Cumbria County Council

Carbon Management **Strategy**

(Corporate Estate)

2020-2025

cumbria.gov.uk

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List of Abbreviations

ASHP	Air source heat pump
AQMA	Air Quality Management Area
CCC	Cumbria County Council
CO_2e	Equivalent carbon dioxide
DEC	Display Energy Certificate
DHW	Domestic hot water
EA	Environment Agency
FCU	Fan coil unit
GIS	Geographic Information System
GSHP	Ground source heat pump
LEP	Local Enterprise Partnership
LIS	Local Industrial Strategy
LTHW	Low temperature hot water
MVHR	Mechanical ventilation with heat recovery
MWSHP	Mine water source heat pump
PV	Photovoltaics
RHI	Renewable heat incentive
WSHP	Water source heat pump

Glossary

CO_2e
A quantity that measures the global warming potential (GWP) of any mixture of greenhouse gases using the equivalent amount or concentration of carbon dioxide.

District heating
The provision of heat to a group of buildings, district or whole city usually in the form of piped hot water from one or more centralised heat source.

Electricity export
Electricity generated by CHP that is not utilised in via private wire arrangements is exported to the national grid, usually at a lower tariff.

Energy centre
The building or room housing the heat and / or power generation technologies, network distribution pumps and all ancillary items.

Energy demand
The heat / electricity / cooling demand of a building or site, usually shown as an annual figure in megawatt hours (MWh) or kilowatt hours (kWh).

Energy hierarchy
A ranking of emissions reduction measures in terms of importance of implementation.

Heat pump
A technology that transfers heat from a heat source to heat sink using electricity (heat sources can include air, water, ground, waste heat, mine water).

Hurdle rate
The minimum internal rate or return that is required for a network to be deemed financially viable, based on Cumbria County Council's borrowing costs.

Mechanical ventilation with heat recovery
Mechanical ventilation that provides fresh air to a building whilst retaining the heat energy already used in heating the air within the building.

Private wire
Electricity generated by a CHP that is supplied to network connections as part of private wire arrangements where underground cables connect the buildings to the energy centre.

Renewable technologies
Technologies that produce energy from resources which are naturally replenished such as sunlight, wind, geothermal heat, or water source heat.

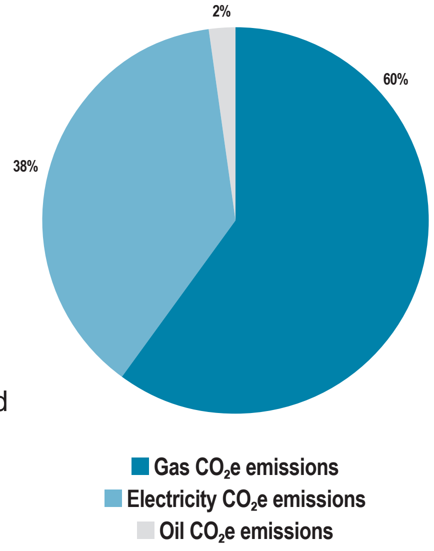
Social IRR
Internal rate of return on investment taking into account long term benefits to society, eg improvements in air quality/public health.

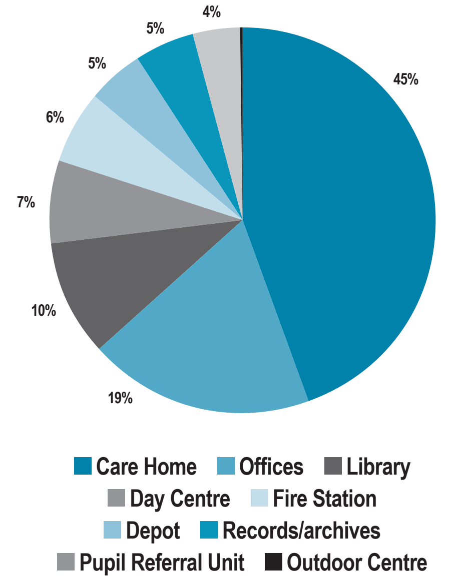
Executive Summary

Cumbria County Council (CCC) is well placed to play a significant role in achieving the national goal of developing a zero-carbon economy, with the added benefit of making significant savings on expenditure and achieving long term security.

The scope of the strategy included:

- Identifying baseline CO_2e emissions for the corporate estate buildings.
- Identifying phased CO_2e reduction targets based on specific resource and investment scenarios.
- Developing a phased delivery plan outlining the measures, resources and actions required to meet targets (set out by CCC and identified in the Cumbria Local Energy Plan and draft Cumbria Carbon Baseline Report.
- High level assessment of capital and revenue costs to include a programme for delivery.





Baseline CO_2e Emissions

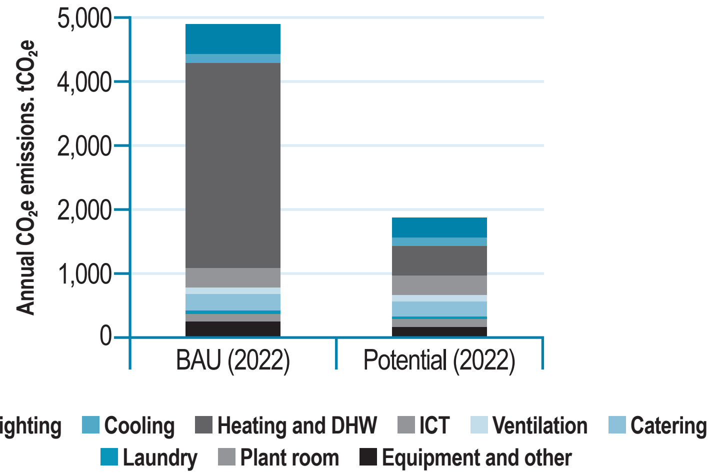
CCC corporate estate operations result in 5,392 tCO_2e annually. The majority of emissions are attributed to the combustion of natural gas for heating and hot water and electricity for lighting, cooling and ICT functions (see breakdown of CO_2e emissions by fuel / energy type (2020) adjacent). CO_2e emissions from natural gas account for over 60% of overall emissions and this proportion will increase as the national grid continues to decarbonise (primarily due to increased deployment of wind and solar photovoltaic (PV) generation technologies).

The largest emitters of CO_2e are care homes due to their consumption of gas for heating and hot water. The second largest are the offices as they are significant electricity users. Combined, these produce nearly two thirds of the corporate estate's CO_2e emissions (see adjacent).

Building CO_2e Reduction

Building CO_2e emissions should be reduced in line with the energy hierarchy where the priority is to reduce a building's energy demand followed by improving efficiency and then integrating renewable energy sources. Any remaining building related CO_2e emissions can then be offset by offsite renewable energy generation.

Measures identified to reduce building CO_2e emissions include improving building fabric, installing heat recovery plant, installing heat pumps, replacing / upgrading equipment and improving general housekeeping measures. The greatest reductions are made through reducing CO_2e associated with heating and domestic hot water (DHW) and the largest contributor to these savings is the installation of heat pumps. Considerable CO_2e savings can also be made through the installation of LEDs. The adjacent chart shows the theoretical first year CO_2e savings achievable through implementing the identified carbon reduction measures.

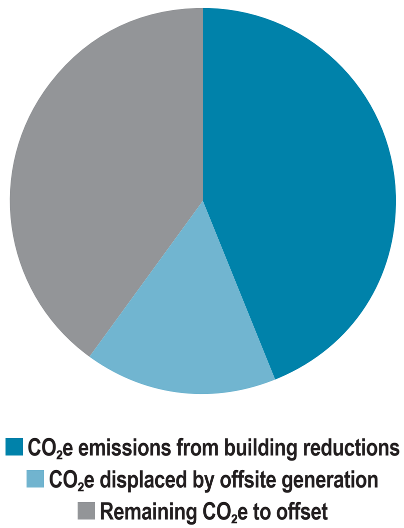


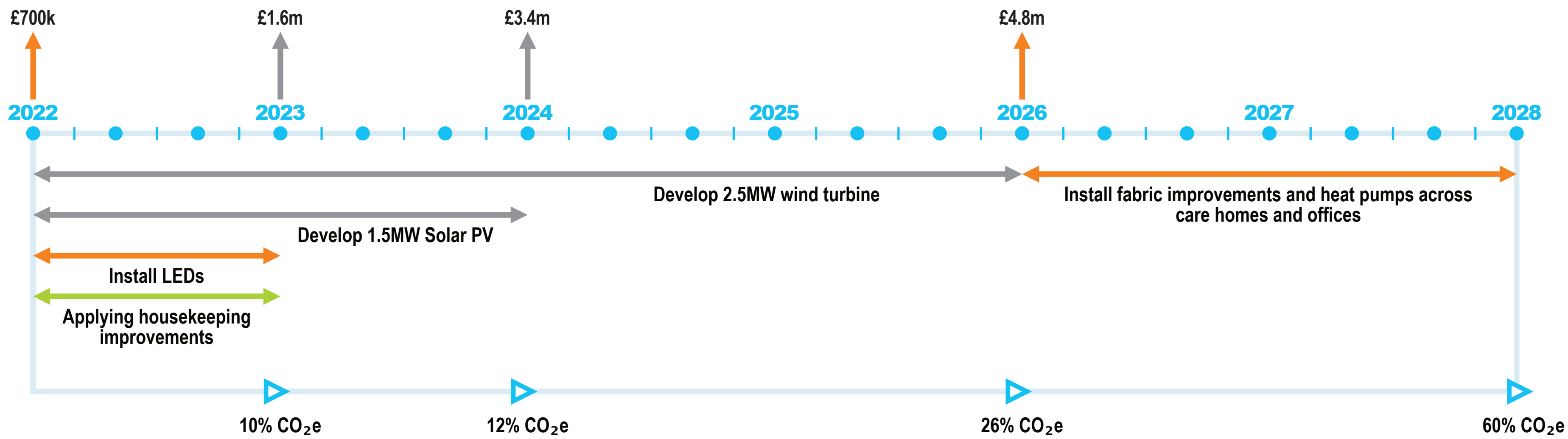
Offsite Renewable Energy Generation

CCC owned sites were assessed as potential locations for offsite renewable energy generation. Of the sixty sites assessed, five were taken forward for further investigation. The technologies identified for large scale offsite electricity generation were solar PV and wind. Offsite generation provides a means of offsetting CCC's CO_2e emissions however, as stated, energy consumption should be reduced as far as possible prior to generating from renewable sources. This is reflected in the proposed carbon management strategy. The CO_2e emissions that could be offset by the installation of approximately 1.5 MW of solar PV and a 2.5 MW wind turbine total 623 tCO_2e or 16%.

Prioritised CO_2e management strategy

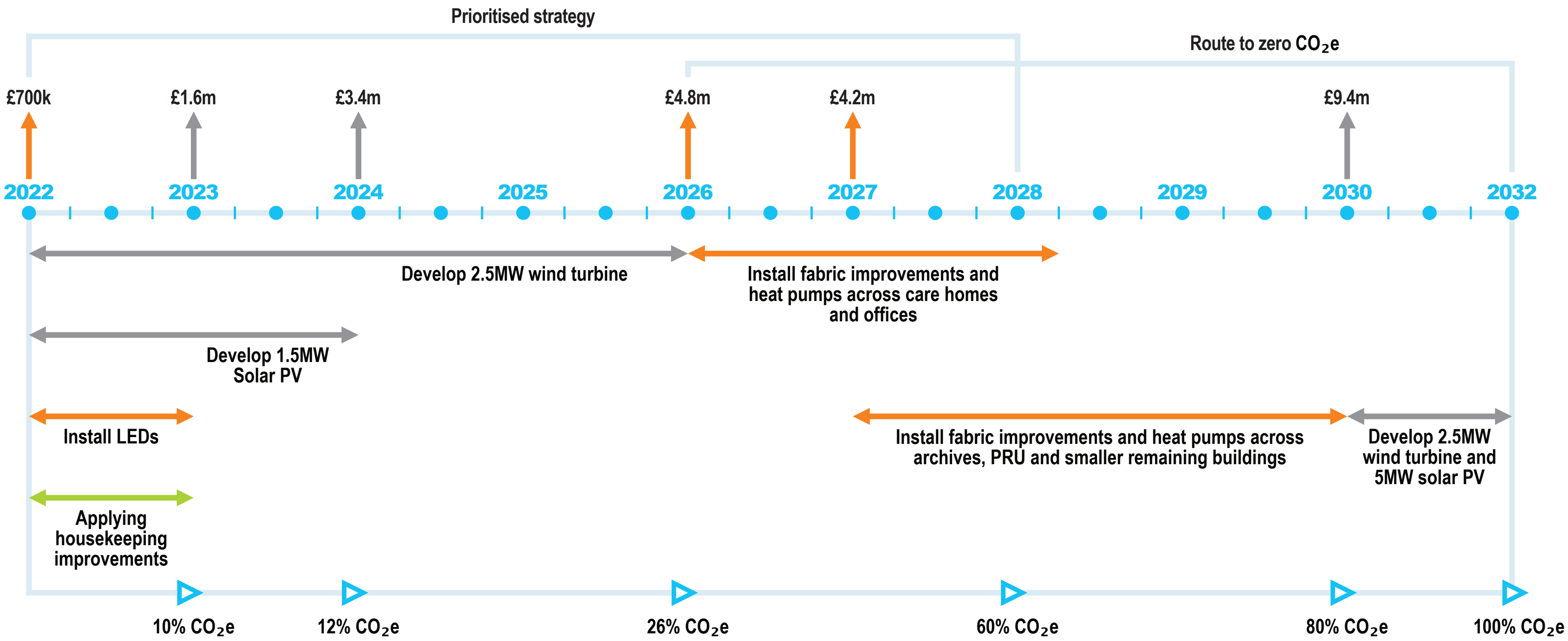
The prioritised strategy (that meets the CCC hurdle rate) involves installing LEDs and making housekeeping improvements across all buildings and upgrading fabric and installing heat pumps in all offices and care homes. To further offset CO_2e emissions a 1.5 MW solar PV farm and 2.5 MW wind turbine are required. Over 25 years, the strategy is projected to reduce CO_2e emissions by 2,338 tCO_2e or 60% of total BAU emissions. The 25 year return on the capital investment of £10.5million will exceed the 8% IRR hurdle rate and will payback within 14 years.




£700k
£1.6m
£3.4m
£4.8m
2022
2023
2024
2025
2026
2027
2028
Develop 2.5MW wind turbine
Install fabric improvements and heat pumps across care homes and offices
Develop 1.5MW Solar PV
Install LEDs
Applying housekeeping improvements
10% CO_2e
12% CO_2e
26% CO_2e
60% CO_2e

Route to Zero CO2e

A potential longer term strategy to achieve 100% CO_2e emission reductions has also been assessed. The additional measures required to achieve 100% reduction include additional heat pump installations in buildings, installing an additional 2.5 MW wind turbine and 5 MW of solar PV. The net zero strategy is currently economically unviable and does not meet CCC's hurdle rate of 8% IRR.



Key Risks

The carbon reduction strategy relies on the future decarbonisation of the national grid at the rate currently predicted. A slow down of this rate will reduce the amount of CO_2e savings made by the installation of heat pumps, though will increase the amount of CO_2e offset by solar PV and wind. Current emission projections end at 2035 but it is likely that the National Grid will further decarbonise after this date.

Cost savings, revenue generation and economics and social value are impacted to changes in electricity and natural gas prices. An increase in natural gas price will increase potential savings and improve the economic case for fossil fuel reduction. An increase in the projected electricity price will negatively affect the economics of installing heat pumps. Offsite generation will benefit from an increase in the price of wholesale electricity and achieve a shorter payback period on initial capital investment.

Capital investment will increase and decrease with project complexity; issues include planning restrictions and required building alterations. Although identified issues and risks have been considered during high level project costing, there will be specific risks associated with each individual project.

Corporate Considerations

The CO2e reduction strategy will deliver against a number of key CCC corporate priorities. It contributes to the Cumbria Local Energy Plan and Cumbria's Local Industrial Strategy (LIS) in driving sustainable economic growth, helping to capitalise on existing energy credentials and further developing Cumbria's green energy infrastructure. Of the six priorities identified by the LEP (ideas, people, infrastructure, business environment, places and green growth), it potentially contributes to all.

If CCC were to declare a Climate Emergency, then a net zero target of say 2030 cannot be met under the proposed plan. While the study identifies a route to net zero over a 10 year period this option is currently uneconomic by CCC, on a simple hurdle rate of 8%. Currently a 60% CO_2e reduction is viable as a phase 1 approach to the CCC Carbon management strategy for corporate buildings.

Next Steps

Next steps include:

- Further surveys for key buildings and sites and development of building specific reports addressing priority measures identified within the strategy.
- Completion of measure-specific studies to further assess feasibility and develop specifications for implementation of building improvement measures such as LED lighting and offsite renewable energy schemes (including discussions with planning team over suitability of offsite generation locations).
- Development of building user behavioural change strategies to contribute to improved housekeeping measures.
- Identification and allocation of budgets to complete short term measures identified in the strategy.
- Accruing feasibility studies for heat pump installation in main offices and care homes.
- Increase resource allocation to include creation of an Energy Manager role to support delivery, monitoring and benefits realisation of CC carbon management strategy.

This strategy will be reviewed on a regular basis, the next review will be no later than 2023. All figures and estimates used in economic assessment are subject to verification and market testing.

1 Introduction

1.1 General

Local authorities consume over 26 billion kWh[1] of energy per year, resulting in annual CO_2e emissions of more than 6.9 MtCO2e[1]. Energy use is a major expenditure for local authorities at a total cost of around £750 million1. Local authorities are therefore well placed to play a significant part in achieving the national goal of developing a low/zero-carbon economy, with the added benefit of making significant savings on expenditure and achieving long term security.

1.2 Project Scope

The project scope included the following elements:

- Identify baseline CO_2e emissions arising from corporate estate buildings.
- Review policy framework.
- Identify key drivers for change.
- Identify phased CO_2e reduction targets based on specific resource and investment scenarios.
- Develop a phased and clearly prioritised delivery plan outlining the measures, resources and actions required to meet agreed targets.
- High level assessment of capital and revenue costs to include a programme for delivery and revenue savings and income generation opportunities.
- Outline key risks and opportunities.
- Consider short, medium and long term finance and budgets to include invest to save funds, interest free loans, prudential borrowing and third party offers.
- Recommendations to address management and reporting, roles and responsibilities and carbon management governance.

1.3 Policy

1.3.1 Cumbria Local Energy Plan

The Cumbria Local Energy Plan is one the documents underpinning Cumbria's Local Industrial Strategy (LIS) which aims to drive sustainable economic growth and make Cumbria one of the fastest growing economies in the UK. The plan aims to capitalise on existing energy credentials and further develop Cumbria's green energy infrastructure, whilst improving energy efficiency across businesses. The Local Enterprise Partnership (LEP) have identified six priorities, reflecting the LIS and Green Grand Energy Challenge:

- Ideas - identifying or adopting new innovations creating a step change towards a low-carbon economy.
- People - creating safe and warm homes.
- Infrastructure - designing in low-carbon solutions.
- Business environment - driving energy efficiency to increase profitability and productivity.
- Places - low-carbon energy generation.
- Green growth - nuclear development.

The LEP has an influential role and works collaboratively with key stakeholders to advance the low-carbon ambitions in the areas and to ensure objectives are met. This report applies most prominently to the 'Business Environment' and 'Places' priorities through the improvement of energy efficiency across businesses and promote the uptake of low-carbon technologies. In addition to the immediate benefits of reducing total CO_2e output, the report highlights other advantages, such as the provision of additional jobs.

[1]Carbon Trust: Local authorities, saving energy in local authority buildings (2012).

1.3.2 Cumbria Local Plans

All six District Councils and two National Park Authorities produce individual local plans for all types of development (besides mineral and waste). Each Local Plan sets out a strategy of how the Council will encourage development throughout the District Borough. The Plans describe the planning policy including what types of development and where, and how the developments should be implemented. A common refrain through each document is the attitude towards climate change and emissions, with a consensus to reduce CO_2e emissions through better energy efficiency and adoption of low-carbon technology.

1.3.3 Cumbria Wind Energy Supplementary Planning Guidance (SPD) (2007)

The Cumbria Wind Energy SPD (July 2007) is a local plan that offers guidance towards the development of wind farms across the County. It has been prepared to assist developers in delivering wind energy developments by addressing the environmental, social and economic effects of such schemes. It also provides technical guidance on landscape capacity, landscape and visual effects and carrying out landscape and visual impact assessments.

Resources provided as part of the guidance include a wind speed map of the County and a summary of operational, approved and refused wind energy development sites.

Cumbria has good wind potential and the greatest resource is on west facing upland slopes and along the coast. Policies have been put in place to protect the landscape value and settings of some of the windiest areas of the County which fall within national landscape designations. These areas include the Lake District National Park, Yorkshire Dales National Park, Arnside and Silverdale, North Pennines and Solway Coast Areas of Outstanding Natural Beauty.

1.3.4 Cumbria Renewable Energy Capacity and Deployment Study (2011)

The Cumbria Renewable Energy Capacity and Deployment Study (August 2011) was produced to provide an evidence base to support the implementation of renewable energy with regards to local development framework. The study found that the total onshore potential capacity in Cumbria was 4.5 GW whilst the existing and planned capacity at time of writing was just over 295 MW. Deployment projections forecasted that 606 MW of renewable energy could realistically be deployed within the county by 2030, with commercial wind making up half of this. The potential annual generation figure of 1,861 GWh would supply between 10% and 13% of the expected annual energy demand of 14,000 to 18,000 GWh in 2030. The report also highlights the need for renewable energy development whilst paying consideration to the potential impact to the particularly sensitive landscape.

1.3.5 Corporate Plan

The Cumbria Council Plan 2018-2022 sets out changes to be made in the four-year period between 2018 and 2022 to improve the lives of the people of Cumbria. Continuing improvements to be made include sustainable growth in the local economy, developing infrastructure and advancing schools and community care and services.

1.3.6 Cumbria Carbon Baseline Report (2019 draft)

In April 2019, Cumbria County Council, all six District Councils and the Lake District National Park Authority formally adopted the Cumbria Joint Public Health Strategy. Incorporated within this strategy is the following aim: ‘To become a “carbon neutral” County and to mitigate the likely impact of existing climate change.’

The Cumbria Climate Change Working Group came together to take this work forward. The group would:

- Propose a shared definition of “carbon neutral”.

- Propose a target date by which this is to be achieved (that is in line with a maximum warming of 1.5C).
- Commission an independent baseline carbon audit for the County and agree ongoing monitoring mechanisms.
- Identify leadership for developing action across key topics + sectors.
- Establish a programme of action by key partners.
- Lead joint campaigning to encourage wider public awareness and action.
- Propose a target and pathway to achieve net zero carbon in Cumbria.

The Carbon Baseline Study is now complete and has recommended an ambitious but achievable target of 2037 to reach a net zero carbon position for Cumbria. The report states that achieving Net Zero Carbon by 2037 is the most feasible target and one that works within the requirements laid down by the Intergovernmental Panel on Climate Change (IPCC) for "limiting warming to 1.5 degrees or below" to curb current global warming trends.

A sector led approach to reducing carbon will now follow to allow clear targets to be set at an achievable and deliverable scale across the key carbon emitting areas. The approach will be based around these 3 stages:

1 Understanding sector carbon footprints - understanding of sector footprints and options for carbon reduction in each sector

2 Develop Sector Roadmaps and Work streams – set targets by reviewing and updating baseline assumptions and where possible including timing for delivering action. This will then form a high level sector 'roadmap'.

3 Current Policy Framework and Funding landscape – what can be achieved within the current local and national policy framework. Identify where shifts in policy/strategy will be required to reach the targets and implement the assumptions.

1.4 Project Drivers

The drivers for this work include:

- Climate emergency - in addition to the need for reduction of energy use and investment in renewable energy highlighted in the individual Local Plans, four out of six District Councils in Cumbria[2] have declared a climate emergency, stating that attention is needed to combating climate change above that of which is currently suggested by the government.[3]
- Improve energy security - decreasing energy use and developing self-supply to decrease the reliance on purchasing energy from third-party sources.
- Investing in the local economy - investing in renewable energy not only provides business to local companies and creates new jobs but also develops new and existing local infrastructure (eg biomass fuel supply chains).
- Improving quality of life for local residents - cutting CO_2e and NOx emissions will improve the air quality in the local area and reduce ailments related to bad air quality, potentially leading to reduced cost of related health care.
- Saving money - savings can be made to the Council budget through reduced energy usage, cheaper energy supply, incentives and grants, and energy sales.
- Lead in delivering good practice - effective implementation of a challenging carbon management strategy will enhance organisational image and provide reputational benefits.

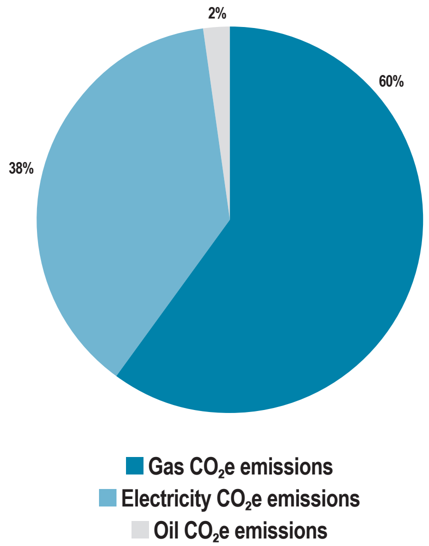
[2]The four District Councils who have declared a climate change emergency at the time of writing this report are Barrow Borough Council, Carlisle City Council, Eden District Council and South Lakeland District Council.
[3]The Climate Change Act (2008) set out the UK's approach to the legally binding target of reducing greenhouse gas emissions by at least 80% by 2050, relative to 1990 levels.

2 Baseline CO_2e emissions

The baseline CO_2e emission were established from the latest available energy consumption data.[4]

2.1 CCC Building Energy Usage

Figure 1: Breakdown of CO_2e emissions by fuel / energy type (2020).



The Cumbria County Council (CCC) corporate estate consumes 17,887 MWh of fossil fuel annually. 426 MWh (approximately 2% of consumption) is currently gas oil and the rest is natural gas for heating and hot water. Fossil fuel consumption results in 3,320 tCO_2e[5] annually.

Electricity consumption for the corporate estate totals 8,186 MWh a year. The largest proportion of electricity is used by offices, closely followed by care homes. Annual CO_2e emissions from electricity is 2,073 tCO_2e.

Figure 1 shows the current proportion of CO_2e emissions from natural gas, gas oil and grid electricity across the CCC corporate estate. CO_2e emissions from natural gas accounts for over 60% of the total and this proportion will increase annually with national grid decarbonisation projections (outlined in Appendix 6 - Assumptions).

2.1.1 Energy Consumption and Emissions by Building Type

Figure 2 shows the proportion of fossil fuel consumption by building type.[6] Over half of fossil fuel consumption arises from the operation of care homes.

Figure 3 shows the proportion of electricity consumed by different building types. The largest users of electricity are offices, followed closely by care homes; combined these make up nearly two thirds of electricity demand.

7

Figure 4 shows the proportion of CO_2e across the corporate estate by different building types. The largest emitters of CO_2e are care homes due to their fossil fuel (gas) usage. The second largest emitters of CO_2e are the offices as they are the largest electricity users. Combined, these produce nearly two thirds of the corporate estate's CO_2e emissions.

Figure 2: Breakdown of fossil fuel consumption by building type (2020).

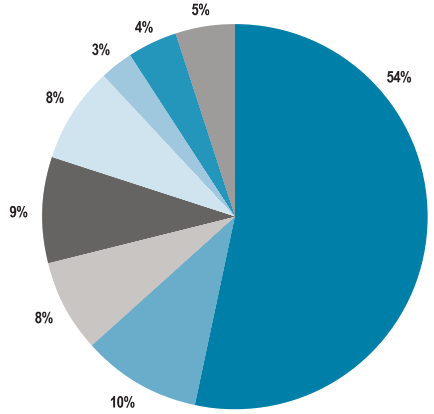


Figure 3: Breakdown of electricity consumption by building type (2020).

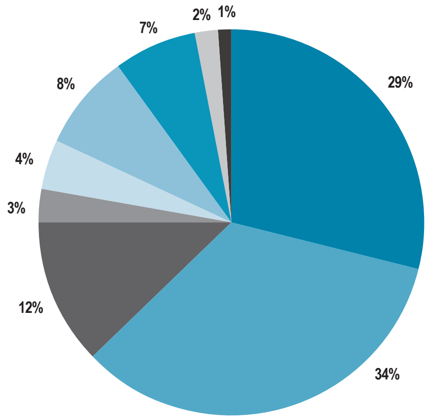
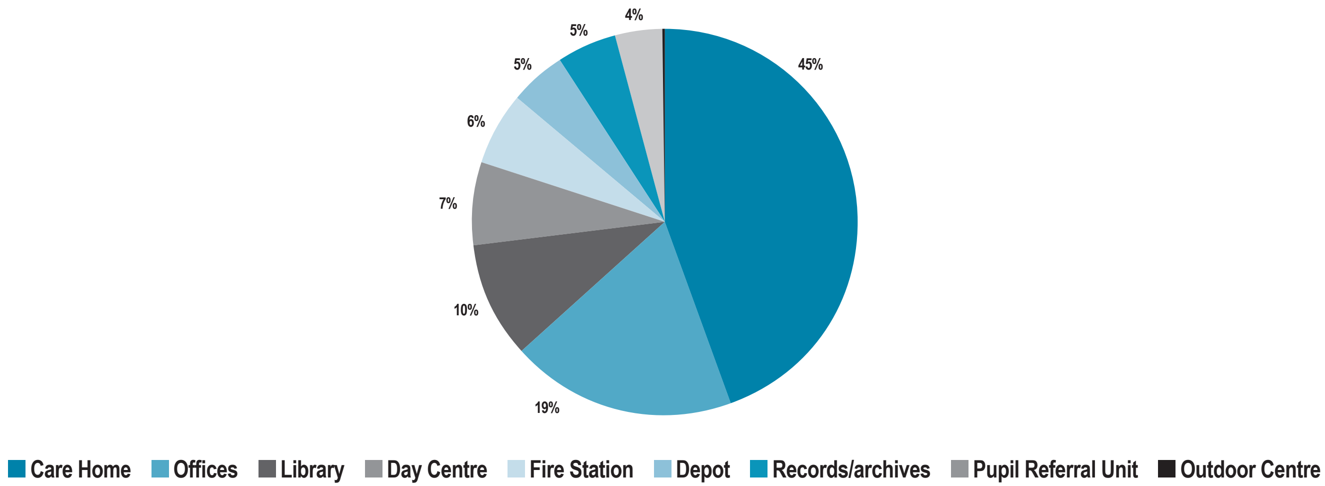


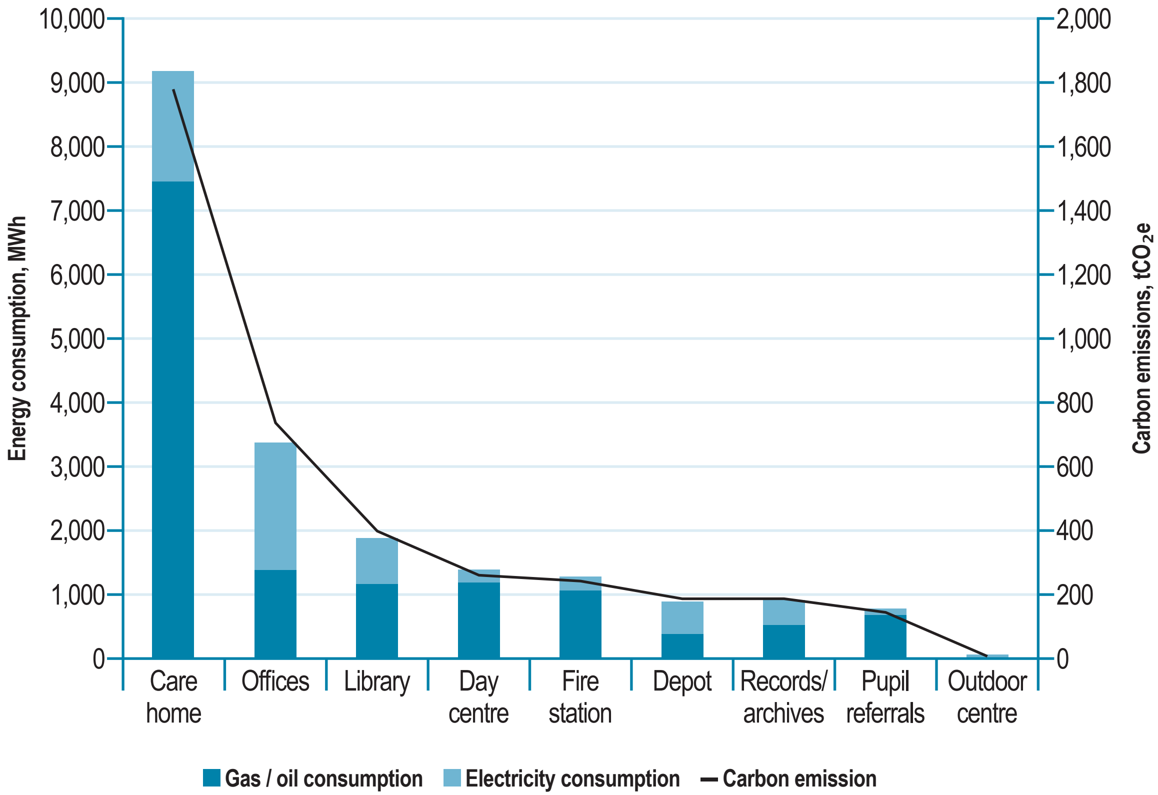
Figure 4: Breakdown of CO_2e emission by building type (2020).



[4] 2018/19.
[5] Based on 2020 BEIS carbon intensity values, all values used in calculations are shown in Appendix 6 - Assumptions.
[6] Energy usage breakdown is based on categorisation of the top 50 energy users in the corporate estate which make up over 74% of CCC's overall energy demand.

Figure 5 compares energy usage with CO_2e emissions across different building types (for the top 50 CO2e emitting buildings[7]). Care homes consume the most fossil fuels, and this is reflected in the associated CO2e emissions. Offices have high associated CO2e emissions due to the high proportion of electricity use. Grid electricity in the UK currently has a higher CO_2e emissivity value than natural gas, although, as seen in Appendix 6 - Assumptions, the grid is decarbonising and projections forecast that grid electricity will have a lower value than that of natural gas by the year 2023.

Figure 5: Breakdown of fuel consumption, electricity consumption and CO_2e emission across top 50 energy users (2020).



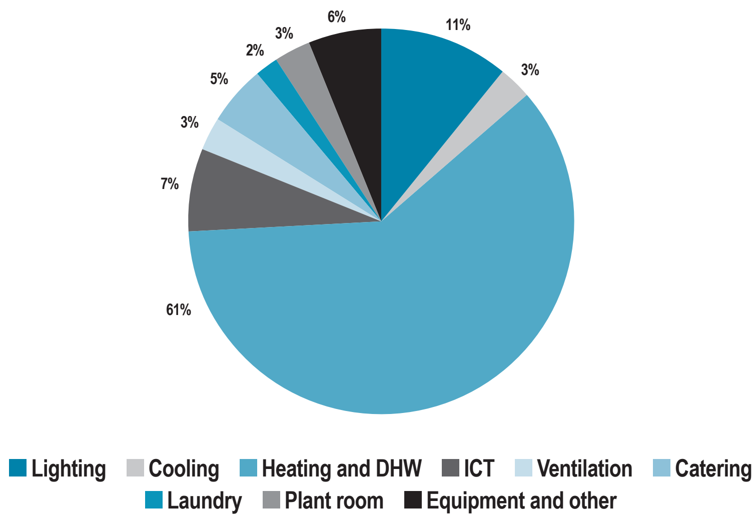
[7]The top 50 CO2e emitting buildings contribute 74% of overall CO2e emissions.

2.1.2 CO_2e by Building Requirement

Site surveys were conducted to determine energy requirements and usage types for different building types, and the proportion of CO2e emissions resulting from specific building requirements were used to inform potential savings.

Figure 6 shows that the majority of CO2e emissions from the corporate estate buildings are derived from space heating and domestic hot water usage. Most of the heating and hot water across the estate is provided by gas and so heating and hot water will result in an increasing proportion of building CO_2e emissions as the national grid decarbonises (in line with the projections shown in Appendix 6 - Assumptions).

Figure 6: CO_2e emissions by building requirement (2020).



2.2 Benchmarking and Prioritisation

The sections above describe the amount of energy used and CO_2e emitted by different building types and requirements but do not provide a comparison of building performance. As stated, the operation of care homes results in the greatest CO2e emissions but they also have the largest combined floor area. Offices have the highest electricity usage and, in most cases, have a greater internal floor area than other buildings within the estate.

The following section details the energy use and CO_2e emissions for each building type by normalising specific buildings by floor area. This allows the identification of key buildings and building types that should be prioritised by CCC to reduce energy demands and CO_2e emissions.

2.2.1 Benchmarking

Figure 7 shows that fire stations and care homes have the highest CO2e per m², with emissions of roughly 90 $kgCO_2e/m^2$ and 70 $kgCO_2e/m^2$ respectively (overall median value of 55 $kgCO_2e/m^2$). The building type with the lowest CO2e emissions per internal floor area are the offices at approximately 30 $kgCO_2e/m^2$.

The CO_2e emission values displayed in Figure 7 are the median values for each building type; the red line is the median value across all buildings in the corporate estate. A comparison of individual buildings within each building type is shown in Appendix 5 - CO2e Benchmarking.

Figure 7: Median CO_2e emissions by building area.

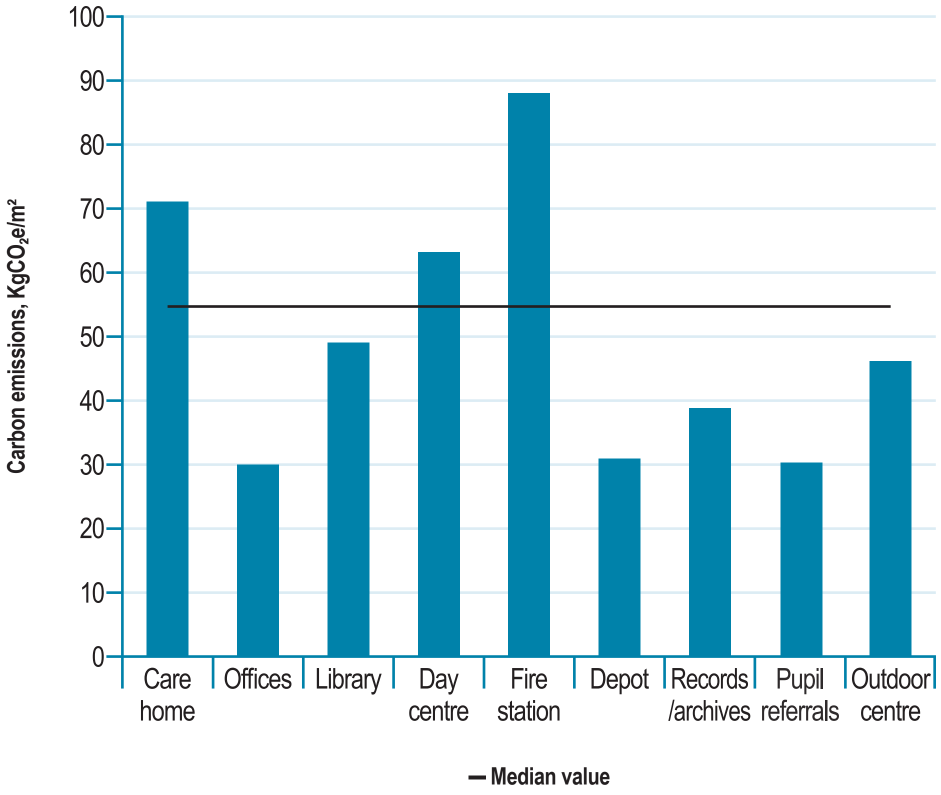
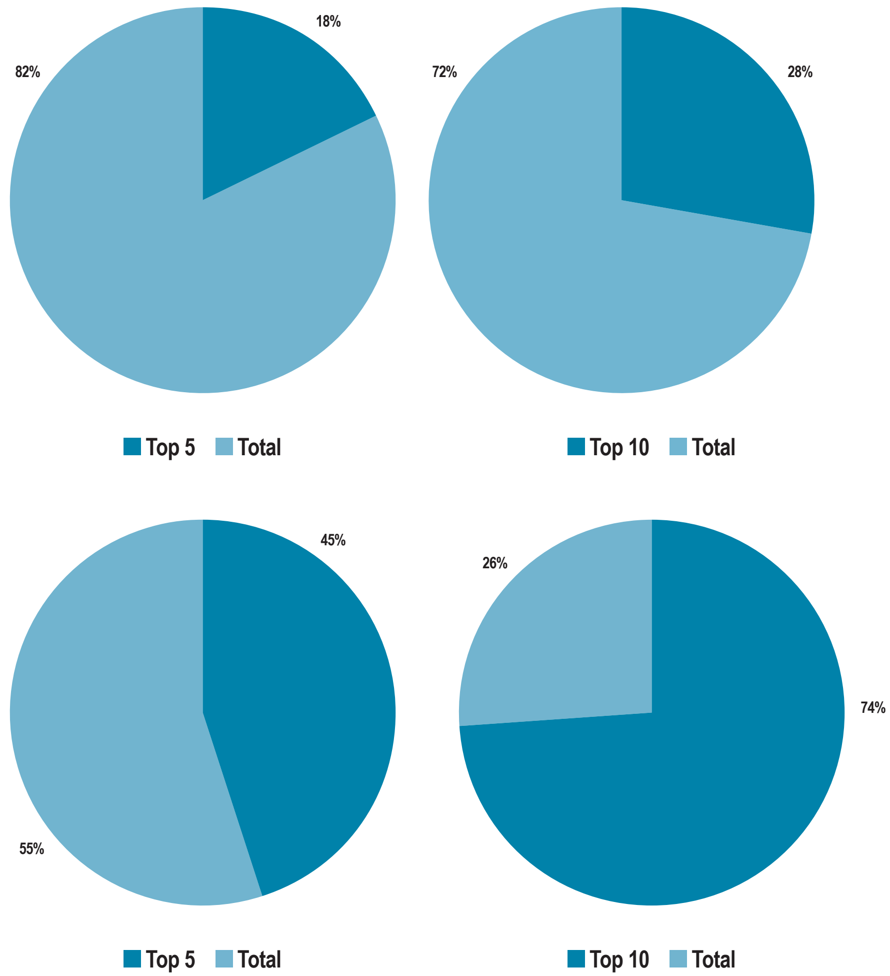


Figure 8: Proportion of top 5, 10, 20 and 50 CO_2e emitting building to total CO_2e emissions (2020)



2.2.2 Prioritisation

The top 50 buildings make up 74% of overall CCC CO2e emissions. The top 20 CO2e emitting buildings make up 45% of overall CO2e emissions and the top 5 CO2e emitting buildings make up 18% of overall CO2e emissions (see Figure 8).

Figure 9 lists the top ten CO_2e emitting buildings in the CCC corporate estate. Five of the top ten CO_2e emitting buildings are care homes, this is primarily due to their large average internal area and significant heating requirements.

Cumbria House is the largest CO2e emitter; although one of the newer buildings in the portfolio, the building is also the largest and has very high utilisation. In addition to all ICT and facilities provided to occupants and visitors, the building also houses the CCC servers[8]. A comparison of Cumbria House with other CCC offices is shown in Figure 10. Cumbria House has a higher CO_2e per floor area than the median, though performs better than the worst performing office building, Parkhouse.

The assessment summarised in Figure 7 and Figure 9 was used to inform the prioritisation and the overall CO_2e management strategy. Care homes should be prioritised as they:

- Make up the largest proportion of CO2e emissions
- Have the second highest CO2e emissions per m²
- Comprise five of the top ten CO2e emitting buildings

The largest offices should also be prioritised as:

- Although, overall, offices have one of the lowest CO2e per m² per building type, the top two CO_2e emitting buildings are offices
- Collectively they make up the second largest cumulative CO2e emission by building type

Fire stations are also a priority for potential improvement as they have the greatest CO2e emission per m².

Prioritisation of buildings within each building type should be informed through assessment of figures in Appendix 5 - CO2e Benchmarking.

Figure 9: Top ten CO_2e emitting buildings (2020).

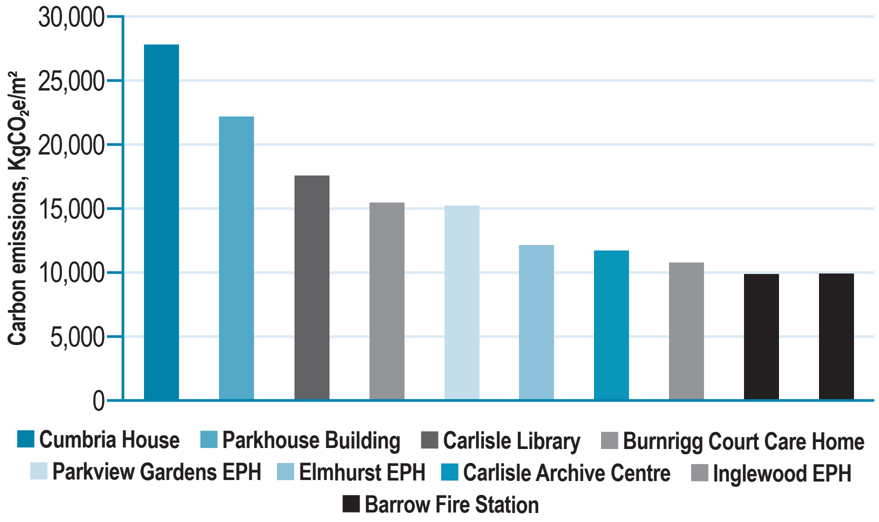
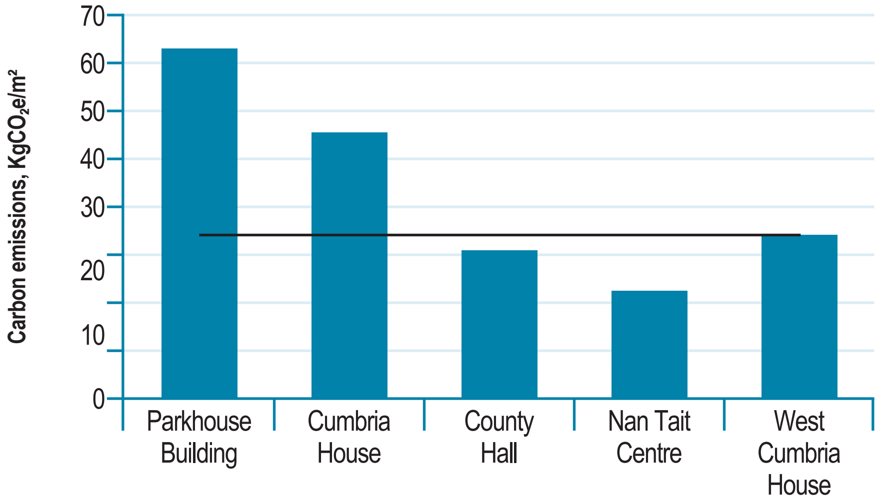


Figure 10: CO_2e emissions of main CCC offices (2020).



[8]First CCC servers are not sub-metered and so building electricity consumption without server demands was not assessed.

3 Carbon Management in Buildings

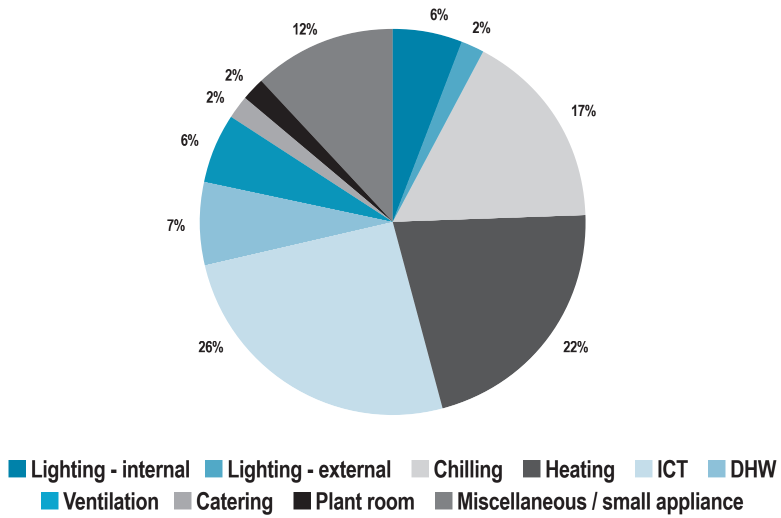
Building energy (and associated CO_2e emissions) should be reduced in line with the energy hierarchy; the priority is to reduce a building's energy demand followed by improving efficiency, and integrating renewable energy sources, once the first two areas have been addressed. Any remaining building related CO_2e emissions should then be offset by offsite renewable energy generation (see Figure 11).

Figure 11: Energy hierarchy.

Cost to implement

- Reduce demand.
- Improve energy efficiency.
- Integrate renewable energy sources.
- Sourcing energy from renewable sources.

Figure 12: Energy usage requirements for Cumbria House.



3.1 Building Surveys

Visits were made to ten buildings to identify energy usage requirements and potential CO_2e reduction measures across the corporate estate. The ten buildings represented a range of building types and ages (Appendix 4 - Building Surveys details the sites visited and data gathered).

Figure 12 is included as an example and shows the energy usage requirements for Cumbria House. The largest requirement is for ICT, this is reflected in the large electricity usage for the building.

3.2 CO_2e Reduction Measures

Measures to reduce building CO_2e emissions were identified in Table 1 below. Publications relevant to the measures are identified in APPENDIX 8 - Relevant Publications.

Table 1: CO_2e emissions reduction measures

Reduction measure	Comments	Economic payback term
Installing LEDs	Replacing existing lamps with LEDs is a cost-effective way to make significant savings on a buildings' electricity usage. Building alterations and downtime are avoided as LED lighting can often use existing light fittings and fixtures. LEDs are more efficient than other lighting such as fluorescent tubes and require less power to produce the same amount of luminosity. LEDs also last a longer than other lighting, do not contain environmentally harmful materials such as mercury and are usually recyclable at end of life.	Short
Converting gas catering to electric	Although there will be limited energy reductions, due to the decarbonisation of the electricity grid, long term CO_2e emissions will be reduced by moving to electricity for catering.	Long
Converting gas laundry to electric	See converting gas catering to electric.	Long
Replacing / upgrading equipment	This involves upgrading or replacing equipment that is not operating efficiently. Examples include replacing single speed pumps in a plant room with new variable speed pumps or replacing individual kettles in a large office with centralised provision of boiling water.	Medium
Upgrading building fabric	As shown in section 2, space heating results in the largest proportion of building CO2e emissions. Building fabric with low insulation values allows heat to escape and the heating plant produces more heat to meet building comfort levels. Building fabric improvement measures include adding or upgrading insulation to roofs and walls and installing triple-glazed windows. It is important that this is completed (as far as possible) prior to operation of heat pump systems.	Medium / long
Installing heat recovery	Heat loss through ventilation results in a significant proportion of space heating demand. Ventilation heat losses occur when heated air is replaced by fresh air, this can be in part to natural leakage through building fabric or mechanical ventilation required to ensure a fresh air supply. Mechanical ventilation heat recovery (MVHR) can provide fresh circulated air to a building whilst recovering up to 60-85% of the heat contained within the replaced air. MVHR can be installed throughout a building but is most effective installed in large open areas or on existing air handling systems.	Medium / long

Reduction measure	Comments	Economic payback term
Installing heat pumps	Heat pumps can provide a building's space heating and hot water without the need for gas and with a lower energy input. Heat is extracted from the environment (ambient air, ground or water) and transferred to buildings via a vapour compression cycle. The required input power is a quarter to a third of the output power. In most cases, the least expensive to install is an air source heat pump (ASHP), although the operating efficiency, or coefficient of performance (CoP), with this type of heat pump varies throughout the year as air temperature changes. Therefore, the seasonal performance will usually be lower than that of a system using the ground or ground water as a heat source. Open loop ground source heat pumps (GSHP) commonly use boreholes (up to several hundred metres deep) to abstract ground water from an aquifer. This water will be significantly warmer than ambient surface temperatures, increasing with depth, and will not fluctuate with air temperature. High source temperatures require less input energy to reach output temperatures and result in a greater CoP. Abstraction boreholes, however, result in increased initial capital costs and operational costs for abstracting ground water, both of which increase with depth. Closed loop heat pumps circulate brine around pipes installed underground, either vertically (in boreholes) or horizontally (in coiled pipe arrays). Vertical arrays take up considerably less space but produce additional cost and engineering requirements. Large closed loop systems typically require more space for a borefield than large open loop systems. For an example of a heat pump feasibility study see Appendix 7 - Cumbria House Feasibility Study.	Short
General housekeeping improvements	CO2e emissions can be reduced by improving the way buildings are operated on a day to day basis. Housekeeping measures can be applied across all energy uses in a building, for both building occupants and building management personnel. For example, occupants can be instructed to turn off computers outside of working hours or leave doors closed to avoid unnecessary heat loss. Better control of a building's heating system can reduce energy use by not heating unoccupied spaces and avoiding occupants using plug in electric heaters.	Long

3.3 Building CO_2e Reduction

Building survey findings were assessed and extrapolated to estimate CO2e savings from implementing energy reduction measures across the portfolio. Figure 13 shows that 56% CO_2e savings could be made (against 2020 CO_2e intensity figures).

The greatest savings are made from reducing CO_2e associated with heating and DHW. The largest contributor to these savings is the installation of heat pumps. Considerable CO_2e savings can be made by addressing lighting energy requirements, through the installation of LEDs. CO_2e savings from catering and laundry are not apparent when using first year CO_2e intensity values (as used in Figure 13) but become much more significant in later years as the national electricity grid decarbonises and less CO_2e is emitted per kWh of electricity consumed.

Figure 14 shows the first year CO_2e savings achievable through implementing the carbon reduction measures identified for Cumbria House. The largest savings are achieved through the installation of a ground source heat pump system at the site. No savings are identified from lighting improvements as the building has LED lights installed. Proportionately the savings are not as high as for some other sites as many of CCC's core activities are undertaken at this office (including operation of the council servers). As with Figure 13, CO_2e savings will increase as the electricity grid decarbonises (see Appendix 6 - Assumptions).

Figure 13: CO_2e reduction through implementation of all carbon management options.

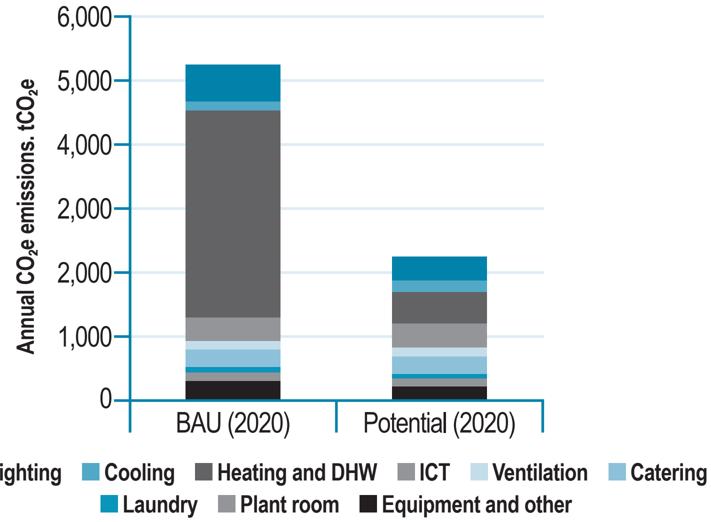
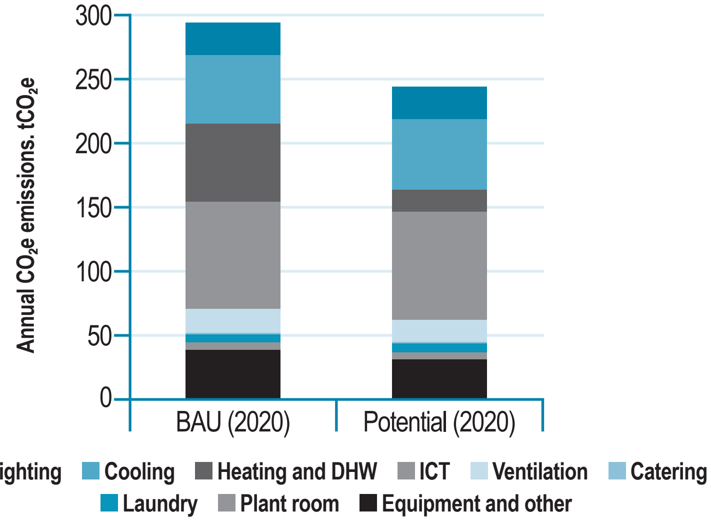


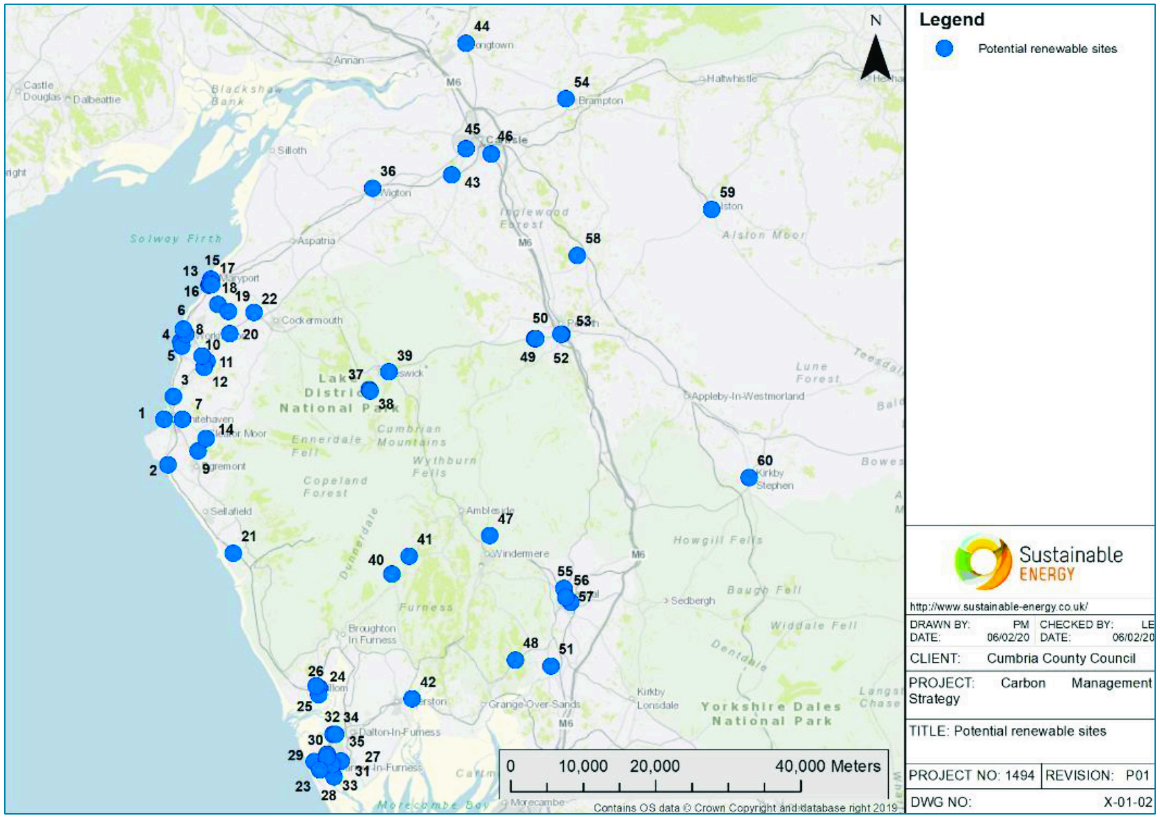
Figure 14: Cumbria House CO_2e emissions reduction.



4 Offsite Renewable Energy Generation

CCC owned sites were assessed as potential locations for offsite renewable energy generation. Of the sixty sites assessed, five were taken forward for further investigation. The sites that were assessed are included in Appendix 3 - Potential Offsite Generation. These sites were used to inform the potential for offsite generation across the county.

Figure 15: Sites investigated for renewable energy generation.



The technologies identified for large scale offsite electricity generation in Cumbria were solar PV and wind. Offsite generation provides a means of offsetting CCC's CO_2e emissions however, as stated, energy consumption should be reduced as far as possible prior to generating from renewable sources. This is reflected in the proposed carbon management strategy.

Figure 16: CO_2e offsetting from offsite renewable energy generation.[9]

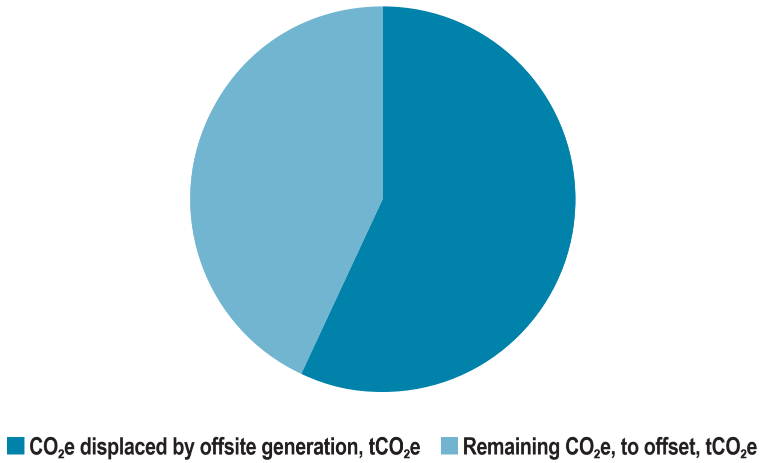


Figure 16 shows the corporate estate CO_2e emissions that could be offset through the installation of approximately 7 MW of solar PV and a 2.5 MW wind turbine. The potential savings total 3,102 tCO_2e or 58%. (see Appendix 3 - Potential Offsite Generation).

7MW of solar PV would require an area of approximately 90,000m². This could be accommodated at sites such as Barrow Waterfront. A 2.5 MW wind turbine could potentially be located at Skirsgill Depot.

[9]First year CO_2e offsetting against BAU 2020 values.

5 Carbon Reduction Strategy and Targets

Potential CO_2e reduction strategies were assessed against the five critical success factors summarised in Table 2 below. The primary factor is the level of reduction in CO_2e emissions but annual cost savings, CAPEX requirements, economics and social value are also important to the success of the strategy.

Four investment options were short listed and assessed and are presented in Table 3. The four scenarios are presented to demonstrate different approaches and can be summarised as follows:

1 Maximum return on investment or best economics.
2 Maximum CO_2e savings whilst meeting 8% hurdle rate.
3 A phased option similar to 2a but with additional measures to achieve 100% CO_2e reduction.
4 Maximum offsite generation meeting 8% hurdle rate.

Table 2: Critical success factors for carbon reduction strategy.

CSF	Benefit description	How it will be measured?
1	CO_2e savings	Calculation of savings against BAU scenario
2	Cost savings	Calculation of savings against BAU scenario
3	Revenue generation	Measured in economic metrics[10]
4	Social value	Calculation of savings against BAU scenario
5	CAPEX	Implementation cost based on previous project experience and soft market testing

Table 3: Assessed carbon reduction strategy options

Short listed scenario	Summary of measures	Results (25 year)		Risks	Benefits
1) Maximum IRR	• Install LEDs in all buildings • Improve housekeeping measures	CO_2e savings	10%	• Lowest CO_2e savings • Low cost savings compared to other options • None	• Highest ROI • Highest social IRR • Lowest investment cost
		Cost savings	£5,829,686		
		Revenue generation	-		
		IRR	47%		
		Social IRR	63%		
		CAPEX	£698,396		
2a) 8% IRR	• Install LEDs in all buildings • Improve housekeeping measures • Install heat pumps and fabric improvements in care homes and offices • 2.5MW wind turbine • 1.5MW solar PV	CO_2e savings	60%	• Does not reach net zero CO_2e • Significant cost savings • Significant revenue generation opportunity	• High cost savings • Meets CCC hurdle rate • High social IRR • Medium CAPEX requirements
		Cost savings	£10,609,757		
		Revenue generation	£10,479,133		
		IRR	9%		
		Social IRR	14%		
		CAPEX	£10,491,062		
2b) 100% CO_2e reduction	• Install LEDs in all buildings • Improve housekeeping measures • Install heat pumps and fabric improvements in care homes, offices, record/archives, pupil referral units and remaining smaller buildings • 2.5MW wind turbine • 1.5MW solar PV • Additional 2.5MW wind turbine • Additional 5 MW solar PV	CO_2e savings	100%	• Low return on investment • High investment cost	• Full CO_2e savings • High cost savings • Energy security • Significant social IRR
		Cost savings	£11,897,212		
		Revenue generation	£19,490,980		
		IRR	3%		
		Social IRR	9%		
		CAPEX	£24,111,377		
3) 8% with maximum offsite renewables	• Install LEDs in all buildings • Improve housekeeping measures • 2no. 2.5MW wind turbine, 4.5MW of solar PV	CO_2e savings	43%	• Low CO_2e savings compared to other options • Low cost savings compared to other options	• Energy security • Meets CCC hurdle rate • Above CCC hurdle rate • Medium CAPEX requirements
		Cost savings	£5,829,686		
		Revenue generation	£21,134,395		
		IRR	8%		
		Social IRR	12%		
		CAPEX	£12,894,396		

The four scenarios have been assessed for each critical success factor and given a score. The option with the highest overall score was taken forward for more detailed assessment and timing/phasing assessment. A higher score indicates a more beneficial outcome (eg a lower CAPEX or higher IRR).

Table 4: Assessment of CO_2e reduction strategies.

Short list option	High level 25 year assessment						
	CO_2e savings	Cost savings	Revenue generation	IRR	Social IRR	CAPEX	Rank total
1) LEDs and housekeeping improvements	10%	£5,829,686	£-	47%	63%	£698,396	15
	Score						
	1	1	1	4	4	4	
2a) 8% CCC hurdle rate	43%	£5,829,686	£21,134,395	8%	12%	£12,894,396	17
	Score						
	3	3	2	3	3	3	
2b) 100% CO_2e reduction	100%	£11,897,212	£19,490,980	3%	9%	£24,111,377	14
	Score						
	4	4	3	1	1	1	
3) CCC hurdle rate with offsite generation	43%	£5,829,686	£21,134,395	8%	12%	£12,894,396	14
	Score						
	2	2	4	2	2	2	

[10]Future energy price changes based on BEIS price projections - central scenario; all values used in calculations are shown in Appendix 6 - Assumptions.

5.1 Prioritised Option

Option 2a has been selected as the prioritised option based on its scoring against the 5 critical success factors. This option achieves high CO_2e savings whilst meeting the 8% hurdle rate. It also has a strong score across all assessment parameters.

5.1.1 Potential Phasing

Table 5 shows the potential phasing of the carbon management options of option 2a, alongside associated capital cost per option. Figure 17 shows the 25 year cumulative cash flow for the prioritised option; the scheme has a simple payback of 14 years. The timeline is summarised in Figure 25 further on in this section.
Table 5: Potential phasing of option 2a.

Table 5: Potential phasing of option 2a

Year	Carbon management measures	Cost	Annual CO_2e savings, tonnes[11]
2022	Install LEDs in all buildings and make housekeeping improvements	£698,396	385
2023	Install offsite 1.5 MW solar PV installation	£1,595,000	96
2024	Install offsite 2.5 MW wind turbine	£3,350,000	528
2026	Improve building fabric and install heat pumps in offices and care homes	£4,846,667	1,419

[11]Based on projected emissions intensity figures in 2047 compared to BAU CO_2e in 2020.

Figure 17: Prioritised cumulative cash flow.

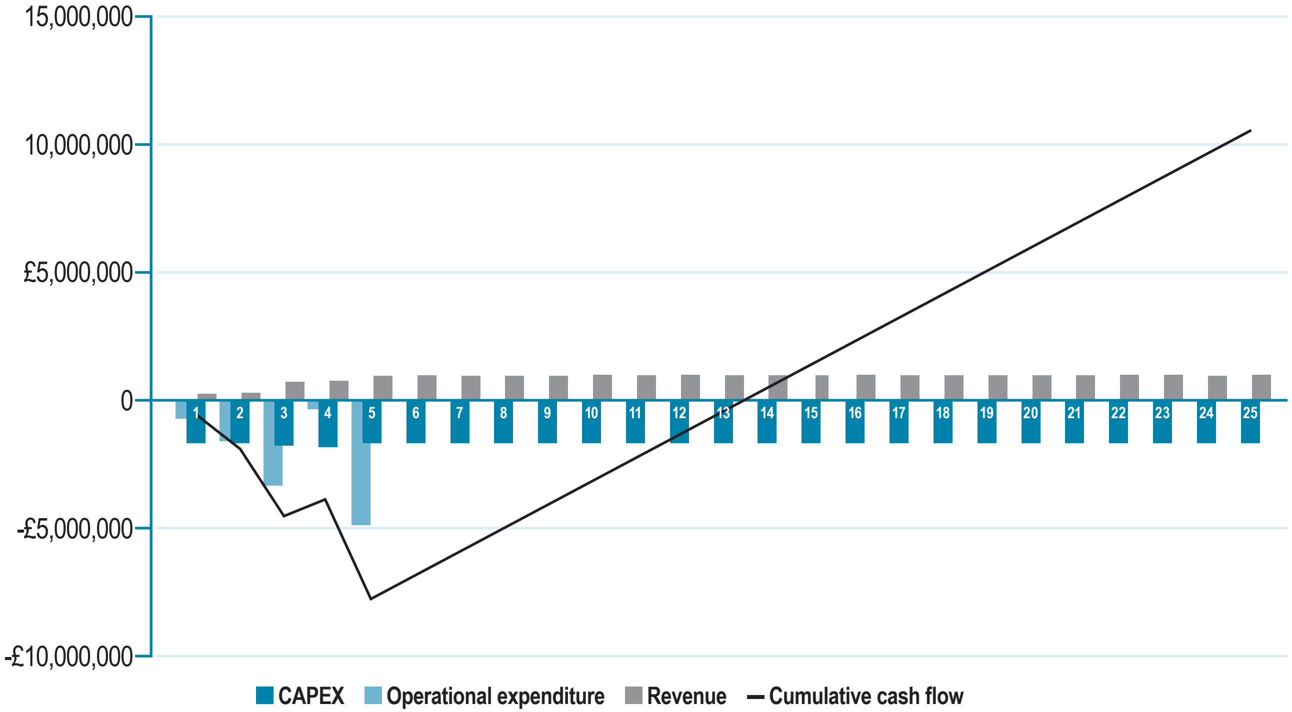
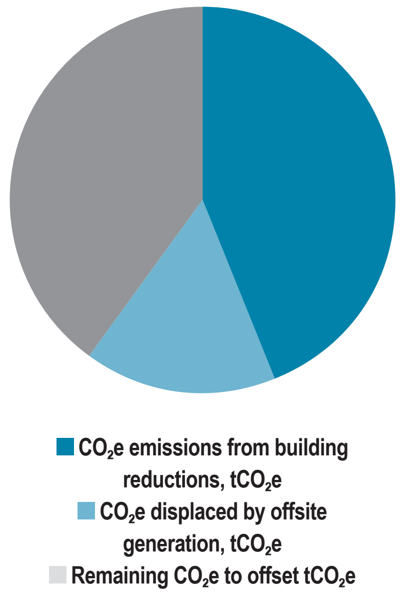


Figure 18: Prioritised option CO_2e savings proportion.

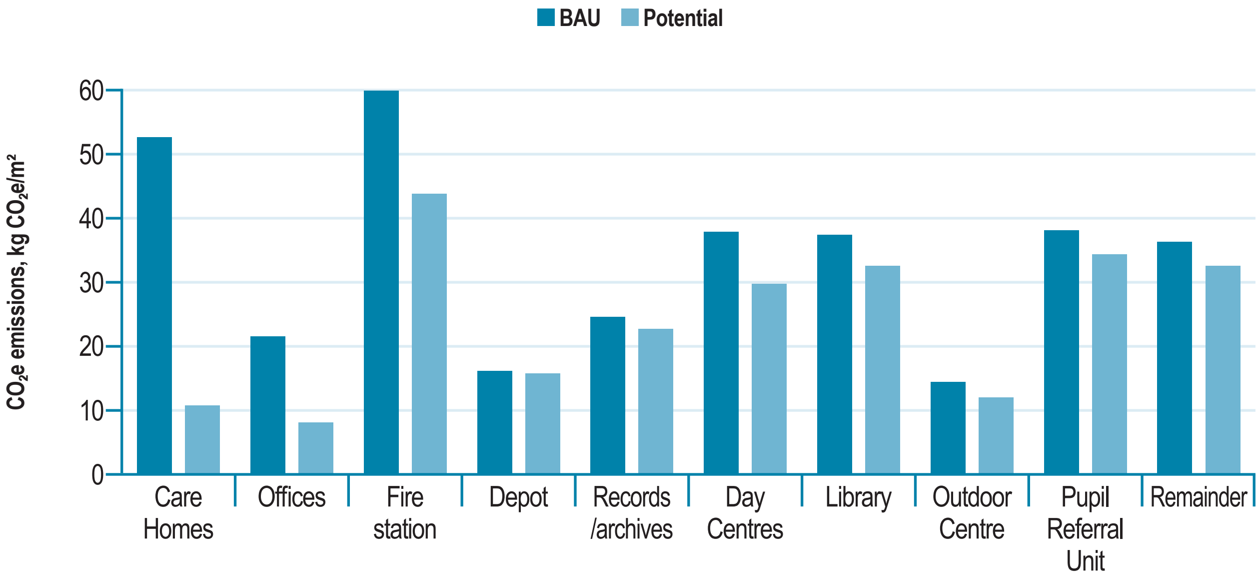


5.1.2 Projected CO_2e savings

Figure 18 shows that the majority of CO_2e savings are made by reducing building emissions[12]. Figure 20 summarises these savings. 36% of total emission savings arise from improving building fabric and installing heat pumps within the offices and care homes. An additional 10% of CO_2e savings result from installing LEDs and improving housekeeping measures across all buildings. 16% of CO_2e emissions are displaced by offsite generation. With all measures applied, approximately 40% of total current CO_2e emissions remain.

Figure 19 shows building CO_2e savings by building type. The largest savings against BAU are made by the care homes, followed by offices. The implementation of heat pumps in care homes results in significantly reduced overall fossil fuel usage. Housekeeping improvements have a proportionally large impact on CO_2e emissions of fire stations. The smallest impact from the installation of LEDs and housekeeping measures is in the depots. This is due to their smaller heat demand and significant electricity requirements that cannot easily be reduced by simple housekeeping improvements.

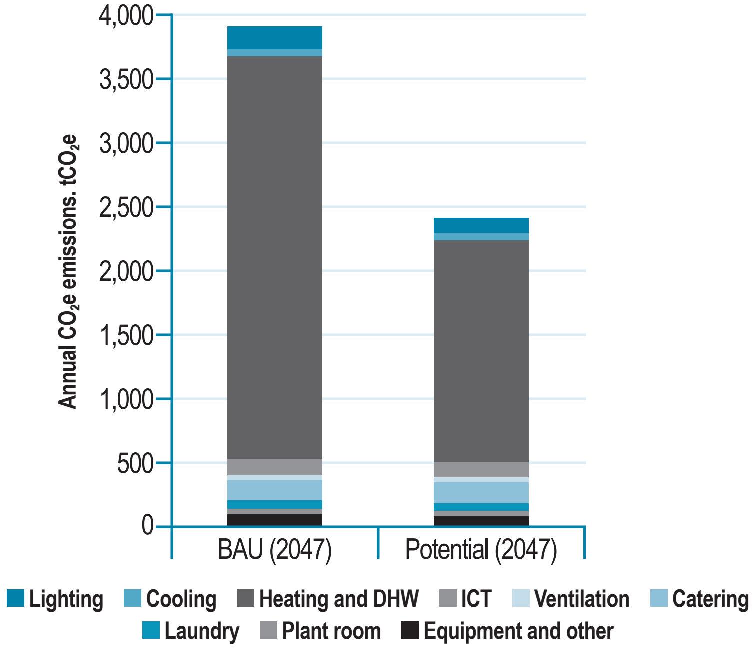
Figure 19: CO_2e savings by building type.



[12]Based on projected emissions intensity figures in 2047 compared to BAU CO_2e in 2020.

Most of the BAU CO_2e emissions arise from heating (see Figure 20). Reducing fossil fuel usage though effective housekeeping improvements and installing renewable heating will greatly reduce CO_2e emissions.

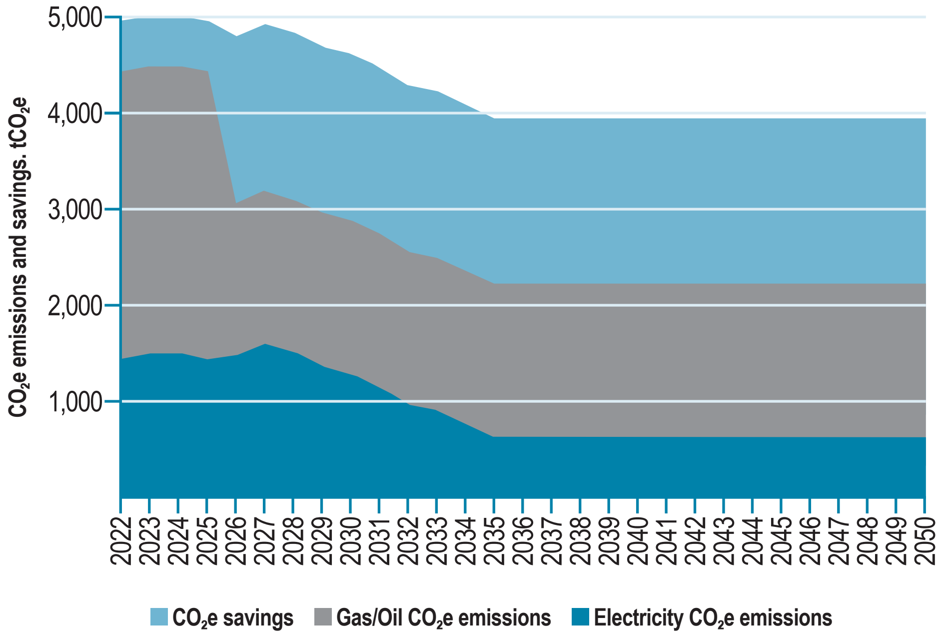
Figure 20: CO_2e savings by carbon management option.[13]



[13]BAU to potential CO_2e emissions calculated using projected emissions intensity figures for year 2047 to illustrate end of 25 year economic case.

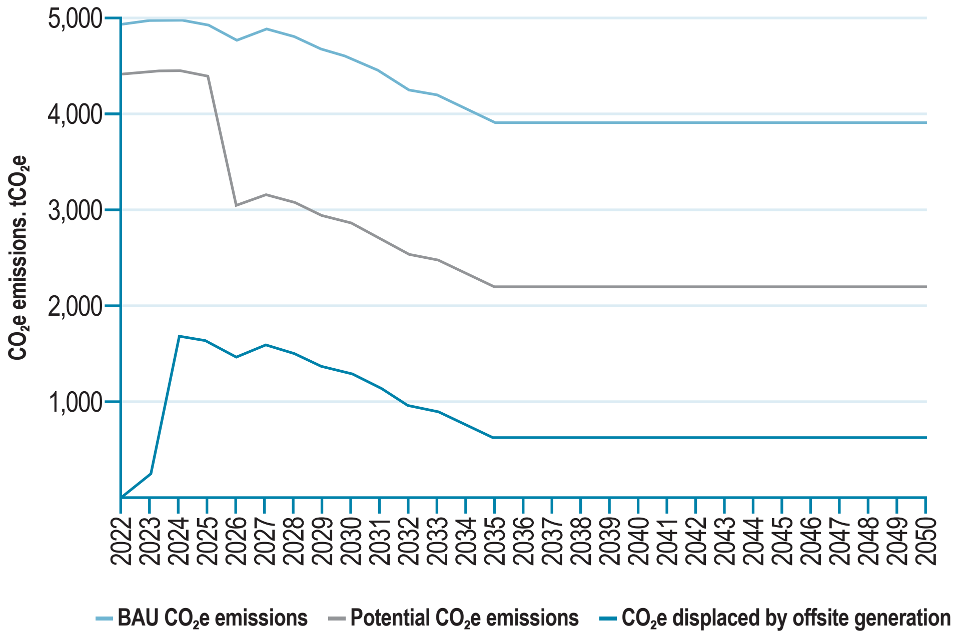
As the grid decarbonises, the CO_2e emissions associated with electricity reduce (see Figure 21). Therefore, the proportion of heat supplied by heat pumps will increase the projected long term CO_2e emissions savings, countering the initial increase in CO_2e emissions that result from the switch to heat pumps. Once all fossil fuel reduction measures are implemented, the annual CO_2e emissions from fossil fuels remain proportionally constant,[14] as shown in Figure 22.

Figure 21: CO_2e savings and emissions projections for prioritised option.



[14]Natural gas CO_2e intensity is assumed to remain constant; an increase in grid methane injection will cause CO_2e intensity to fall, whereas a greater reliance on LNG will cause CO_2e intensity to rise - at the time of writing, there are no formal CO_2e emissions intensity projection data for the gas grid.

Figure 22: CO_2e projected emissions and displacement for prioritised option.



5.1.3 Route to 100% CO_2e reduction

Option 2a results in approximately 60% reduction in CO_2e emissions by 2035. Once these measures have been implemented, additional measures can be undertaken to achieve a 100% reduction in CO_2e emissions. As shown in Table 4, option 2b (which achieved net zero) has less favourable economics and does not currently meet the CCC hurdle rate of 8%. The additional measures applied through the option of 2b include making fabric improvements to records/archives buildings and pupil referral buildings and installing an additional 2.5 MW wind turbine and 5 MW solar PV by 2030.

As parameters and priorities change, the additional CO_2e reduction measures proposed in option 2b may become economic. The workplace is a constantly changing landscape, for example the current Covid-19 pandemic has had a profound effect on the working environment and is possible to have a lasting impact on the size and operation of the corporate estate. Regular review of the strategy will identify opportunities for further CO_2e savings as conditions change.

Figure 23: Increase CO_2e projected reduction with addition of option 2b measures.

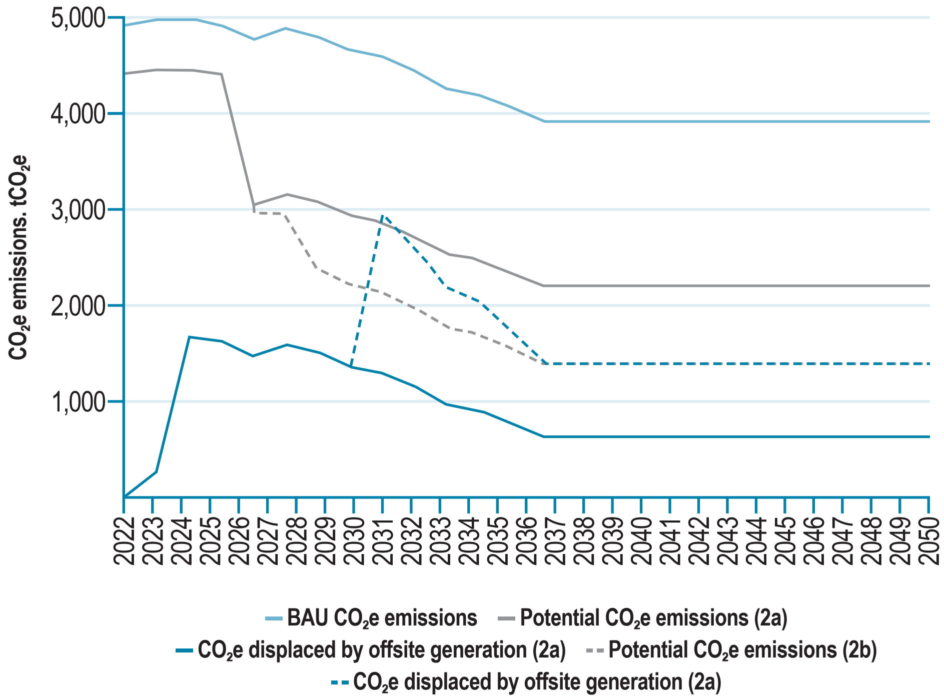
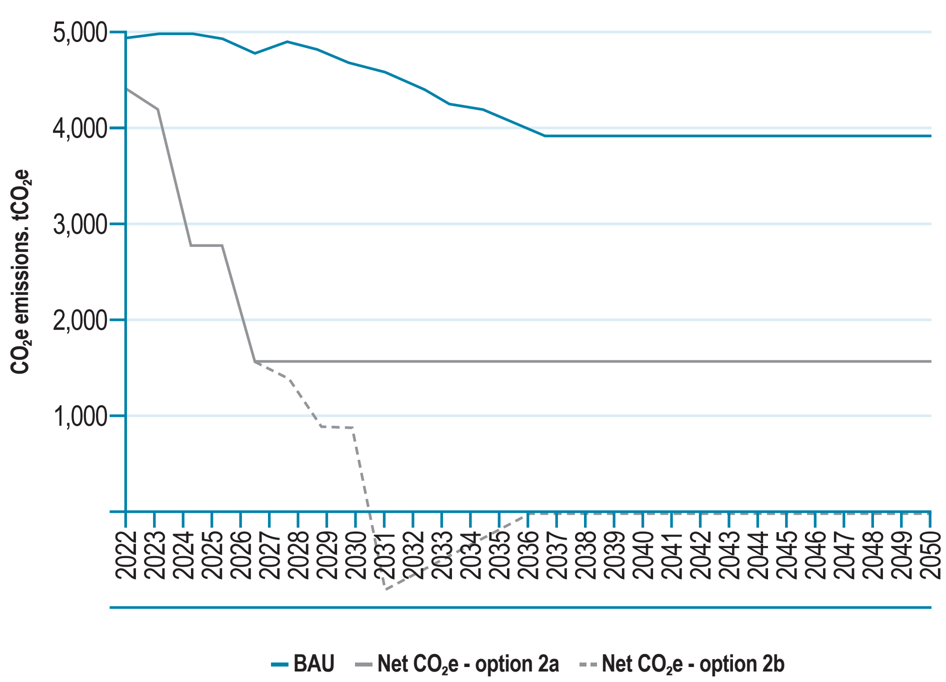


Figure 23 shows the projected CO_2e emissions and CO_2e displacement by generation by the blue and grey lines respectively. The solid lines depict the prioritised CO_2e reduction strategy whereas the dotted line shows the projection of the zero CO_2e strategy. The spike and then decline of the CO_2e displaced by offsite generation in option 2b is caused by the decarbonisation of the National Grid reducing the amount of CO_2e displaced per kWh generated.

Figure 24 illustrates the net CO_2e emissions under the proposed option 2a and the additional phases in 2b. Option 2b will continue to make increased net CO_2e savings until all measures are in place by 2030. Similar to what's seen in Figure 23, net CO_2e emissions are seen to increase after 2030 as the National Grid continues to decarbonise and the effectiveness of building energy CO_2e emissions displacement from offsite generation decreases. As the emissions intensity of National Grid electricity reduces, renewable electricity generation displaces less CO_2e per unit of electricity produced.

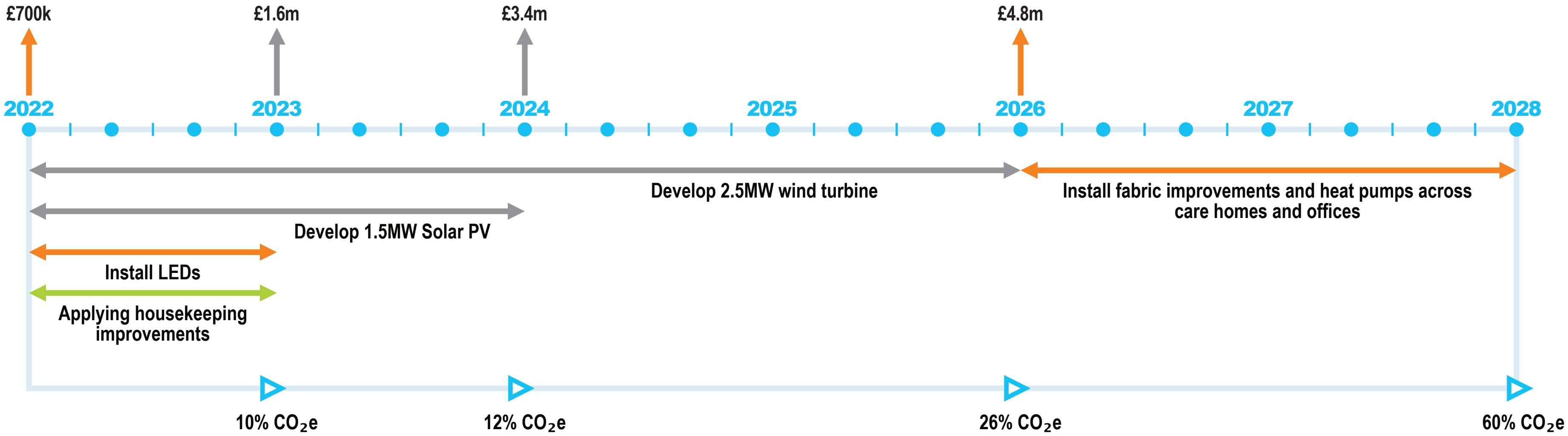
Figure 24: Potential net CO_2e emissions.



5.2 Summary

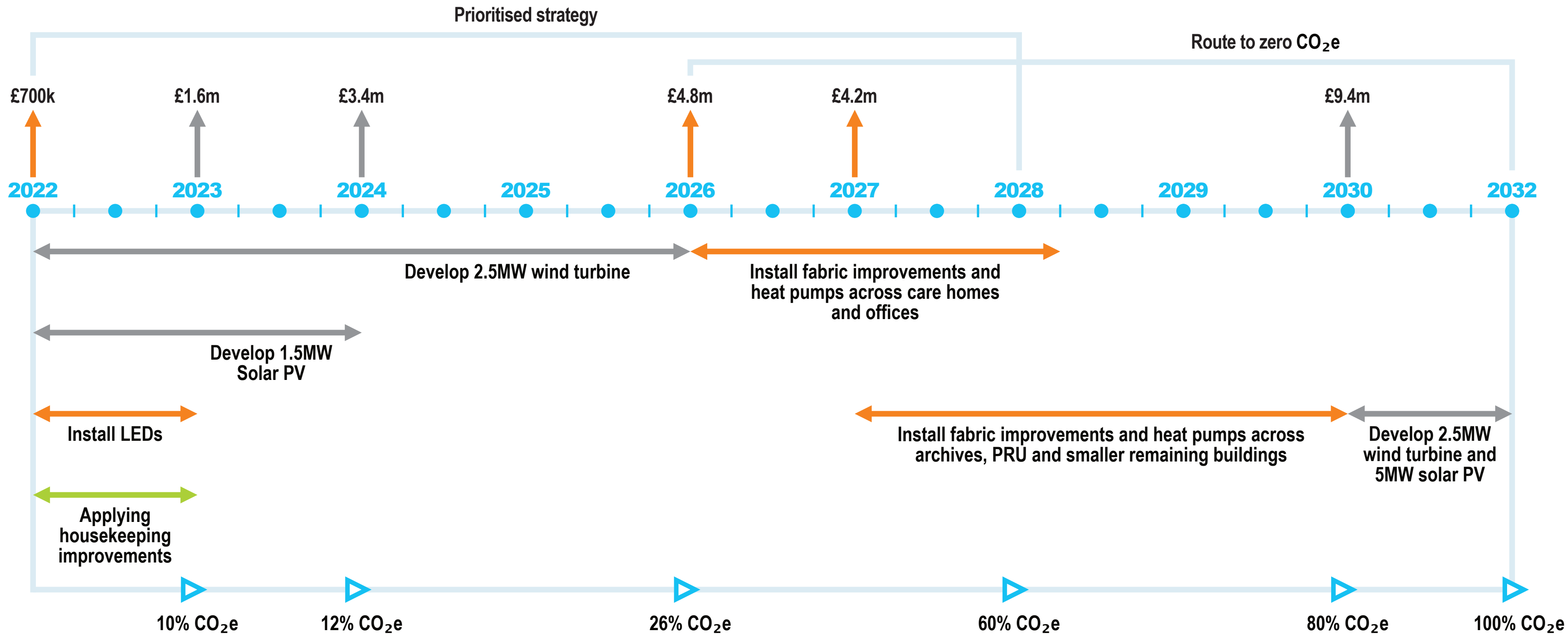
Figure 25 summarises prioritised CO_2e reduction strategy (that meets the CCC hurdle rate), with associated costs and CO_2e savings. The orange arrows show building improvement measures, grey offsite generation and green demand reduction measures.

Figure 25: Prioritised CO_2e reduction strategy timeline.[15]



[15] CO_2e savings based on projected emissions intensity figures in 2047 compared to BAU CO_2e in 2020.

Figure 26 shows the combined timeline of the prioritised CO_2e reduction strategy and the potential route to zero CO_2e.[16]



[16] CO_2e savings based on projected emissions intensity figures in 2047 compared to BAU CO_2e in 2020.

6 Conclusions

The conclusions of the Cumbria County Council Carbon Management Strategy Report are outlined below.

Baseline CO_2e Emissions

CCC corporate estate produces 5,392 tCO_2e annually, the majority of which arises from natural gas for heating and hot water and electricity for lighting, cooling and ICT functions (see breakdown of CO_2e emissions by fuel / energy type (2020) adjacent). CO_2e emissions from natural gas accounts for over 60% and this proportion will increase annually as the national grid decarbonises primarily due to increased deployment of wind and solar photovoltaic (PV) generation technologies.

The largest emitters of CO_2e are care homes due to their consumption of gas for heating and hot water. The second largest emitters of CO_2e are the offices as they are the largest electricity users. Combined, these produce nearly two thirds of the corporate estate's CO_2e emissions.

Building CO_2e Reduction

Measures identified to reduce building CO_2e emissions include replacing / upgrading equipment, improving building fabric, installing heat recovery plant, installing heat pumps and improving general housekeeping measures. The greatest savings are made from reducing CO_2e associated with heating and domestic hot water (DHW) and the largest contributor to these savings is the installation of heat pumps. Considerable CO_2e savings can be made through the installation of LEDs. Publications relevant to the carbon reduction measures are identified in APPENDIX 8 - Relevant Publications.

Energy Hierarchy

As stated, building energy (and associated CO_2e emissions) should be reduced in line with the energy hierarchy; the priority is to reduce a building's energy demand followed by improving efficiency, and integrating renewable energy sources, once the first two areas have been addressed. Any remaining building related CO_2e emissions should then be offset by offsite renewable energy generation.

Table 6 categorises the carbon reduction actions in line with the energy hierarchy.

Table 6: Energy hierarchy and related carbon reduction actions.

Energy hierarchy	Carbon reduction actions
1 Reduce demand	Apply housekeeping improvements Install fabric improvements
2 Improve energy efficiency	Install LEDs
3 Integrate renewable energy sources	Install heat pumps
4 Source energy from renewable sources	Develop 1.5 MW solar PV and 2.5 MW wind turbine

Offsite Renewable Energy Generation

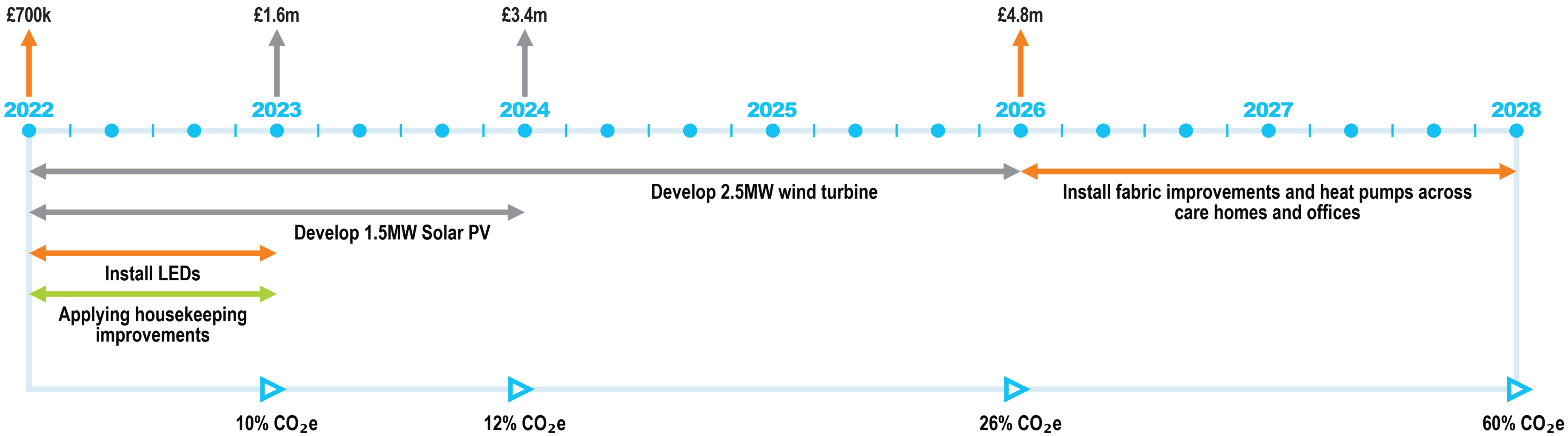
CCC owned sites were assessed as potential locations for offsite renewable energy generation. Of the sixty sites assessed, five were taken forward for further investigation. The technologies identified for large scale offsite electricity generation were solar PV and wind. Offsite generation provides a means of offsetting CCC's CO_2e emissions however, as stated, energy consumption should be reduced as far as possible prior to generating from renewable sources. This is reflected in the proposed carbon management strategy. The CO_2e

emissions that could be offset by the installation of approximately 1.5 MW of solar PV and a 2.5 MW wind turbine total 623 tCO_2e or 16%.

Prioritised CO_2e reduction strategy

The prioritised strategy (that meets the CCC hurdle rate) involves installing LEDs and making housekeeping improvements across all buildings and upgrading fabric and installing heat pumps in all offices and care homes. To further offset CO_2e emissions a 1.5 MW solar PV farm and 2.5 MW wind turbine are required. Over 25 years, the strategy is projected to reduce CO_2e emissions by 2,338 tCO_2e or 60% of total BAU emissions. The 25 year return on the capital investment of £10.5million will exceed the 8% IRR hurdle rate and will payback within 14 years.

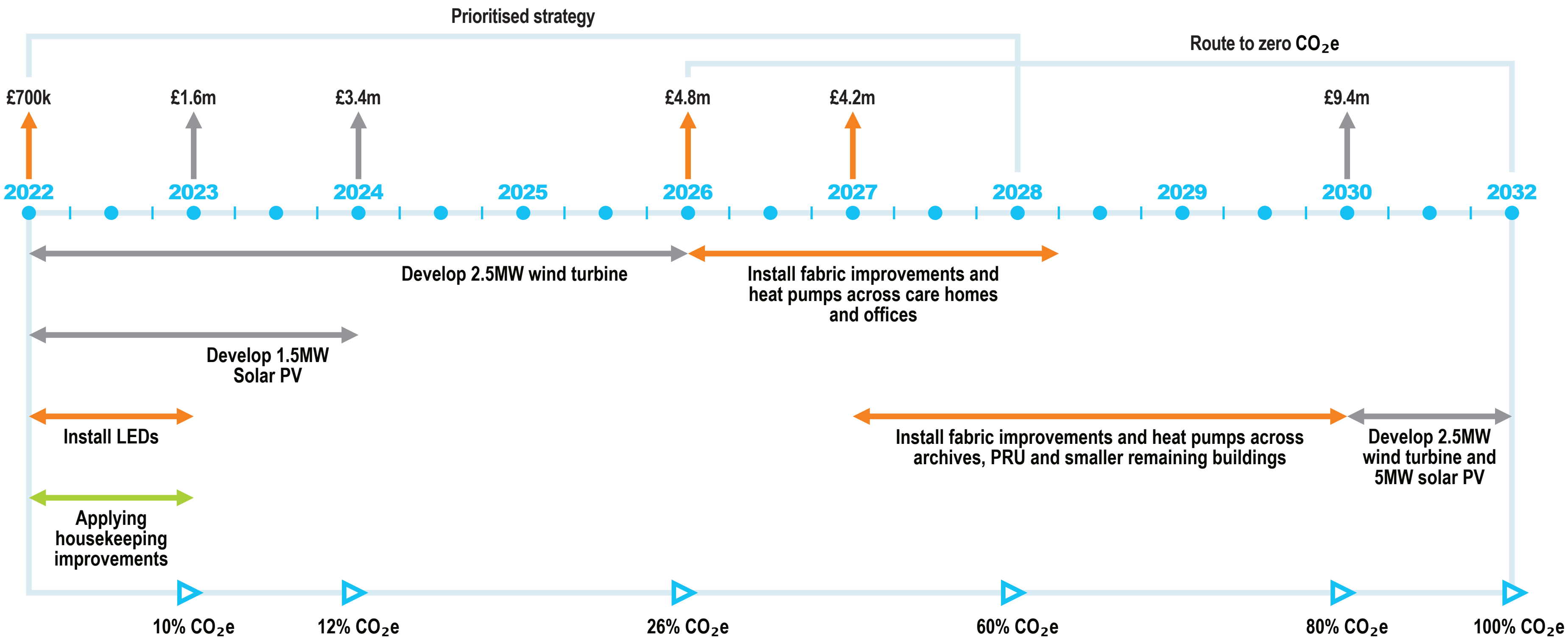
Figure 27: Timeline of prioritised CO_2e reduction strategy.



Route to Zero CO2e

A potential longer term strategy to achieve 100% CO_2e emission reductions has also been assessed. The additional measures required to achieve 100% reduction include additional heat pump installations in buildings, installing an additional 2.5 MW wind turbine and 5 MW of solar PV. The net zero strategy does not currently meet CCC's hurdle rate of 8% IRR.

Figure 28: Timeline for route to zero CO_2e



Key Risks

The carbon reduction strategy relies on the future decarbonisation of the national grid at the rate currently predicted. A slow down of this rate will reduce the amount of CO_2e savings made by the installation of heat pumps, though will increase the amount of CO_2e offset by solar PV and wind. Current emission projections end at 2035 but it is likely that the National Grid will further decarbonise after this date.

Cost savings, revenue generation and economics and social value are impacted to changes in electricity and natural gas prices. An increase in natural gas price will increase potential savings and improve the economic case for fossil fuel reduction. An increase in the projected electricity price will negatively affect the economics of installing heat pumps. Offsite generation will benefit from an increase in the price of wholesale electricity and achieve a shorter payback period on initial capital investment.

Capital investment will increase and decrease with project complexity; issues include planning restrictions and required building alterations. Although identified issues and risks have been considered during high level project costing, there will specific risks associated with each individual project.

Corporate Considerations

The CO2e reduction strategy will deliver against a number of key CCC corporate priorities. It contributes to the Cumbria Local Energy Plan and Cumbria's Local Industrial Strategy (LIS) in driving sustainable economic growth, heling to capitalise on existing energy credentials and further developing Cumbria's green energy infrastructure. Of the six priorities identified by the LEP (ideas, people, infrastructure, business environment, places and green growth), it potentially contributes to all.

The CO2e reduction strategy can contribute to the objectives of the Cumbria Council Plan 2018-2022 in providing sustainable growth in the local economy, saving money through reduced energy usage and cheaper energy supply, incentives and grants, improving energy security, providing investment in the local economy, improving air quality by cutting CO_2e and NOx emissions, leading in delivering good practice and providing reputational benefits. However, as the CO2e reduction strategy is due to start as this plan ends in 2022, the strategy should be considered during the development of the next plan.

If CCC were to declare a Climate Emergency, then a net zero target of say 2030 cannot be met under the proposed plan. While the study identifies a route to net zero over a 10 year period this option is currently uneconomic by CCC, on a simple hurdle rate of 8%. Currently a 60% CO_2e reduction is viable as a phase 1 approach to the CCC Carbon management strategy for corporate buildings.

Recommendations and Next Steps

Next steps include:

- Further surveys for key buildings and sites and development of building specific reports addressing priority measures identified the strategy.
- Completion of measure-specific studies to further assess feasibility and develop specifications for implementation of building improvement measures such as LED lighting and offsite renewable energy schemes (including discussions with planning team over suitability of offsite generation locations).
- Development of building user behavioural change strategies to contribute to improved housekeeping measures.
- Identification and allocation of budgets to complete short term measures identified in the strategy.
- Developing feasibility studies for heat pump installation in main offices and care homes.
- Employing a carbon reduction/energy manager to drive and oversee improvement actions across the corporate estate (25 years estimated housekeeping savings of £2,760,000 (8,300 tCO_2e) can be achieved and the role of a carbon reduction manager can be partly justified against these savings).

Table 7 summarises the timing of specific actions required to implement the carbon reduction strategy.

Table 7: Carbon reduction strategy timeframe and timing of reduction actions

Timeframe	Timeframe	Actions
Short term 2022-2024	Appoint dedicated carbon reduction/energy manager.	• Specify role • Secure budget • Recruit appropriate candidate
	Install LEDs across all buildings.	• Conduct further building surveys • Develop specifications • Engage with contractors • Procure equipment and services
	Implement housekeeping measures across all buildings.	• Employ carbon reduction manager • Develop housekeeping strategy to include staff engagement, behavioural change and improved energy management and controls
	Design, procurement and installation of 1.5 MW solar PV.	• Discussions with planning team over suitability of sites • Liaison with DNO • Detailed feasibility studies for selected sites • Planning application • Develop specifications • Engage with contractors • Procure scheme
	Design and planning of 2.5 MW wind turbine.	• Discussions with planning team over suitability of sites • Liaison with DNO • Detailed feasibility studies for selected sites • Planning application
Medium term 2024-2026	Procurement and construction of 2.5 MW wind turbine.	• Develop specifications • Engage with contractors • Procure scheme
Long term 2026-2028	Install fabric improvements and heat pumps across care homes and offices.	• Detailed feasibility studies for care homes and offices • Develop specifications • Engage with contractors • Procure schemes

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