Appendix A

A NET-ZERO CARBON ROADMAP FOR LEEDS

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PREFACE

Background

The first version of the Leeds Net-Zero Carbon Roadmap was published by the Leeds Climate Commission in the spring of 2019. A lot has happened and so much has changed in the short period of time since the first version of the roadmap was published that a new version is clearly needed.

Policy Change

At the national level, in June 2019 UK Parliament passed legislation requiring the government to reduce the UK's net emissions of greenhouse gases by 100%, relative to 1990 levels, by 2050. At the local level, 2019 also saw a wave of local climate emergency declarations with places setting their own, usually more ambitious targets to reach net-zero emissions. By February 2020, 68% of UK district, county, unitary and metropolitan councils had declared a climate emergency, along with eight combined authorities/city regions*.

Within Leeds, Leeds City Council declared a climate emergency in March 2019, and it resolved to work to make Leeds carbon neutral by 2030 whilst also calling on central government to provide the funding and powers to make this possible. This declaration was followed by the "Big Leeds Climate Conversation", with extensive engagement at multiple events, and nearly 8,000 responses to a survey on what the public thought should be done about climate change.

Leeds City Council also set up its Climate Emergency Advisory Committee, and ran a State of the City event in early 2020 to review progress and guide next steps. This led to some significant policy changes with major investments in better transport and district heating already underway. Undoubtedly though many challenges remain and much still needs to be done.

The Leeds Climate Change Citizens' Jury

Later in 2019, the Leeds Climate Change Citizens' Jury brought together a representative sample of the public drawn from different groups and areas across the city to consider what Leeds should do about the climate emergency.

The jury process, which ran for a total of 30 hours,resulted in the jurors producing a set of 12 recommendations for the city, covering transport, housing, recycling, education and communication, policy instruments and finance.

This updated version of the Leeds Carbon Roadmap considers the impact that implementing all the jurors' recommendations would have on Leeds' (Scope 1 and 2) carbon footprint**. On top of the measures already identified, which the roadmap shows could close the gap between "business-as-usual" and net-zero emissions by 60% by 2030, implementing the Citizens' Jury recommendations would close the gap by a further 10% (or by 70% in total). That brings us a lot closer to our net-zero target, but it still leaves us to roll out some further more innovative options.

*Source: https://www.climateemergency.uk/

**The impacts of the Citizens' Jury recommendations relating to Leeds' wider (Scope 3) carbon footprint will be addressed in future analysis.

Green Recovery

Clearly the world has changed in 2020 with the coronavirus pandemic. From a climate perspective, the first, and we hope main phase of national lockdown in the spring and early summer did reduce our carbon footprint for a short period – and it triggered some changes in our behaviour that could help us in the longer term – but we clearly need a more positive way of addressing the climate challenge in the context of a healthy, inclusive and vibrant city.

This roadmap shows how, in the years to come, Leeds can radically reduce its carbon footprint whilst also becoming a better place, with cleaner air, improved public health, reduced poverty and inequality, increased employment and enhanced prosperity. The opportunities to stimulate the development of the city through climate action clearly highlight the need for a green recovery plan with investment in the decarbonisation of our homes, our businesses and our transport systems at its heart.

Andy Gouldson, Chair, and
Cllr Lisa Mulherin, Vice-Chair,
Leeds Climate Commission

Leeds Climate Commission

The Leeds Climate Commission was established in 2017 to support Leeds to make positive choices on issues relating to energy, carbon, weather and climate. Members of the Commission are drawn from key organisations and groups across the city from the public, private and civic sectors.

Informed by the work of the UK Committee on Climate Change, the Leeds Climate Commission is an independent voice in the city, providing authoritative advice on steps towards a low-carbon, climate resilient future to inform policies and shape the actions of local stakeholders and decision makers. It monitors progress towards meeting the city's carbon reduction targets, recommends actions to keep the city on track and advises on the assessment of the climate-related risks and adaptation opportunities in the city and on progress towards climate resilience.

The Commission aims to foster collaboration on projects that result in measurable contributions towards meeting the city's climate reduction targets and the delivery of enhanced climate resilience, It promotes best practice in public engagement on climate change in order to support robust decision-making and acts as a forum where organisations can exchange ideas, research findings, information and best practice.

https://leedsclimate.org.uk

LEEDS CARBON ROADMAP
PATHWAY TO NET-ZERO*

PCAN | LEEDS CLIMATE COMMISSION

BACKGROUND

1.5°C
The level of global temperature rise at which we risk triggering dangerous climate change

2030
The point at which - at current rates - the world will have locked into more than 1.5°C of warming

GLOBAL TO LOCAL

31m tonnes
Leeds' share of the global carbon budget (to keep to 1.5°C of warming)

Leeds is emitting
4m tonnes
of carbon a year. At this rate, we will have used up our budget by
2029

BASELINES AND TARGETS

40%
The decline in Leeds' carbon emissions since 2000

This needs to be increased to

70% by 2025
85% by 2030
100% by 2050

Leeds has committed to work towards being
CARBON NEUTRAL
by
2030

That leaves a **big gap** but we can close it by the following options

COST-EFFECTIVE OPTIONS

Cost-effective options such as
better housing and transport
could close the 2030 gap by
41%

These would reduce Leeds' energy bill by
£651m
per year, and would create nearly
15,000
years of extra employment

MORE AMBITIOUS OPTIONS

More ambitious but expensive options could
close the 2030 gap by
60%
These would have **benefits for** health, equality, travel and the environment

Doing all the Leeds Climate Change Citizens' Jury's recommendations would
close the 2030 gap by another
10%

REACHING OUR TARGET

Leeds can close the gap by
100% by 2030
through a range of
INNOVATIVE INTERVENTIONS

These include
decarbonising heating and planting trees - changing some behaviours and consumption habits would take us further still

Net Zero by 2030

*Net-zero, like "carbon neutral", refers to achieving an overall balance between emissions produced and emissions taken out of the atmosphere, with any residual emissions removed through carbon sinks.

EXECUTIVE SUMMARY

Background

- Scientific evidence calls for rapid reductions in global carbon[1] emissions if we are to limit average levels of warming to 1.5ºC and so avoid the risks associated with dangerous or runaway climate change.
- Globally, the Intergovernmental Panel on Climate Change (IPCC) suggests that we will have used up the global carbon budget that gives us a good chance of limiting warming to 1.5ºC within a decade. This science underpins calls for the declaration of a climate emergency.
- Dividing the global carbon budget up by population gives Leeds a total carbon budget of just 31 million tonnes from 2020. Based only on the fuel and electricity directly used within its boundaries (i.e. its Scope 1 and 2 emissions), Leeds currently emits c.4 million tonnes of carbon a year, and as such it would use up its carbon budget by 2029.
- This revised roadmap takes into account the recommendations of the Leeds Citizens' Jury on climate change by accelerating and intensifying the levels and rates of decarbonisation to be pursued, especially in areas such as housing and transport within the city.
- It is important to note that this assessment does not assess all elements of Leeds' broader carbon footprint – for example, those relating to longer distance travel or the goods and services that are produced elsewhere but consumed within the city (i.e. its consumption-based/Scope 3 emissions). These broader emissions add significantly to the carbon footprint of Leeds[2,3].

Baselines and Targets

- Scope 1 and 2 carbon emissions from Leeds have fallen by 40% since the turn of the Millennium. With on-going decarbonisation of grid electricity, and taking into account population and economic growth within the city region, we project that Leeds' 2000 level of annual emissions will have fallen by a total of 45% in 2030 and 49% in 2050.
- If it is to stay within its carbon budget, Leeds needs to add to the emissions reductions already achieved to secure 70% reductions on its 2000 level of emissions by 2025, 85% by 2030, 95% by 2035, 97% by 2040, 99% by 2045 and 100% by 2050.

[1]For simplicity, we use the term "carbon" as shorthand for all greenhouse gases. All figures in this report relate to the carbon dioxide equivalent (CO2e) of all greenhouse gases. Note that our assessment therefore differs from other assessments that focus only on CO_2. One exception to this rule is in our presentation of the IPCC 1.5 degree climate budget which is based in CO_2.

[2]For example, in its position paper on aviation, Leeds Climate Commission estimated that emissions from the flights taken by Leeds residents are currently equivalent to c.30% of the direct (Scope 1 and 2) carbon footprint of the city.

[3]Although these broader consumption-based/Scope 3 emissions are not fully considered in this report, they are a focus for on-going work and will be addressed in a forthcoming extension to this report.

- Without further activity to address its carbon emissions, we project that Leeds' annual emissions will exceed its carbon budget by 4 million tonnes in 2030, and 3.5 million tonnes in 2050.
- Emissions have obviously been influenced by the Covid-19 pandemic. Analysis suggests that Leeds' Scope 1 and 2 emissions were up to 43% lower than normal during the lockdown period from March to June 2020. Based only on this lockdown period, Leeds' annual emissions for 2020 as a whole would be 13% lower than expected. In the longer term, this reduction would only delay the point at which Leeds exceeds its overall carbon budget by 2 months.

Cost-Effective Options

- To meet these carbon emissions reduction targets, Leeds will need to adopt low carbon options that close the gap between its projected emissions in future and net-zero emissions. This can be partially realised through cost-effective options that would more than pay for themselves through the energy cost reductions they would generate whilst generating wide social and environmental benefits in the area.
- More specifically, the analysis shows that Leeds could close the gap between its projected emissions in 2030 and net-zero emissions by 41% purely through the adoption of cost-effective options in houses, public and commercial buildings, transport and industry.
- Adopting these options would reduce Leeds' total projected energy bill in 2030 by £651m whilst also creating 14,623 years of employment in the city. They could also help to generate wider benefits, including helping to tackle fuel poverty, reducing congestion and productivity losses, improving air quality, and enhancements to public health.
- The most carbon-effective options for the city to deliver these carbon cuts include improved deep retrofitting of heating, lighting and insulation in houses, cooling and insulation in offices, shops and restaurants, and a range of measures across the transport sector including modal shift to non-motorised transport and the wider up-take of electric vehicles.

More Ambitious Options

- The analysis also shows that Leeds could close the projected gap to net-zero emissions in 2030 by 60% through the adoption of options that are already available, but that some of these options would not pay for themselves directly through the energy savings that they would generate. Many of these options would, however, create wider indirect benefits both economically and socially in the city.
- This means that although it can achieve significant reductions in emissions by focusing on established cost-effective and technically viable measures, Leeds still has to identify other more innovative interventions that could deliver the last 40% of shortfall between projected emissions in 2030 and a net-zero target.

EXECUTIVE SUMMARY

- Options identified elsewhere - and discussed by the Leeds Climate Change Citizens' Jury - include promoting the use of low carbon vehicles, electrification and use of hydrogen for heating and cooking, and planting trees. Carbon emissions could be cut further still through behavioural and consumption-based changes such as the promotion of active travel (e.g. walking and cycling), reductions in meat and dairy consumption and the generation of food waste, and reduced consumption of concrete and steel with more emphasis on green infrastructure.
- As well as reducing Leeds' direct (Scope 1 and 2) carbon footprint, some of these more innovative measures (e.g. reducing meat and dairy or concrete and steel consumption) could start to focus on tackling the city's broader consumption-based (i.e. Scope 3) carbon footprint.

Next Steps

- In 2019, Leeds declared a climate emergency and made a commitment to work towards net-zero emissions by 2030.
- These commitments were reviewed by the Leeds Citizens' Jury, which made a series of recommendations for intensified climate action in the city. These recommendations have been included in the analysis presented here, and they clearly accelerate the rate and inform the path of decarbonisation for the city.
- This roadmap shows that Leeds' net-zero target can be met if a wide range of measures and changes to reduce carbon emissions can be adopted at scale and at pace across the city over the next decade.
- The case for the adoption of such measures is supported by evidence that much – but not all - of the action that is required will improve social, economic and environmental outcomes across the city as well as cutting its carbon emissions. Such measures could form a central part of a post-Covid recovery strategy for the city.
- However, even where there are wider social, economic and environmental benefits, too frequently there are also significant barriers preventing decarbonisation.
- To help to first identify and then to tackle these barriers, the Leeds Climate Commission has undertaken a city-wide Climate Action Readiness Assessment (CARA).
- The CARA process is helping to identify those areas where we are ready to take action to reduce carbon emissions now, those where we could be ready in the near future if some barriers were removed, and those where there are more fundamental challenges to be overcome before we are ready to act. This is helping to develop a timetable for action and priorities for intervention.
- The CARA process especially highlights the need for policy change and the need to stimulate investment. To address these, the Leeds Climate Commission is currently preparing a series of policy briefs to highlight the policy changes required at the local, regional or national scales to unlock low carbon activities across the city. It is also preparing an investment prospectus – with an emphasis on community-based as well as institutional investment – to stimulate low carbon investments across the city.
- These activities should focus initially on Leeds' direct (Scope 1 and 2) carbon footprint as these emissions are most directly under the city's influence. However, we should also recognise the need to consider our broader (consumption-based/Scope 3) carbon footprint – including those from areas such as food and aviation. As stated above, work is currently underway to better understand these broader carbon emissions – and this report will be extended to address these in the near future.

INTRODUCTION

Climate science has proven the connection between the concentration of greenhouse gases in the atmosphere and the extent to which the atmosphere traps heat and so leads to global warming. The science tells us – with a very high level of confidence – that such warming will lead to increasingly severe disruption to our weather patterns and water and food systems, and to ecosystems and biodiversity. Perhaps most worryingly, the science predicts that there may be a point where this process becomes self-fuelling, for example where warming leads to the thawing of permafrost such that significant quantities of greenhouse gases are released, leading to further warming. Beyond this point or threshold, the evidence suggests that we may lose control of our future climate and become subject to what has been referred to as dangerous or "runaway" climate change.

Until recently, scientists felt that this threshold existed at around 2ºC of global warming, measured as a global average of surface temperatures. However, more recent scientific assessments (especially by the IPCC in 2018) have suggested that the threshold should instead be set at 1.5ºC. This change in the suggested threshold from 2ºC to 1.5ºC has led to calls for targets for decarbonisation to be made both stricter (e.g. for the UK to move from an 80% decarbonisation target to a net-zero target, which it did in 2019) and to be brought forward (e.g. from 2050 to 2030), which the UK has not done, although many local authorities and other places have set themselves this ambitious goal.

Globally, the IPCC suggests that from 2020 we can only emit 344 billion tonnes of CO_2 if we want to give ourselves a 66% chance of avoiding dangerous climate change. We are currently emitting over 37 billion tonnes of CO_2 every year, which means that we will have used up our global carbon budget within a decade. It is this realisation – and the ever accumulating science on the scale of the impacts of climate change – that led to calls for organisations and areas to declare a climate emergency and to develop and implement plans to rapidly reduce carbon emissions.

OUR APPROACH

(a). Measuring an Area's Carbon Footprint

Any area's carbon footprint – measured in terms of the total impact of all of its greenhouse gas emissions – can be divided into three types of greenhouse gas emissions.

- Those coming from the fuel (e.g. petrol, diesel or gas) that is directly used within an area and from other sources such as landfill sites or industry within the area. These are known as Scope 1 emissions.
- Those coming from the electricity that is used within the area, even if it is generated somewhere else. These are known as Scope 2 emissions. Together Scope 1 and 2 emissions are sometimes referred to as "territorial" emissions.
- Those associated with the goods and services that are produced elsewhere but imported and consumed within the area. After taking into account the carbon footprint of any goods and services produced in the area but that are exported and consumed elsewhere, these are known as Scope 3 or consumption-based emissions.

In this report[4] we focus on Scope 1 and 2 emissions, and exclude consideration of long-distance travel and of Scope 3 or consumption-based emissions. We do this because Scope 1 and 2 emissions are more directly under the control of actors within an area, and because the carbon accounting and management options for these emissions are better developed.

We stress though that emissions from longer distance travel (especially aviation) and consumption are very significant, and also need to be addressed.

(b). Developing a Baseline of Past, Present and Future Emissions

Having a baseline of carbon emissions is key to tracking progress over time. We use local authority emissions data to chart changes in emissions from 2005 to 2018. We also break this down to show the share of emissions that can be attributed to households, public and commercial buildings, transport and industry.

We then project current emissions levels for the period through to 2050. To do this, we assume on-going decarbonisation of electricity in line with government commitments and a continuation of background trends in a) economic and population growth, and b) energy use and energy efficiency. Specific numbers for the key variables taken into account in the forecasts are presented in the technical annex published separately. As with all forecasts, the level of uncertainty attached increases as the time period in question extends. Even so, it is useful to look into the future to gauge the scale of the challenge to be addressed in each area, especially as it relates to the projected gap between the forecasted emissions levels and those that are required if an area's emissions are to be consistent with a global strategy to limit average warming to 1.5ºC.

(c). Setting Science-Based Carbon Reduction Targets

To set science-based carbon reduction targets for an area, we take the total global level of emissions that the IPCC suggests gives us a 66% chance of limiting average levels of warming to 1.5ºC, and divide it according to the share of the global population living in the area in question. This enables us to set the total carbon budget for an area that is consistent with a global budget. To set targets for carbon reduction, we then calculate the annual percentage reductions from the current level that are required to enable an area to stay within its overall carbon budget.

(d). Identifying and Evaluating Carbon Reduction Opportunities

Our analysis then includes assessment of the potential contribution of approximately 130 energy saving or low carbon measures for:

- **Households and for both public and commercial buildings** (including better insulation, improved heating, more efficient appliances, some small scale renewables)
- **Transport** (including more walking and cycling, enhanced public transport, electric and more fuel efficient vehicles)
- **Industry** (including better lighting, improved process efficiencies and a wide range of other energy efficiency measures).

We stress that the list of options that is assessed may not be exhaustive; other options could be available and the list can potentially be expanded.

For the options included, we assess the costs of their purchase, installation and maintenance, the direct benefits (through energy and fuel savings) of their adoption in different settings and their viable lifetimes. We also consider the scope for, and potential rates of deployment of each option. This allows us to generate league tables of the most carbon- and cost-effective options that could be deployed within an area.

It is important to note that we base the analysis on current capital costs, although future costs and benefits are adjusted for inflation and discounting factors. This could be overly cautious if costs fall and benefits increase as some options become more widely adopted, or if the costs increase as the rates of deployment increase. It is also important to note that, although we consider the employment generation potential of different options, we do not consider the wider indirect impacts of the different options relating to their social, economic or environmental implications.

Beyond the range of currently available options, we also consider the need for more innovative or "stretch" options to be developed and adopted within the area if it is to meet its carbon reduction targets. These need to be developed in each area, but the some of the ideas for innovative options identified elsewhere include targeting a full transition to net-zero homes and public/commercial buildings by 2030, promoting the rapid acceleration of active travel (e.g. walking and cycling), tackling food waste, reducing meat and dairy consumption and reducing concrete and steel consumption/promoting adoption of green infrastructure.

[4] Further details of the data, assumptions and methodology are set out in a separate technical annex that is available at https://pcancities.org.uk/reports

A NET-ZERO CARBON ROADMAP FOR LEEDS

OUR APPROACH

(e). Aggregating Up to See the Bigger Picture

Based on this bottom up analysis of the potential for different options to be adopted within the area, we then aggregate up to assess the potential for decarbonisation within that area, and the costs and benefits of different levels of decarbonisation. We then merge the aggregated analysis of the scope for decarbonisation with the baseline projections of future emissions to highlight the extent to which the gap between the projected and required emissions levels that can be met through different levels and forms of action.

To break this gap down, we merge interventions into three broader groupings:

- **Cost-Effective (CE)** options where the direct costs of adoption are outweighed by the direct benefits that they generate through the energy savings they secure, meaning the portfolio of measures as a whole has a positive economic impact in present value. These options may also generate indirect benefits, for example through job creation, fuel poverty and improved air quality and public health.
- **Cost-Neutral (CN)** options where the portfolio of interventions mentioned above is expanded to consider investments that may not be as cost effective on their own terms, but where the range of measures as a whole will have near-zero net cost.
- **Technical Potential (TP)** options where the direct costs are not (at present) covered by the direct benefits. However, the cost of many low carbon options is falling quickly, and again these options could generate important indirect benefits such as those listed above.

As it is unlikely that adopting all of the cost-effective or even technically viable options will enable an area to reach net-zero emissions, we also highlight the need for a fourth group of measures:

- **Innovative or "stretch" options** that include low-carbon measures that are not yet widely adopted. Some of the options within this group may well be cost- and carbon-effective, and they may also generate significant indirect benefits, but whilst we can predict their carbon saving potential, data on their costs and benefits is not yet available.

(f). Developing Targets and Performance Indicators

Linked to the analysis detailed above, we extend our evaluation of potential emissions reductions across Leeds' economy to substantive, real-life indicators for the levels of investment and deployment required to achieve targets. These Key Performance Indicators (KPIs) illustrate the scale of ambition required to reach the emissions savings presented in the Technical Potential scenario and are disaggregated by sector.

(g). Focusing on Key Sectors

As well as presenting an aggregated picture, we also focus on the emissions saving potential in the housing, public and commercial buildings, transport, industry and waste sectors. We focus in on overall investment needs and returns, and present more detailed league tables of the most carbon- and cost-effective options that could be adopted in each sector.

DEVELOPING A BASELINE OF PAST, PRESENT AND FUTURE EMISSIONS FOR LEEDS

Analysis shows that Leeds' baseline (Scope 1 and 2) emissions have fallen by 40% since 2000, due to a combination of increasingly decarbonised electricity supply, structural change in the economy, and the gradual adoption of more efficient buildings, vehicles and businesses.

With full decarbonisation of UK electricity by 2045, and taking into account economic growth (assumed at 1.5% p.a.), population growth (assumed at 0.1% p.a.) and on-going improvements in energy and fuel efficiency, we project that Leeds' baseline (Scope 1 and 2) emissions will only fall by a further 6% by 2030, 9% by 2040, and 10% by 2050. This is a total of just under 50% between 2000 and 2050.

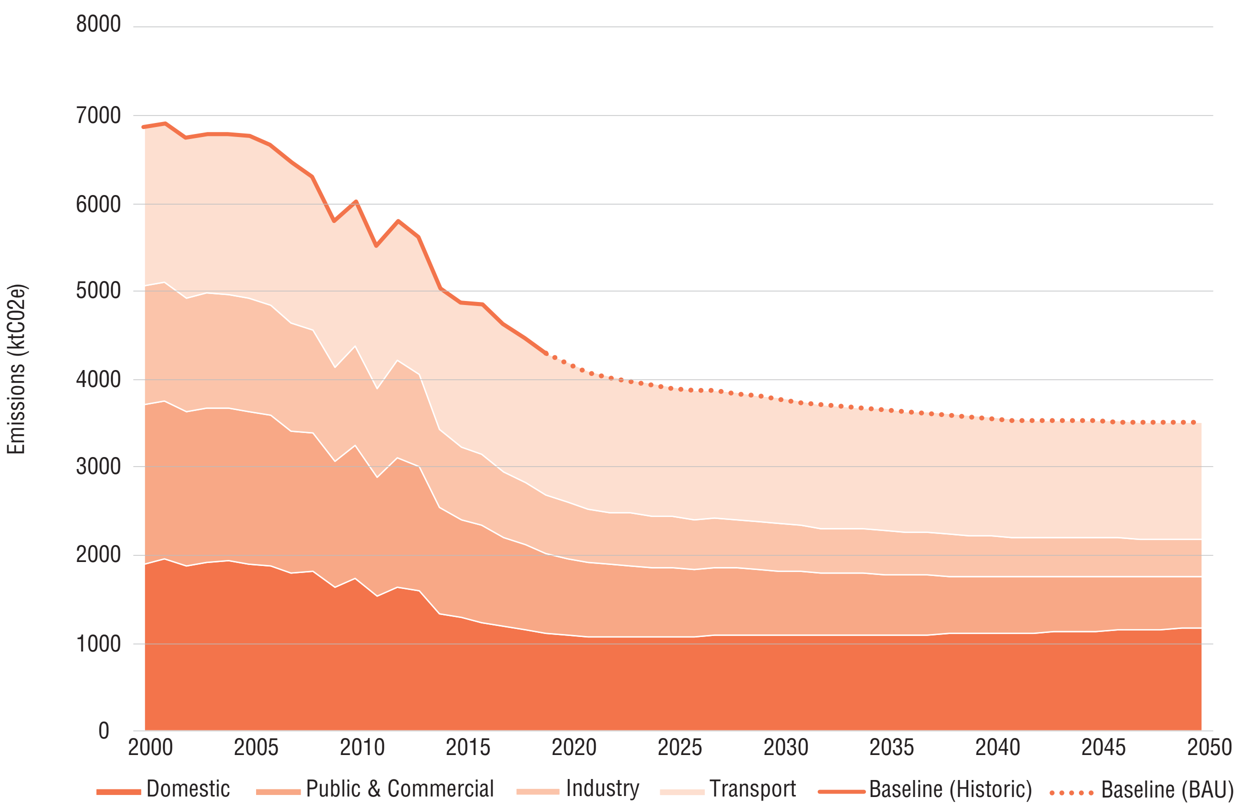

Figure 1: Leeds' Scope 1 and 2 carbon emissions (2000-2050)

Currently, 38% of Leeds' emissions come from the transport sector, with housing responsible for 26% of emissions, public and commercial buildings for 21% and industry 15%. Emissions related to land use contribute c.0.5% and are not considered technically in this report. By 2050, under BAU, we project emissions from transport will decrease very slightly (still producing c.38%) with a significant 7% increase in the proportion of emissions from housing. Small decreases are forecast in the proportion of emissions from public and commercial buildings and industry, largely as a result of expansion in the output of the domestic buildings sector over this period.

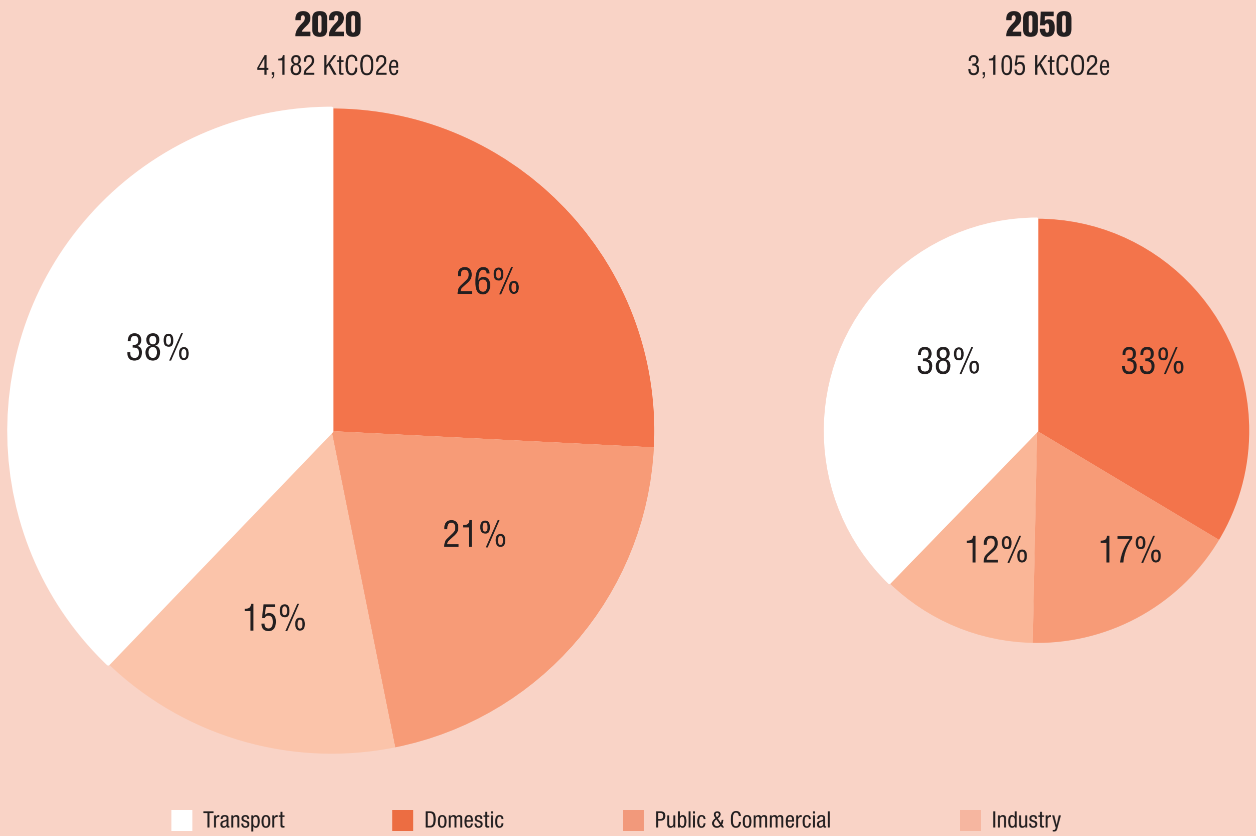

Figure 2: Leeds' Present and Projected Emissions by Sector

DEVELOPING A BASELINE OF PAST, PRESENT AND FUTURE EMISSIONS FOR LEEDS

Related to this emissions baseline, after evaluating the range of energy sources Leeds consumes (spanning electricity, gas, all solid and liquid fuels across sectors) we find that in 2019, £1.4 billion was spent on energy across the city. Transport fuels generated the majority of this demand (51%), followed by domestic buildings (28%) then public and commercial buildings and industry (17% and 4% respectively). By projecting demand and energy prices into future with reasonable baseline assumptions over population, inflationary measures and efficiency gains across the economy, we find that Leeds' business-as-usual (BAU) energy expenditure will likely grow to just over £1.5 billion per year in 2030 and c.£2 billion per year in 2050, with transport expenditure growing to over half (63%) of Leeds' total (see Figure 3 below).

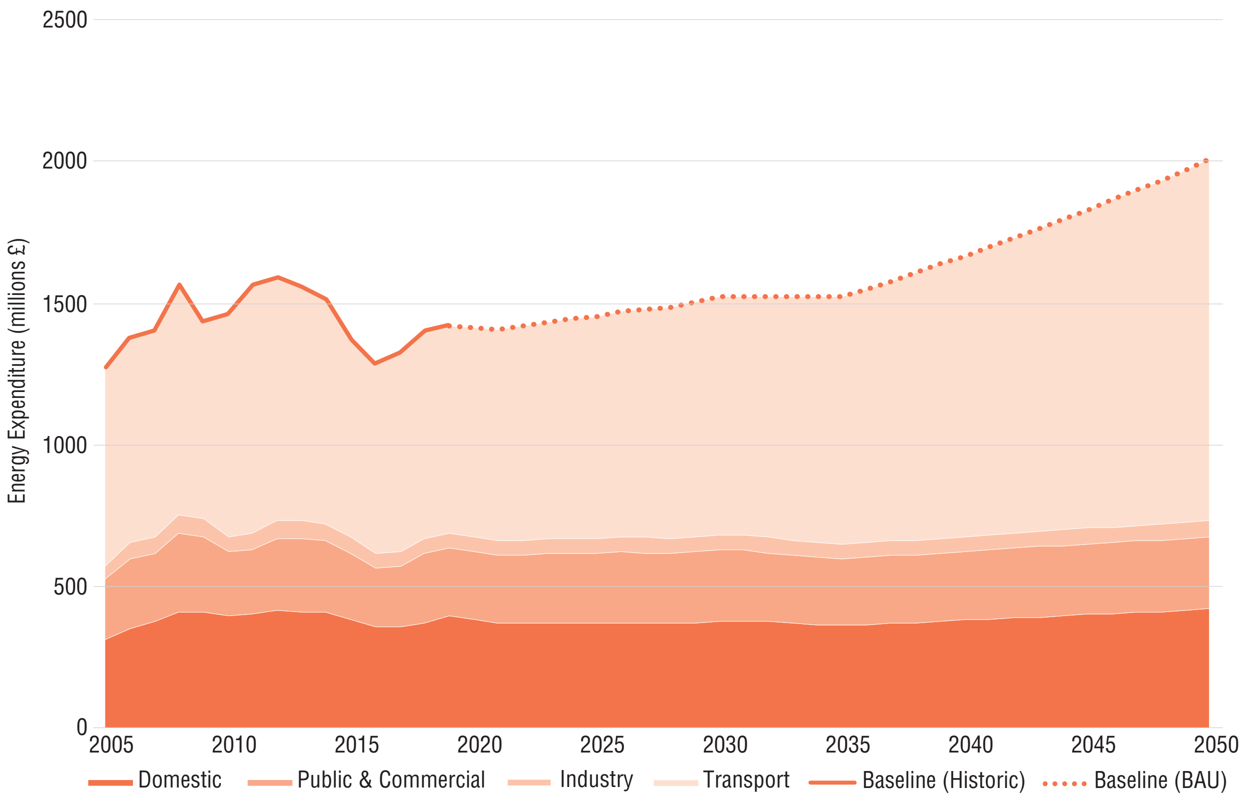

Figure 3: Leeds' Present and Projected Energy Expenditure by Sector

SETTING SCIENCE-BASED CARBON REDUCTION TARGETS FOR LEEDS

The Intergovernmental Panel on Climate Change (IPCC) has argued that from 2020, keeping within a global carbon budget of 344 gigatonnes (i.e. 344 billion tonnes) of CO_2 emissions would give us a 66% chance of limiting average warming to 1.5ºC and therefore avoiding dangerous levels of climate change. If we divide this global figure up on an equal basis by population, and make adjustments so that our budgets include all greenhouse gases, this gives Leeds a total carbon budget of 31 megatonnes over the period between the present and 2050.

At current rates of emissions output, Leeds would use up this budget in 2029. However, Leeds could stay within its carbon budget by reducing its emissions by c.11% year on year. This would mean that to transition from the current position where emissions are 40% lower than 2000 levels to a local pathway that is consistent with the world giving itself a 66% chance of avoiding dangerous, runaway climate change, Leeds should adopt the following carbon reduction targets (on 2000 levels):

70% by 2025

85% by 2030

95% by 2035

97% by 2040

99% by 2045

100% by 2050

Such a trajectory would mean that the majority of all carbon cuts needed for Leeds to transition to a 1.5ºC consistent pathway need to be delivered by 2030.

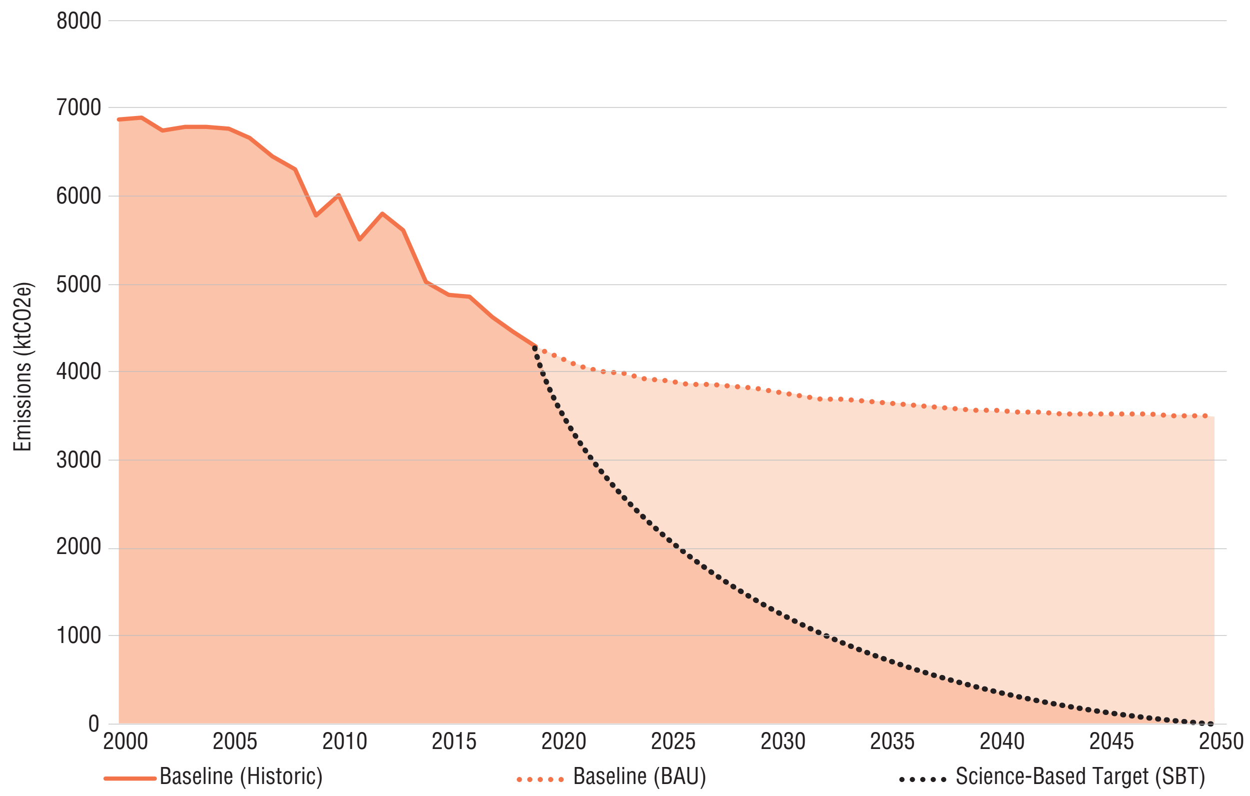

Figure 4: Leeds' Baseline and Science-Based-Target Emissions Pathways

AGGREGATING UP: THE BIGGER PICTURE FOR LEEDS

a) Emissions reductions

Our analysis predicts that the gap between Leeds' business-as-usual (BAU) emissions in 2030 and the net-zero target could be closed by 41% (1.6 MtCO2e) through the adoption of cost-effective (CE) options, by a further 11% (403 ktCO2e) through the adoption of additional cost-neutral (CN) options at no net cost, and then by an additional 8% (287 ktCO2e) through the further adoption of all technically viable (TP = technical potential) options. This means that Leeds still has to identify the innovative or stretch options that could deliver the last 40% (1.5 MtCO2e) of the gap between the business-as-usual scenario and net-zero in 2030 following science-based targets (SBT).

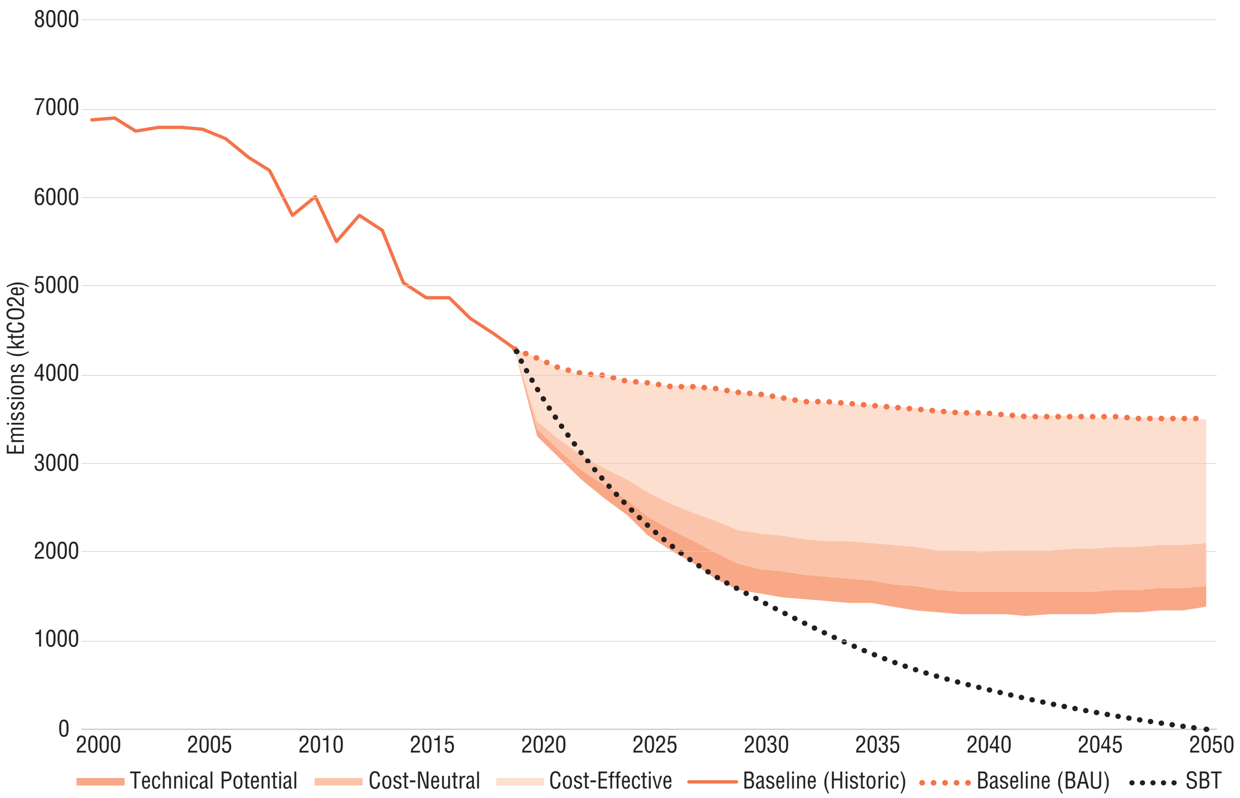

Figure 5: Leeds' BAU Baseline with Cost-Effective, Cost-Neutral, & Technical Potential Scenarios

		2025	2030	2035	2040	2045	2050
Reduction on BAU Baseline (2050)	**CE**	32%	41%	42%	44%	42%	40%
	CN	38%	52%	54%	57%	56%	54%
	TP	44%	60%	61%	64%	63%	61%
Reduction on 2020 Emissions	**CE**	29%	37%	37%	37%	36%	33%
	CN	36%	47%	47%	48%	47%	45%
	TP	41%	54%	53%	54%	53%	51%

Table 1: Leeds' Potential Five-Year Emissions Reduction Percentages

AGGREGATING UP: THE BIGGER PICTURE FOR LEEDS

b) The most carbon- and cost-effect options

Figure 6 below presents the emissions savings that could be achieved through different groups of measures in Leeds. Appendices 1 and 2 present league tables of specific measures and their potential emissions savings over this period.

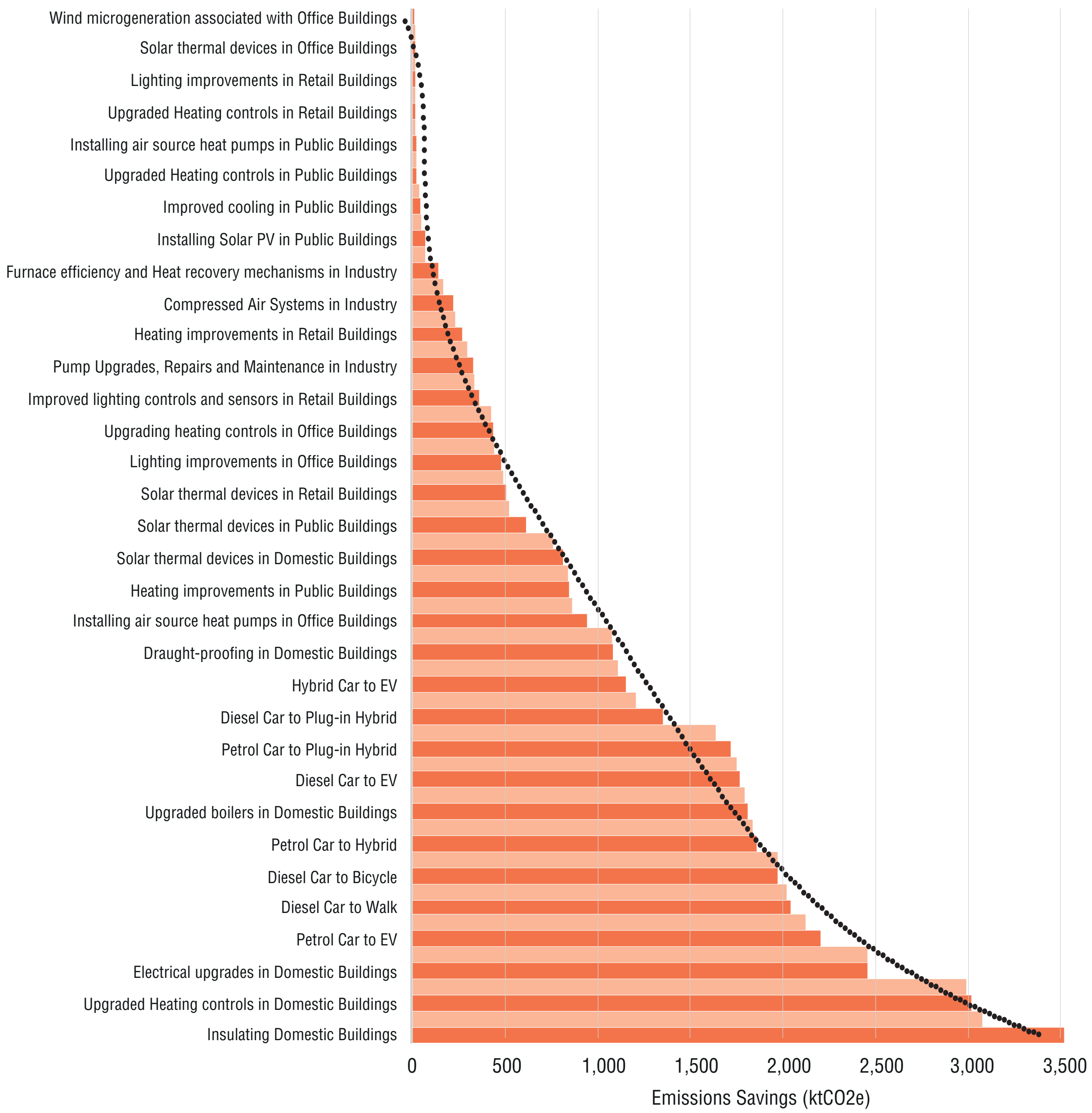

Figure 6: Simplified Emissions Reduction Potential by Measure for Leeds

Simplified league tables of the most cost- and carbon effective options in Leeds are presented below (see the technical annex published separately for more detailed league tables).

Rank	Measure	Cost Effectiveness (£/tCO2e)
1	Compressed Air Systems in Industry	-610
2	Pump Upgrades, Repairs and Maintenance in Industry	-566
3	Diesel Car to Diesel Bus Journeys	-464
4	Fabric improvements in Retail Buildings	-452
5	Petrol Car to Diesel Bus Journeys	-417
6	Diesel Car to Walk Journeys	-372
7	Petrol Car to Walk Journeys	-350
8	Diesel Car to Bicycle Journeys	-348
9	Fabric improvements in Public Buildings	-342
10	Petrol Car to Bicycle Journeys	-326

Table 2: Leeds' Top Ten Most Cost-Effective Emission Reduction Options

Rank	Measure	Emissions Reduction Potential (ktCO2e)
1	Insulating Domestic Buildings	3,520
2	Petrol Car to Bicycle Journeys	3,076
3	Upgraded Heating controls in Domestic Buildings	3,016
4	Petrol Car to Walk Journeys	2,991
5	Electrical upgrades in Domestic Buildings	2,460
6	Installing heat pumps in Domestic Buildings	2,457
7	Petrol Car to EV Journeys	2,202
8	Petrol Car to Electric Bus Journeys	2,124
9	Diesel Car to Walk Journeys	2,040
10	Fabric improvements in Public Buildings	2,021

Table 3: Leeds' Top Ten Most Carbon-Effective Emission Reduction Options

AGGREGATING UP: THE BIGGER PICTURE FOR LEEDS

Some of the ideas for innovative options identified elsewhere, that could also be considered for Leeds, include targeting a full transition to net-zero homes and public/commercial buildings by 2030, promoting the rapid acceleration of active travel (e.g. walking and cycling), tackling food waste, reducing meat and dairy consumption and reducing concrete and steel consumption/promoting adoption of green infrastructure. These are highlighted at the end of our report ("Innovative Stretch Measures for Leeds").

c) Investment needs, paybacks and employment creation

Exploiting the cost-effective options in households, public and commercial buildings, transport, industry and waste could be economically beneficial. Although such measures would require total investments of nearly £6 billion over their lifetimes (equating to investments of £600m a year across all organisations and households in the city for the next decade), once adopted they would reduce Leeds' total energy bill by £651 million p.a. in 2030 whilst also creating 14,823 years of employment (741 full-time jobs for the next 20 years).

By expanding this portfolio of measures to at no net cost to Leeds' economy (the Cost-Neutral scenario), investments of £9 billion over their lifetimes (or £900m a year for the next decade) would generate 22,229 years of employment (or 1,111 jobs for the next 20 years) whilst reducing Leeds' emissions by 52% of projected 2030 levels.

Exploiting all technically viable options would be more expensive (at least at current prices, c.£11 billion or £1,110m a year for the next decade) but realise further emissions savings – eliminating 60% of the projected shortfall in Leeds' 2030 emissions, whilst saving hundreds of millions of pounds on an annual basis.

		2025	2030	2035	2040	2045	2050
Cumulative Investment (£M)	**CE**	3,175	5,272	5,484	5,538	5,542	5,542
	CN	5,257	8,329	8,641	8,716	8,719	8,719
	TP	6,740	10,919	11,280	11,355	11,359	11,359
Annual Energy Expenditure Savings (£M)	**CE**	535	651	649	632	552	501
	CN	416	553	554	537	448	375
	TP	369	555	556	540	454	377

Table 4: Potential Five-Year Investments and Energy Expenditure Savings

Sector	Scenario	Investment (£M)
Domestic	**CE**	2,600
	CN	4,384
	TP	5,523
Public & Commercial	**CE**	1,306
	CN	1,618
	TP	2,623
Industry	**CE**	429
	CN	744
	TP	1,238
Transport	**CE**	1,208
	CN	1,974
	TP	1,974

Table 5: Potential Investments by Sector & Economic Scenario

		Total	Domestic	Industry	Transport	Public & Commercial
Years of Employment	**CE**	**14,823**	5,559	1,467	1,653	6,144
	CN	**22,229**	9,374	2,544	2,702	7,609
	TP	**31,088**	11,811	4,234	2,702	12,341
Jobs (20-year Period)	**CE**	**741**	278	73	83	307
	CN	**1,111**	469	127	135	380
	TP	**1,554**	591	212	135	617

Table 6: Potential Job Creation by Sector & Economic Scenario

DEVELOPING TARGETS AND PERFORMANCE INDICATORS

To give an indication of the levels of activity required to deliver on these broader targets, the tables below detail total deployment across different sectors in Leeds through to 2050. We also give an indication of the rate of deployment required in the city if it is to even come close to its climate targets. These lists are not exhaustive, and also apply by measure; any one building or industrial facility will usually require the application of several measures over the period. These figures effectively become Key Performance Indicators (KPIs) for the delivery of climate action across the city.

Domestic Homes

Measure	Total Homes Applied	Mean Annual Rate of Installation (homes)
Lighting Upgrades	200,058	11,114
Floor Insulation	188,103	10,524
Gas Boiler Upgrades & Repairs	181,340	10,030
Glazing Upgrades	176,676	9,885
Solar thermal	141,157	7,795
Solar PV	138,754	7,678
Thermostats & Heating Controls	136,068	7,499
Loft insulation	125,088	6,984
Wall Insulation	89,548	4,985
Draught Proofing	71,298	3,993
Cavity wall Insulation	59,477	3,284
Heat Pumps	14,648	808

Table 7 (a): Leeds' Sectoral Emissions Reduction KPIs for Domestic Homes

Public & Commercial Buildings

Measure	Floorspace Applied (m^2)	Mean Annual Rate of Installation (m^2)
Office Lighting Upgrades	1,824,991	102,310
Lighting/Heating Controls and Sensors	7,253,707	418,900
Retail Heating Upgrades	7,032,178	410,809
Wind Turbines	4,023,813	223,545
Office Fabric Improvements	1,779,828	102,042
Office Solar PV	612,517	34,617
Office Heat Pumps	612,517	34,547

Table 7 (b): Leeds' Sectoral Emissions Reduction KPIs for Public & Commercial Buildings

Transport

Measure	Deployment
High Quality Protected Cycling Highways Built	28 kilometres
Additional Electric Buses Procured and In Service	203 per annum
Increase in Public Transport Ridership	13M trips per annum
Additional EVs Replacing Conventional Private Cars	15,241 per annum

Table 7 (c): Leeds' Sectoral Emissions Reduction KPIs for Transport

FOCUSING ON KEY SECTORS IN LEEDS

At full deployment (technical potential) across Leeds, we calculate that there is potential to avoid 63 MtCO2e in emissions that will otherwise be produced in the city between 2020 and 2050.

The domestic housing and transport sectors will contribute most significantly towards this total, with a combined decarbonisation potential of between 35 MtCO2e (cost-effective scenario) and 48 MtCO2e (technical potential) through the period. However, industry and public and commercial buildings also play a major role; upgrading and retrofitting of Leeds' built environment (including public and commercial buildings) reduce emissions by up to c.12 MtCO2e over the same period at full technical potential, with industry similarly showing the potential to decarbonise nearly 3 MtCO2e under the same conditions.

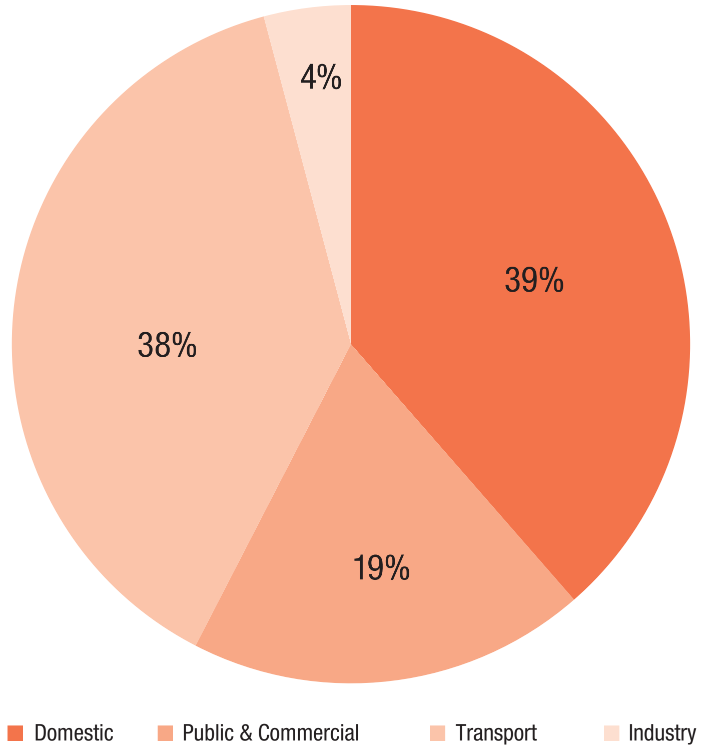

Figure 7: Leeds' Emissions Reduction Potential (2020-2050) by Sector

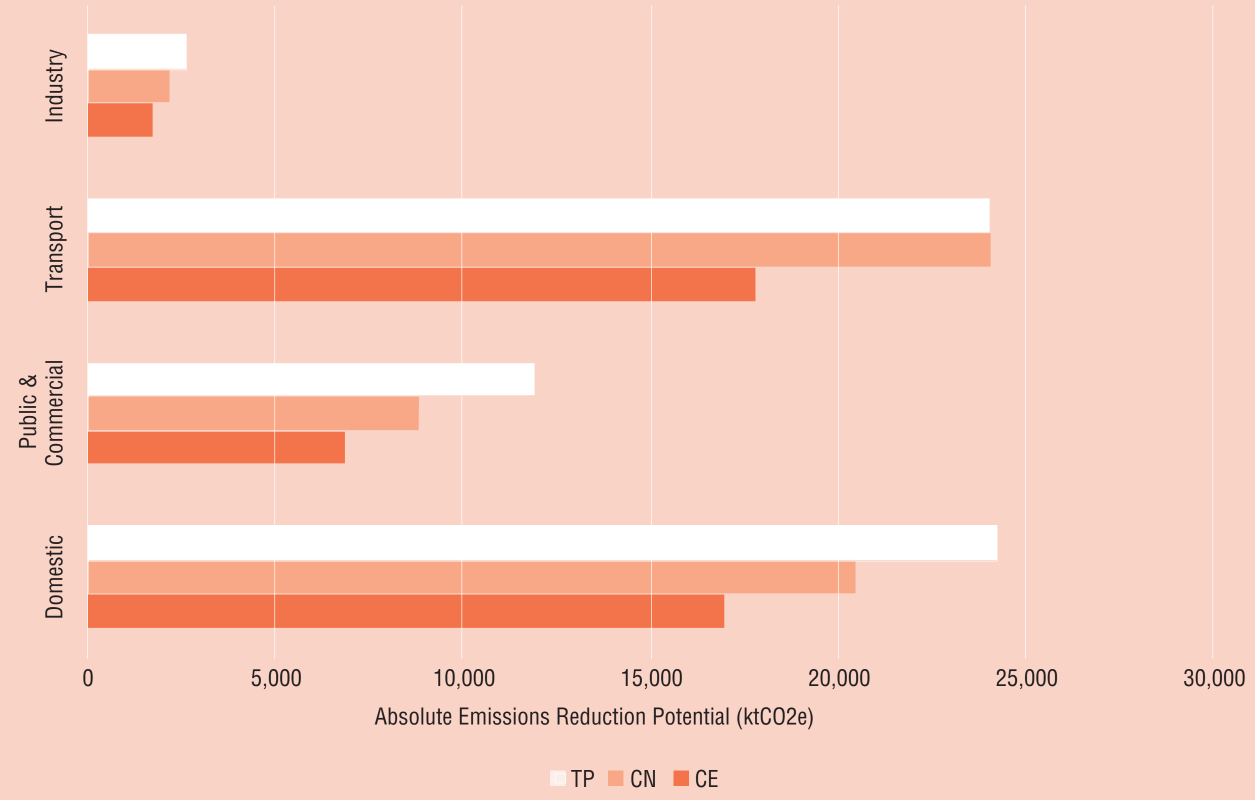

Figure 8: Leeds' Emissions Reduction Potential By Sector & Economic Scenario (2020-2050)

FOCUSING ON KEY SECTORS IN LEEDS

In the following section, summaries of the emissions reduction potential and economic implications of investment are presented for the four main sectors comprising this analysis. For display and continuity purposes, each sector is displayed with a summary of the same metrics: (1) emissions reduction potential over time in the three economic scenarios, (2) five-year totals for cumulative emissions savings, investment requirements and annual energy expenditure reductions, and (3) a simplified table of the most cost-effective low carbon measures applied in each sector across Leeds.

(a). Domestic Housing

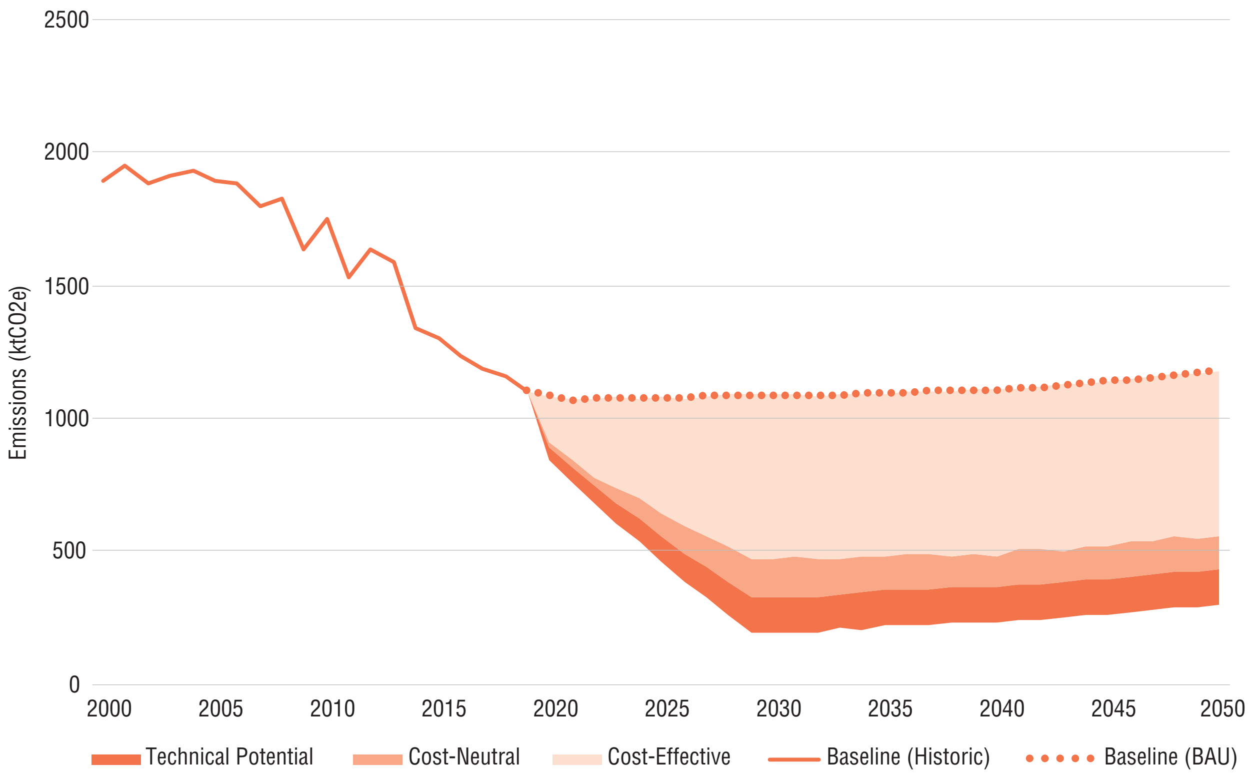

Figure 9: Housing BAU Baseline with Cost-Effective, Cost-Neutral and Technical Potential Scenarios

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	432	618	620	605	624	626
	CN	520	762	740	737	744	744
	TP	617	899	871	871	878	879
Annual Energy Expenditure Savings (£M)	**CE**	124	141	136	131	117	117
	CN	155	175	169	162	145	145
	TP	129	143	139	134	123	123
Cumulative Investment (£M)	**CE**	1,481	2,472	2,600	2,600	2,600	2,600
	CN	2,559	4,198	4,384	4,384	4,384	4,384
	TP	3,235	5,288	5,523	5,523	5,523	5,523

Table 8: Housing Emissions Reductions, Expenditure Savings and Investment Levels

Rank	Measure	Cost Effectiveness (£/tCO2e)
1	Electrical Appliance & Fixture Upgrades	-180
2	High Efficiency Lighting Improvements	-158
3	Electricity Demand Reduction	-106
4	Draught-proofing & Fabric Improvements	-39
5	Installing Heat Pumps	-31
6	Glazing improvements & Upgrades	-29
7	Upgraded Heating Controls	-26
8	Installing Biomass Boilers	-19
9	Solar PV and Thermal Device Installation	-14
10	Upgraded Boilers	-10

Table 9: The Most Cost-Effective Measures for Housing

FOCUSING ON KEY SECTORS IN LEEDS

(b). Public & Commercial Buildings

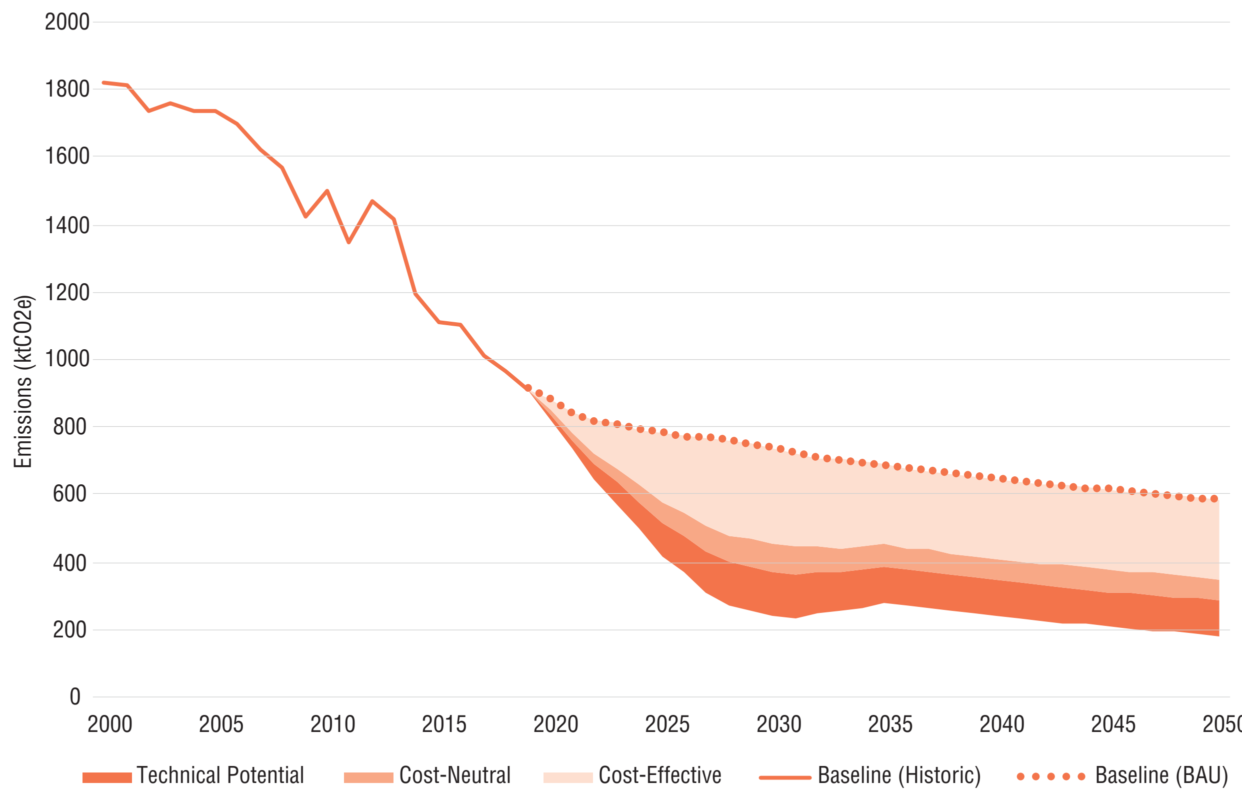

Figure 10: Public and Commercial Buildings BAU Baseline with Cost-Effective, Cost-Neutral and Technical Potential Scenarios

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	210	279	235	236	239	239
	CN	271	359	302	301	305	303
	TP	371	488	410	408	408	408
Annual Energy Expenditure Savings (£M)	**CE**	201	228	221	211	187	188
	CN	48	55	53	51	45	45
	TP	72	83	80	76	68	68
Cumulative Investment (£M)	**CE**	817	1,306	1,306	1,306	1,306	1,306
	CN	1,130	1,618	1,618	1,618	1,618	1,618
	TP	1,641	2,623	2,623	2,623	2,623	2,623

Table 10: Public and Commercial Buildings Emissions Reductions, Expenditure Savings and Investment Levels

Rank	Measure	Cost Effectiveness (£/tCO2e)
1	Fabric Improvements in Retail Buildings	-452
2	Fabric Improvements in Public Buildings	-342
3	Improved Cooling in Retail Buildings	-301
4	Lighting Improvements in Public Buildings	-176
5	Improved Cooling in Office Buildings	-147
6	Lighting Improvements in Retail Buildings	-138
7	Heating Improvements in Public Buildings	-104
8	Improved Cooling in Public Buildings	-83
9	Lighting Improvements in Office Buildings	-64
10	Heating Improvements in Office Buildings	-59

Table 11: The Most Cost-Effective Measures for Public and Commercial Buildings

FOCUSING ON KEY SECTORS IN LEEDS

(c). Transport

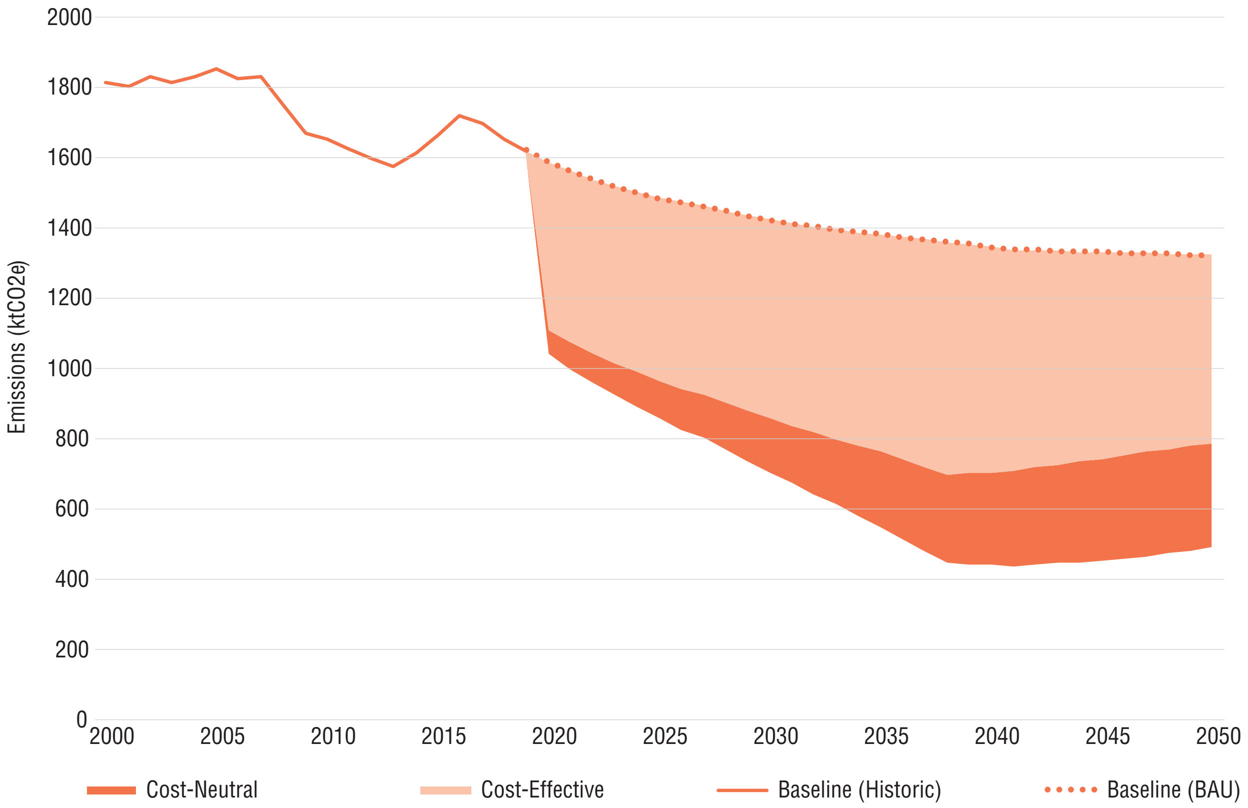

Figure 11: Transport BAU Baseline with Cost-Effective and Cost-Neutral Scenarios[5]

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	521	566	622	640	588	535
	CN	627	719	835	905	882	833
	TP	627	719	835	905	882	833
Annual Energy Expenditure Savings (£M)	**CE**	224	235	244	251	223	197
	CN	252	265	273	275	228	185
	TP	252	265	273	275	228	185
Cumulative Investment (£M)	**CE**	619	1,065	1,150	1,203	1,208	1,208
	CN	1,122	1,770	1,896	1,971	1,974	1,974
	TP	1,122	1,770	1,896	1,971	1,974	1,974

Table 12: Transport Emissions Reductions, Expenditure Savings and Investment Levels

Rank	Measure (as Journey Shift)	Cost Effectiveness (£/tCO2e)
1	Diesel Car to Diesel Bus Journey	-464
2	Petrol Car to Diesel Bus Journey	-417
3	Diesel Car to Walk Journey	-372
4	Petrol Car to Walk Journey	-350
5	Diesel Car to Bicycle Journey	-348
6	Petrol Car to Bicycle Journey	-326
7	Petrol Car to Plug-in hybrid Journey	-255
8	Diesel Car to Plug-in hybrid Journey	-152
9	Petrol Car to Hybrid Journey	-136
10	Petrol Car to EV Journey	-134

Table 13: The Most Cost-Effective Measures for Transport

[5] Due to the high inherent cost effectiveness of many transport modal shift options, the TP scenario has been removed and emissions pathways are covered by CE and CN only.

FOCUSING ON KEY SECTORS IN LEEDS

(d). Industry

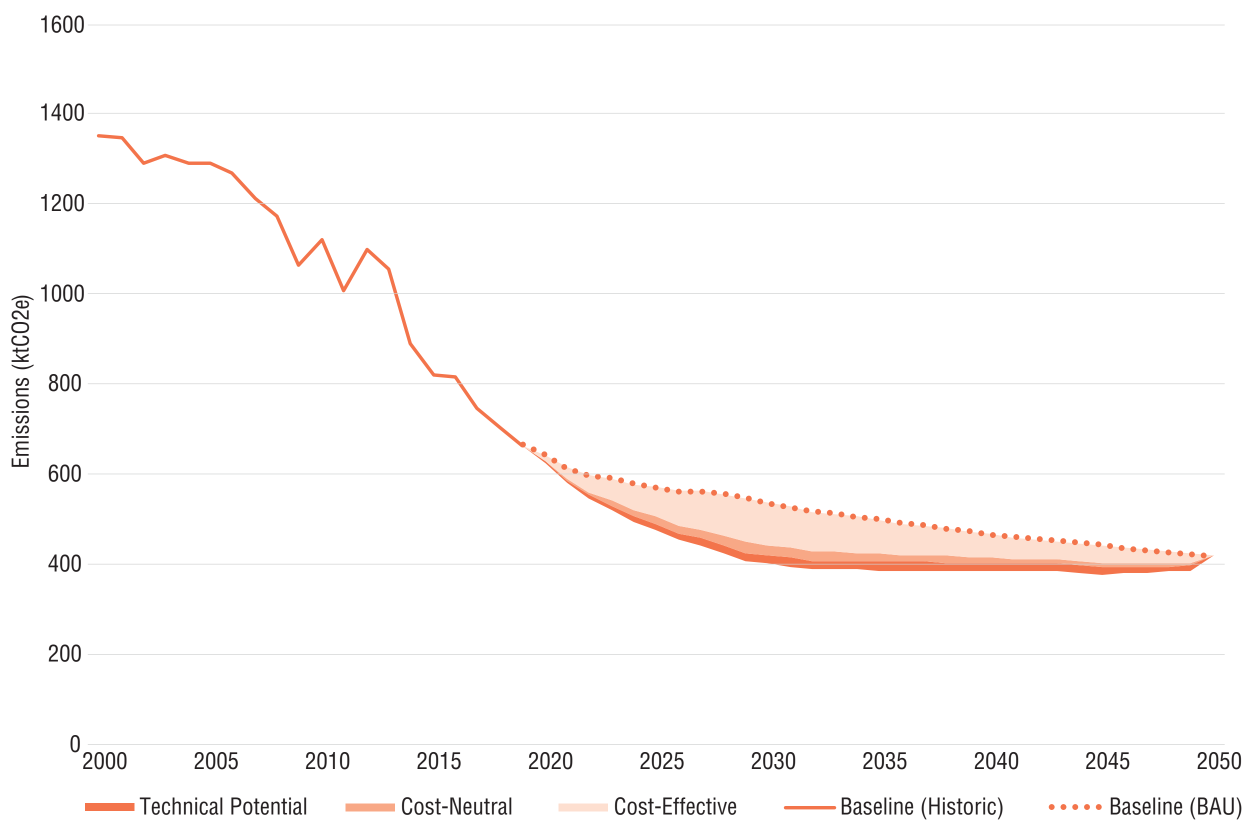

Figure 12: Industry BAU Baseline with Cost-Effective, Cost-Neutral and Technical Potential Scenarios

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	67	94	76	53	39	23
	CN	83	117	93	65	48	27
	TP	96	137	112	82	64	37
Annual Energy Expenditure Savings (£M)	**CE**	-15	47	47	39	24	12
	CN	-39	58	58	49	30	14
	TP	-85	64	64	55	35	17
Cumulative Investment (£M)	**CE**	257	429	429	429	429	429
	CN	446	744	744	744	744	744
	TP	743	1,238	1,238	1,238	1,238	1,238

Table 14: Industry Emissions Reductions, Expenditure Savings and Investment Levels

Rank	Measure[6]	Cost Effectiveness (£/tCO2e)
1	Compressed Air Systems in Industry	-610
2	Pump Upgrades, Repairs and Maintenance in Industry	-566
3	Fan Correction, Repairs, & Upgrades in Industry	-299
4	Compressors and Variable Speed Systems in Industry	-223
5	Improving Efficiency of Boilers and Steam Piping in Industry	-71
6	Refrigeration Efficiency and Technical Upgrades in Industry	15
7	Condensing & Insulation Measures to Boilers & Steam Piping in Industry	48
8	Furnace Efficiency and Heat Recovery Mechanisms in Industry	539

Table 15: The Most Cost-Effective Measures for Industry

[6] For display purposes interventions in industry have been aggregated here into process type

INNOVATIVE STRETCH MEASURES FOR LEEDS

Even with full delivery of the broad programme of cross-sectoral, city-wide low carbon investment described above, there remains an emissions shortfall of 40% between Leeds's 2030 BAU baseline and the net-zero target. Here we briefly consider the productivity of certain key technologies and interventions that may well be able to plug this gap into the future. Many of these so-called "stretch options" are innovative by nature but they will be required to reach Leeds' targets in future.

		2025	2030	2035
Annual Emissions Reduction Potential (ktCO2e)	Zero carbon heavy goods transport	68	319	313
	Electrification of industrial heating and cooling	40	38	22
	Electrification of domestic heating	26	133	189
	Electrification of domestic cooking	8	44	63
	Electrification of commercial and public heating	14	42	14
	Hydrogen-based heating (H21)	0	289	275
	2000 Ha Annual Reforestation (2020-29)*	133	343	422

Table 16: Decarbonising Potential of Stretch Measures (*Sequestration Values)

Figure 13 below shows the impact that the adoption of these stretch measures would have on Leeds' carbon emissions, with the black dotted line showing the business-as-usual baseline, the orange dotted line showing emissions after adoption of all technically viable options and the grey dotted line showing emissions after all technically viable and stretch options. This indicates that Leeds would still have some residual emissions through to 2050. For illustration, the grey shaded area shows that in theory Leeds could offset its residual emissions through a UK based tree planting scheme; however this would require the planting of 89 million trees, which even with the densest possible planting would require 20,000 hectares of land, equivalent to 36% of the total land area of the city.

Carbon emissions could be cut further still through with the adoption of behavioural and consumption-based changes such as the promotion of active travel (e.g. walking and cycling), reductions in meat and dairy consumption and the generation of food waste, and reduced consumption of concrete and steel with more emphasis on green infrastructure. Such consumption-based changes – which would impact on the broader Scope 3 carbon footprint of the city – will be the focus of future work.

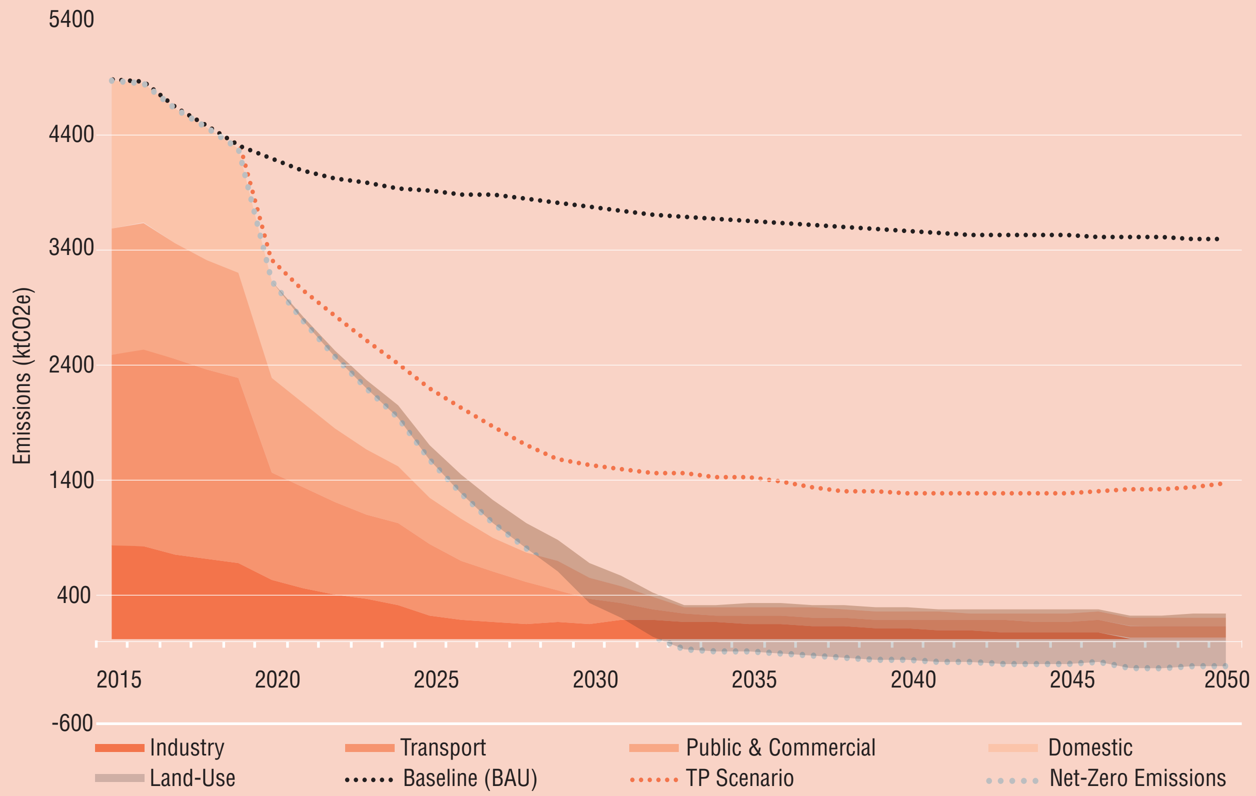

Figure 13: Sectoral Emissions Shortfall Reduction with Stretch Measures

NEXT STEPS FOR LEEDS

Leeds has already made a commitment to work towards net-zero emissions by 2030. This roadmap shows we can get very close to meeting this ambitious target if a wide range of measures and changes to reduce carbon emissions can be adopted at scale and at pace across the city over the next decade. The case for the adoption of such measures is supported by evidence that much – but not all – of the action that is required will improve social, economic and environmental outcomes across the city as well as cutting its carbon emissions. Such measures could form a central part of a post-Covid recovery strategy for the city.

However, even where there are wider social, economic and environmental benefits, too frequently there are also significant barriers preventing decarbonisation. To help to first identify and then to tackle these barriers, the Leeds Climate Commission is currently undertaking a city-wide Climate Action Readiness Assessment (CARA). The CARA process is helping to identify those areas where we are ready to take action to reduce carbon emissions now, those where we could be ready in the near future if some barriers were removed, and those where there are more fundamental challenges to be overcome before we are ready to act. This is helping to develop a timetable for action for the Commission, and priorities for intervention.

Key barriers to decarbonisation in Leeds emerging from the CARA process relate to the need for policy change and the need to stimulate investment. To address these, the Commission is currently preparing a series of policy briefs to highlight the policy changes required at the local, regional or national scales to unlock low carbon activities across the city. It is also preparing an investment prospectus – with an emphasis on community-based as well as institutional investment – to stimulate low carbon investments across the city. The Commission is also restructuring itself to develop action groups to support, catalyse, guide and track low carbon initiatives in housing, public and commercial buildings and transport across the city.

These activities should focus initially on Leeds' direct (Scope 1 and 2) carbon footprint as these emissions are most directly under the city's influence. However, we should also recognise the need to consider our broader (consumption-based/Scope 3) carbon footprint – including those from areas such as food and aviation. As stated above, work is currently underway to better understand these broader carbon emissions – and this report will be extended to address these in the near future.

APPENDIX 1. LEAGUE TABLE OF THE MOST CARBON-EFFECTIVE OPTIONS FOR LEEDS

Measure	Emissions Reduction Potential (ktCO2e)
Insulating Domestic buildings	3,520
Petrol Car to Bicycle Journeys	3,076
Upgraded Heating controls in Domestic buildings	3,016
Petrol Car to Walk Journeys	2,991
Electrical upgrades in Domestic buildings	2,460
Installing heat pumps in Domestic buildings	2,457
Petrol Car to EV Journeys	2,202
Petrol Car to Bus (electric) Journeys	2,124
Diesel Car to Walk Journeys	2,040
Fabric improvements in Public buildings	2,021
Diesel Car to Bicycle Journeys	1,974
Fabric improvements in Retail buildings	1,973
Petrol Car to Hybrid Journeys	1,859
Petrol Car to Bus (diesel) Journeys	1,838
Upgraded boilers in Domestic buildings	1,810
Installing solar PV in Domestic Buildings	1,793
Diesel Car to EV Journeys	1,767
Diesel Car to Bus (electric) Journeys	1,753
Petrol Car to Plug-in hybrid Journeys	1,720
Electricity demand reduction in Domestic buildings	1,639
Diesel Car to Plug-in hybrid Journeys	1,352
Diesel Car to Bus (diesel) Journeys	1,207
Hybrid Car to EV Journeys	1,153
Condensing & Insulation Measures to Boilers & Steam Piping in Industry	1,109
Draught-proofing in Domestic buildings	1,081
Lighting improvements in Domestic buildings	1,078
Installing air source heat pumps in Office buildings	942
Installing biomass boilers in Domestic buildings	862
Heating improvements in Public buildings	847
Glazing improvements in Domestic buildings	841
Solar thermal devices in Domestic buildings	816
Improving Efficiency of Boilers and Steam Piping in Industry	758
Solar thermal devices in Public buildings	614
Improved lighting controls and sensors in Public buildings	522
Solar thermal devices in Retail buildings	504
Improved cooling in Office buildings	488
Lighting improvements in Office buildings	480
Wind microgeneration associated with Public buildings	443
Upgrading heating controls in Office buildings	438
Diesel Car to Hybrid Journeys	426
Improved lighting controls and sensors in Retail buildings	362
Improved lighting controls and sensors in Office buildings	336
Pump Upgrades, Repairs and Maintenance in Industry	328
Lighting improvements in Public buildings	297
Heating improvements in Retail buildings	271
Fan Correction, Repairs, & Upgrades in Industry	234
Compressed Air Systems in Industry	219
Compressors and Variable Speed Systems in Industry	169
Furnace Efficiency and Heat Recovery Mechanisms in Industry	139
Refrigeration Efficiency and Technical Upgrades in Industry	71
Installing solar PV in Public buildings	70
Fabric improvements in Office buildings	49
Improved cooling in Public buildings	44
Improved cooling in Retail buildings	39
Upgraded heating controls in Public buildings	23
Installing solar PV in Office buildings	21
Installing air source heat pumps in Public buildings	20
Heating improvements in Office buildings	18
Upgraded heating controls in Retail buildings	17
Installing air source heat pumps in Retail buildings	17
Lighting improvements in Retail buildings	14
Wind microgeneration associated with Retail buildings	14
Solar thermal devices in Office buildings	13
Installing solar PV in Retail buildings	13
Wind microgeneration associated with Office buildings	13
TOTAL	**62,806**

APPENDIX 2. LEAGUE TABLE OF THE MOST COST-EFFECTIVE OPTIONS FOR LEEDS

Measure	Cost Effectiveness (£/tCO2e)
Compressed Air Systems in Industry	-610
Pump Upgrades, Repairs and Maintenance in Industry	-566
Diesel Car to Bus (diesel)	-464
Fabric improvements in Retail buildings	-452
Petrol Car to Bus (diesel)	-417
Diesel Car to Walk	-372
Petrol Car to Walk	-350
Diesel Car to Bicycle	-348
Fabric improvements in Public buildings	-342
Petrol Car to Bicycle	-326
Improved cooling in Retail buildings	-301
Fan Correction, Repairs, & Upgrades in Industry	-299
Petrol Car to Plug-in hybrid	-255
Compressors and Variable Speed Systems in Industry	-223
Electrical upgrades in Domestic buildings	-180
Lighting improvements in Public buildings	-176
Lighting improvements in Domestic buildings	-158
Diesel Car to Plug-in hybrid	-152
Improved cooling in Office buildings	-147
Lighting improvements in Retail buildings	-138
Petrol Car to Hybrid	-136
Petrol Car to EV	-134
Petrol Car to Bus (electric)	-128
Electricity demand reduction in Domestic buildings	-106
Heating improvements in Public buildings	-104
Improved cooling in Public buildings	-83
Improving Efficiency of Boilers and Steam Piping in Industry	-71
Lighting improvements in Office buildings	-64
Diesel Car to Bus (electric)	-64
Insulating Domestic buildings	-63
Heating improvements in Office buildings	-59
Diesel Car to EV	-45
Heating improvements in Retail buildings	-44
Draught-proofing in Domestic buildings	-39
Installing heat pumps in Domestic buildings	-31
Fabric improvements in Office buildings	-30
Glazing improvements in Domestic buildings	-29
Upgraded heating controls in Domestic buildings	-26
Upgrading heating controls in Office buildings	-19
Installing biomass boilers in Domestic buildings	-19
Solar thermal devices in Domestic buildings	-14
Diesel Car to Hybrid	-13
Upgraded heating controls in Public buildings	-12
Upgraded boilers in Domestic buildings	-10
Upgraded heating controls in Retail buildings	-6
Installing air source heat pumps in Retail buildings	-1
Installing solar PV in Domestic Buildings	2
Hybrid Car to EV	3
Installing air source heat pumps in Public buildings	8
Refrigeration Efficiency and Technical Upgrades in Industry	15
Solar thermal devices in Retail buildings	24
Installing air source heat pumps in Office buildings	33
Improved lighting controls and sensors in Retail buildings	36
Installing solar PV in Public buildings	43
Condensing & Insulation Measures to Boilers & Steam Piping in Industry	48
Installing solar PV in Office buildings	54
Installing solar PV in Retail buildings	57
Improved lighting controls and sensors in Office buildings	60
Solar thermal devices in Public buildings	74
Solar thermal devices in Office buildings	86
Improved lighting controls and sensors in Public buildings	164
Wind microgeneration associated with Office buildings	186
Wind microgeneration associated with Public buildings	209
Wind microgeneration associated with Retail buildings	257
Furnace Efficiency and Heat Recovery Mechanisms in Industry	539

PLACE-BASED CLIMATE ACTION NETWORK (PCAN)

The Place-based Climate Action Network (PCAN) is about translating climate policy into action "on the ground" in our communities. PCAN commenced in January 2019 with the aim of establishing an agile, effective and sustainable network for climate action that is embedded in localities and based around partnerships with local authorities. The objective is to build broader capacity to effect transformative change.

PCAN is an ESRC-supported network that brings together the research community and decision-makers in the public, private and third sectors. It consists of five innovative platforms to facilitate two-way, multi-level engagement between researchers and stakeholders: three city-based climate commissions (in Leeds, Belfast and Edinburgh) and two theme-based platforms on adaptation and finance, with a business theme integrated into each climate commission.

Our vision is for PCAN to produce a replicable model that delivers climate policies on a global to local scale, facilitating and inspiring places across the UK, and this has started to take off: alongside the original PCAN commissions we are delighted to support new climate commissions that have established in places such as Lincoln, Surrey and Croydon, with ever more new commissions coming on stream across the UK.

The five-year project is led by an experienced team of researchers with strong track records of engaging with public, private and third-sector decision-makers. PCAN builds on the policy connections, networking capacity and research strengths of its host institutions: Queen's University Belfast, the University of Edinburgh, the University of Leeds and the London School of Economics and Political Science.

For more information, go to **https://pcancities.org.uk** or contact **pcan@lse.ac.uk**

PARTNERSHIPS

UKRI Economic and Social Research Council

PCAN Place-Based Climate Action Network

The University of Edinburgh

University of Leeds

Queen's University Belfast

LSE The London School of Economics and Political Science

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https://pcancities.org.uk

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