north east & yorkshire
NET ZERO HUB

ANNOTATED HEAT DECARBONISATION PLAN

North East & Yorkshire Net Zero Hub

Public Sector Estate Decarbonisation Programme

Turner & Townsend

OUR PARTNERS

Hull & East Yorkshire LEP, North East LEP, South Yorkshire Mayoral Combined Authority, Tees Valley Combined Authority, West Yorkshire Combined Authority, and York & North Yorkshire LEP

Contents

1 Introduction

1.1 Purpose of this document

This document outlines the structure of a good practice heat decarbonisation plan. The document will provide and annotated commentary of each of the sections of a heat decarbonisation plan, including a general checklist to help you write a heat decarbonisation plan for your building(s).

1.2 Purpose of a heat decarbonisation plan

The ambition of the UK Government, as set out in the Net Zero Strategy[1], is to reduce greenhouse gas emissions from public sector buildings by 75% by 2037 and reach net-zero emissions by 2050. All buildings in the UK will need to be fully decarbonised by 2050 if the government are to achieve its net zero commitment.

The purpose of a heat decarbonisation plan is to provide an organisation with a pathway to reducing greenhouse gas emissions from building use to net-zero. This typically means reducing or eliminating the use of fossil fuels in a building, which are typically associated with providing heating and hot water.

Solutions need to be pragmatic, cost-effective and timebound, charting a realistic pathway for an organisation to decarbonise buildings on its estate. A heat decarbonisation plan should provide and organisation with not only a measurable and realistic objective, but the pathway to achieving it.

1.3 Whole building approach

The whole building approach sets out a pragmatic process for decarbonising energy use in a building.

1. **Understanding your baseline:** provides a reference point to begin identifying an verifying solutions and their impact.
2. **Improve operational efficiency:** by enacting low-cost changes to existing controls and equipment (e.g. reducing temperature set points).
3. **Energy efficiency**: replacing energy-consuming equipment with modern equivalents to reduce energy consumed for little to no impact on output (e.g. LED lighting upgrades).
4. **Decarbonisation:** moving away from fossil fuel use to clean alternatives. For buildings, this is typically moving a heating system to a low-carbon alternative (e.g. heat pump).
5. **Renewables:** reducing dependency on grid electricity through local generation (e.g. solar PV).

This guide will use the energy hierarchy as a premise for structuring a good-practice heat decarbonisation plan, summarised on the next page.

[1] Net Zero Strategy (2021): Build Back Greener: https://www.gov.uk/government/publications/net-zero-strategy

1.4 Structure of a best practice heat decarbonisation plan

1

Purpose and introduction

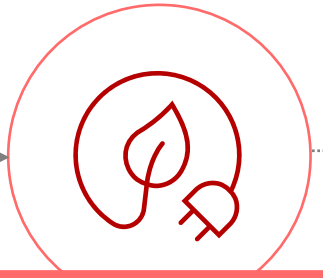
This section sets out the **objectives** of the heat decarbonisation plan and provides a **summary** of the outputs from the document.

2

Buildings and baselining

Outlining the **scope of the plan** in terms of the portfolio of buildings covered, information needed to understand **energy use** and **carbon footprint** to develop a baseline.

3



Retrofit measures and solutions

Potential **technologies** to meet the site needs, following the **energy hierarchy** of reducing consumption, energy efficiency, decarbonisation and renewables.

4

Key challenges and costs

Identifying some **common challenges** to undertaking retrofit projects including DNO considerations, and estimating **budget costs**.

5

Delivery plan and risk

Development of a compelling **delivery plan** to support successful project delivery and undertaking an **assessment of risks**.

6

Funding sources and the PSDS

Understanding what **funding routes** are available to enable identified projects to proceed, with a particular focus on **the Public Sector Decarbonisation Scheme**.

2 Introducing your heat decarbonisation plan

Each section of this guide will briefly introduce the premise of each section of a heat decarbonisation plan and provide a simple checklist of suggested content to include in each section.

2.1 Executive summary

The executive summary is a good opportunity to introduce:

1. The purpose of the heat decarbonisation plan, including its scope and objectives.
2. Introduce the building(s) and the energy baseline.
3. Outline the key findings and recommendations.

One way you might look to do this is through a graphical demonstration of the pathway to net zero. A chart that works well for this is a waterfall chart (see **Error! Reference source not found.**) that demonstrates how each of the solutions identified help move the building towards decarbonisation.

Executive summary	✓
Introduce the building(s) covered by the plan.	
Summarise the current heating system including age.	
Provide a baseline energy and carbon emissions figure.	
Outline the key findings and solutions identified, including benefits to be achieved.	
Detail the next steps, actions to be taken and timescales.	

It might be that the next steps for your heat decarbonisation plan is to achieve internal sign offs. You could seek endorsement in the executive summary from a senior staff member to add weight to the recommendations and actions to be taken.

Summarise your heat decarbonisation plan purpose, introduce the buildings and the energy and carbon baseline.

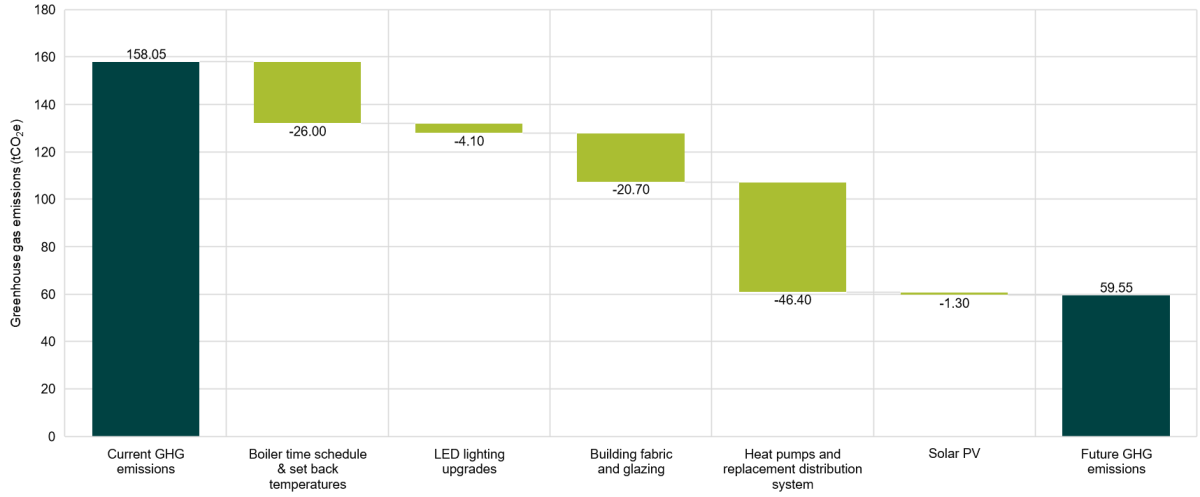


Figure 1: Example waterfall chart showing pathway from current greenhouse gas (GHG) emissions to a low-carbon future

2.2 Purpose

The purpose section is an opportunity to outline in detail the scope of your heat decarbonisation plan. The scope of a heat decarbonisation plan will change based on the individual needs of your organisation.

Organisations looking to set a carbon emissions reduction target might look for a plan that summaries their estate at a macro level. Organisations that are looking to decarbonise a single building might look for a plan to serve as an investment-grade proposal.

Purpose	✓
Provide wider context influencing your plan (e.g. statutory emissions reduction targets).	
Provide your organisation / building(s) current context.	
Outline the scope of your heat decarbonisation plan.	
Include what approaches you are using (e.g. whole building approach) to structure your document.	

Strategic plan
A strategic **business case** detailing an organisation's energy use at the macro level. Sets **timebound targets** to reduce emissions. **Prioritises action** on high-emission sources. Identifies **risks** and outlines **lessons learned** from similar projects.

Investment grade proposal
A detailed overview of single or multiple buildings, their energy use and carbon emissions. Provides a whole building approach **recommendations** including **costs**, **savings** and **paybacks**. Detailed enough to inform **stakeholders** and secure budgets or funding.

Detailed technical design
Prepare a **detailed design** for an individual or suite of technologies. Detailed designs of heating systems. **Procurement** of services and capital equipment. **Site logistics** and **construction programme**. Preparation of **building manual** for use with new equipment.

Figure 2: 'Sliding scale' of heat decarbonisation plan scope

Figure 2 provides a visual scale of scopes that can be included under the umbrella term of a 'heat decarbonisation plan'. Your document introduction should firmly set out the stall of the scope so that the audience understands what level of information to expect, what conclusions can be drawn, and what next steps to expect. You might note some similarities between Figure 2 and the Royal Institute of British Architect (RIBA) Plan of Works.[2] This is intentional, to ground the heat decarbonisation at stages recognised by a wide audience.

Think about your target audience. Does your heat decarbonisation plan provide them with the information they need to take a decision? Does it provide you with the information needed to apply for funding? Do you have access to the capacity and capability needed to collect this information?

[2] RIBA plan of works: https://www.architecture.com/knowledge-and-resources/resources-landing-page/riba-plan-of-work

2.3 Site

Introduce your site and how it fits into the wider context of your organisation. You should describe the building(s') location, notable characteristics, local environment, construction material and their general condition, age, gross internal floor area (m^2) and usage type (e.g. office). You could use the summary table provided below as an example in setting this information out.

Buildings	✓
Address including unique property reference number (UPRN)	
Floor area in m2	
Display energy certificate rating	
Description of building use	
Year of construction	
Condition of building fabric	
Site	**✓**
Description of local environment / area	
Plans for changes to use or refurbishment	
Maintenance schedule	
Specific restrictions or challenges	
Site logistics	
Technical and legislation considerations.	

Describe how the building(s) fit into the wider organisational context, their general characteristics including gross internal floor space and usage type.

3 Baseline

Setting a baseline provides you with a reference point from which to set targets against and measure benefits from projects.

Baseline	✓
Consumption (kWh) by type of fuel (e.g. gas)	
Specified which greenhouse gas conversion emissions factors[3] are used to calculate carbon equivalent	
Cost per unit of fuel (p/kWh) taken from recent bills	
Meter numbers (MPAN or MPRN)	
Green book carbon emissions for future emissions modelling	
Details of existing energy efficiency projects	
Analysis of heat demand, using degree days	

3.1 Benchmarking

If your site has access to sub-metering, it might be possible to create baselines for individual areas, consumption sources or pieces of equipment. If this isn't available, you can look towards comparative data sources such as the Building Energy Efficiency Survey (BEES)[4], as shown in Figure 3.

[3] Government carbon conversion factors are often used. See Appendix A for a demonstration.

[4] Building Energy Efficiency Survey (BEES): https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees

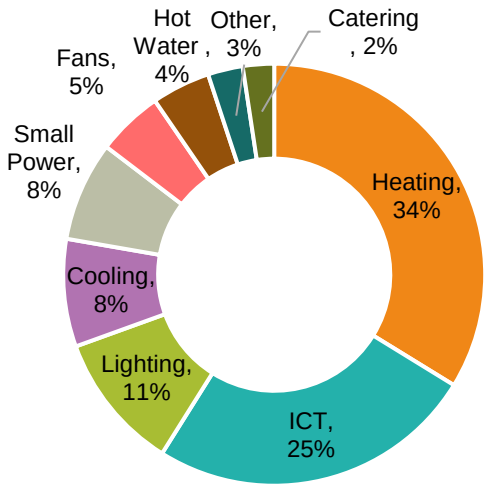


Figure 3: BEES energy consumption breakdown for a typical office

You might be interested in comparing how your building compares to others of comparable usage types. This can help you prioritise buildings based on how well they perform against industry-standard benchmarks (kWh per m^2), published by the Chartered Institute of Building Services Engineers (CIBSE).[5]

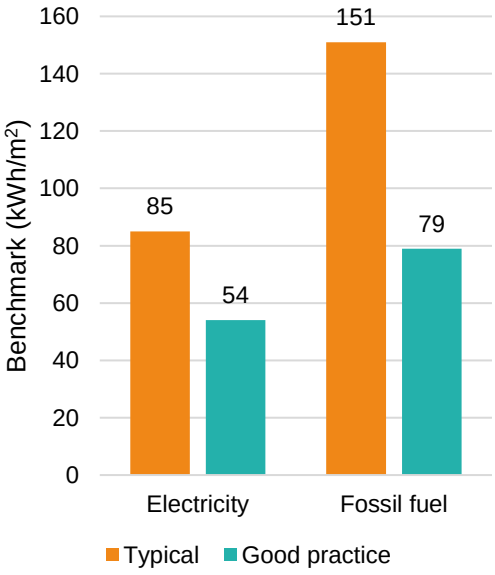


Figure 4: CIBSE benchmarks for naturally ventilated open plan office

3.2 Description of building fabric

The purpose of this section is to provide an overview of the general construction of the building(s). Building fabric includes the make-up of the internal and exterior walls, roofs and glazing.

The table below provides an example of the type of information to capture as part of a building fabric description.

Building Envelope Element		Construction	U value (W/m^2k)
Walls			
Classroom	Outside	Dressed Stone	1.38
		Loose Fill Granular Stone	
		Lath (25mm timber)	
	Inside	Dense Lime Plaster	

The U-value represents the overall thermal conductivity of the building fabric and can be used in a heat loss calculation to determine the conductive heat lost through an element.

Recording a condition rating of building fabric could help link up the findings of your HDP with maintenance schedules.

[5] CIBSE benchmarking tool: https://www.cibse.org/knowledge-research/knowledge-resources/knowledge-toolbox/benchmarking-registration

3.3 Heating, ventilation and cooling (HVAC) characteristics

3.3.1 Existing heating system

Make	Model	Age of systems (years)	Unit to be removed or retained	Output load per unit (kW)	Number of duty units	Current seasonal efficiency (%)	Gross internal heated area (m2)	Space heating / DHW / both	Existing flow temp for heating (°C)	Hot water temp for DHW (°C)	Does heating system form part of multi-building

3.3.2 Like-for-like cost

Removal of existing equipment (£)	Main equipment cost including controls (£)	Pipework connections and insulation (£)	Installation (£)	Commission (£)	Total cost of fossil fuel replacement system (like-for-like)	Comments

This level of information is typically required by government funding schemes such as the Public Sector Decarbonisation Scheme (PSDS). Information on your existing heating system might already be readily available in an asset register, or previous maintenance surveys.

4 Measures

Using the whole building approach to structuring your heat decarbonisation plan provides a logical pathway to decarbonisation of a building.

The premise is to reduce and manage consumption as much as possible, before then investigating decarbonisation and renewable solutions. This will allow better sizing of replacement low-carbon heating solutions to meet a lowered building demand.

This section provides some questions to ask yourself / your contractor while designing the recommendations in your HDP.

Operational efficiency	✓
Are controls for (e.g. for heating) set appropriately to meet building occupation?	
Is there opportunity for staff engagement to reduce consumption?	
Do staff use personal items (e.g. portable heaters) to solve wider service issues?	
Are there any low-cost timer controls that could switch off equipment (e.g. point of use hot water) when not in use?	
Is there local temperature control (e.g. thermostats) and are set points appropriate (e.g. 21°C) and tamperproof?	

When thinking about replacing equipment with more efficient alternatives, have you considered whether:

Energy efficiency	✓
How will the measure(s) interact with other equipment (e,g. BEMS)?	
Is the solution appropriate for the site and its usage?	

Energy efficiency	✓
Is there an opportunity to combine when measures are installed to save on labour?	
Will the new equipment require different maintenance regimes and who will provide this?	
Do you have the capacity and capability to estimate cost and savings?	
Does the solution have longevity? For example, replacing a gas boiler like-for-like will make the move to low-carbon solutions difficult in the future.	

It's important that you inform the estates manager of the findings in your report as they will have oversight of how equipment on site overlap in the services they provide.

Decarbonisation of heat	✓
Has demand for heat been reduced as much as possible through other measures (e.g. building fabric)?	
Is the distribution system (e.g radiators) appropriate to support a low-carbon solution?	
Has the replacement solution been sized appropriately?	
Will you retain fossil fuels as back up?	
What modifications are needed to the plantroom?	
Is there space for the low-carbon technology?	

For all the measures considered in a robust HDP, you should ask your contractor to provide a detailed methodology of how costs and energy savings have been calculated.

You will need to demonstrate the estimated savings, the methodologies used and any assumptions in applications for funding. This might also include providing data sheets for equipment or products identified as a possible solution.

Renewables	✓
Have you conducted a structural survey for any roof-mounted solar panels?	
Planning permission is granted on a case-by-case basis, have you sought advice on what permissions are required?	
Do you have suitable information about your site energy demand (e.g. half-hourly data) to properly size your renewable solutions?	

5 Other considerations

5.1 Heat networks

You may wish to carry out an assessment as to whether there is a feasible connection to a heat network (also known as district heating). Heat networks can provide a cost-effective way of decarbonising heat in your buildings.

Heat networks forms part of the government's strategy for decarbonising heat and funding is available through schemes such as the Heat Network Efficiency Scheme (HNES)[6] to ensure you maximise the potential benefits of heat networks. Additional guidance and support are available through the Heat Network Delivery Unit (HNDU)[7].

Heat networks	✓
Are there heat networks that could feasibly connect to your building?	
Do you know the heat demand for your building?	
What is the source of heating (e.g. gas Combined Heat and Power) of the heat network?	

5.2 District network operator

A district network operator (DNO) owns and operates the network of pylons, transformers, cables, and meters that distribute electricity from the National Grid across Great Britain. There are currently 11 DNOs covering 14 regions across Great Britain.

If you are planning on installing a piece of electrical equipment that will significantly change your demand for electricity, such as a heat pump, you may need to contact your DNO to upgrade your electricity supply. The type of information you will need to submit to your DNO includes:

- The Meter Point Administration Number (MPAN) for your building(s)
- The full address of the site and your contact details
- The total capacity attributed for your building(s)
- The total capacity you will need for your building(s) going forwards
- A letter of authority if you do not own the land
- A drawing or plan of your building(s)

Applying to your DNO for a change in supply can be a lengthy process, typically 6 months. It is therefore recommended that you engage with your DNO early in a project to ensure

6 https://www.gov.uk/government/publications/heat-network-efficiency-scheme-hnes

7 https://www.gov.uk/guidance/heat-networks-delivery-unit

that timescales are appropriately accounted for in your project plan.

DNO	✓
Have you contacted your DNO to find out whether your site has the appropriate capacity to support a heat pump?	

6 Cost

Your heat decarbonisation plan should outline budget costs for each of the recommended measures. These costs can be calculated from experience of previous projects, or from quotes sought from contractors.

Cost	✓
Provide budget and/or firm costs for each of the measures.	
Break these down by cost source (see below).	
Detail what the next steps are to firm up the costs.	
Determine what costs are eligible for funding programmes.	
Using the savings calculated for each measure, determine a payback.	
Engage with business partner or procurement team to develop cost section (and delivery plan).	

As much as possible, it is recommended that you breakdown the costs as much as possible. For example:

- Design and engineering.
- Main equipment capital expenditure.
- Installation and commissioning.
- Project delivery.
- Contingency.
- Ancillary or enabling work.
- VAT.

You should include commentary that outlines how costs have been calculated, or evidence quotes if they have been received.

6.1 Procurement

Your heat decarbonisation plan should take account of the organisation's requirements to competitively tender a project. Thresholds for procurement will be different from organisation to organisation.

Some organisations will have a dedicated procurement team who can help advise on the best process for attaining quotes, and what processes need to be followed based on the projected project costs. Smaller organisations should seek advice from their finance business partners or local authority where applicable.

Procurement can take often be a lengthy process. The length of the process is often defined by the complexity of the solution:

Procurement type	Timescale
Design	5-7 weeks
Open procedure	8-10 weeks
Restricted procedure	12-14 weeks
Competitive procedure with negotiation	Up to 18 months
Competitive procedure with dialogue	Up to 18 months
Innovation partnership	Open ended

Solution complexity

It is good practice to engage with your procurement / finance team at an early stage in the planning process. If possible, having valid quotes in hand before any future funding round open (such as the Public Sector Decarbonisation Scheme) will place the organisation in good position to make an application.

7 Delivery plan and assessment of risk

7.1 Delivery

Your heat decarbonisation plan should include a detailed delivery plan for any measure(s) that you plan to take forwards. Your delivery plan could include the following points:

Milestone	Completion date	Days of contingency
Project Approval		
Pre-Design Stage		
Designs Complete		
Out to Tender		
Tenders Complete		
Orders Placed		
Works in Progress on Site		
Final Commissioning		
Completed on Site		

7.2 Risk

A best practice risk assessment will cover all of the uncertain events that might occur throughout a project lifecycle.

By monitoring risk, you are better placed to decrease the likelihood of impacts to the delivery of your project.

The table below outlines how you might score each of your risks before mitigating actions and after you have put protections in place (so the severity and likelihood should decrease).

You should also identify risk owners, those who will actively monitor and manage a risk throughout the project delivery.

8 Governance

Having clear governance in place for a project could make the difference between a project meeting its objectives to time and budget, and not.

Governance	✓
Have you identified a senior responsible officer for the project?	
Have you identified project manager(s)?	
What processes will you put in place to actively govern the project delivery?	
How will you manage contractors (e.g. contracts) in your governance procedure?	

9 Presenting your findings

The final sections of your heat decarbonisation plan should summarise the potential measures that have been identified for your building(s).

Table 1 below provides an example of the type of information to consider when summarising potential measures and/or solutions.

		Severity of Consequences				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood of Occurrence	Rare	1	2	3	4	5
	Remote	2	4	6	8	10
	Possible	3	6	9	12	15
	Likely	4	8	12	16	20
	Almost Certain	5	10	15	20	25

Figure 5: Scoring a risk assessment

Table 1: Summary of potential measures

Project type	Energy type impacted	Fuel cost (p/kWh)	Annual pre-consumption (kWh)	Annual post-consumption (kWh)	Annual consumption saving (kWh)	Estimated capital cost (£)	Impact on annual fuel bill (£)	Payback (years)	Impact on annual carbon emissions (tCO_2e)	Carbon cost threshold (£/tCO_2e lifetime)
Operational efficiency										
Staff training										
Demand-based controls										
Temperature set points										
Energy efficiency										
Building fabric and glazing										
Catering equipment										
Heating, controls and building energy management systems (BEMS)										
Hot water										
HVAC										
Lighting and controls										
Motors and pumps										
Decarbonisation of heat										
Biomass										
Heat pumps – air / ground / water										
District heating (existing opportunities)										
Solar thermal										
Renewables										
Solar PV										
Wind										
Hydro										

A succinct way of showing a pathway to decarbonising a site is to use a water fall diagram. The example below shows the current site carbon footprint, how each of the measures will reduce the carbon impact of the site, and the resulting carbon emissions once all measures have taken place. Its also important to remember that by moving your site to low-carbon fuels, such as electricity, will mean that as the electricity grid continues to decarbonise, as more renewable and nuclear generation come on line, the carbon footprint of your building will also continue to reduce.

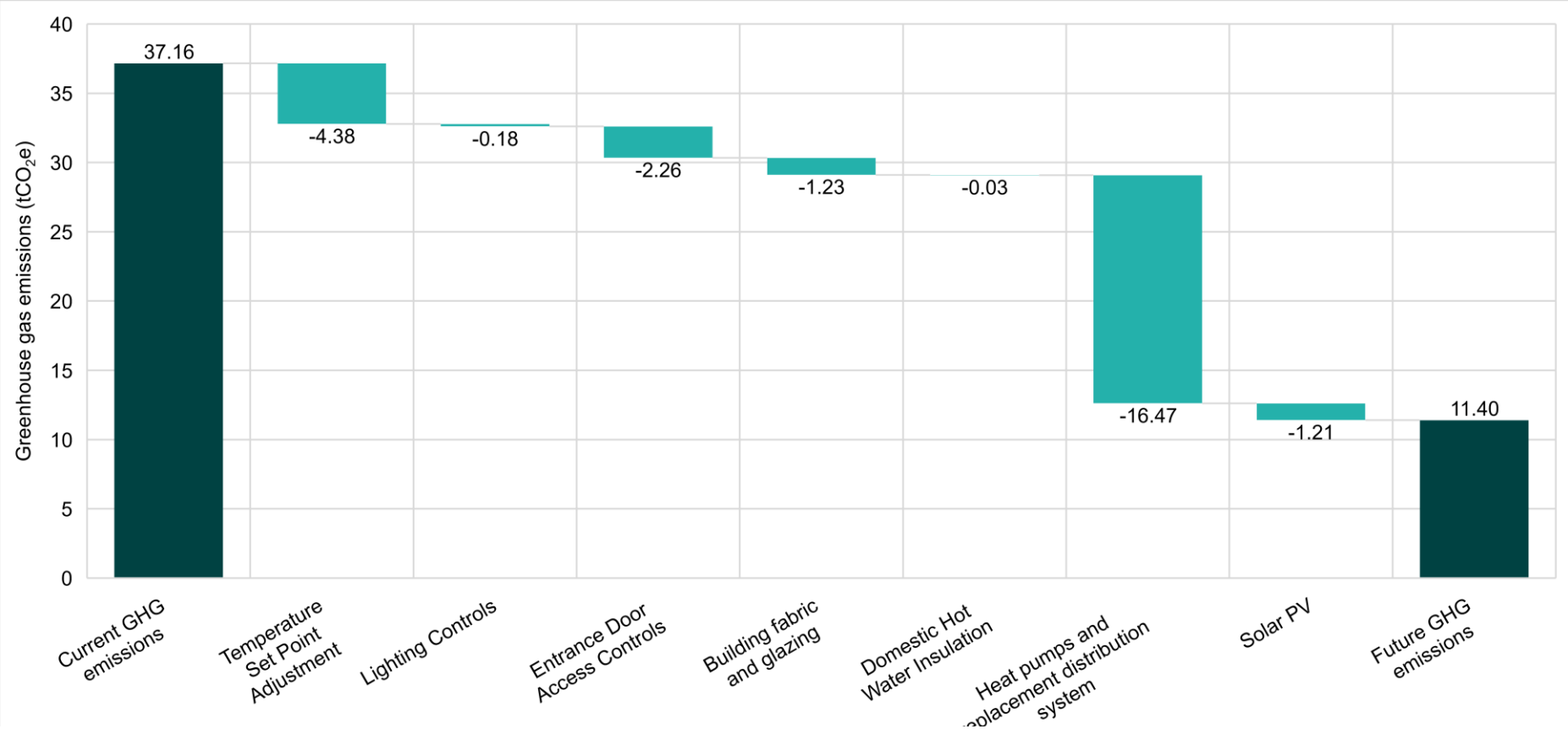


Figure 6: Example waterfall diagram

Appendix A: Greenhouse gas emissions

9.1 Annual GHG emissions

The UK Government publishes an annual set of greenhouse gas emissions that can be used by organisations for foot printing purposes.

The latest set of emissions factors can be found here: https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting.

It is recommended that you download the latest version direct from the .GOV website.

Some of the most common greenhouse gas emission conversion factors are outlined in the table below, taken from the 2022 dataset:

Fuel type	$kgCO_2e$ per kWh
Electricity from the grid including transmission and distribution losses	0.211
Gas	0.184
LPG	0.214
Fuel oil	0.268
Coal (industrial)	0.325
Wood chips	0.011
Wood pellets	0.011

If your building uses 250,000 kWh of gas per annum, you can quickly calculate a greenhouse gas (carbon equivalent) emission by multiplying your units by the relevant conversion factor:

$$250{,}000 \times 0.184 = 46{,}000\ kgCO_2e$$

Or dividing by one thousand to calculate tonnes of carbon equivalent (46 tCO_2e).

9.2 Measuring change in emissions over time

To measure change in greenhouse gas emissions into the future, you will need to use modelled emissions factors published by the government.

The Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal provides modelled conversion factors out to 2050. The data set is also updated annually, so it is recommended you download the latest information from the .GOV website: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal.

The green book provides individual emissions factors for each year, accounting for the decarbonisation of the grid.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