them. This creates bottlenecks in assessing the impact of actions taken to inform future strategy and delivering climate action.

## Recommendations

We make a number of recommendations in response to these findings. With heat recognised as one of the most complex challenges in reducing area-wide emissions, if adopted these recommendations would improve delivery of both area-wide emissions strategies and LHEES.

1. **Data.** There is a need to develop national standards and guidelines for setting area-wide boundaries, and to use these as the foundation for centralising the collection, processing and management of a national emissions dataset for baselines and annual monitoring. This dataset would be used to support all area-wide strategies, including LHEES.
2. **Tools.** Adoption of a single solution for Scotland would be the most effective way to improve coordination and effectiveness of area-wide approaches. Our assessment concludes that:
  - Adoption and co-development of an established and scalable tool across Scotland will be the most cost and time efficient way to deliver this
  - An appraisal of current market solutions against stakeholder requirements has led to recommending an existing solution that has received significant investment and development.
  - Options should be investigated for purchasing a Scotland-wide licence of this tool and providing resources to support implementation and to align it further to city requirements.
3. **Capacity.** While our recommendations for data management and tool adoption will realise efficiencies in local authorities and drive data-informed decision making, there is still a clear need to build capacity in this area. The delivery of area-wide approaches to energy efficiency and emissions reduction needs more capacity across all areas, with the resources and influence to ensure that climate impact is a priority embedded in all decision making. We also suggest that some of this capacity should come from local partners, who both partially own the problem and have a stake in the outcome.
4. **Capability.** Training to support net zero decision-making should be reviewed at all levels, and additional material developed to underpin the skills and knowledge required for the delivery of climate targets. Programmes should be designed to ensure that:
  - Officers charged with delivering area-wide targets have the climate and data skills and knowledge they need to design, present, and deliver strategies for maximum impact
  - Decision makers have the knowledge to understand the climate implications of their decisions across service delivery and local development, enabling them to take different decisions with confidence.

## Actions

### *Stakeholder Actions*

The findings and recommendations from this project highlight the challenges that local authorities face in taking the lead in reducing territorial emissions, and their need to build capability and capacity to deliver on area-wide emissions. Effective use of data to embed climate impact into city decisions can help build this capability, and our project demonstrates several areas for improvement to support delivery of Scotland's climate ambitions.

Stakeholders in this project need to develop a common and shared approach to territorial emissions data across Scotland and agree how best to resource and deliver this in support of Scotland's net zero targets. The actions to achieve this are:

- **Agree a consistent area-wide boundary and rules** for defining and reporting area-wide emissions data
- **Commit to establishing a national dataset** for area-wide emissions, and agree responsibility for ongoing hosting and maintenance
- **Agree a common set of requirements** for a decision support tool for area-wide climate action, including the alignment with LHEES
- **Identify budget to invest in and procure a decision support tool for Scotland-wide use** which supports the development and implementation of area-wide strategies for emissions reduction
- **Develop capability and build capacity across the local authority network** to manage, present and interpret data on climate impact to inform decision making

### *How the CST Pathfinder project can support these actions*

The remainder of this pathfinder project, and a subsequent project on data standards, can help deliver these actions by:

- Supporting the project stakeholders in capturing needs and requirements to inform future strategies and solutions for consistent management of emissions data across Scotland.
- Producing an outline brief for future development of climate data solutions, focusing on the gaps in climate assessment at the project level.
- Conducting further analysis and making clear recommendations for consistent data methodologies and management approaches across Scotland.
- Understanding, shaping and supporting the needs for capacity building across Scotland's city authorities.

## List of Abbreviations

BAU	Business as Usual
BEIS	Department for Business, Energy, and Industrial Strategy
CCC	Climate Change Committee
CDP	formerly Carbon Disclosure Project
CEC	City of Edinburgh Council
CHP	Combined Heat and Power
CO <sub>2</sub>	carbon dioxide
CO <sub>2</sub> e	carbon dioxide equivalent
CoM	Covenant of Mayors
CST	Carbon Scenario Tool
ECCI	Edinburgh Climate Change Institute
EF	emission factor
EPN	EnergyPath® Networks
GHG	greenhouse gas
GIS	geographic information system
GPC	Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories
IPCC	Intergovernmental Panel on Climate Change
ISM	Individual, Social and Material
LHEES	Local Heat and Energy Efficiency Strategy
PBCCD	Public Bodies Climate Change Duties
PEAT	Portfolio Energy Analysis Tool
SCA	Scottish Cities Alliance
SCATTER	Setting City Area Targets and Trajectories for Emissions Reduction
SEAP	Sustainable Energy Action Plan
SSN	Sustainable Scotland Network
UK	United Kingdom

## Glossary

**Action:** intervention in a system that changes the level or type of activity that will happen; actions are considered at a higher level/in broader categories than projects. For example, an active travel action could be to construct 100 km of new bike lanes from existing road network.

**Activity:** something that leads to emissions of greenhouse gases. Examples include combustion of fossil fuels for heat, generation of electricity, transport, treatment of waste and wastewater, and industrial processes. Activity data is the quantitative measure of how much of this activity is taking place and has a variety of different units e.g. kWh, passenger kilometres, tonnes of waste etc.

**Adaptation:** adjusting to the current and expected future effects of climate change; based on reducing vulnerability to the effects of climate change.

**Area-wide footprint:** a measure of the total annual GHG emissions that occur within, or because of activity from, a territorial area and uses the GHG Protocol nomenclature of Scopes. The boundary for this footprint is set on a territorial rather than an organisational basis and with the precise boundary depending on the interpretation of the GPC (see definition below).

**Baseline:** the starting point for emissions reductions. This report primarily uses the term baseline to refer to a local authorities' current emissions (their starting point of measuring reductions). However, baseline can also refer to the year reductions are measured against; for example, a 75% reduction in emissions from the 1990 baseline.

**Benchmarking data:** data which allows an organisation to compare their activity data, emissions data or footprint to what is typical for similar organisations.

**Business As Usual (BAU):** a future projected state based on a set of assumptions that build on historical norms. For emissions, BAU refers to the emissions trajectory if no additional mitigating actions were taken.

**Capability:** skills and/or knowledge in an individual or organisation to deliver services.

**Capacity:** the resources of an individual or organisation to deliver services.

**Carbon dioxide equivalent (CO<sub>2</sub>e):** carbon dioxide equivalent is a measure used to compare the emissions from various greenhouse gases based upon their global warming potential. For example, based on the fourth Assessment Report by the Intergovernmental Panel on Climate Change, the global warming potential for methane over 100 years is 25<sup>[1]</sup>. Therefore 1 tonne of methane released is equivalent to 25 tonnes of CO<sub>2</sub> (measured on a 100-year time horizon). Essentially, CO<sub>2</sub>e works as a single 'currency' for greenhouse gases.

**Carbon emissions:** used to refer to emissions of carbon dioxide but often also used as a shorthand to refer to greenhouse gas (GHG) emissions that are included in the Kyoto Treaty. Carbon dioxide is the most common GHG, and other gases can be measured in relation to it (see CO<sub>2</sub>e).

**Carbon footprint:** a measure of the total GHG emissions caused directly and indirectly by a person, organisation, event or product.

**Carbon neutral:** the balancing of carbon emissions against carbon removals and/or carbon offsetting with the net result being zero (see also net zero carbon). Depending on definition used, it can refer just to carbon dioxide or include all greenhouse gases in the Kyoto Treaty.

**Carbon reduction:** an activity that reduces carbon emissions compared to a baseline scenario.

**CDP:** (formerly the Carbon Disclosure Project) an international non-profit organisation based in the United Kingdom, Japan, India, China, Germany and the United States of America that helps companies and cities disclose their climate and environmental impact.

**Climate change:** the large-scale, long-term shift in the planet's weather patterns or average temperatures.

**Conversion factors:** an arithmetical multiplier for converting a quantity expressed in one unit into an equivalent expressed in an alternative standard unit.

**Corporate footprint (or organisational footprint):** a measure of the annual GHG emissions that occur because of direct and indirect activity by an organisation or company. Uses the GHG Protocol nomenclature of scopes, but the boundary can cover multiple territories depending on where the company operates and how the boundary is drawn.

**Country footprint (or consumption-based footprint):** a measure of the annual greenhouse gas emissions which are associated with the spending of residents on goods and services, wherever in the world these emissions arise, together with emissions directly generated by households through energy use for heating and motoring. This type of footprint aims to allocate emissions to the end user, rather than where they are emitted.

**Country GHG inventory:** a measure of the actual annual emissions or removals that occur within the territory of the Country, as well as an allocation for international aviation and shipping. Used for UK and international reporting, using an international standard.

**Covenant of Mayors (CoM):** an initiative gathering voluntary commitment by European cities to accelerate action on EU climate and energy objectives. Signatories of the Covenant of Mayors (CoM) committed to reducing their territorial emissions by at least 20% by 2020 compared to a 2005 baseline year<sup>[2]</sup>.

**Decarbonisation:** reducing the carbon intensity of activities by increasing efficiency or changing energy source from fossil fuels to renewable or lower carbon sources. It is often used with reference to the electricity delivered through the national grid.

**Emissions data:** data recorded in units of mass of either CO<sub>2</sub> or CO<sub>2</sub>e.

**Emission factor:** a coefficient used to convert activity data into GHG emissions data based on the average emissions rate of a given source relative to units of activity.

**Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories (GPC):** a robust framework of standard methodologies for calculating and reporting city-wide greenhouse gas emissions.

**Global warming:** refers to the recent and ongoing rise in global average temperature near Earth's surface. It is caused mostly by increasing concentrations of greenhouse gases in the atmosphere. Global warming is causing climate patterns to change. However, global warming itself represents only one aspect of climate change.

**Greenhouse Gas (GHG):** a gas in our atmosphere that absorbs and emits radiation within the thermal infrared range. There are naturally occurring greenhouse gases in our atmosphere which maintain surface temperatures in a range conducive to life. However, since the industrial revolution, anthropogenic sources of GHGs have increased hugely, leading to 40% increase in atmospheric concentration of carbon dioxide<sup>[3]</sup>. This is causing increases in surface temperatures and is the main

cause of climate change. There are seven GHGs covered by the Kyoto Treaty, but the main ones are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O), and action needs to be taken to reduce emissions of these.

**Individual, Social and Material (ISM):** a comprehensive, multi-disciplinary tool to help understand behaviour change and design effective policy interventions based on behavioural economics, social psychology, and sociology.

**Local Heat and Energy Efficiency Strategy (LHEES):** a Scottish Government programme aiming to establish local authority area-wide strategies that will set out the long-term plan for decarbonising heat in buildings and improving their energy efficiency across an entire local authority area.

**Mitigation:** action taken to reduce levels of greenhouse gases in the atmosphere, either through reducing emissions at a source or removing GHG from the atmosphere.

**Net zero carbon:** the balancing of carbon emissions against carbon removals and/or carbon offsetting with the net result being zero emissions (see also carbon neutral).

**Product footprint:** a measure of the GHG emissions associated with the supply chain of goods and services, either on a cradle to gate or cradle to grave basis.

**Projects:** a specific set of tasks that must be completed to attain a certain outcome. Projects are more detailed than actions, covering both what will happen and where it will occur.

**Public Bodies Climate Change Duties (PBCCD) reporting:** the mandatory climate change reporting for all public sector bodies classified by the Scottish Government as ‘major players.’ The legislation was brought in under the Climate Change (Scotland) Act 2009, with a Statutory Order in 2015 and mandatory reporting beginning in 2016<sup>[4]</sup>.

**Removal:** the uptake and storage out of the atmosphere of greenhouse gases. Carbon removal methods include natural strategies like tree restoration and agricultural soil management; high-tech strategies like direct air capture and enhanced mineralisation; and hybrid strategies like enhanced root crops or bioenergy with carbon capture and storage.

**Scenario:** a pathway of emissions reduction built by aggregating actions to enable organisations to see potential trajectories of emissions.

**Scope:** a way of categorising emission sources in relation to the reporting organisation, used as a way of providing transparency in emissions accounting, making it clear the type of emission source and the level of control of the reporting organisation over the source. Three levels of scope have been defined and are used on a global basis. For further information on the three scopes, see the GPC<sup>[5]</sup>.

**Scottish Climate Change Declaration:** a public statement in which local authorities acknowledge the reality and implications of climate change and their responsibility to respond effectively. All 32 local authorities in Scotland are signatories: committing themselves to providing leadership on climate change, reducing their own corporate emissions, taking actions to reduce area-wide emissions, assessing the risks of climate change and working towards adaptation, and producing annual statements on their plans, activities and achievements<sup>[6]</sup>.

**Sustainable Energy Action Plan (SEAP):** signatories of the CoM are obliged to create SEAPS which outline the concrete actions and responsibilities for the local authority to achieve their voluntary area-wide emissions reduction goals.

# 1. Introduction

## 1.1 Meeting Scotland's Climate Commitments

To meet Scotland's Climate Change Act 2019 target of net zero greenhouse gas (GHG) emissions by 2045, there will need to be fundamental changes to almost every aspect of the way that the public sector provides services, the way businesses operate, how goods and people move and how people live their lives. While there will be significant benefits from shifting to a zero carbon society, including improved air quality and green spaces, lower fuel bills and reduced reliance on fuel imports, barriers still exist around prevailing power structures, decision-making processes and priorities and short-term political cycles.

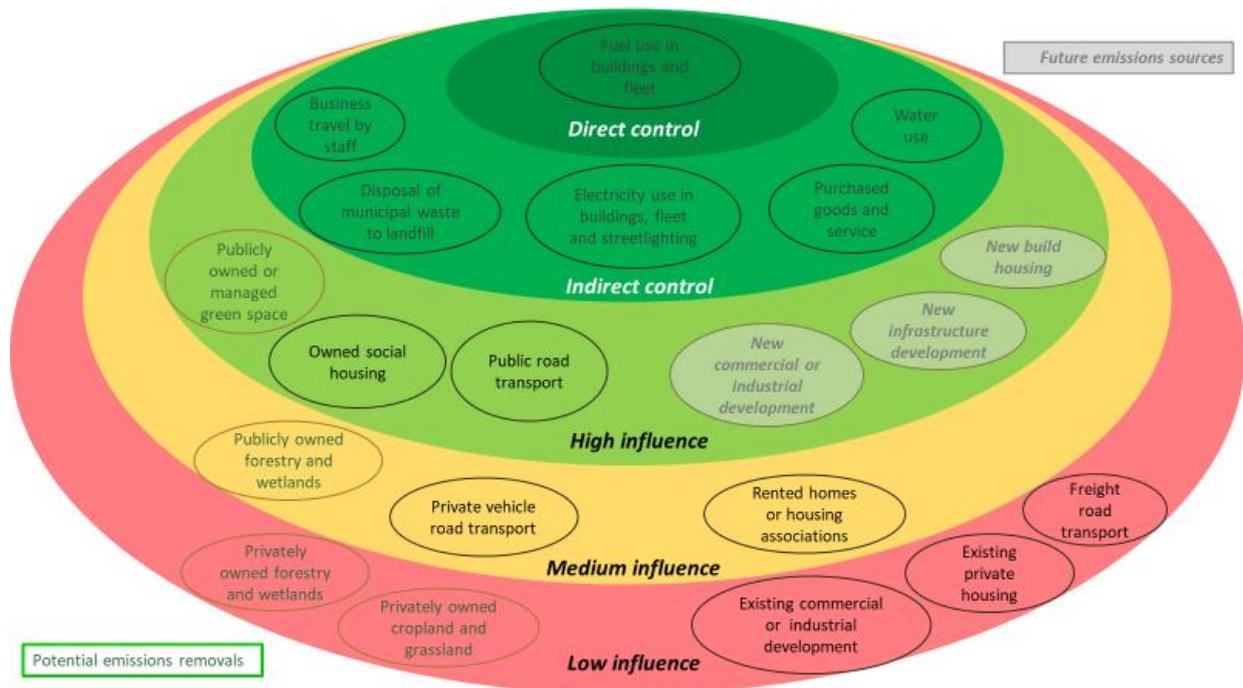
Tackling climate change at this scale is a complex problem that will require collaboration, coordination, and cooperation between different levels of government and between the public and private sectors and citizens. Previous focus has been on measuring, reporting, and managing emissions at the level of individual organisations, but it is now recognised that a large proportion of emissions are spread diffusely between many smaller organisations and individuals and they are often locked into a system that it is hard for change without using multiple economic and societal levers. However, coordinating action is difficult because the levers and decisions sit across many organisations in each area and shifting the system might require a variety of actions to be taken by national and local government, public and private organisations and individual household level, creating a complex web of decision-making.

## 1.2 Adopting Area-wide Approaches

This awareness has shifted local government from looking at climate change at their level of their organisation to also taking a geographical perspective, where the emissions resulting from actions and decisions in a geographical area are used as the basis for target setting. In Scotland, the responsibility for setting area-based targets and developing plans and strategies has been taken on by local authorities but, unlike their own organisational footprint, the level of control and influence of any single organisation over the area-wide footprint is much lower. Figure 1 represents this problem, showing how the level of control and influence varies for different emission sources in a local area, from the perspective of a local authority. It is estimated that the proportion of emissions under the control (direct or indirect) of local authorities is around 6% of the UK's total area-wide emissions inventory<sup>[7]</sup>.

Therefore, the methodologies, datasets, tools, and approaches used to tackle this problem need to be appropriate to the scale and complexity of the problem; the same is true of the resourcing, both in terms of people and finances.

Figure 1: Control/influence scale over area-wide emissions from local authority perspective



This project has been developed and funded in response to the acknowledgement of the need for better tools and data for net zero decision-making but also increased understanding of the context that surrounds local authority staff who are tasked with developing and delivering net zero strategies. Although it started as an investigation into the use of a specific tool designed to support decision-making, this project has evolved to provide a more comprehensive set of recommendations aimed at influencing not only use of decision-support tools and data but also increasing capacity within local authorities through support and funding models.

### 1.3 Development of the CST pathfinder project

The CST project originated from a collaboration between the CEC and the ECCI to set Edinburgh on a trajectory to net zero by 2030. This partnership created the evidence base for the city's net zero targets, breaking down emissions by source and analysing the potential of a wide range of measures for emission reduction in the *Edinburgh Net Zero Roadmap*. To support delivery, an excel-based Carbon Scenario Tool (CST) was developed and deployed to help embed climate impact into city decision making by developing project costing methodologies and drawing on national datasets to assess emissions impact of upcoming city projects.

The potential to use the CST to support Scotland's net zero targets and emission reduction strategies in Scotland's cities was identified in discussions with the Scottish Cities Alliance (SCA). A partnership was formed between ECCI and SCA to deliver a programme of engagement across the city authorities, which would assess current capability for embedding climate impact into city decision making and map this against future requirements for delivery of city climate strategies and targets. The partnership project has been part-funded by the Scottish Government to help support integration with, and implementation of, Local Heat and Energy Efficiency Strategies (LHEES).

## 1.4 Aim and Objectives of this project

The overall aim of the CST pathfinder project is to **identify the approaches, tools and resources required to develop a standardised approach for incorporating climate change implications into decision making for net zero**. The objectives of the project are to:

- Examine the context for tackling area-wide emissions within Scotland.
- Understand the relationship between LHEES and area-wide net zero tools, including identifying practical routes to combine these approaches.
- Review the requirements of cities for approaches to support planning, implementing, and monitoring area-wide net zero targets.
- Undertake a solution scan of existing area-based tools that may meet city requirements and identify suitable tools.
- Audit data approaches and requirements of area-wide tools.
- Understand current capabilities and capacity within cities to operationalise the solutions and to inform decision making, including identifying current gaps and future needs.
- Provide recommendations on how to progress area-wide net zero action for key stakeholders in Scotland.

## 1.5 Report Outline

This report is split into a further seven sections. Section 2 explains the terminology used, looks at the literature and context for area-wide footprints and summarises the current position of the seven cities. Section 3 looks at the relationship of area-wide footprints to the area-based policy on LHEES.

The next four sections detail the methodology and high level findings of this project with respect to city requirements for tools and approaches (Section 4), a scan of existing solutions against these requirements (Section 5), the data requirements of these solutions (Section 6) and the context for cities in terms of capability and capacity for area-wide climate action (Section 7).

The final section (Section 8) pulls together the recommendations resulting from the findings into an ordered plan.

## 2. The context around area-wide action by Scottish cities

### 2.1 Introduction

The aim of this section is to frame the proposed developments discussed in this report by setting out the context of Scotland's interim and long term climate change targets, and the role of local authorities in delivering them.

### 2.2 Relationship between different types of footprints

This report will be focusing on a particular type of carbon footprint boundary, called an **area-wide footprint**. Several other common footprints are defined below. All these footprint types can intersect at various points, but they are fundamentally measuring different things. Thus, it is important to understand and be clear about what they represent and what they are used for.

- **Country GHG inventories** (or **production-based** footprints) are how national emissions are reported. They contain all the emissions produced (and removed) within a country's territorial boundary, as well as an allocation for international aviation and shipping.
- **Country carbon footprints** (or **consumption-based footprints**) adjust production emissions according to trade, allocating the responsibility for emissions to the country of the end-user, rather than the country where they are emitted. Thus, these footprints contain the emissions associated with the spending of residents on goods and services, regardless of where in the world these emissions arise, together with emissions directly generated by households, through private heating and motoring.
- **Area-wide footprints** set a territorial boundary and collate all relevant emissions that occur within that geographic boundary, along with emissions that occur elsewhere because of activity within that boundary. The precise boundary of these footprints, both in terms of territorial boundary and which emissions are included, depends on interpretation of the Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories (GPC).
- **Corporate footprints** (or **organisational footprints**) measure the GHG emissions that occur as a result of direct or indirect activity by an organisation or company. Unlike area-wide footprints, the boundary can cover multiple territories depending on where the company operates. The operational and organisational boundary depends on interpretation of the GHG Protocol Corporate Accounting and Reporting Standard (Corporate Standard).
- **Product footprints** measure the GHG emissions associated with the supply chain of goods and services, either on a cradle to gate or cradle to grave basis. Emissions are not tied to any single territory, organisation, or time frame but follow the production, manufacture, distribution, use and end of life disposal of a product or service.

### 2.3 Area-wide footprinting in the literature

Academic interest around area-wide emissions is largely a recent phenomenon, so the terminology is still developing with a lack of consensus on approaches. Even the concept of area-wide emissions as defined in this report, is referred to differently depending on the source; alternative terminology includes city-wide, territorial, or community-wide emissions<sup>[8,9]</sup>. Regardless of the term, the recent proliferation of research has uncovered pervasive issues which underlie the concept. The most notable issues surround data availability, comparability, and discrepancies in determining emissions boundaries<sup>[10]</sup>.

The CDP, formerly the Carbon Disclosure Project, runs a global climate disclosure system and is one of the most widely used environmental reporting platforms<sup>[11]</sup>. In their 2020 City-Wide Emissions dataset<sup>[12]</sup>, which contained 776 city-wide footprints, the most common protocol used to report emissions was the GPC. The GPC accounted for 45% of city emissions reported; the next most common protocols were the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (8%) and U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (6%). Thus, the global standard for reporting emissions from cities appears to be coalescing around the GPC. The GPC prescribes which emission sources should be included in reporting, with BASIC (Scope 1 stationary energy, transport, and waste, all Scope 2, and Scope 3 waste) and BASIC+ (BASIC plus Scope 1 IPPU and AFOLU and Scope 3 transport and energy transmissions and distribution losses)<sup>[5]</sup>. However, even with consistency developing in the protocol, the boundary for what geographical area is included in the emissions reporting still varied within the dataset, with some covering only part of the city boundary, others including the entire city, and some including the city and adjoining areas. Future standards are likely to move towards the latter, with the further inclusion of transboundary emissions, highlighting that net-zero targets cannot be achieved by focusing only on decarbonising within administrative boundaries<sup>[9]</sup>.

Seto *et al.*<sup>[9]</sup> emphasize the difficulty of collating robust city-level, place-specific data. In Scotland, there is no central repository for data, despite numerous local authorities requesting one to accelerate their climate action<sup>[13]</sup>. Some data sources such as gas and electricity consumption are of good quality; others like solid and liquid fuel consumption are based on estimated allocations, introducing uncertainty. Many datasets require additional processing which has an impact on consistency between local authorities. Thus, alongside agreeing consistent boundaries, good quality data is a necessary area of development for area-wide emissions.

Furthermore, net zero research highlights the disconnect between climate commitments and actions at all levels of governance<sup>[14]</sup>. Therefore, carbon tools to support informed decision-making are of critical importance.

## 2.4 The solution proliferation

As noted in Section 2.3, the concept of area-wide footprints is new and as such the supporting tools are still developing. There has been an explosion of tools, guide and approaches aimed at supporting organisations with the net zero transition. This is the first stage of technological innovation systems in which variety supports learning through small-scale experimentation<sup>[15]</sup>. However, in moving away from innovation and towards technological evolution, similar to biological evolution, there is often the emergence of a dominant design, which drives uptake and grows efficacy<sup>[16]</sup>. For area-wide emissions tools, it is yet to be seen what dominant design will emerge from the varied solutions, or if tools must still be used in combination to cover all aspects of area-wide climate action decision-making. Thus, this report takes the step of evaluating existing tools against the requirements of the cities to suggest which tools will be most helpful in driving effective climate action.

## 2.5 The relationship between area-wide emissions and Local Heat and Energy Efficiency Strategies (LHEES)

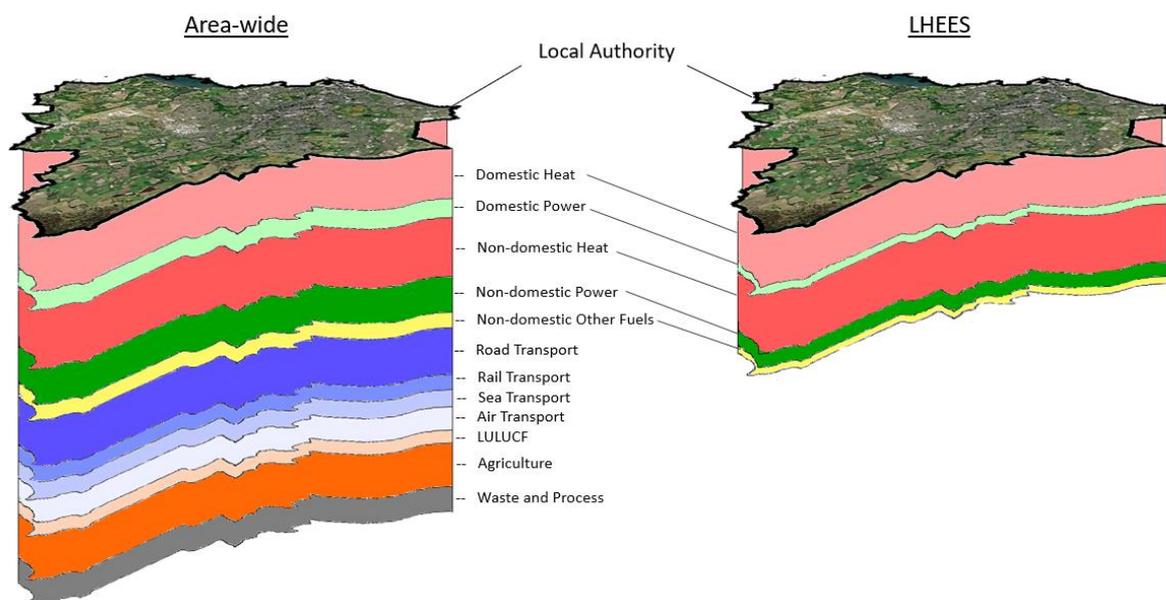
The challenge of decarbonising heat and improving energy efficiency in homes and buildings is recognised as one of the most significant and complex for progressing and achieving net zero targets. The LHEES programme specifically targets this, aiming to underpin an area-based approach to heat and energy efficiency planning and delivery<sup>[17]</sup>. LHEES will set out the long-term plan for decarbonising heat in buildings and improving their energy efficiency across an entire local authority area. LHEES sits as part of the Scottish Government's Heat in Buildings programme, as established in the Heat in Buildings Strategy<sup>[17]</sup>, which sets out a pathway to zero emissions buildings by 2045 and details a series

of near-term actions and longer-term commitments to accelerate the transformation of Scotland's building stock.

LHEES and area-wide emissions align on their use of a local authority-wide boundary but differ in the range of activities covered; Figure 2 uses the CEC boundary as an example and shows a representation of the activities covered by area-wide emissions and those covered by LHEES. The focus of LHEES is on decarbonising heat in buildings, including energy efficiency and heat networks. While the programme does not directly consider emissions, emissions reductions should be an outcome of successful implementation. For area-wide emissions, heat and energy use in buildings make up a significant proportion of overall emissions, but strategies and approaches also need to consider power, transport, agriculture, waste disposal and land use. Therefore, these approaches are complementary and should support each other.

The LHEES programme is likely to be the first legislated area-based decarbonisation programme for local authorities. It represents an important step in thinking about how to decarbonise across a whole area as opposed to only a single organisation or sector. This conceptual shift is necessary for local authorities to achieve area-wide targets. Furthermore, a significant portion of area-wide emissions can be addressed through LHEES, making it an integral part of the area-wide discussion.

**Figure 2: Representation of the activities covered by area-wide approaches and LHEES (not to scale).**



## 2.6 Area-wide emissions in Scottish local authorities

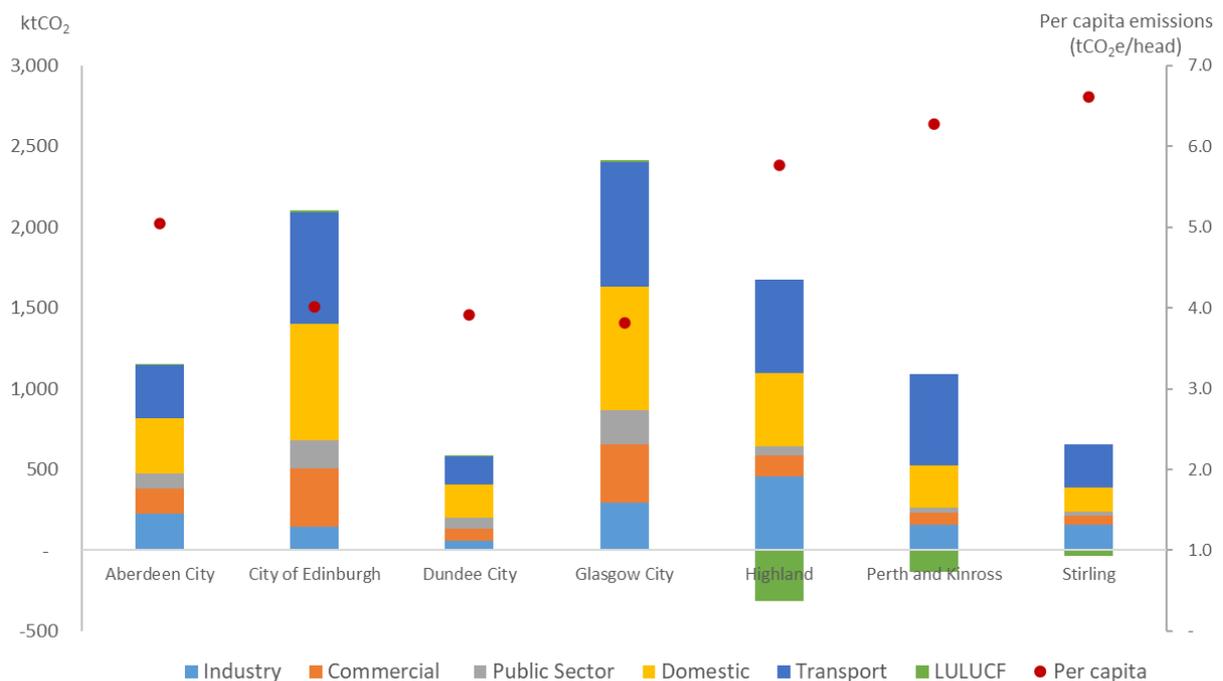
For this project, the geographic boundary of area-wide emissions is drawn at the local authority boundary. This mirrors most area-wide accounting in Scotland. While cities are often the focus of area-wide emissions reporting because of their density of population and buildings, in the UK it is very difficult to separate out cities from their surrounding peri-urban and rural areas. This difficulty comes from a restriction of datasets, many of which use a local authority boundary rather than trying to split the urban city context from the surrounding rural areas. Thus, this project treats cities as synonymous with their encompassing local authority.

Figure 3 shows area-based CO<sub>2</sub> emissions for the seven Scottish cities, based on their local authority boundary. This data is produced annually by the Department of Business, Energy and Industrial Strategy (BEIS)<sup>[18]</sup>, with a two year time lag. It covers only direct CO<sub>2</sub> emissions, apart from electricity

(indirect) which is allocated on a consumption basis. It covers industry, commercial, public sector, domestic and transport sectors and the balance of land use, land use change and forestry (which can be negative or positive depending on the land use).

Figure 3 illustrates the significant variation in the amount, distribution, and per capita emissions between the seven local authorities. It is worth noting the surprising importance of industry for Highland; less surprising is the importance of transport (over 40% of the area total) for the three local authorities with significant rural areas within their boundary (Stirling, Perth and Highland). The most consistent emission source is for domestic heating and power, which makes up between 24 – 35% of emissions in all seven local authorities.

**Figure 3: 2019 Local authority carbon dioxide (CO<sub>2</sub>) emissions dataset for seven cities**



## 2.7 A brief history of climate change activity within Scottish Local Authorities

Climate change is not a new activity for local authorities in Scotland. Development of carbon management plans were introduced as early as 2004, and all 32 local authorities signed the Climate Change Declaration in 2007<sup>[6]</sup>. Scottish local authorities are already familiar with the idea of considering emissions outside of those they are directly responsible for.

Mandatory public bodies climate change reporting was introduced for the reporting year 2014/15<sup>[19]</sup>. The Public Bodies Climate Change Duties (PBCCD) report includes a wider influence section for organisations to report their influence in reducing GHG emissions beyond their corporate estate<sup>[4]</sup>. Local authorities reported their direct policies and actions to reduce emissions, as well as their partnerships, communication, and capacity building which contribute to their emissions reductions<sup>[4]</sup>.

Local authorities which are signatories of the Covenant of Mayors (CoM) committed to reducing their territorial emissions by at least 20% by 2020 compared to a 2005 baseline year<sup>[2,20]</sup>. The CoM launched in 2008 with the intention of accelerating the European Union's Kyoto Protocol commitments through voluntary participation by European cities. The CoM requires its signatories to create a Sustainable Energy Action Plan (SEAP) which outlines the concrete actions and responsibilities for local authorities to achieve their voluntary area-wide emissions reduction goals<sup>[21]</sup>. In Scotland, many local authorities

including Aberdeen, Dundee, Edinburgh, Glasgow, and Stirling have signed the CoM and developed SEAPs at various times since 2009<sup>[22]</sup>.

## 2.8 What area-wide targets have the seven cities set?

The Scottish Government has set a net zero target by 2045 through the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019, with an interim target of 75% lower than the baseline by 2030. More recently, local authorities have been declaring a climate emergency and started to set net zero targets for their whole area. This represents a huge step change in not only the size and complexity of the problem but also the requirement for partnership working with the organisations and individuals who have direct control over these emissions. However, there has not been an accompanying increase in resourcing this activity, either internally for local authorities or externally from other public and private bodies. The limited provision of resourcing is already setting limits on effective action and will prevent the delivery of these targets in the future if it is not solved.

Figure 4 shows when area-wide targets were set and when they are to be achieved by. Table A1 (Appendix A) provides further detail about the exact working and sources of these targets. Figure 4 demonstrates the range of target maturity dates; interestingly the three organisations to set targets up to 2030, were also the first three organisations to set targets, whereas the other four local authorities have all set targets that match Scotland's overall net zero target. While all area-wide net zero targets are extremely challenging, targets which are more ambitious than the national target bring additional challenges, although they might be more consistent with science-based targets.

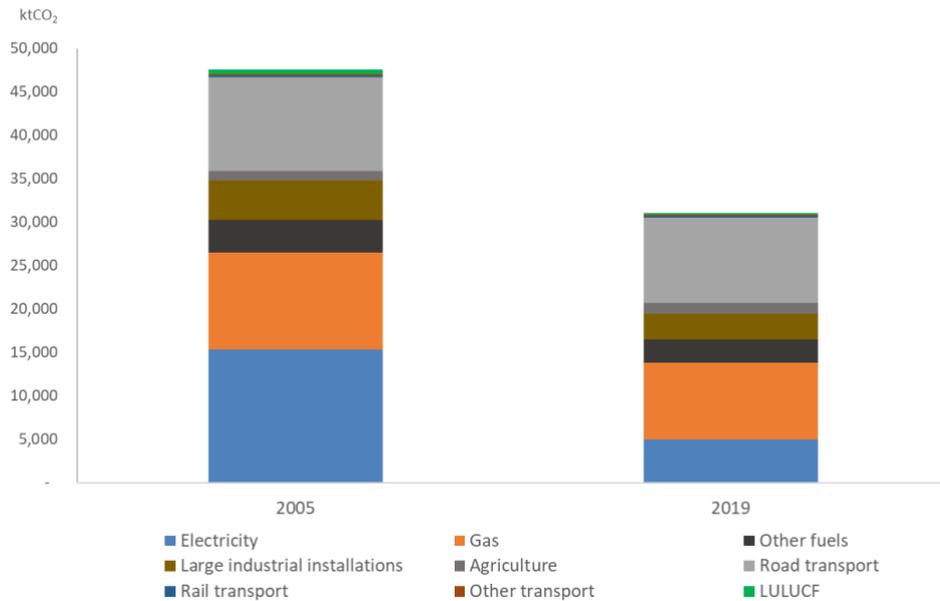
Figure 4: Area-wide targets



## 2.9 The increasing challenge of emissions reductions

While emissions in Scotland have decreased over that past two decades, future reductions will be harder to achieve. Figure 5 shows the combined local area emissions (carbon dioxide rather than GHG) in 2005 and the equivalent dataset for 2019<sup>[18]</sup>. This shows that the largest decrease in emissions has happened due to the decarbonisation of the UK electricity grid; mainly from fuel switching from coal to natural gas and renewables, with some increase in energy efficiency. There are also clear reductions in direct natural gas use consumption (-20%), other fuels that are used for heating and equipment (-30%) and large industrial installations (-35%). Reductions in industrial use are likely to be largely due to relocation of heavier industry to other countries. Conversely transport emissions have only decreased by 9% over this period. As was made very clear by the UK's Climate Change Committee (UKCCC) at a recent (December 2021) Sustainable Scotland Network (SSN) conference<sup>[23]</sup>, the decarbonisation of the electricity grid has enabled many organisations to achieve the initial tranche of carbon reduction targets relatively easily and with little societal change.

Figure 5: Area-wide emissions in Scotland



Initial climate change targets focused on reducing emissions by double digit percentage values, whereas net zero targets mean that there is no room to maintain the status quo with public and domestic buildings or transport. To achieve the very challenging interim target of a 75% cut in emissions on the 1990 baseline by 2030, Scotland must both reduce and decarbonise transport and heat in buildings. Both challenges require changes by multiple problem owners, societal shifts and difficult decisions to achieve a just transition. This in turn requires a coordination and stimulation role by local government, who need:

- 1) Clear policy drivers and economic levers to support the transition
- 2) Data and tools to evidence and enable this decision-making
- 3) Capability and capacity to undertake this role

This report focuses specifically on these last two requirements, which are vital in enabling local authorities to move from setting climate targets and making policy commitments to delivering measurable impact and achieving success in reducing area-wide emissions.

## 3. Aligning LHEES and area-wide net zero tools

### 3.1 Introduction

This section addresses the relationship between LHEES and area-wide net zero tools, including identifying practical recommendations to support the joint implementation of area-based approaches.

Energy use in buildings is one of the key activities producing Scotland's area wide footprint. The main source of emissions is combustion of natural gas, although other fuels such as heating oil and electricity are also significant emission sources in buildings.

The aim of the programme is to establish long-term plans for decarbonising heat in buildings and improving their energy efficiency across every local authority<sup>[17]</sup>. It is the first actionable energy planning programme in Scotland which takes an area-based approach. Before LHEES, SEAPs were the only other energy programme to make a plan for the local authority-wide area. However, most local authorities' SEAPs rely heavily on other programmes for projects and funding to reach their goals<sup>[24]</sup>.

The aims of LHEES are new, large scale and complex. The area-based approach inherently involves integrating sectors which have traditionally been covered under separate policies. Within each local authority, LHEES is tasked with covering the domestic sector, non-domestic sector, public sector, individual projects, heat networks, and advice.

This section looks at how LHEES coincides with and is complemented by area-wide tools and where there are discrepancies that need to be acknowledged and/or addressed.

### 3.2 Methodology

The Scottish Government introduced LHEES in 2017 and have since gone through three pilot phases involving all 32 Scottish local authorities<sup>[25]</sup>. To understand the requirements of LHEES in the context of area-wide tools, this project reviewed the evaluation reports of all three pilot phases, discussed with the LHEES team in the Scottish Government, attended the LHEES update webinar (6 October 2021) and reviewed the LHEES tools and guidance issued to local authorities in October 2021.

### 3.3 What key points can be pulled out of the LHEES pilots

The three phases of LHEES pilots involved trialling development processes, identifying sources of data and understanding local resources and capacity requirements<sup>[25]</sup>. These pilots enabled local authorities to identify challenges and opportunities in their areas and provided feedback to the Scottish Government for input into the developing LHEES Methodology. The identified challenges included a lack of clarity in the scope and methodology leading to consistency concerns, limited skills and capacity particularly around stakeholder engagement, data collation, data analysis and GIS, a lack of resources for the time-intensive process, barriers to data access and sharing, concerns around data accuracy and difficulty securing buy-in from senior management and elected officials<sup>[13,25]</sup>. Recommendations from the pilots included making LHEES a statutory duty with greater resources and funding, providing additional LHEES guidance, standardisation and support, particularly around data and stakeholder engagement and integrating LHEES into wider local authority strategies and plans<sup>[25]</sup>. Phase two of the pilots also emphasised the need for a single repository of relevant data to develop LHEES faster and more consistently<sup>[13]</sup>.

The pilots indicated the appetite and willingness of local authorities to engage in developing LHEES but highlighted the need for more national level support<sup>[25]</sup>. Support is needed in the form of legislation to make LHEES a statutory requirement, guidance on implementation (now provided by the LHEES Methodology), support on policy integration, resources, upskilling and solutions for data access

and sharing<sup>[25]</sup>. Many of the recommendations from the LHEES pilots, particularly those around data, upskilling, and consistent approaches, align with the proposed recommendations of this project around area-wide emissions covered in Section 8.

### 3.4 Where do LHEES and area-wide approaches requirements align?

Table 1 shows where there is similarity and complementarity between LHEES and area-wide climate action approaches. LHEES covers a significant proportion of area-wide emissions, in the hard to tackle area of heat, and should lead to emissions reductions through localised approaches to energy efficiency and improved building performance.

**Table 1: Similarity and complementarity between LHEES and area-wide climate approaches**

Similarity	LHEES	Area-wide approaches
<b>Purpose</b>	LHEES Strategies will set out the long-term plan for decarbonising heat in buildings and improving their energy efficiency across an entire local authority area. LHEES Delivery Plans will provide a strong basis for action for local communities, government, investors, developers and wider stakeholders, pinpointing areas for targeted intervention and early, low-regrets measures.	Support decision making for area-wide net zero targets across all emission sources by assembling baseline data, developing scenarios based on actions and providing data on the implications of decisions that impact on the delivery of net zero transition.
<b>Desired outcomes</b>	Support the decarbonisation of heat and efficient use of energy in buildings across Scotland.	Support the transition to net zero through decarbonisation, increased efficiency or reduced consumption of all emission producing activities.
<b>Capability and capacity</b>	LHEES requires a range of skills and expertise, including the collation and analysis of numerous datasets, and knowledge of energy in buildings	Area-wide emission strategies require data analysis and visualisation (including GIS) skills and increased decision-maker knowledge and understanding to interpret.
	LHEES requires cross working between service areas across the local authority including Housing, Planning, Sustainability, Building Services etc. and with building owners, communities and other stakeholders.	Delivering area-wide carbon reduction strategies requires cross-working within departments, between local authorities, and with other local problem owners and stakeholders across the public and private sector.
	Capability and capacity gap in data analysis/GIS and stakeholder engagement. Officers lacked influence to engage with senior management <sup>[13]</sup> .	Capability and capacity gap in data analysis, visualisation, community consultation and interpretation for decision-making.
<b>Delivery</b>	A local heat and energy efficiency strategy is a long-term strategic framework for:	Overall reporting and targets and scenarios are area-wide, but projects are place-based and much more granular.

	<p>(a) the improvement of the energy efficiency of buildings in the local authority's area, and</p> <p>(b) the reduction of greenhouse gas emissions resulting from the heating of such buildings.</p> <p>A local heat and energy efficiency delivery plan is a document setting out how a local authority proposes to implement its local heat and energy efficiency strategy.</p>	
	<p>In the pilots, many local authorities struggled to get past strategy setting and into the delivery planning stage (SG, 2022).</p>	<p>Developing a strategy, setting targets and producing an action plan are easier than individual project costing, decision-making and implementation.</p>
	<p>Evaluation of pilots identified concerns about LHEES becoming a report and not leading to action and lack of confidence about engaging internal and external stakeholders.</p>	<p>ISM context analysis demonstrated the under-current of fear about responsibility and delivery of area-wide targets.</p>

Table 1 shows that there is opportunity for aligning the resourcing and delivery of LHEES and area-wide net zero targets, and several of the recommendations in this report are designed to support both area-wide climate action and LHEES.

### 3.5 Where is there discrepancy between LHEES and area-wide approaches?

While there is significant overlap and complementarity, there are also some key areas of discrepancy. It is important to recognise these as they potentially have implications for effective communication and decision-making. The main area of discrepancy is around the underlying assumptions used to indicate successful transition.

The LHEES methodology does not use greenhouse gas emissions as a metric within its methodology or baseline tool, however it is based on Scotland's Heat in Buildings Strategy which provides a definition of what is meant by low and zero emissions heating systems:

*These are systems that have zero direct greenhouse gas emissions, such as individual electric heat pumps and connection to heat networks, or electric systems such as storage heaters, and systems that have very low emissions such as those that use hydrogen. Buildings connected to existing heat networks, powered using natural gas, will be considered to be future proofed and net zero ready. However, these heat networks will need to decarbonise by 2040-45 and, once the consenting regime is in place, new heat networks will need to use heat from low or zero emissions sources, such as surplus or waste heat or heat pumps, or be powered using hydrogen, including via the latest "fifth generation" heat networks. Bioenergy, for example in the form of biomass, bio-heating oil, bio-propane, where they come from sustainable sources, are included as low emissions systems, but likely to have a more limited role. This list of low and zero emissions heating systems will be kept under review.*

**Heat in Buildings Strategy; Achieving Net Zero Emissions in Scotland's Buildings, Page 16**

However, corporate and organisational footprints and area-wide footprints use a different approach for electricity, which is based on the UK average annual grid factor. This means that Scotland is not

seen as a separate territory because the electricity grid is cross border. Although a large percentage of the UK's renewable generation is located in Scotland, the grid is balanced by combined gas turbine power stations based in England and Wales. The direct emissions from grid combustion are distributed evenly between the Scotland, England and Wales (and includes imports and exports to other countries). The risk of Scotland deciding that generating the equivalent of 100% of Scotland's consumption in renewables based on an annual account is that England and Wales have not increased their own grid factor to accommodate this and it does not really take into account the way that the grid operates on a daily basis.

Likewise, emissions from heat follow methodologies to estimate direct emissions from combustion and then allocations based on output to different users. Therefore, turning waste heat into a usable domestic heating through a heat network would produce a reallocation of emissions from the producer to the consumers.

For investment to happen successfully, the distribution of financial costs and benefits of projects need to be considered but the benefit of GHG emission reduction is an important driver for both private and public sector organisations so there needs to be transparent, logical and consistent rules applied about allocation of emissions, which also support long-term decisions for net zero.

Other discrepancies are listed in Table 2.

**Table 2: Discrepancies between LHEES and area-wide climate approaches**

Discrepancies	LHEES	Area-wide approaches
<b>Whole life costing</b>	LHEES does not use a whole life costing approach to project decision making, concentrating on the long-term operational decarbonisation of heating in buildings.	Embodied carbon emissions in carbon reduction activities and projects should be considered when choosing project options and maintaining the status quo.
<b>Datasets</b>	Core datasets are the Scotland heat map, Home Analytics and the One Scotland Gazetteer.	Main datasets are BEIS sub-national gas, electricity, fuels and transport, UK conversion factors for company reporting.

### 3.6 Evidence of integration between LHEES and area-wide Climate Plans

It is possible to identify similarity between requirements, but it is also important to know if integration between these areas is happening. To investigate this, we searched for mention of LHEES in the area-wide plans of the seven Scottish local authorities in this project; lack of reference could be due to timing of policies versus writing plans but ultimately, LHEES should be one of the key delivery mechanisms for net zero targets and therefore will require integration.

**Table 3: Evidence of integration between LHEES and area-wide Climate Change Plans**

Integration	City	Stage	Relevant document
Limited	Stirling Council	No mention of LHEES in broad climate plan	Climate and Nature Emergency Plan <sup>[26]</sup>
	Dundee City Council	LHEES is recognised as part of the energy and low-carbon heat plan	Dundee Climate Action Plan <sup>[27]</sup>

Integration	City	Stage	Relevant document
		and the council will respond to proposals to create a statutory framework for LHEES	
	Aberdeen City Council	LHEES is recognised as a driver for renewable and low carbon heating.	Council Climate Change Plan 2021-25 <sup>[28]</sup>
Started funding	Perth and Kinross Council	Secured Scottish Government funding to accelerate development of the LHEES programme and delivery plan.	Climate Change Strategy and Action Plan Report <sup>[29]</sup>
	Highland Council	According to the Future Highlands document, LHEES isn't in development, but is included as part of the strategic objectives for creating a Green Energy Hub. <i>The Highland Council has applied for £50K to advance work on LHEES.</i>	Future Highlands: Health and Prosperity Strategic Partnership Plan <sup>[30]</sup> , <i>News Article: Highland's transition to net zero emissions progressing well</i> <sup>[31]</sup>
	City of Edinburgh Council	LHEES is integrated in the net zero target plan. The council plans to incorporate LHEES into a new city-wide heat and energy masterplan. LHEES is listed as a confirmed funding source under the development of a citywide programme of heat and energy generation with £35K from the Scottish Government.	Council's emissions reduction plan <sup>[32]</sup> , 2030 Climate Strategy <sup>[33]</sup> , 2030 Climate Strategy Implementation Plan
Started development	Glasgow City Council	The council has started developing LHEES with external partners and in line with Glasgow's Circular Economy route map. LHEES is also integrated in the net zero action plan.	Glasgow's Climate Plan <sup>[34]</sup>

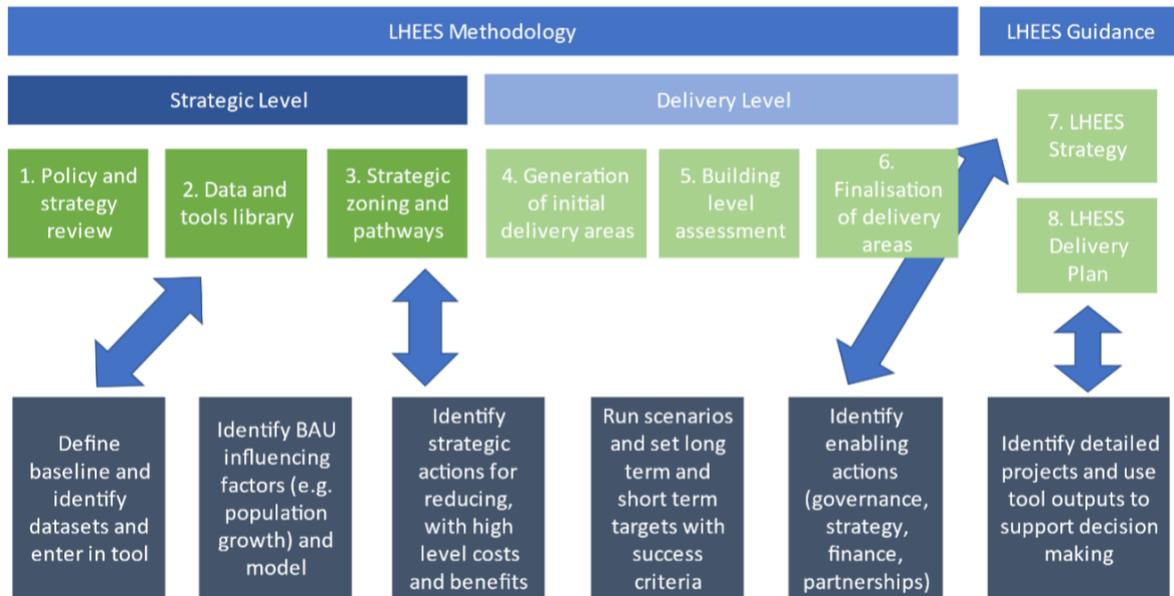
### 3.7 How LHEES and area-wide action might integrate in the future

There clearly needs to be integration between LHEES and area-wide strategies and plans. In terms of the LHEES methodology there are several points where this could occur, including:

- 1) Stage 2. Data and tools library
- 2) Stage 3. Strategic zoning and pathways
- 3) Stage 7. LHEES Strategy
- 4) Stage 8. LHEES Delivery Plan

These points of interaction are shown graphically in Figure 6. However, this will not happen without strategic action to link the two areas, which could include providing training and support to staff about how to use LHEES Strategy and Delivery Plans to populate their area-wide emissions strategies and action plans, explicitly discussing the complementarity and discrepancies between the two areas and providing joint resources, such as a single data repository.

Figure 6: Points of potential intersection between LHEES methodology stages and area-wide methodology stage



### 3.8 Conclusions about aligning LHEES and area-wide requirements

The complexity of area-wide action is recognised in the LHEES programme; there are clear opportunities to promote sharing of resources, capacity and capability between area-wide net zero strategies and plans and LHEES Strategies and Delivery Plans, but this needs to be co-ordinated and supported through shared data, tools and approaches.

In particular, it is important to recognise that differences in low and zero carbon heat is defined by Scotland's Heat in Buildings Strategy and by area-wide approaches which draw on the GHC Protocol and IPCC methodologies could lead to uncertainty and confusion by decision-makers and investors and that these need to be discussed and either reconciled or at least explicitly acknowledged.

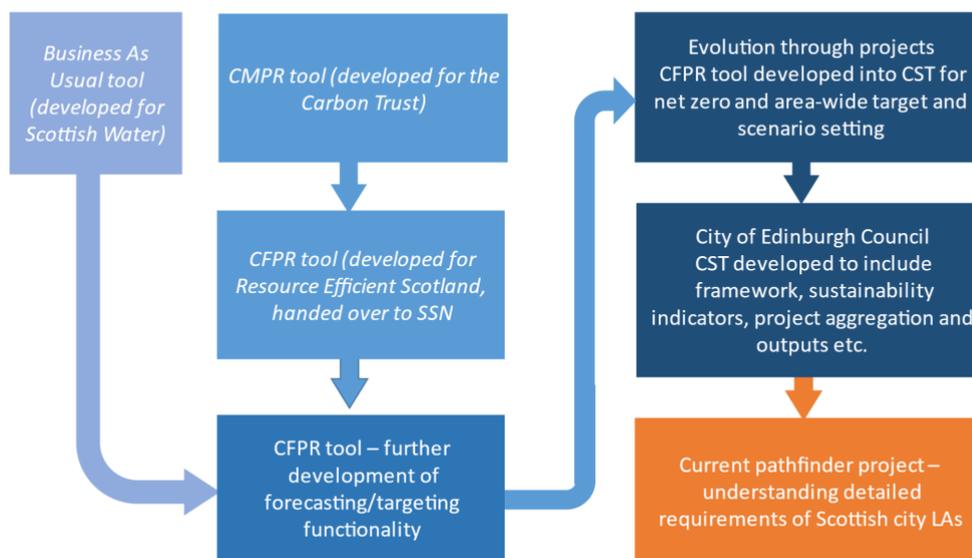
Overall, we find that there is clear commonality between the aims of LHEES and area-wide strategies and that success for both approaches can be demonstrated by the same measures; an overall reduction in emissions, accelerated by the policies and actions they stimulate.

## 4. Tool requirements to plan, meet and monitor area-wide net zero targets

### 4.1 Introduction

This section looks in more detail about the requirements that cities have for tools to report, plan and monitor net zero targets. As the initial focus of this project, the CST has essentially evolved over time and through multiple specific use cases (Oxfordshire County Council, Lewisham Borough Council, Conway Council and Dumfries and Galloway Council). Figure 7 shows the development of the CST from original concepts around modelling Business as Usual and the impact of Capital Expenditure project which was developed for Scottish Water more than a decade ago, through to the current iteration of the tool.

**Figure 7: Origins of the Carbon Scenario Tool**



However, this gradual evolution has been also accompanied by delivery of consultancy support, so more attention has been on functionality, often at the expense of usability and external communication. The development of the tool has always followed an *ad hoc* pattern of responding to specific questions that an organisation wants to answer, rather than collecting and refining a set of requirements around functionality and usability.

This project has represented the opportunity to capture a more universal and consistent set of requirements for a tool to support the development of net zero targets, plans and decision-making.

### 4.2 Methodology

These requirements have been developed from workshop outputs, individual meetings and other evidence from the sector. Some requirements are clearly defined and consistent across nearly all organisations; some others come from detailed practical knowledge of implementing net zero strategies, and therefore fewer organisations explicitly request them.

The identified requirements relate to functionality and usability. Functionality refers to what the tool can do in terms of data storage, calculations and useful outputs. Usability relates to how straightforward the tool is to use, update and audit as well as how well the tool can visualise and enable communication of outputs.

### 4.3 Functional requirements

Functionality has been further split into five elements deemed necessary to net zero methodology:

- 1) Calculating an area-wide baseline footprint
- 2) Estimating the Business as Usual (BAU)
- 3) Producing scenarios and reduction pathways
- 4) Identify actions for reducing carbon
- 5) Detailed project carbon costing

From these five functionality categories, along with usability, assessment criteria were developed and used to evaluate available solutions. Tables B1 – B4 in Appendix B list the detailed assessment criteria along with justifications for inclusion, and Section 5 covers the results of this evaluation. The following section expands on the identified requirements.

### 4.4 Calculating the area-wide footprint

As discussed in Section 2.2, an area-wide footprint is the annual GHG emissions that occur within, or because of activity within a territorial area and uses the GHG Protocol nomenclature of Scopes. However, rather than defining the scopes in terms of the organisation, they are in relation to the location e.g., direct emissions are those that occur within the local authority area.

GHG emissions are calculated from activity data e.g., the amount of energy consumed, multiplied by an emission factor that provides an estimate of the emissions resulting from the activity unit. In some cases, direct activity data is not available, so it is estimated from population size and pro-rata national data.

Currently many local authorities in the UK use the BEIS UK local authority and regional carbon dioxide emissions national statistics which are produced annually. While convenient, these statistics are not appropriate for estimating the area-wide footprint for several reasons:

- 1) They are high level statistics and therefore contain fewer breakdown categories than the underlying data.
- 2) They are in units of CO<sub>2</sub> only, rather than activity or CO<sub>2</sub>e (which mean other important GHGs are excluded).
- 3) The units of pre-calculated emissions data rather than activity data means it is much harder to model business as usual, activities, scenarios, and projects.
- 4) The dataset is not compatible with reporting through the CDP cities and other mechanisms because it excludes some emission sources and all non-CO<sub>2</sub> gases.

One of the frequent comments that came up in workshops was the need to have a standardized boundary for baseline calculations and an easily available dataset, produced on an annual basis to promote consistency between local authorities.

### 4.5 Estimating the Business as Usual

BAU scenarios enable decision-makers to model how emissions might change in the absence of climate action by the reporting entity. This is often modelled as how emissions would increase with

population growth, but BAU can also include national action that is independent of the local entity e.g., decarbonization of the national grid.

In the context of decisions by local governments, private and public organisations, and individuals in an area, the BAU should really represent the direction of travel for decisions outside of the control of these organisations. This enables more accurate understanding of the impact of actions within the local authority, helps understand where additional levers might enhance action and how to evaluate the impact of implemented actions. The advantage of tools which produce a documented BAU scenario is that it becomes easier to see where climate action is having its predicted impact because the reference scenario for comparison is more accurate. However, it should be noted that deciding what growth factors should be modelled as BAU, and what should be included as project actions requires a level of expertise and invested time that is not always available in individual teams.

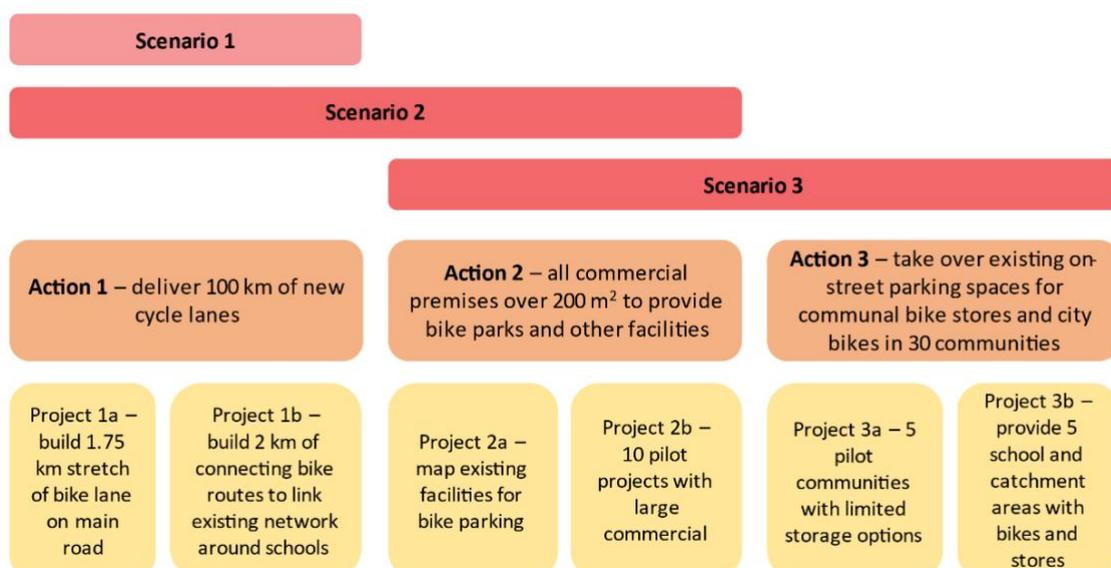
#### 4.6 Producing scenarios and reduction pathways, actions for reducing carbon and detailed project carbon costing

These three parts of tools represent the hardest part of area-wide decision-making tools and where the approaches taken are most diverse. For the purposes of this project, they have been defined in the following ways:

- 1) **Scenarios** are built up from cumulative or alternative groups of actions and enable organisations to see trajectories of emissions. Scenarios can be simple grouping of actions or more sophisticated interactions.
- 2) **Actions** are defined by ‘what’ we are planning to do. For example, an action around active travel might be to construct 100 km of new active travel network.
- 3) A **project** is more specific, usually smaller and delivers part of an action. A project has both a ‘what’ and a ‘where’ e.g. a particular section of connecting active travel network.

Figure 8 shows how these three elements interact, using an example of active travel.

Figure 8: Relationship between scenarios, actions and projects



Understanding the relationship between 1) scenarios to get closer to net zero, 2) actions that will help deliver change and 3) projects that enable those actions to be implemented bit by bit, is likely to be crucial to decision-making for net zero. Information about the carbon, financial and sustainability costs and benefits needs to be estimated, communicated, refined and communicated again all through the decision-making process.

An often overlooked element is the embodied carbon cost of infrastructure. This comes from emission sources such as the use of construction equipment and the supply chain of materials, which can often be international and complex. By asking the question about the carbon cost of implementing actions, relative to their operational emission reduction, it enables a more nuanced understanding of decision-making. However, existing tools for estimating carbon footprints of products such as construction materials are not easy to integrate into tools that aim to provide high level estimates at the early stages of action/project development; at these stages, details about specific construction materials and methods are not usually available. One of the key points noted by multiple organisations was that while project carbon costing was a key requirement for decision-makers, it did not need to necessarily be done in the same tool as all the other functional requirements.

#### **4.7 Usability requirements**

The usability requirements have been developed from feedback from existing users of tools (City of Edinburgh Council, Dundee Council, Perth and Kinross Council), from experience of consultants supporting organisations and from decision-makers from local authorities and other services. Key elements from tool users were around communicability and ease of use, whereas consultants and decision-makers contributed several requirements around auditability. Table B5 in Appendix B lists the usability requirements and reasons for inclusion.

#### **4.8 Conclusions about requirements**

The review of requirements of tools to plan, meet and monitor area-wide net zero targets has produced a long list of requirements, both in terms of functionality and usability of tools. Some of these requirements were strongly supported by most or all the organisations that we talked to, whereas others were only identified by frequent users of tools. It is likely that the list of requirements will evolve as policy, strategy, and methodology for delivering net zero targets mature. However, the requirements identified in this report are likely to be a reasonable representation of the current and near future needs of local authority sustainability teams tasked with developing and delivering net zero targets. The list of requirements has been used to evaluate existing tool solutions in Section 5.

## 5 Solutions scan

### 5.1 Introduction

In recent years there has been an upsurge in the development of tools designed to support both public and private sector organisations with all aspects of climate change management. In this context a tool is defined as *something that you use in order to perform a job or to achieve an aim*<sup>[35]</sup>. Therefore, for something to be defined as a tool, it needs to do something more than provide written guidance, such as undertaking calculations or producing outputs.

Tools come in a huge variety of formats (from excel-based to online platforms) and can also vary by:

- 1) Range of functionality in relation to the requirements of users
- 2) Openness of access e.g., free to public bodies, paid for service or completely open source
- 3) The geography that is covered
- 4) The sophistication and understanding required by the user

The aim of this section is to look at available solutions and evaluate the extent to which they match with the area-wide net zero requirements which have been identified in Section 4.

### 5.2 Methodology

The first part of the methodology was to identify potential solutions for evaluation, but there is no central repository or comparison site of existing tools. Instead, we found tools based on what our team was aware of from working in the field, topical research, and references from one tool to another. To be included in the evaluation, the tools had to be geographically relevant to local authorities in Scotland. It is very probable that the resulting list does not represent the full spectrum of climate change tools; some tools have access restriction or are behind paywalls. This is also a very fast evolving field and new solutions are constantly being developed. However, we believe we have evaluated the majority of accessible tools most likely to meet the requirement of area-wide net zero decision-making.

To evaluate tools rapidly but thoroughly, we set up a two phase evaluation process. The first phase evaluation was a yes/no scoring system for tool focus and broad functionality. Any tool scoring higher than 50% was then evaluated in more depth against 5 key areas of detailed functionality (with 31 criteria spread across the five areas) and usability (7 criteria). The scoring for the detailed phase 2 assessment was a scale of strong, medium, weak and non-existent. To produce a percentage score, these bands were numerically scored, and then an overall average score was calculated from the average of each category, in order to weight all categories equally.

In this section, the overall results from the phase 1 sieving and phase 2 evaluation are shown, and then the three highest scoring solutions are reviewed in more depth.

### 5.3 Results from Rapid phase 1 assessment

Table 4 shows the summary results of the phase 1 assessment. The aim of this initial evaluation was to categorise tools into broad areas of focus, both in terms of the aspects of climate change and sustainable development, and also in terms of the temporal and spatial focus of the tool. The rank of tools in Table 4 is based on the overall percentage, which is calculated as the percentage of yes responses for required aspects. Table 4 indicates that there were six solutions that scored over 50% against required aspects; these six tools were taken forward for the more detailed phase 2 assessment. The lower scores of the other four tools does not mean that they are not useful, just that they were not suitable for the requirements of net zero area-wide decision-making.

Table 4: Rapid phase 1 assessment of climate change tools

	Net zero carbon tools									
Rapid phase 1 assessment	ClimateOS	SCATTER	Carbon Scenario Tool	Net Zero Navigator	National Atmospheric Emissions Inventory CO <sub>2</sub> Interactive Map	Place-Based Carbon Calculator	Climate Action Co-benefits Toolkit	Tyndall Carbon Budget Tool	Gaia and Net Zero Carbon tool	Healthy Streets Check for Designers
Mitigation coverage	100%	100%	100%	83%	75%	42%	33%	42%	50%	8%
Adaptation coverage	0%	0%	0%	0%	0%	0%	50%	0%	25%	0%
Sustainability coverage	12%	12%	12%	47%	18%	12%	41%	12%	18%	29%
Functionality coverage	73%	53%	67%	47%	33%	53%	47%	33%	40%	33%
Accessibility	100%	100%	40%	100%	100%	100%	80%	100%	40%	20%
Overall percentage score (based on basic requirements)	88%	79%	76%	70%	61%	58%	48%	48%	45%	21%
Rank	1	2	3	4	5	6	7	7	9	10

## 5.4 Results from detailed phase 2 assessment

Table 5 shows the results of the detailed evaluation. Since the scoring was more nuanced, it was possible to separate out the functionality of tools more effectively. The full list of the criteria questions and rationale for inclusion for the six categories is provided in Appendix B. Table 5 shows the varied range of strengths and weaknesses amongst the tools. The CST scored highest overall for the functionality, which is perhaps unsurprising as the requirements were partially developed by the author of the tool and it was developed specifically with Scottish area-wide action in mind. However, all the other tools scored higher on usability criteria. This category included ease of populating and updating of the tool, internal and external publication of contents and auditing. The CST performed poorly in this area because it is an excel-based tool which as a format does not lend itself to collaborative action or communication.

**Table 5: Detailed phase 2 assessment of higher scoring climate change tools**

Detailed phase 2 assessment	Net zero carbon tools					
	ClimateOS	Carbon Scenario Tool	Net Zero Navigator	SCATTER	Place-Based Carbon Calculator	National Atmospheric Emissions Inventory CO <sub>2</sub> Interactive Map
Baseline	67%	76%	33%	48%	43%	24%
Business as Usual (BAU)	67%	75%	50%	0%	0%	0%
Scenarios/pathways	100%	78%	0%	56%	0%	0%
Actions	48%	52%	37%	0%	4%	0%
Projects	42%	67%	0%	0%	0%	0%
Usability	90%	24%	62%	57%	62%	71%
Average percentage score	69%	62%	30%	27%	18%	16%
Rank	1	2	3	4	5	6

## 5.5 Details of the three top scoring tools

### 5.5.1 ClimateOS

ClimateOS is an online platform created by the Swedish technology company, ClimateView, to help cities manage their climate change transition<sup>[36]</sup>. ClimateOS was developed in partnership with Microsoft and CDP, and both organisations promote the tool through their networks<sup>[37]</sup>. Some of the ClimateOS functionality is available by creating a free account<sup>[36]</sup>. However, upgrading to a paid

account unlocks additional features such as the collaboration toolkit, allowing access to multiple users, and the implementation toolkit which helps make the business case for actions<sup>[37]</sup>. ClimateOS has had significant external commercial investment (EUR 14.5 million to date)<sup>[38]</sup>.

ClimateOS performs well across four out of five of the defined functionality categories. The platform allows cities to calculate, visually display and understand their emissions inventory with activity-based data for each sector of their economies. ClimateOS also provides a BAU view of a city's emissions before exploring emissions reductions strategies through the transition element. The transition elements represent a shift to a low-carbon way of meeting a specific need covering broad categories like industry, agriculture, transport, and energy<sup>[37]</sup>. Users then select interdependent low-carbon actions to build up transition elements with the platform displaying the emissions reduction impact of those actions. Thus, through selecting different combinations of actions mirroring different "what-if" scenarios, cities can explore different pathways to reaching their net zero targets. One of the greatest advantages of ClimateOS is its online platform and ability to publish a live climate action plan.

The interface is easy to understand considering the complexity of what is being represented. Dundee City Council who uses the tool were very happy with the support offered by the team at Climate View, although the depth of support might have been in part because they were in an earlier piloting cohort. They did query the amount of effort taken by both themselves and Climate View to find and manipulate the baseline datasets into a usable format but felt that would be quicker for other organisations in the same country. One of the weaker areas of ClimateOS was around projects, with no specific facility to develop detailed project carbon costing outputs.

## 5.5.2 Carbon Scenario Tool

The CST evolved to support local authorities and regions respond to the net zero challenge, including setting an area-wide baseline, predicting the BAU scenario, understanding actions and projects that make up reduction scenarios and pathways, and providing information about the carbon, financial and sustainability costs and benefits for decision-making. The CST was developed purely through project investment for individual organisations (estimated £120,000 in total). While it remains open source and available on request, it requires expert consultancy support to set up and implement effectively.

The CST scores well across the five functional categories; in part because it was co-designed with the CEC. It is probably the strongest tool in terms of detailed project cost and benefits, including the qualification of co-benefits. However, the weaknesses of this tool is the excel format which restricts multiple users and makes the user interface very inaccessible. In terms of communication and visualisation, this tool did not perform well.

## 5.5.3 Net Zero Navigator

The Net Zero Navigator was developed by Connected Places Catapult in partnership with Useful Simple Trust, Space Syntax and OnePlanet<sup>[39]</sup>. From the outset, the intention of the tool was to provide strategic guidance for local authorities in developing climate action plans to accelerate the transition to net zero carbon. As such, development of the tool also sought input from more than 40 local authorities<sup>[39]</sup>. While local authorities are the primary target of the tool, it is accessible by anyone with the creation of a free OnePlanet.com log in. Creating an account also allows users to export the action plans from the Net Zero Navigator to OnePlanet for additional supporting features including inviting editors, allocating action, monitoring process, and publishing.

The Net Zero Navigator has two primary functions<sup>[40]</sup>:

- 1) aggregating and presenting current place data for a local authority
- 2) suggesting and detailing appropriate area-wide interventions based on the characteristics of the local authority.

The place data includes a carbon profile, with emissions from agriculture, forestry and land use, energy generation, industrial processes and product use, stationary energy, and transportation and waste, an assessment of the user's organisational zero carbon maturity based on their response to a questionnaire, information on the available skills in the area, regional opinions on environmental issues and local energy and building data. The interventions section presents specific, strategic programmes of work which users select to create action plans. Each intervention covers the risks, co-benefits, ease, approximate cost and return on investment of the action as well as signposting funding, case study and other resources to help users get started with the action. While not the primary focus of the tool, the Net Zero Navigator also presents a simple BAU projections for the selected local authority based on population growth and grid decarbonisation. Thus, the tool fulfils three of the five functionality categories: baseline, BAU, and actions. The weaknesses of this tool are the proportional benefit of interventions rather than quantified carbon saving estimates and the lack of reduction pathways and detailed project costing.

## 5.6 Conclusions about solutions

The solutions scan has identified that there are multiple tools aimed at supporting climate and sustainability action. These tools can be quickly evaluated to identify potential solutions for different challenges e.g., organisational footprinting, adaptation, sustainable development. However, there is no single place where these tools are collated and evaluated.

For area-wide net zero action, there are several tools that are designed to help approach this problem. We have evaluated these solutions against the identified list of requirements and two solutions stand out for different reasons. ClimateOS has had significant investment, is used globally, and has the best platform and data visualisation. The CST has been developed with much less funding and has useful functionality but is not user friendly or accessible.

To get the CST into an online platform with a well-designed user interface would require significant investment over a minimum two year programme to achieve a tool that could be used by Scottish local authorities, but that could be made more widely available. However, the Scottish Government's digital strategy states that *"Our vision is one in which national and local government play a full and active part in a network of organisations from all sectors of the Scottish economy, each of which focusses on what they do best in order to meet the expectations of our service users...It means that **the public sector will not seek to reinvent commodity technologies but instead focus on accessing them in the most efficient way through common platforms capable of achieving economies of scale and enabling us to focus our efforts and resources on meeting the needs of local people, businesses and communities** by improving the quality of services we offer and taking action to prevent issues before they arise"*<sup>[41]</sup>.

## 6 Data approaches and requirements

### 6.1 Introduction

In this project, data is defined as a collection of facts, whereas information is how these facts are understood in context. Tools designed to support decision-making around area-wide action cannot be considered separately from the data that they utilise and the information that they generate through their functionality. In this section, we have developed a broad classification of how tools utilise activity and carbon data, which we think has implications for how organisations evaluate and make decisions that are consistent with a net zero future.

To understand the classification, this section provides some background into the different types of data sources and how these are used in the different functional aspects of tools. This is important as it demonstrates that early simplistic data approaches result in reduced functionality at the sharp end of decision-making. The section also demonstrates some of the current issues with data for area-wide decision-making which are having very real consequences within local authority sustainability teams.

### 6.2 Methodology

Compared with the other sections of the report, this section did not follow a clear methodology; understanding which datasets are available and how they can be used has been an evolving workstream, throughout the development of the CST and the evaluation of the other potential solutions and LHEES. A database of datasets has been assembled as part of this project and each of the tools has been reviewed in the context of which datasets are used and how they are used.

However, the review of datasets has demonstrated the complexity around recording data. Datasets can have multiple formats and manifestations, change over time, get cancelled or experience changes to their coverage or units. In some cases, tools only used small aspects of a whole dataset, or the data undergoes various conversions before being used. The lack of consistent nomenclature, schedule, and repository all also impact on the usability of the data.

### 6.3 Data Types

Each dataset is made up of different types of data, often with more than one type of data in a single dataset. Table 6 shows the types of data used in area-wide climate action.

**Table 6: Types of data used in area-wide climate action**

Type of data	What is it	Examples
<b>Activity data</b>	Quantitative measures of an activity that generates GHG emissions <sup>[42]</sup>	Litres of petrol consumed by a vehicle or kilometres travelled by a vehicle of estimated fuel consumption
<b>Emissions data</b>	Data in mass of usually either CO <sub>2</sub> or CO <sub>2</sub> e	kg CO <sub>2</sub> resulting from a given amount of vehicle fuel consumption or km travelled

Type of data	What is it	Examples
<b>Conversion factors</b>	An arithmetical multiplier for converting a quantity expressed in one unit into an equivalent expressed in an alternative standard unit	Factor of 1.609 to convert from miles to kilometres
<b>Emission factors</b>	A coefficient used to convert activity data into GHG emissions data based on the average emissions rate of a given source relative to units of activity	kg CO <sub>2</sub> e emitted per litre of fuel consumed or kgCO <sub>2</sub> e emitted per km of average size petrol car
<b>Explanatory factors</b>	These are datasets that help generate metrics and contextualise activity and emission data	The number and size of households in an area or the percentage of car ownership
<b>Metric data</b>	These are calculated area averages that can be used to estimate carbon costs and savings from actions and projects	The average annual private vehicle km per car owning household
<b>Benchmarking data</b>	Data which allows an organisation to compare their activity data, emissions data or footprint to what is typical for similar organisations <sup>[43]</sup>	Published data on average commuting distance and mode

## 6.4 The data dichotomy

Area-wide reporting approaches can be broadly split into two categories:

- 1) Activity data first
- 2) Carbon units throughout

The first approach, which is used by both ClimateOS and the CST, is to build the baseline with activity data or by using metrics to estimate activity data. This requires a much deeper and extensive review of available datasets, as well as annual updating of emission factors within the tool.

The second approach, which is used by Net Zero Navigator, is to work in units of CO<sub>2</sub> or CO<sub>2</sub>e exclusively. This often means that relatively simple national datasets can be input directly into the tool without requiring conversion and emission factors.

However, units of CO<sub>2</sub>e have a large disadvantage when it comes to carbon costing actions and projects. For example, while it is still difficult to get estimates of future operational energy use of retrofitted buildings, it is much easier than asking for estimated reductions in CO<sub>2</sub>e, which if they are provided are often calculated using an undocumented methodology and assumptions. Basing tools in activity data and then calculating carbon and cost units means that there is maximum flexibility for estimating project savings.

However, the consequence of this approach is that constructing the baseline is more complex and involves accessing many more datasets and, in some cases, converting data using non-standard conversion methods. This uses up time within sustainability teams and increases uncertainty around the data.

## 6.5 The sheer quantity of data

As part of this project, we reviewed the datasets used by a variety of area-wide tools (where the dataset was essentially standardised) and also LHEES as an area-based programme. We expected to find a large overlap of datasets, with a few unique and extra ones for specific purposes. Instead, as shown in Table 7, we found over 60 different data sources being used, of which less than a quarter were used by two or more tools. This demonstrates how difficult it is for local authorities and other public sector users to even keep up with the publication of existing dataset, let alone identify and use new ones.

**Table 7: Unique and overlapping datasets for area-based tools**

Data Category	Number of datasets	Overlap (datasets used by at least two tools)
Emissions	2	1
Heat	6	2
Power	4	1
Renewable energy	4	1
Combined heat and power	2	0
Transport	12	0
Heat, power and transport	4	1
Waste	3	2
EF	1	1
Spatial	4	2
Consumption	2	0
Demographic/context	10	3
Future context	7	0

## 6.6 Dataset complexity and delay

Several organisations have questioned the time lag between collection and publication of area-wide data. Table 8 below shows the set of data issued annually by BEIS as an example of this. Although the data is combined into a single dataset of CO<sub>2</sub> emissions, the underlying datasets do not relate to the same period and the units for fuel and transport are in tonnes of oil equivalent which requires certain processing to get to useful activity units such as passenger km. While for large centralised area-based datasets some time lag between collection and publication is required to allow for processing and auditing, where this data is essential to decision-making and monitoring, these timelines or alternatives should be investigated to optimise timely delivery. In the future there might be

opportunities to replace centralised datasets with local data that is more accurate and up to date, but this requires ongoing investment in data standards.

**Table 8: Dataset complexity and delay**

BEIS dataset	Publication date	Year of most recent data	Unit	Collection time period
Postcode level electricity statistics <sup>[44]</sup>	22-Dec-20	2019	kWh	February 2019 – January 2020
Postcode level gas statistics <sup>[45]</sup>	22-Dec-20	2019	kWh	mid-May 2019 to mid-May 2020
Total final energy consumption at regional and local authority level: 2005 to 2019 <sup>[46]</sup>	30-Sep-21	2019	ktoe	Various from source data
UK local authority and regional carbon dioxide emissions national statistics: 2005 to 2019 <sup>[18]</sup>	24-Jun-21	2019	ktCO <sub>2</sub>	Various from source data

## 6.7 Conclusions about data

What this section demonstrates is that data for area-wide reporting is complex. If local authorities are left to calculate their own area-wide baseline, it is almost certain that we will end up with 32 different methodologies and outputs. Such heterogeneity reduces confidence in; using the data for decision making, the ability of local and national decision-makers to understand progress, the ability to analyse and compare action plans to identify successful implementation strategies, and the ability of citizens to participate in the process. The less standard the approach, the more complexity is required in reporting frameworks and analysis.

Individually sourcing data and calculating a baseline and updating it annually also takes up significant resources and capacity in areas of shortage. This role could be more efficiently and effectively carried out as a central function, providing more reliable data with a documented methodology and audit trail. A centralised Climate data repository would also make data that could be used for action and project carbon costing and for the implementation of area-based programmes such as LHEES much more accessible.

## 7 Capabilities and Capacity within cities

### 7.1 Introduction

This section explores the findings of this project in relation to capabilities and capacities within the seven cities with respect to the actions required around area-wide targets. So far, this report has focused on the data requirements and solutions available for local authorities to manage their area-wide climate change data. However, these only represents the material aspect of the problem; there is also the individual and social context to consider. There is always a temptation to invest heavily in tools to collect and manage data with the hope that providing these tools will embed climate change into decision-making processes and that those decisions will be consistent with the direction and pace required to meet net zero targets. Experience should tell us that this is not the case.

There is almost certainly a role for effective area-wide tools to support the creation and implementation of net zero plans. Yet, these will only be effective if there is recognition of the context within which local authorities are working and accompanying investment in the capability and capacity of staff.

The first part of this section looks at some of the feedback from the seven local authorities about this context, pulling out some of the key themes that came up in both workshops and individual discussions. The second part looks at the current picture of resourcing from Climate Change activity and the gaps identified by the local authorities.

### 7.2 The context for area-wide climate change data and decision-making within Local Authorities

One aspect of this project has been to focus not just on the requirements of tools, but to consider the context within which local authority staff are developing and implementing net zero plans. In order to understand this context, one of the workshops used a tool called ISM (Individual, Social and Material). ISM is based on theory and evidence which shows that three different contexts - the Individual, Social and Material - influence people's behaviours<sup>[47]</sup>. One of the key principles is that interventions should take account of influences across multiple contexts to achieve substantive and long-lasting change. Traditionally interventions have tended to focus on either the Individual, or on the Material contexts, and sometimes on both. However, this is often insufficient to lead to the change that practitioners are expecting. ISM encourages broader thinking and enables understanding of the context to develop a more integrated package of interventions. Findings from the workshop and the individual conversations with sustainability teams have been grouped into the ISM themes and displayed fully in Appendix C.

There are expected findings around capacity constraints, which existed before area-wide targets became widespread, and the skills gap around data analysis, especially spatial data. However, one of the important pervasive themes that came across was the emotion of fear. This was brought up in multiple different contexts and at many different points in the decision-making process. There were perfectly rationale fears expressed around the consequences of climate change but also fears around the consequences of changes required to combat climate change. Specifically in terms of data, there were fears of not having it, but also of having it and using it to make decisions, only to find it was wrong or insufficient.

Where there is fear of both action and inaction, it is easy to understand how decision-making paralysis manifests, which also then produces its own anxiety. Clearly the strategy for overcoming this is not to

provide more tools, complexity and data but to recognise the fears and provide resources, support and guidance to overcome the fear. Climate change training, aimed at both officers and elected members, needs to explicitly address these fears, enabling individuals to recognise not only what they feel, but how to make decisions under uncertainty.

Interestingly, analysis of the LHEES pilot phases (shown in Appendix D)<sup>[13, 48, 49]</sup> also identified fear and uncertainty as dominant emotional themes in early development but as the methodology evolved, there was more sense of empowerment, albeit still with concerns about investment and capacity to deliver outcomes. This progression of emotion from fear to empowerment (with specific concerns around implementation) needs to be undertaken for area-wide reporting.

### 7.3 Current capacity within Local Authorities

As part of our in depth interviews with each individual local authority, the annual tasks in relation to both organisational and area-wide climate change were broken down and each local authority was asked to estimate the amount of full time equivalent resource that was currently allocated and how much they felt was needed. However, it became very quickly apparent that this was not how organisations managed their resources. All the following factors varied:

- 1) Job titles, roles, and responsibilities
- 2) How the sustainability team was structured e.g., combined with energy team or as a separate sustainability or climate change team
- 3) Where in the organisation it was based and whether it had corporate or service influence
- 4) Contribution to tasks from other services within the local authority

For that reason, it was not possible to present an accurate resourcing picture across the seven cities. However, the following points were noted:

- 1) Even allowing for team structure, there was a large variance in the level of resourcing between different local authorities, especially when the size of the area-wide footprint was considered.
- 2) While some of the organisations had taken on more staff and widened the skill sets, all organisations recognised the huge scale of the challenge of achieving net zero in their area.
- 3) Without exception, all organisations noted that one of the major constraining factors in undertaking all the tasks required to develop and effectively implement area-wide net zero plans was resourcing, with many teams already over-stretched even before net zero targets were set.

### 7.4 Current capability within Local Authorities

Climate change as a public sector discipline has evolved rapidly from its start around 2020, to the current day. Initially carbon management was primarily associated with energy use, and thus often managed by energy officers with an engineering background, or within the estates team. As the boundary of emissions evolved, and transport, waste and water were reported, climate change has still often remained the responsibility of energy and estate or fleet managers.

However, the structure has begun to change in the last 5 to 10 years. Organisations have increasingly understood and recognise the role of staff behavioural change, procurement decisions, and the links between climate change mitigation and adaptation and wider sustainability impacts. The result has been to start to widen the skillset from more traditional engineering disciplines to data analysts, project managers, adaptation specialists, ecologists, engagement specialists, circular economy,

project finance, carbon budgeting etc. Organisations who purposely widened the skillset of their team have observed multiple benefits.

There remains a key set of scarce skills around data analysis and interpretation, especially in spatial data; this was commented on by all local authorities that we spoke to. With decision-makers starting to realise the possibilities and benefits of evidencing decisions with carbon data, coinciding with the private sector also increasing their demand for these skills, it is likely that there is a shortage of supply which will remain without intervention.

## **7.5 Conclusions on capability and capacity**

There is little chance of Scotland meeting its challenging climate change targets without local government successfully implementing net zero plans for area-wide emissions. However, the scale of action required needs to be reflected with sufficient resourcing; the scale of the problem is clearly completely out of proportion with the current level of staff resources devoted to delivery of climate change action. As well as quantity, there is also an issue of efficiency; in many cases valuable staff time is being used to repeatedly address the same problem in every individual organisation; a good example of this is sourcing of data and calculation of annual area-wide footprints.

This project has also surfaced an issue about how people involved in the planning and delivery of area-based climate action are feeling and the paralysing effect of fear on effective decision-making. Part of this fear comes from organisations and individuals being uncertain about data, from baselines all the way through to project costing. In Section 8, there are recommendations aimed at increasing capacity and capability and increasing support and training.

## 8 Recommendations

### 8.1 Introduction

This aim of this section is to pull together the findings of this project into a series of recommendations for Scottish Government, local authorities, support organisations such as ECCI, SSN and the Improvement Service, and the wider public and private sector including education. Although developed through a different process, the resulting recommendations mirror the findings of the SSN Strategy<sup>[50]</sup>. The recommendations are summarised below and detailed in Table 9, where they have been grouped into themes, with a brief explanation of why they are important, the outcomes expected, and some notes on costs to deliver.

### 8.2 Summary of recommendations

**Data:** We recommend developing rules for setting and reporting on area-wide boundaries and then centralising collecting and processing annual baseline data. Nearly all organisations struggled with aspects of data analysis and felt insecure about methodologies and resulting information for decision-making. Although a large amount of data analysis around actions and projects would still sit with individual organisations, by creating a uniform and consistent starting point, some of these barriers to action could be managed and sustainability teams experiencing capacity issues would be supported.

**Tools:** Although initially it was anticipated that this project would provide a starting point for investing in and developing the CST as a Scottish-based area-wide tool, this project has identified that there are likely to be other pathways that are more cost and time effective. Cost is often seen as the main barrier whereas in reality the key limitation is time; all seven local authorities have set net zero targets that mature between 2025 and 2045, meaning there is no time to waste.

Therefore, the recommendation is to investigate the option of purchasing a Scotland-wide solution and to invest in set up, support and training for all 32 local authorities. Our assessment shows Climate OS to be the best fit with current requirements in terms of functionality, cost and ease of deployment but further due diligence would be required. There are additional benefits of a consistent tool that creates live action plans, to support both better public and private engagement and monitoring the implementation of Scotland's Climate Change Plan.

**Capacity:** Action on data and tools does not solve all the capacity and capability gaps that exist in local authorities to deliver area-wide action, whether it is net zero targets or LHEES. Local authorities need to build capacity in this area, both by securing existing resources and recruiting new skills and by developing areas where efficiencies can be realised through alternative delivery models which draw on the resources and expertise of other public and private sector organisations. This report recognises the need to develop a shared funding model where we can more easily coordinate and make resources, people, knowledge and expertise available from the private sector or the wider public sector. This shared problem and solution approach is necessary, so that local authorities are not left feeling that they are responsible and accountable for delivery of area-wide targets alone.

**Capability:** Finally, training aimed at decision-makers, including elected members, needs to be reviewed to make sure it enables understanding of the data available, the opportunities and limitations of the evidence and how to support and make decisions compatible with a net zero future. We need to develop both professional development programmes and further and higher education content to make sure that there is a throughput of new practitioners and existing staff trained in the approaches, practices and data skills required to work in public sector area-wide climate action which matches the increasing demand for expertise, knowledge and capacity in this area.

Table 9: Recommendations

Theme	Recommendation	Reason for recommendation	Expected outcome	Anticipated costs	LHEES alignment	Suggested ownership
<b>Data: Carbon accounting rules and guidelines</b>	Set a nationally agreed boundary for area-wide emissions that is consistent with the GPC and compatible with international reporting to the CDP.	The GPC is the most common standard for reporting to the CDP (which is the <i>de facto</i> option for international reporting for regions). However, differing interpretations of the GPC can cause inconsistency; a problem that a nationally agreed boundary would resolve. The boundary needs to be standardised for efficiency of baseline dataset production and to underpin a consistent approach between local authorities.	A standard agreed boundary for area-wide emissions will reduce confusion and resource intensive decisions and defence by individual sustainability teams in local authorities. There is likely to be some initial pushback from organisations who have already set a more limited (or more extensive boundary) but as demonstrated by the PBCCD, inconsistency generates more costs in the future.	The cost for this would be minimal as a lot of research has already been carried out by local authorities and academic bodies. However, the coordination and negotiation role would need to be undertaken by Scottish Government or their nominated representatives.	The need for consistency around rules was mirrored in the findings of the LHEES pilots <sup>[25]</sup> which led to the development of the LHEES Methodology.  However, current discrepancies exist around how emissions from electricity and potentially waste heat are allocated. A consistent rulebook would help to either eliminate this difference or at least explain any differences.	The Scottish Government, Improvement Service, and/or Sustainable Scotland Network

Theme	Recommendation	Reason for recommendation	Expected outcome	Anticipated costs	LHEES alignment	Suggested ownership
<b>Data: Baseline dataset</b>	<p>Task a central agency with producing an annual baseline dataset for area-wide emissions that is fully referenced, transparent and guaranteed to be produced annually at the same time for a number of years.</p>	<p>Individual organisations expend significant time and resources finding appropriate data, converting it to appropriate units and producing graphical outputs. This makes it hard to produce consistent approaches and is inconsistent with Scotland’s digital strategy.</p>	<p>Producing a standardised annual dataset will be more efficient and will enable organisations to focus their staff, resources and innovation on coordinating and implementing climate action. It will result in a higher quality dataset, with a coherent and documented approach to changing data and methodology.</p>	<p>While there would be a central staff cost (expected to be around 1 FTE initially, with lower costs once the system was set up), this is much lower than the existing cost of total resources for the task across the 32 local authorities.</p> <p>This is already partially achieved by SCATTER, but there are no guarantees of annual updates which makes organisations reluctant to use it.</p>	<p>The LHEES pilots found data collation and analysis to be one of the most resource intensive elements of the LHEES development process<sup>[25]</sup>.</p> <p>Baseline emissions data is helpful for LHEES, particularly for identifying hotspots and monitoring progress. Thus, having baselines provided is one less burden for local authorities to calculate themselves. Using the baseline as a starting point for tracking decarbonisation impact can also help identify effective actions and inform Delivery Plans.</p>	<p>Management by the Improvement Service alongside other national datasets</p>

Theme	Recommendation	Reason for recommendation	Expected outcome	Anticipated costs	LHEES alignment	Suggested ownership
<b>Data: Emissions data repository</b>	Develop a climate data repository for Scotland that provides a one-stop shop for all data that is used for area-wide action and other area-wide programmes.	There are more than 50 datasets that can or need to be used by local authorities for area-wide programmes. There is no single place where the most up to date publication and the data standards are collated and therefore useful data sources are missed, or time is wasted searching for them.	A centralised data repository would benefit both area-wide emissions strategies and plans and LHEES data and tool libraries by making datasets more accessible. Standardised cataloguing and properties would improve auditability of data evidence.	There would be a cost to both setting up and maintaining a climate data repository and making sure that data properties and search terms were effective. This is likely to require a full time post to set it up initially, plus any web design costs.	<p>A repository would ease local authorities' data collection burden, allowing limited resources to be focused on analysis and delivery planning. It also addresses data accuracy and sharing concerns.</p> <p>A Scotland-wide assessment of the building stock and identification of heat decarbonisation zones based on national datasets is currently being carried out as part of the next steps in an LHEES National Assessment<sup>[25]</sup>. This could be combined with the suggested repository to create a single resource on data for local authorities.</p>	Management by the Improvement Service alongside other national datasets

Theme	Recommendation	Reason for recommendation	Expected outcome	Anticipated costs	LHEES alignment	Suggested ownership
<b>Tools: Adoption of a Scotland-wide solution</b>	Investigate the options and conduct due diligence on purchasing ClimateOS licence for all 32 local authorities in Scotland, as the recommended shared solution for monitoring area-wide emission plans.	ClimateOS has been specifically designed for cities and local authorities to develop and implement net zero climate action plans. It meets a large percentage of the requirements that local authorities and public sector experts have identified.	Providing access to an existing tested platform that is being used by 10 UK local authorities and more than 38 Cities worldwide will provide an instant solution to setting consistent baselines, identifying trajectories and actions and publishing plans.	<p>The annual cost of ClimateOS for all of Scotland’s 32 local authorities is estimated from known licence fees at between £150,000 and £360,000.</p> <p>Initial centralised purchase of the licence can reduce costs of individual organisational procurement and could be managed in a centralised procurement framework for managing and monitoring climate strategies.</p>	<p>Providing local authorities access to ClimateOS would also help them to develop both LHEES Strategies and Delivery Plans. ClimateOS would allow local authorities to explore multiple “what-if” scenarios built by aggregating the emissions reduction impact of low-carbon actions. The database of actions can also help local authorities to move past <i>what</i> to do and instead focus on <i>how</i> to do it.</p> <p>The platform also allows for live action plans allowing LHEES Delivery Plans to be an ongoing, iterative decision making tool.</p>	<p>Initial requirements can be defined by ECCI and SCA</p> <p>Purchasing through Scottish Government Procurement</p>

Theme	Recommendation	Reason for recommendation	Expected outcome	Anticipated costs	LHEES alignment	Suggested ownership
<b>Tools:</b> <b>Management and support</b>	Provide a centralised support service to populate and set up ClimateOS, including staff and decision-maker training and a facilitated user group and helpdesk.	ClimateOS is designed to solve complex problems and therefore embedding and socialising the tool within local authorities will require support for the first few years.	With a strong support network and a consistent approach to data, staff will have more confidence in developing and producing live action plans. Once the tool is embedded, resources used to develop and write action plans and calculate baselines will become available for coordination and implementation.	Ideally the support capability would be developed in Scotland in partnership with Climate View. However, it would require increasing centralised staff capacity at one or more support agencies.	The LHEES pilots highlighted a deficiency in many local authority's in-house technical skills and expertise as well as a lack of resources around technical support and training. A centralised support service, even if it was only to help with ClimateOS, would cover many of the areas of technical difficulty which were stumbling blocks for local authorities in the pilots.	Shape resource requirements across the Scottish Government, Improvement Service and/or Sustainable Scotland Network.

Theme	Recommendation	Reason for recommendation	Expected outcome	Anticipated costs	LHEES alignment	Suggested ownership
<b>Tools: Future requirements and functionality</b>	<p>Work in partnership with Climate View to develop project carbon costing methodologies for common carbon reduction projects within area-wide action plans.</p>	<p>The area that ClimateOS is weaker is individual project carbon costing. However, they have previously expressed and demonstrated willingness to adapt and develop the platform to meet the needs of users and to galvanise climate action in cities.</p>	<p>From work undertaken with the City of Edinburgh Council, data estimating carbon costs and benefits, and sustainability co-benefits of individual projects still lies within the Carbon Scenario Tool. If ClimateOS is chosen as the area-wide action planning tool, it would be logical to move everything to one usable platform.</p>	<p>There are likely to be some costs in terms of staff time to support converting the requirements for project carbon costing. Climate View may absorb or share development costs to build this module if it would benefit all their clients.</p>	<p>In carrying out the LHEES Delivery Plans, local authorities will need to deal with the specifics of individual projects. They will need to carry out the same method of carbon costing in their decision making. Rather than each local authority creating their own method, developing this functionality once in ClimateOS provides consistency and comparability. In addition, it would allow all parts of the LHEES Delivery Plan to sit within ClimateOS in a live, sharable platform.</p>	<p>Initial requirements can be defined by ECCI and SCA</p> <p>Purchasing through Scottish Government Procurement</p> <p>Ongoing support for effective use by Scottish Government, Improvement Service, and/or Sustainable Scotland Network</p>

Theme	Recommendation	Reason for recommendation	Expected outcome	Anticipated costs	LHEES alignment	Suggested ownership
<b>Capacity and capability: Sustainability teams</b>	Develop a model to increase capacity and address key capability gaps in local authority Sustainability Teams from the private sector and the wider public sector.	Area-wide net zero targets are not the sole responsibility of local authorities, who contribute only a small proportion of area-wide emissions. To effectively resource area-wide climate action, there needs to be finance or in-kind resources contributed by the other sectors.	Currently local authority Sustainability Teams already feel stretched beyond capacity; this is likely to be at least contributing to the slow implementation of required action. De-scoping these teams by having more centralised support for tasks that can be more effectively delivered at scale is one part of the solution; there is also a need to make more resources available, especially in specialist areas.	There are costs to managing teams that cross-over public and private organisations, but this should also deliver efficiency savings across organisations by joining up expertise into a larger team, rather than paying for additional resources. Even contributing small amounts of staff time could pay dividends to many organisations through improved staff knowledge, job satisfaction and delivery on climate commitments.	LHEES is already developing some of the necessary private-public integration with intentions for the programme to signal potential areas of investment to market actors. However, to achieve area-wide targets, the integration needs to go beyond signalling. If a model could be developed to draw on capabilities from the private sector and wider public section for area-wide net zero target, the same model of coordination and collaboration could be applied to effectively resourcing LHEES.	Local authorities, Skills Development Scotland, Sustainable Scotland Network, Scottish Funding Council, Higher and Further Education Partners

Theme	Recommendation	Reason for recommendation	Expected outcome	Anticipated costs	LHEES alignment	Suggested ownership
<b>Capacity and capability: Decision-makers</b>	<p>Audit training courses designed for Councillors and Senior Managers and, if required, develop net zero carbon decision-making modules. If recommendations around rules, data and tools are adopted, design and incorporate these into training materials.</p>	<p>Many organisations identified the need to continually train decision-makers about data, uncertainty, and net zero decision-making. Area-wide climate action is a very fast moving field and training courses need to include decision-making practice as well as knowledge.</p>	<p>Effective training courses for decision-makers will help local authorities tell better data stories because senior staff and elected member will ask for information and understand the implications. It should also lead to better decisions that are more consistent with net zero pathways.</p>	<p>There are several existing training courses which have been very well received; these could be reviewed and modified if required for a fairly minimal investment. The benefits of standard boundaries, baseline datasets and tools are clear as the training would be appropriate across the whole Country.</p>	<p>A point of note in the LHEES phase 1 pilot was the desire from local authority officers for the Scottish Government to engage and educate senior management and councillors to gain greater traction for the programme. Thus, the recommended net zero training programmes for decision-makers can explicitly tie in LHEES while educating on area-wide climate action. This would increase awareness and likely support for LHEES at senior levels which the pilots noted as key to delivering a successful programme.</p>	<p>Local authorities, Skills Development Scotland, Sustainable Scotland Network, Funding Council, Higher &amp; Further Education Partners</p>

Theme	Recommendation	Reason for recommendation	Expected outcome	Anticipated costs	LHEES alignment	Suggested ownership
<b>Skills development pipeline</b>	Audit Climate Change related education in Scotland in relation to the skill and knowledge required for area-wide climate action. Develop specific public sector modules for both education and professional development.	Over the next 20 years there will need to be a significant increase in jobs that coordinate and support the delivery of area-based climate action. Therefore, we need to make sure that we are consciously developing educational courses that provide people with the specific necessary skills and knowledge.	Investing in professional development modules that can be taken by existing staff but also students with an interest in this area will help develop a greater pool of qualified resource. Ensuring that there is a practical element to the course can also add valuable real-world experience to students and provide resource to support centralised activity. Naming modules as public sector expertise helps professionalise this sector.	The cost of developing new modules and content, potentially linked to master's and other courses, would be relatively low because there is already a lot of material that can be utilised. Staff time for attending courses should deliver returns for sponsoring organisations as the increase in proficiency would lead to more effective working practices. The integrated nature of the area-wide problems also means knowledge and resources should be shared across public and private sector partners.	The LHEES pilots noted the multitude of skills required for LHEES development including project management, stakeholder engagement and data analysis, particularly GIS. Many councils did not have the necessary in-house skills, and thus relied on consultants. The upskilling of local authority officers through professional development models would mutually benefit LHEES by developing greater in-house skills and knowledge in the councils. While the LHEES pilots highlight the need for at least one dedicated LHEES officer, net zero ambitions will likely require councils to expand their sustainability staff.	Local authorities, Skills Development Scotland, Scottish Funding Council, Higher and Further Education Partners

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## Appendix A: Precise target wording

Table A1: Area-wide and organisational targets

Local Authority	Area-wide target			Organisational target		
	Date set	Date to be achieved	Target wording	Date set	Date to be achieved	Target wording
<b>Aberdeen City</b>	May, 2020	2045	"below zero carbon (climate positive) balance by 2045" <sup>[51]</sup>	Mar, 2021	2045	"net zero and climate resilient Council assets and operations, by 2045" <sup>[28]</sup>
<b>City of Edinburgh</b>	May, 2019	2030	"a hard target that Edinburgh will be net zero carbon by 2030." <sup>[52]</sup>	Apr, 2021	2030	"it [the council] will be a net zero organisation by 2030" <sup>[32]</sup>
<b>Dundee City</b>	Dec, 2019	2045	"net-zero greenhouse gas emissions by 2045 or sooner" <sup>[27]</sup>	TBD	TBD	"The Council adopted, and continues to develop, a Carbon Management Plan in 2009 to reduce carbon dioxide emissions from its own operations...In 2020, the Council will produce an updated Carbon Management Plan" <sup>[53]</sup>
<b>Glasgow City</b>	Sep, 2019	2030	"a carbon neutral Glasgow by 2030" <sup>[54]</sup>	official approval TBD	2020	"The new Carbon Management Plan (CMP3) aims to address the city's direct carbon emissions and will commit Glasgow City Council as an organisation to achieve the 2030 net zero carbon target." <sup>[34]</sup>
<b>Highland</b>	Jun, 2013	2025	"Members agreed to an initiative to achieve a carbon neutral Inverness in a low carbon Highlands by 2025" <sup>[55]</sup>	TBD	TBD	"The immediate priorities for the Climate Change project are...Setting a target date for net zero emissions from Council operations" <sup>[56]</sup>

<b>Perth and Kinross</b>	Dec, 2021	20"5	"Net Zero aligned with the Paris Agreement and the Scottish Government Targets, with the ambition of achieving them sooner, subject to available resour"es" [29]	Dec, 2021	20"5	"decarbonise our operations... reaching net zero by no later than 2"45" [29]
<b>Stirling</b>	Jun, 2021	20"5	"Stirling Council area will achieve net zero carbon by 2"45" [26]	Jun, 2021	20"5	"Stirling Council will be carbon neutral for our own operations by 2"35" [26]

## Appendix B: Assessment criteria for evaluating area-wide net zero tools

**Table B1: Requirements for calculating an area-wide baseline footprint**

Requirement	Reason for inclusion
The tool enables the creation of an area-wide baseline	Part of setting targets is being able to set and communicate a clear starting point
The tool provides flexibility about how the area-wide baseline is defined	Although initially the need for flexibility around the baseline boundary was identified as a requirement, some of the recommendations around setting rules for area-wide reporting would make this less relevant
The tool provides activity data units, carbon units and cost units	In order to be able to usefully carbon cost activities and projects, it is important to be able to translate between activity, cost and carbon units
The baseline dataset can easily updated on an annual or more frequent basis	The baseline functionality also represents the target monitoring aspect of the tool. Baseline data becomes available at different times in the annual cycle but organisations only required annual updates.
Local subsets of data be added	This was a requirement identified by many organisations who recognised that there is often more accurate local data available or that it is important to be able to use higher resolution local data.
The tool is compatible with the Greenhouse Gas Protocol for Cities (GPC)	The GPC was used by nearly 50% of City regions that reported to the CDP and compatibility with this protocol should be standard
The baseline dataset be displayed internally/externally	Baseline datasets that conform to the GPC are complicated but there should be functionality to present and display the baseline both as a diagram and as a graph

**Table B2: Requirements for estimating the Business as Usual**

Requirement	Reason for inclusion
The tool can predict the future reference scenario	The importance of this varies between Local Authorities, with areas experiencing net immigration and economic and population growth being more likely to identify it as a requirement.
BAU factors can be individually applied to footprint emission sources	Not all BAU growth factors apply to each emission source. For example, grid decarbonisation would not apply to emissions from

	non-electric heating. However, there is also a trade-off between completeness and communication.
Multiple BAU factors can be applied to each footprint emission	This was not a requirement identified by organisations but to model the BAU effectively, some emission sources need to have multiple factors applied.
The BAU forecast can be easily communicated to stakeholders	Communicating the BAU forecast as a minimum requires both a graphical representation and a clear list and audit trail of the factors applied.

**Table B3: Requirements for scenarios and actions**

Requirement	Reason for inclusion
Different combinations of actions to meet net zero can be combined to produce reduction pathways?	This flexibility means that rather than actions being only cumulative, different combinations can be combined to optimise reduction pathways
Mapped actions take account of fuel switching emission increases	This is fundamental to map the impact of switching fuel sources e.g., petrol/diesel vehicles to electric vehicles charged from the national grid
Mapped actions automatically rebalance the remaining reduction opportunities	This was identified not as a requirement specifically but as a solution to the problem of tracking the available reductions from emission sources relating to the delivery of a service e.g., if electric vehicles are increased, reduction opportunities from public transport are automatically decreased because they both provide transport services.
The tool contains a bank of appropriate actions for achieving reduction pathways	Many organisations identified the need for a bank of actions of how reduce area-wide emissions. In an ideal world, these would come with costs, benefits and other information required to implement.
Actions can be allocated to individuals and organisations	To maintain responsibility and accountability, organisations recognised the need for named individuals to be attached to actions and projects. However, if the wider context of multiple project owners is recognised, responsibility for coordinating many of the actions will sit outwith the Local Authority and this needs to be tracked
The financial costs of actions are tracked	The financial cost of actions is often high-level and based on scaled up individual projects or benchmarks based on floor area etc.
The financial benefits of actions clearly defined	This is an area that requires more investigation. The financial benefits from reduced fuel consumption or fuel switching are

Requirement	Reason for inclusion
	easy to define but the financial benefits resulting from improved sustainability or avoided offset cost are often hard to define.
The carbon costs of actions are clearly defined	This is one of the areas of area-wide reporting that is starting to be identified as important and requires high level estimation methodology.
The carbon benefits of actions are clearly defined	This is the quantification of operational benefits of carbon reduction actions that will be seen within the area-wide footprint.
Actions can be monitored/tracked	Tracking actions that might be implemented as multiple individual projects can be difficult, but it is important to be able to review to what extent actions have been implemented in order to evaluate effectiveness.
LHEES strategy actions can be easily mapped	As a subset of actions, LHEES strategy actions should be easily translated into actions that deliver area-wide emissions reductions as this is one of the key programmes for area-based decarbonisation.

**Table B4: Requirements for projects**

Requirement	Reason for inclusion
Specific local carbon increase and decrease projects can be entered in the tool	These are projects where there is sufficient information about the size and location to develop a more detailed project output covering the carbon, financial and sustainability costs and benefits.
The tool can provide a collated output for simple projects (covering one emission source)	Consistency of project outputs, providing detail and context of the project within the whole area-wide footprint and the specific emission source was identified as a key requirement.
The tool can provide a collated output for complex projects (covering multiple emission sources)	Experience of area-wide project carbon accounting led to the inclusion of a requirement for single collated project outputs covering multiple emission sources. For example, a rebuilt school could be combined with active travel facilities and local route upgrades to achieve much higher carbon reductions than from just an upgrade of heating systems.
The tool can support quantification of sustainability co-benefits	Local Authorities understand the need to achieve multiple sustainability outcomes simultaneously, but these are hard to track and evidence in a quantified way.

The tool can support qualification of sustainability co-benefits	An alternative to quantification of sustainability co-benefits is qualifying them e.g. an action is considered highly probable to have a positive outcome for a particular indicator (direction) but the exact amount of improvement is unknown.
Projects can be monitored/tracked	Tracking the progress of projects and monitoring their effectiveness support the Sustainability team to demonstrate outcomes
LHEES delivery actions can be mapped	As a subset of projects, LHEES delivery actions should be easily translated into actions that deliver area-wide emissions reductions as this is one of the key programmes for area-based decarbonisation.

**Table B5: Requirements for usability of tools**

Requirement	Reason for inclusion
It is straightforward to populate tool initially	For both Edinburgh and Dundee Council (who used CST and ClimateOS respectively), the initial population of the tools required a significant input of resources to source and wrangle the appropriate datasets. This has led to key recommendations around centralising this function to reduce the initial barrier to use.
It is straightforward to update the tool annually	Annual updates are an essential part of monitoring and reporting for an area-wide baseline and it needs to be straightforward to update the baseline data.
The tool can have multiple users and track changes	The experience of Edinburgh Council who are using a tool which only permits a single user at any time and has very limited audit trail functionality has created a bottleneck of actions and projects requiring to be entered into the tool. Single users also make organisations vulnerable to staff changes and losing capability. Therefore, allowing multiple users with effective change tracking is an essential requirement.
The outputs of the tool can be published online	Area-wide emissions are a multiple owner problem and being able to easily publish and communicate the outputs of tools online has been identified as a key requirement for enabling better participation by both companies and citizens.
The tool can produce a live action plan?	Several organisations have produced a Climate Change Strategy and Action Plan as a document for publication. The amount of resource (both internal and external) required to write, consult and publish these plans is very high but they rapidly become out of date as technology, policy and understanding evolve. Therefore, the ability to produce, amend and republish a live action plan is a new way of approaching this problem. This was

Requirement	Reason for inclusion
	not a requirement identified by many Local Authorities, possibly because it outside of normal practice.
It is possible to audit the outputs of the tool	Virtually all officers and decision-makers identified the need to be able to query and audit tool outputs in order to respond to questions.
The tool contains graphical outputs that can aid decision making	Storytelling, data visualisation and providing context and consequences to decision-makers were common themes. The more effective and consistent the graphical outputs were, the easier it was to be able to train and support decision-makers to interpret them.

## Appendix C: Workshop findings according to ISM themes

Table C1: Key ISM themes from workshop

ISM Category	Theme	What does or would help?	What is hindering?
Individual	Values, beliefs and attitudes	<p>Media and public debate is stimulating appetite for change</p> <p>Accessible data can support citizens who want to hold decision-makers to account</p>	<p>Working in sustainable development not seen as a high profile or valued job</p> <p>Level of urgency varies between areas</p>
	Cost & benefits	<p>There are obligations and financial and carbon savings to be made and these can be communicated to decision-makers</p>	<p>Hard to get organisations to invest financially in tools even when they save staff time or make processes more efficient</p>
	Emotions	<p>Trust that the data is standardised and applicable across the board</p>	<p>Fear of:</p> <ul style="list-style-type: none"> <li>• The impacts of climate change</li> <li>• The societal and financial costs of transition</li> <li>• Negative feedback from media and citizens</li> <li>• Making wrong decisions</li> <li>• Using data to make decisions</li> <li>• LAs becoming accountable for all carbon emissions</li> <li>• Being asked for data that they don't have</li> </ul> <p>Uncertainty around:</p> <ul style="list-style-type: none"> <li>• What is best practice in sustainability</li> <li>• Ever changing data baseline due to pandemic</li> <li>• What staff are being asked to do as a consequence of the data</li> </ul>

<b>Social</b>	Agency	Where stakeholders and decision-makers are mandated to act	Decision makers lack confidence to engage with the data Consultants are bought in to fix problems, but this doesn't build capability and skills Starting to understand the sphere of influence for area-wide emissions and the lack of direct or indirect control that Local Authorities have over the majority of these emissions
	Skills	Starting to consider an expansion of skill sets required e.g. psychology	Data analyst and GIS skills are in short supply Officers with knowledge cannot get in front of managers to talk about the implications
	Tastes	When visual presentation is flexible, it can be used to meet different tastes	
	Meanings		Data analysis is not just about numbers but also about being able to convert the numbers into a format that can be communicated as an effective story for managers
	Networks and Relationships	Collaboration and knowledge sharing between Local Authorities and other sectors is key	
	Opinion Leaders	Participatory budgeting with a climate focus can be used to develop citizen support and understanding	Getting all committees to take on board the carbon costs into all decisions Some of the people in decision-making roles have the skills/interests/experience for a different (older) challenge

<b>Material</b>	Institutions	<p>Area-wide emissions have multiple problem owners – where these partnerships are engaged, action can be joined up and more effective</p> <p>Where business sector recognises the need for a partnership approach and is prepared to contribute and buy-in resources</p>	<p>Uncertain about which system to use</p> <p>Decision-making can be led by short-term thinking, especially close to election time</p> <p>There are structural splits between teams that are required to deliver climate action that make it harder to collaborate</p>
	Norms	<p>LHEES trying to create standard approach across Local Authorities</p> <p>When Climate Change is seen as core to strategy rather than an add on</p>	<p>Need to align multiple areas of work</p> <p>Lots of data held in different places and hard to access or understand</p> <p>There is no proportionality of effort with regards to carbon reduction projects</p>
	Rules & Regulations	<p>Where there are legislative requirements to collect and report on data</p> <p>Using the same rules and tools promotes consistency and makes outcomes comparable</p>	<p>Lack of data gathering plan and conventions</p> <p>Lack of transparency about where carbon data comes from – baseline data from Whitehall is uninterpretable</p> <p>Plethora of statutory instruments – there is a challenge of keeping on top of them</p>
	Technologies	<p>Effective presentation of data is key – some people need colours and pictures to interpret effectively</p> <p>Good data can help partners understand the fuller picture and level of need</p>	<p>Lacking data capture structures around emissions</p> <p>Hard to extract actual place-based data from national datasets</p> <p>Hard to justify cost of existing platform for presenting area-wide data so looking at building an organisational specific platform in GIS</p>

	Time & Schedules	<p>If data is more readily available to other teams, stakeholders etc. they can use it independently</p> <p>Where new skills and resource have been bought in, they have made a big difference by working with departments to co-design projects, encouraging more innovation</p>	<p>Increasing workload has reduced capacity – if anything new is added, teams will struggle to cover it</p> <p>Need internal capacity to make sense of the data and just to stay on top of statutory obligations</p> <p>Salaries are not high enough in sector to attract the right people</p> <p>Positions are often short-term funded positions which makes it hard to build teams</p>
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## Appendix D: Emotional themes from the three phases of the LHEES pilot

Table D1: Key emotion themes from evaluation of LHEES pilots

Pilot phase 1 - Testing and developing method, finding data sources, and understand capabilities	Pilot phase 2 - LHEES development focusing on organisational and social aspects	Pilot phase 3 - LHEES development focusing on areas of high heat demand or lots of off-gas properties
<p><b>LA officers feel there is a lack of clarity on LHEES and what it could become. General inaction as they are unsure of what next long-term steps to take.</b></p> <p><b>LA officers were not confident to engage more senior officers due to their inability to answer specific questions on LHEES.</b></p> <p><b>Senior management as unlikely to engage with LHEES so long as it is not a statutory duty so not a priority (dismissive if not required).</b></p> <p><b>LA officers worry about a lack of power/authority over building owners and suggest need for legislation/power to enforce.</b></p> <p><b>Fear LHEES will become only a report and not lead to action.</b></p>	<p>LA officers expressed concern about the increase in work without an increase in resources.</p> <p>Confusion and inconsistent opinions over what to do with data sharing agreement/ data protection.</p>	<p>LA officers felt more empowered in performing the pilot when there was support from senior officers and elected officials as well as a sense of ownership in LA.</p> <p>Large concern over lack of long-term funding.</p> <p>Uncertainty about how to implement strategies produced scepticism over the material impact of LHEES.</p> <p>When LA officers had the right skills and expertise, they felt empowered and took ownership of the LHEES process which was a factor in success</p>