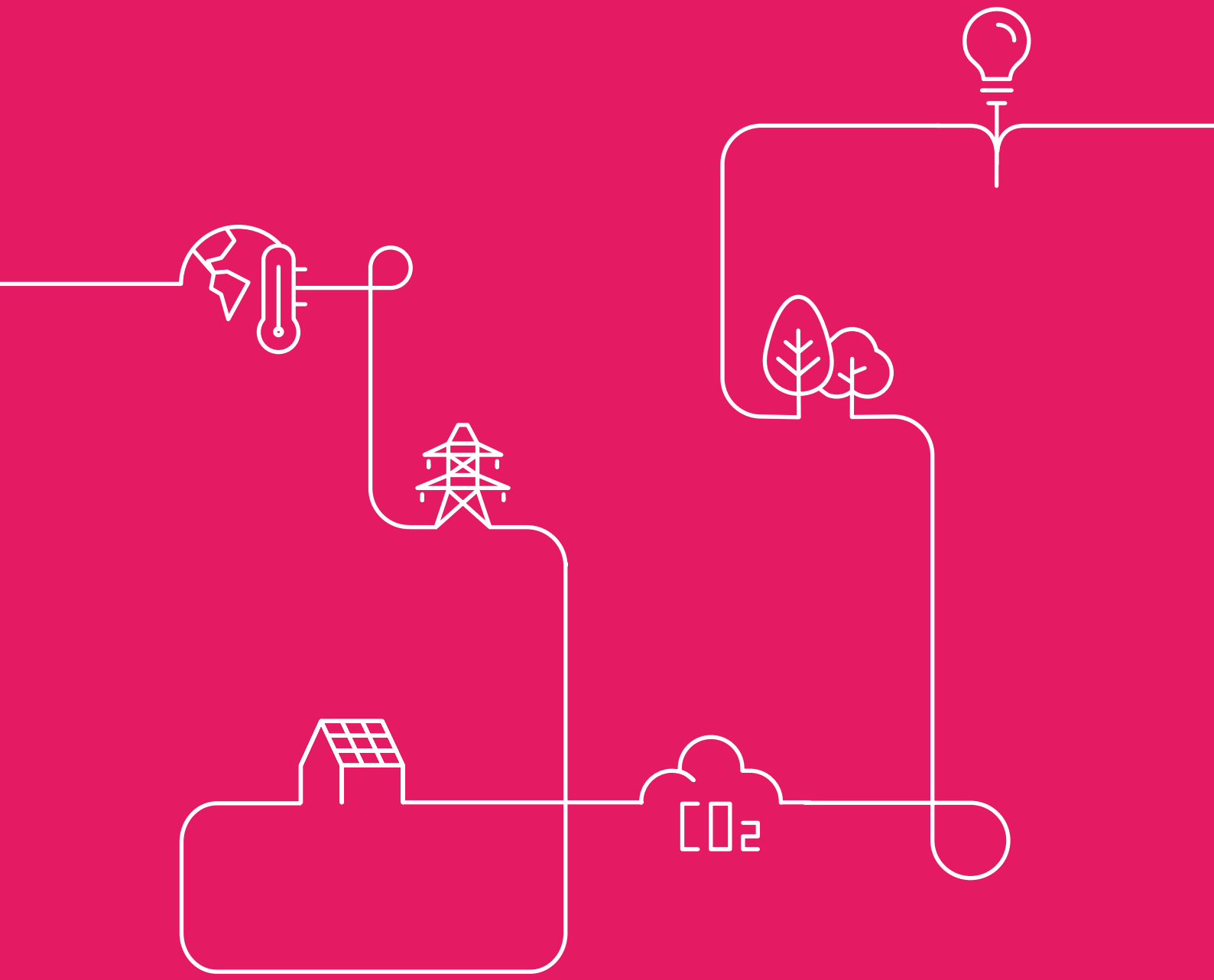
A NET-ZERO ASSESSMENT FOR KIRKLEES: A TECHNICAL AND ECONOMIC OPTIONS APPRAISAL

Andy Gouldson, Andrew Sudmant, Amelia Duncan,
Ruaidhri Higgins-Lavery



UKRI Economic and Social Research Council
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Kirklees COUNCIL

Please reference as:

Gouldson, A., Sudmant, A., Duncan, A., Higgins-Lavery, R. (2021)

A Net-Zero Assessment for Kirklees: A Technical and Economic Options Appraisal, Place-Based Climate Action Network.

Contact

a.gouldson@leeds.ac.uk

a.sudmant@leeds.ac.uk

a.duncan@leeds.ac.uk

https://pcancities.org.uk

https://www.kirkleesclimate.org.uk

CONTENTS

FOREWORD

We are approaching a decisive moment in our efforts to tackle the climate crisis, a challenge that is increasingly real and ever-present. In recent years, the number of local authorities who have pledged to reach net-zero emissions by the 2030s has grown exponentially, but so have greenhouse gas emissions.

The gap between rhetoric and action needs to close if we are to have a fighting

chance of tackling the climate emergency, reaching Kirklees' target of net zero by 2038 and making our contribution to limiting the rise in global temperatures to 1.5 °C. Doing so requires clear strategies, detailed plans and ambitious actions, alongside collaboration, innovation, partnership, and explicit central government direction and support.

Only last year, the 26th Conference of the Parties (COP26) of the United Nations Framework Convention was held in Glasgow. This was the most significant climate conference since Paris in 2015. It was also a focal point for strengthening global ambitions and action on climate change by building on the foundations of the Paris Agreement and seen by many as the last chance to prevent irreversible climate change. It was also an important opportunity for the UK to show leadership on how best to take action to establish net zero policies and then deliver.

The 'Net Zero Assessment for Kirklees: A Technical and Economic Options Appraisal' enables Kirklees, as a district, to understand the emission reduction and investment required to achieve net zero and a low carbon, sustainable future.

We hope this report, prepared by leading academics at the University of Leeds, and using an internationally-recognised methodology, helps lead the way on what needs to be done now in order to accelerate the adoption of net zero solutions across Kirklees, such as promoting behaviour change and the decarbonisation of transport, industry and housing. We are also proud to achieve another milestone for Kirklees Council and all its partner organisations through providing an evidence-based understanding of how we can get to net zero by 2038 and spelling-out some of the district-wide actions that need to be prioritised.

The Net Zero Assessment provides a scientific analysis and assessment, which enables Kirklees Council to identify the areas for focus, inform decision-making and further embed climate change within the policies of the Council and other organisations. This document will also act as an evidence base in the development of the Kirklees Council Climate Action Plan, where the high-level measures outlined in the Assessment will be developed and detailed through additional research and analysis, which will build upon our Phase 1 actions, and the progress made since. This plan will identify investment opportunities that will reduce carbon emissions and will also serve as a catalyst for wider economic, social and environmental benefits for Kirklees as a whole.

The report provides a strong evidence base for policies and practices that can limit further climate change. But it is important to note that there is even more that can be done which is not captured within the methodology, such as land-based activities, which will inevitably will play a role in a semi-rural borough such as ours.

Importantly, this report will also help inform and prioritise the workplan of the Kirklees Climate Commission, who have and will continue to do good work in building capacity, knowledge and understanding to drive collaborative and targeted climate action, in all sectors, across Kirklees. This report sets out the scale of the challenge we all face and some of the potential work we can undertake to rise to this.

The negative impacts of climate change are felt most strongly by disadvantaged, marginalised and vulnerable groups. We need to ensure our efforts and actions not only achieve our net zero targets, but avoid practices which broaden existing inequalities. Of all the information detailed in this report, one of principle importance is our commitment to achieve net zero, whilst striving to tackle inequalities in our society and deliver a just transition.

Despite the current gap between rhetoric and action on climate change, the report shows that there are still achievable pathways to reach the UK's national ambition of net zero by 2050 - and Kirklees' ambition of net zero by 2038. The report outlines a number of challenging emission reduction scenarios, including those that are cost-effective, cost-neutral, offer technical potential and involve innovation and stretch. In order to achieve the emission reduction scenarios outlined, collaborative action by Kirklees' stakeholders, including local government and other public bodies, businesses, investors, and residents is required year-on-year, so that our goal does not slip out of reach. Our pathway to net-zero across Kirklees requires action from everyone.

Councillor Will Simpson
Cabinet Member for Culture & Greener Kirklees and Vice-Chair of the Kirklees Climate Commission

Professor Peter Roberts
Chair of the Kirklees Climate Commission

Councillor Simpson:

''We are ambitious about tackling the climate emergency and continuing to deliver on our plans for a carbon neutral Kirklees. That is why it is a privilege to be able to publish this evidence-based report with our independent Climate Commission to support them and work together in our ongoing efforts to promote climate leadership.

"As the report makes clear, the scale of the challenge ahead for all of us - and the collaboration needed to achieve net zero by 2038 - is considerable.

"According to the 6th Carbon Budget of the UK's national Climate Change Committee, 30% of the progress needed to get us to net zero relies on some involvement within the scope of local authorities. Kirklees Council are committed to playing that key role, that is why creating our local Commission was such an important step: to provide independent advice and best practice for all who want to engage on a positive climate journey - and to act as a forum where partners can exchange ideas.

"This report shows that whilst the road ahead is challenging, the journey to net zero is one that we can achieve, but we can only do it together."

Peter Roberts:

"This report sets out the challenge facing us in moving towards a net zero Kirklees by 2038. Even though achieving the target will involve many changes to the way in which we live, there is no other choice if we are to leave a positive inheritance to future generations. The alternative, business as usual, will exacerbate existing problems and will leave our children and grandchildren with massive difficulties.

It is important that the Kirklees Climate Commission sets the pathway to a better, more sustainable future, but it is also essential that everyone in Kirklees works to ensure that we follow the agreed route. Join us now – this is an urgent and essential journey."

KIRKLEES NET ZERO ASSESSMENT

PCAN KIRKLEES CLIMATE COMMISSION

BACKGROUND

1.5ºC

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 1.5ºC of warming

GLOBAL TO LOCAL

15m

tonnes

Kirklees' share of the global carbon budget (to keep to 1.5ºC of warming)

Kirklees is emitting

2m

tonnes

of carbon a year. At this rate, we will have used up our budget by the end of

2028

BASELINES AND TARGETS

39%

The decline in Kirklees' carbon emissions since 2000

This needs to be increased to

63% by 2025
78% by 2030
92% by 2040
100% by 2050

Kirklees has committed to work towards being

CARBON NEUTRAL

by

2038

This leaves a **big gap** but Kirklees can achieve its target by adopting the following options:

COST-EFFECTIVE OPTIONS

Cost-effective options such as

better housing and transport

could close the 2038 gap by

47%

This would reduce Kirklees' energy bill by

£157m

per year, and would create over

8,000

years of new employment in the area.

MORE AMBITIOUS OPTIONS

More ambitious but currently available options could

close the 2038 gap by

68%

These would have **benefits for** health, equality, travel and the environment

Doing all of the above leaves a

32%

shortfall to reach net zero by 2038

REACHING OUR TARGET

Kirklees can close the gap by

100% by 2038

and achieve net zero by adopting a range of

INNOVATIVE INTERVENTIONS

These include **decarbonising heating and planting trees - changing some behaviours and consumption habits would reduce emissions further still.**

Net Zero

*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.

A NET-ZERO ASSESSMENT FOR KIRKLEES

EXECUTIVE SUMMARY

Aims and Scope

- How can Kirklees reduce its carbon emissions and achieve its ambitions on net zero? There are multiple options available across different sectors and choosing between them can be difficult. Ideally, decisions should be guided by an evidence base on the most cost and carbon effective measures.
- To develop that evidence base, this report identifies and assesses a range of the low carbon options that could be adopted in Kirklees, with a focus on the technical and economic performance of different options across the housing, public and commercial buildings, transport and industrial sectors.
- This report is not necessarily comprehensive – other options may be available in the sectors covered, and important actions in other sectors such as agriculture and land-use may also be available that are not assessed here.
- The report does not consider whether the most cost and carbon effective options are also the most socially or politically desirable options. Further work needs to be done to assess these important dimensions and to consider how ready Kirklees is to adopt any of the options before a practical, deliverable climate action plan can be developed.

Background

- Scientific evidence calls for rapid reductions in global carbon[1] emissions if we are to limit average levels of warming to 1.5°C 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 1.5°C degrees within a decade. This science underpins calls for the declaration of a climate emergency.
- Dividing the global carbon budget up by population gives Kirklees a total carbon budget of 15 million tonnes from 2021. Based only on the fuel and electricity used within its boundaries, Kirklees currently emits c.2 million tonnes of carbon a year, and as such it would use up its carbon budget by the end of 2028.
- This assessment does not include its broader carbon footprint – for example relating to longer distance travel or the goods and services that are produced elsewhere but consumed within Kirklees (i.e. its Scope 3 emissions).

[1] For simplicity, we use the term “carbon” as shorthand for all greenhouse gases, with all figures in this report relating to the carbon dioxide equivalent (CO2e) of all greenhouse gases unless otherwise stated. Note that our assessment therefore differs from other assessments that focus only on CO_2.

[2] Taken to include all greenhouse gas emissions (i.e. CO2e) and to relate to the direct or territorial emissions from Kirklees (i.e. the scope 1 and 2 emissions arising from the use of fuels within Kirklees, other (e.g. industrial) emissions from within Kirklees and emissions arising from the electricity consumed within Kirklees, even if that electricity is generated elsewhere).

[3] However, the regional target also seeks to deliver ‘significant progress’ towards net zero by 2030.

[4] This carbon budget is calculated on a simple per capita basis, taking the global carbon budget consistent with giving us a 66% chance of keeping the global average surface level warming below 1.5°C and dividing it by population. It does not adjust the carbon budget for historical emissions and is therefore slightly higher than the carbon budget for Kirklees set by the Tyndall Centre (i.e. 14.7 MT compared to 11.7 MT).

Baselines and Targets

- Kirklees has set itself a target of reaching net zero carbon emissions by 2038[2]. This target is in line with both the West Yorkshire Combined Authority target, and the regional target for Yorkshire and Humber set by the Yorkshire Leaders Board[3].
- Kirklees’ share of the global carbon budget consistent with having a good chance of avoiding dangerous climate change is 14.6 million tonnes[4]. At current rates, Kirklees will have used up this share of the global carbon budget by the end of 2028.
- Direct (scope 1 and 2) carbon emissions from Kirklees have fallen by 39% since 2000. With on-going decarbonisation of grid electricity, and taking into account population and economic growth within Kirklees, we project that Kirklees’ 2000 level of annual emissions output will have fallen by a total of 49% in 2050.
- If it is to stay within its carbon budget, Kirklees needs to add to the emissions reductions already achieved to secure 63% reductions on its 2000 level of emissions by 2025, 78% by 2030, 87% by 2035, 92% by 2040, 95% by 2045 and 100% by 2050. In short, the majority of all emissions reductions across the district need to be delivered within the next ten years.
- Without further activity to address its carbon emissions, we project that Kirklees’ annual emissions will exceed its carbon budget by 1.1 million tonnes in 2030, and 1.6 million tonnes in 2050.

Cost-Effective Options

- To meet these carbon reduction targets, Kirklees 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 Kirklees could close the gap between its projected emissions in 2050 and net-zero emissions by 47% purely through the adoption of cost-effective options in houses, public and commercial buildings, transport and industry.
- Adopting these options would reduce Kirklees’ total projected energy bill in 2050 by £157 million per year whilst also creating 8,080 years of employment in the district. 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 district to deliver these carbon cuts include improved 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.

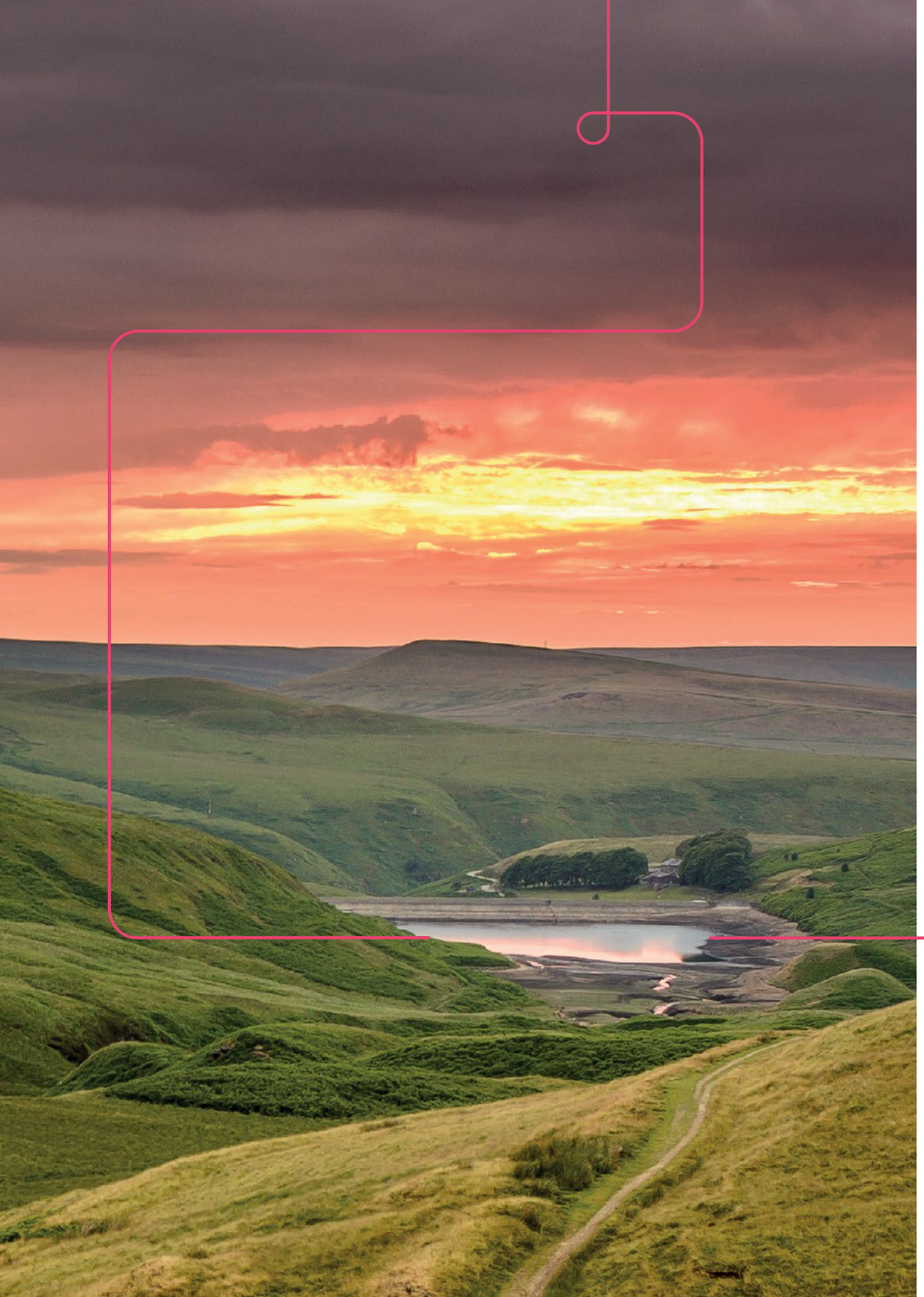
EXECUTIVE SUMMARY

More Ambitious Options

- The analysis also shows that Kirklees could close the gap to net-zero emissions in 2050 by 70% 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 district.
- This means that although it can achieve significant reductions in emissions by focusing on established cost-effective and technically viable measures, Kirklees still has to identify other more innovative interventions that could deliver the last 30% of shortfall between projected emissions in 2050 and a net-zero target. It will have to further accelerate it's progress if it is to achieve its target of reaching net zero by 2038.
- Options identified elsewhere that could be considered in Kirklees include promoting the use of low carbon vehicles, electrification of 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.
- The scale of activity and investment needed to reach or even get close to the carbon emissions reduction targets set is significant. We find that across the district, many hundreds of thousands of homes and square-metres of floorspace will require retrofitting and widespread changes will be needed in the travel patterns and the way that people travel.
- However, the analysis finds that by adopting innovative measures such as these, Kirklees can close the gap between its projected emissions and net zero by 100% and that it is possible to do this and to reach its target of securing net zero emissions by 2038.

Next Steps

- Kirklees needs to adopt a clear and ambitious climate action plan. The case for the adoption of such a plan is supported by the evidence that much – but not all – of the action that is required can be based on the exploitation of win-win low-carbon options that will simultaneously improve economic, social and health outcomes across the district.
- The climate action plan should adopt science-based targets for emissions reduction. As well as longer term targets, it should include five-yearly carbon reduction targets.
- The action plan should focus initially on Kirklees' direct (Scope 1 and 2) carbon footprint as these emissions are most directly under the district's influence, but in time it should also widen its scope to consider its broader (Scope 3) carbon footprint.
- The action plan should also set out the ways in which Kirklees will work towards achieving these science-based targets, drawing on the deployment KPIs listed in this report. Action should also be taken to monitor and report progress on emissions reductions.
- It is important to stress that delivering on these targets will require action across the district and the active support of the public, private and third sectors. Establishing an independent Kirklees Climate Commission has already helped to draw actors together and to build capacities to take and track action.
- Driven by the Kirklees Climate Commission, leadership groups should be formed for key sectors such as homes, public and commercial buildings, transport and industry, to develop clear plans for the delivery of priority actions in each sector. All large organisations and businesses in the district should also be asked to match broader carbon reduction commitments and to report back on progress.



A NET-ZERO ASSESSMENT FOR KIRKLEES

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[2] 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.

[2] 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.

OUR APPROACH

(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).
- **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.

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 Kirklees' economy to propose 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 and industry 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 KIRKLEES

Analysis shows that Kirklees' baseline (Scope 1 and 2) emissions have fallen by 39% 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 Kirklees' baseline (Scope 1 and 2) emissions will only fall by a further 12% by 2030, 17% by 2040, and 16% by 2050. This adds up to a total of just over 49% between 2000 and 2050.

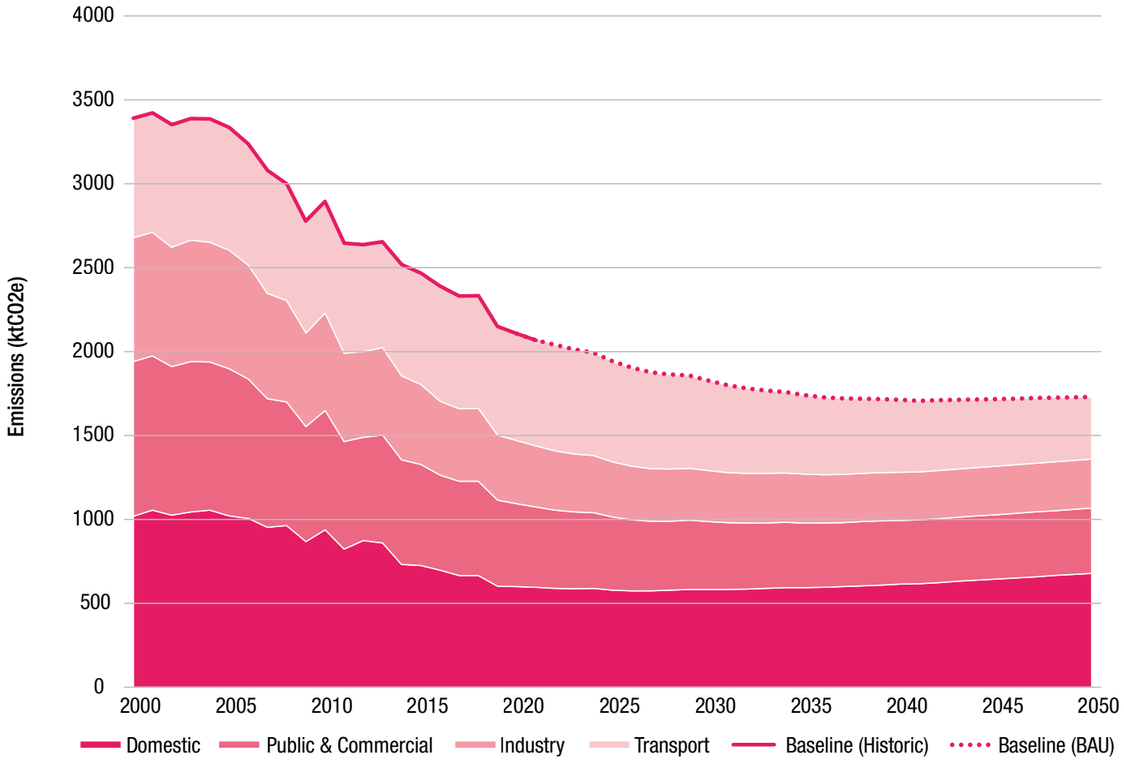


Figure 1: Kirklees' Scope 1 and 2 Carbon Emissions (2000-2050)

Currently, 31% of Kirklees' emissions come from the transport sector, with housing responsible for 28% of emissions, public and commercial buildings for 23% and industry 18%. Emissions related to land use contribute c.1% and are not considered in this report. By 2050, under BAU, we project emissions from transport will decrease significantly (still producing c.21%) with a significant increase in the proportion of emissions from housing (producing c.39%). Small decreases are forecast in the proportion of emissions from industry, while the proportion from public and commercial buildings remain the same, this is largely as a result of expansion in the output of the domestic buildings sector over this period.

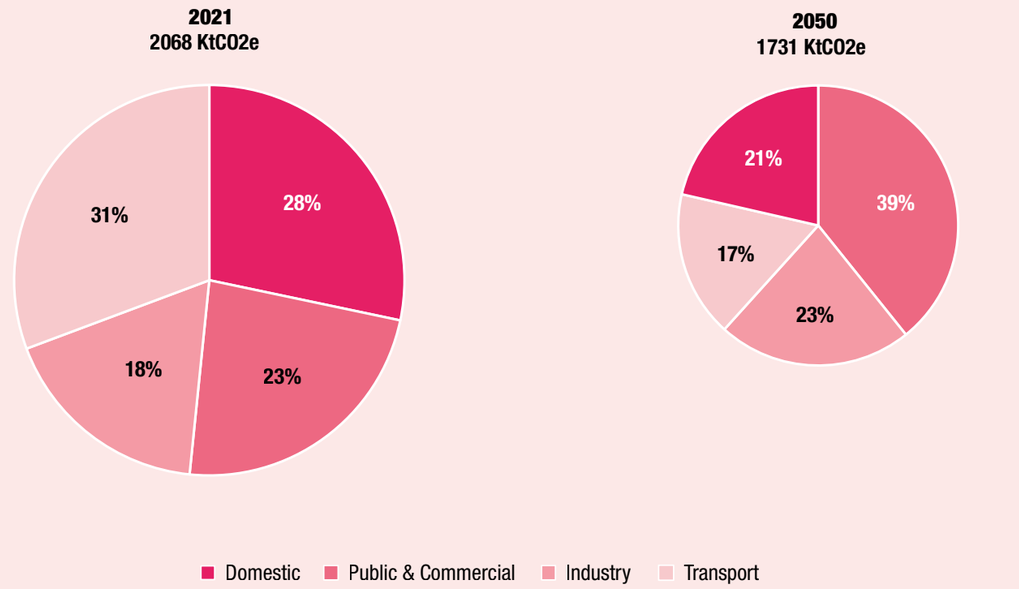


Figure 2: Kirklees' Present and Projected Emissions by Sector

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

Related to this emissions baseline, after evaluating the range of energy sources that Kirklees consumes (spanning electricity, gas, all solid and liquid fuels across sectors) we find that in 2021 the total energy bill for Kirklees was £637 million. Transport fuels generated the majority of this demand (47%), followed by domestic buildings (32%) then public and commercial buildings and industry (12% and 9% respectively). By projecting demand and energy prices into the future with reasonable baseline assumptions over population, inflationary measures and efficiency gains across the economy, we find that Kirklees' business-as-usual (BAU) energy expenditure will likely grow to just over £667 million per year in 2030 and c.£722 million per year in 2050, with transport expenditure growing slightly (to 57%) in Kirklees' total (see Figure 3 below).

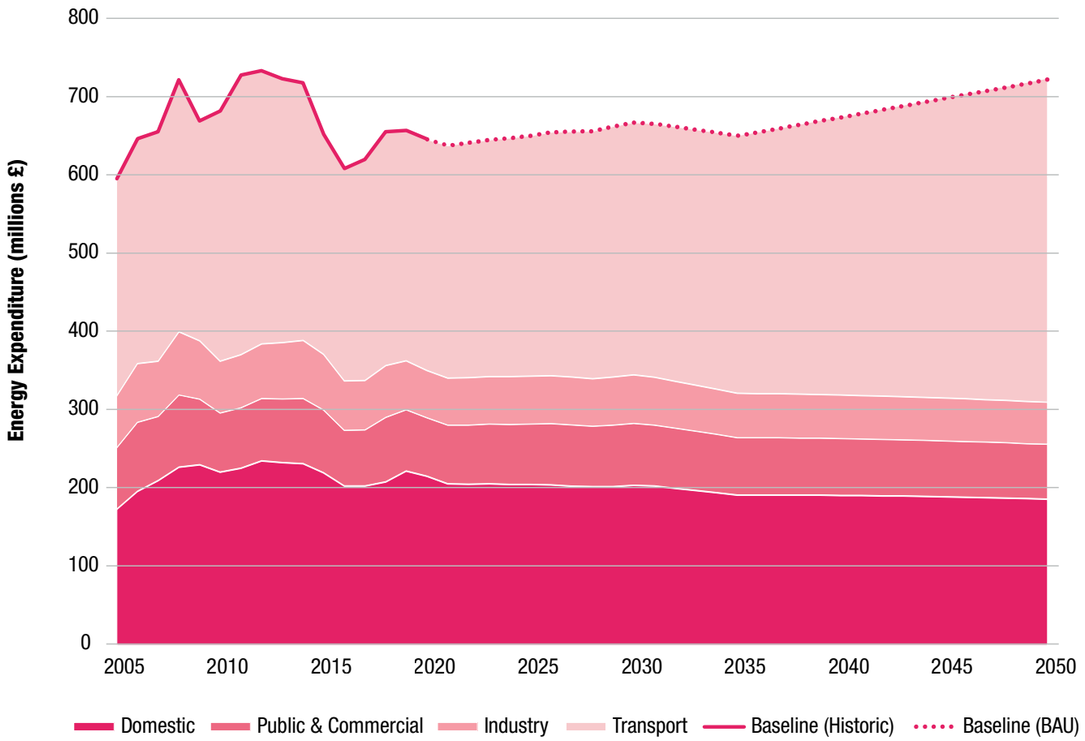
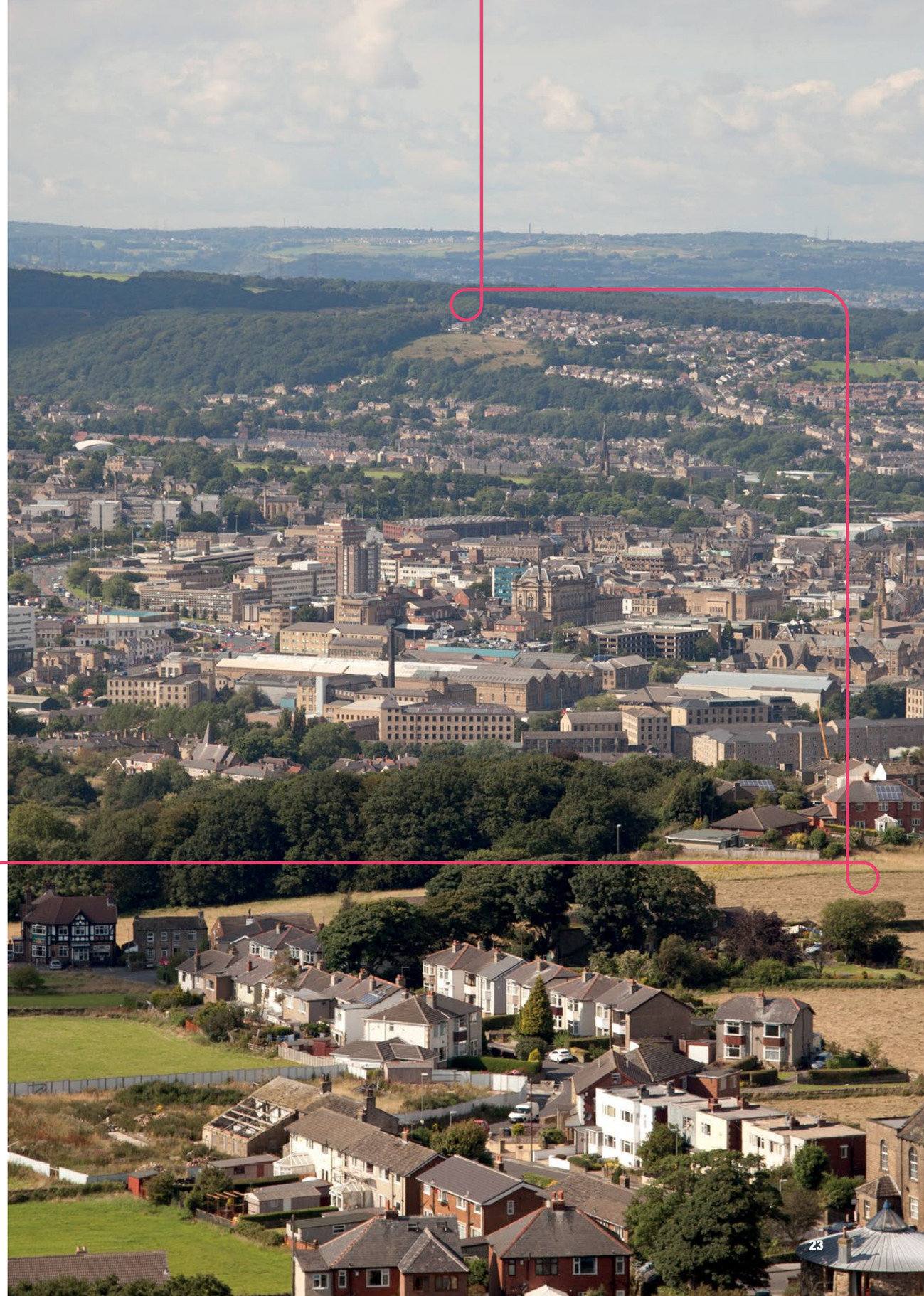


Figure 3: Kirklees' Present and Projected Energy Expenditure by Sector



SETTING SCIENCE-BASED CARBON REDUCTION TARGETS FOR KIRKLEES

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 adjust the budget to consider other gases that contribute to climate change, this gives Kirklees a total carbon budget of c.15 megatonnes over the period between the present and 2050.

At current rates of emissions output, Kirklees would use up this budget at some point by the end of 2028. However, Kirklees could stay within its carbon budget by reducing its emissions by c.9.8% year on year. This would mean that to transition from the current position where emissions are 39% 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, Kirklees should adopt the following carbon reduction targets (on 2000 levels):

63%
by 2025

78%
by 2030

87%
by 2035

92%
by 2040

95%
by 2045

100%
by 2050

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

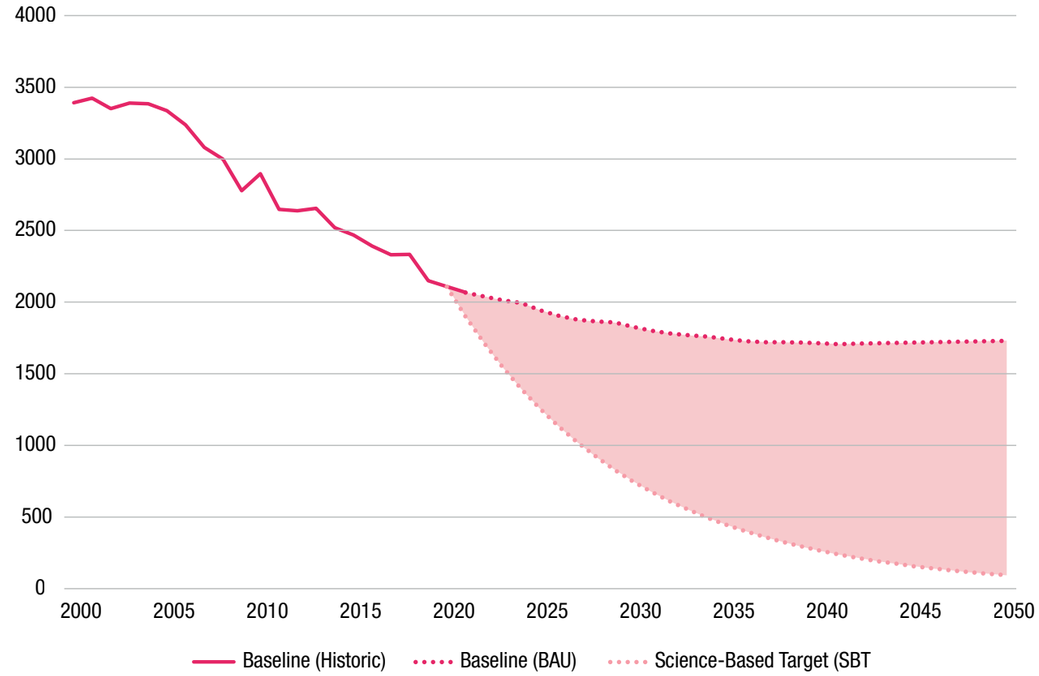


Figure 4: Kirklees' Baseline and Science-Based-Target Emissions Pathways

AGGREGATING UP: THE BIGGER PICTURE FOR KIRKLEES

a) Emissions reductions

Our analysis predicts that the gap between the Kirklees business-as-usual (BAU) emissions in 2050 and the net-zero target could be closed by 47% (820 ktCO2e) through the adoption of Cost-Effective (CE) options, by a further 10% (180 ktCO2e) through the adoption of additional Cost-Neutral (CN) options at no net cost, and then by an additional 13% (222 ktCO2e) through the further adoption of all technically viable (TP) options. This means that Kirklees still has to identify the innovative or stretch options that could deliver the last 30% (513 ktCO2e) of the gap between the business-as-usual scenario and net-zero in 2030 following science-based targets (SBT).

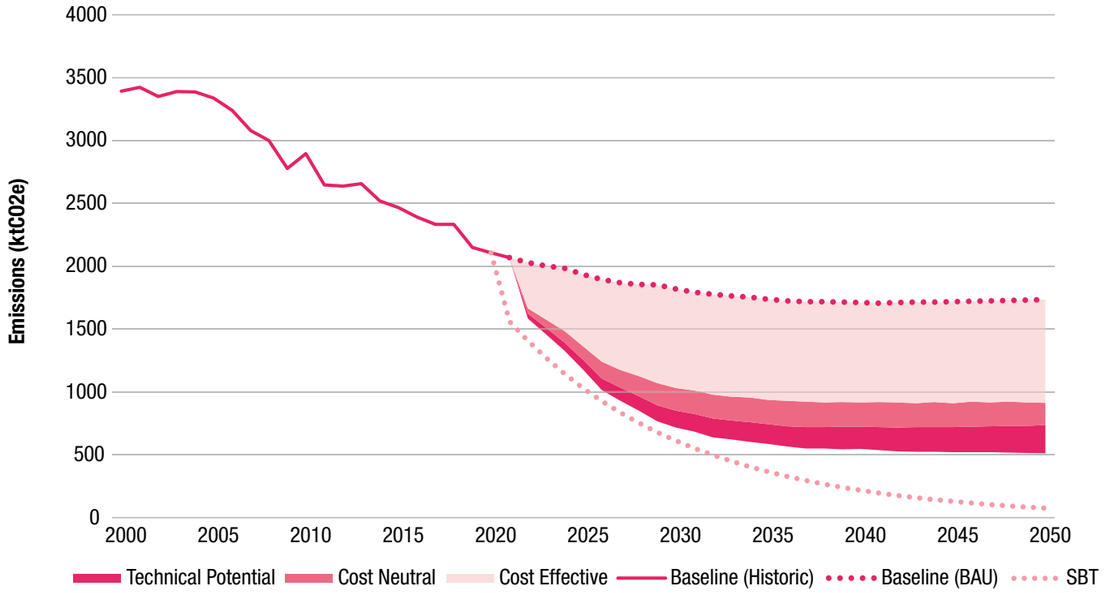


Figure 5: Kirklees' BAU Baseline with Cost-Effective (CE), Cost-Neutral (CN), & Technical Potential (TP) Scenario

		2025	2030	2035	2040	2045	2050
Reduction on BAU Baseline (2050)	**CE**	30%	43%	46%	47%	47%	47%
	CN	35%	53%	57%	58%	58%	58%
	TP	39%	61%	66%	68%	70%	70%
Reduction on 2021 Emissions	**CE**	28%	38%	39%	39%	39%	40%
	CN	33%	47%	48%	48%	48%	48%
	TP	37%	54%	56%	56%	58%	59%

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

AGGREGATING UP: THE BIGGER PICTURE FOR KIRKLEES

b) The most carbon- and cost-effect options

Figure 6 presents the emissions savings that could be achieved through different groups of measures in Kirklees. Appendices 1 and 2 present league tables of specific measures and their potential emissions savings over this period. The chart shows that the most carbon-effective measure in Kirklees is to install heat pumps in homes across the area.

Some of the ideas for innovative options that could also be considered for Kirklees, including targeting a full transition to net-zero homes and public/commercial buildings by 2030 and promoting the rapid acceleration of active travel (e.g. walking and cycling), are highlighted in the section on "Innovative Stretch Measures for Kirklees".

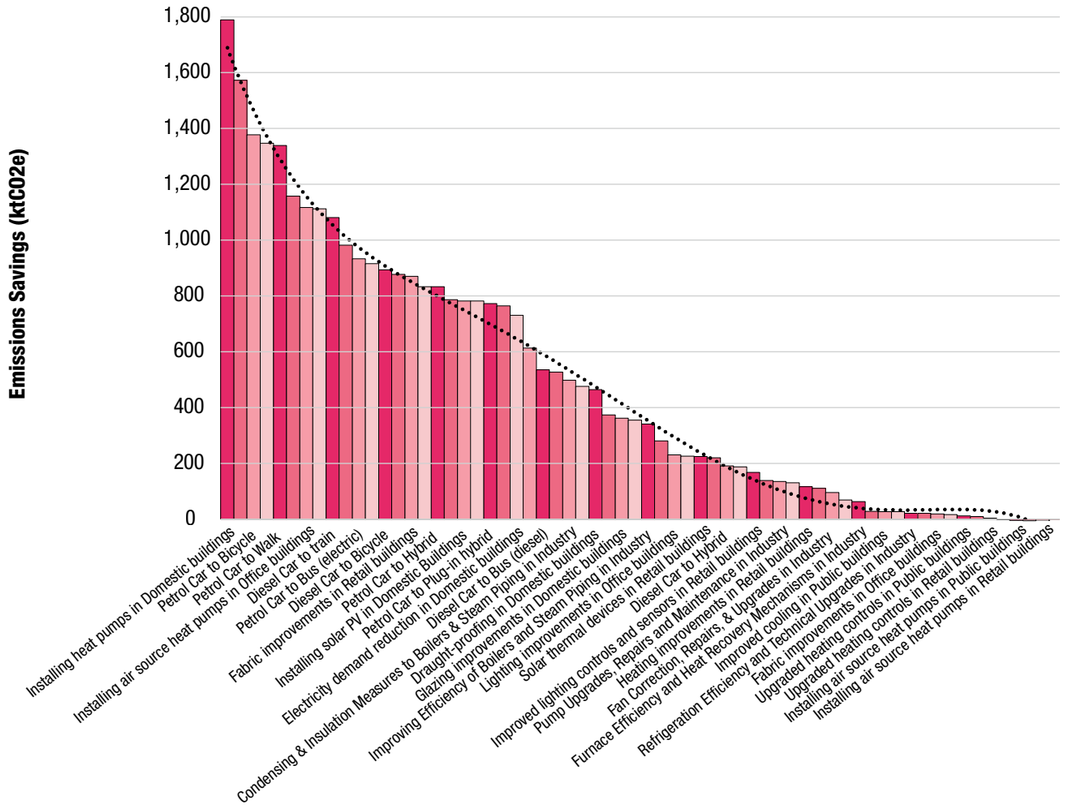


Figure 6: Simplified Emissions Reduction Potential by Measure for Kirklees

Simplified league tables of the most cost- and carbon-effective options in Kirklees are presented below (see Appendices 1 & 2 for more detailed league tables)

Rank	Measure	Cost Effectiveness (£/tCO2e)
1	Compressed air systems in industry	-603.24
2	Pump upgrades, repairs and maintenance in industry	-574.94
3	Diesel car to bus journeys	-458.77
4	Fabric improvements in retail buildings	-445.10
5	Petrol car to bus journeys	-406.64
6	Diesel car to walk journeys	-371.43
7	Petrol car to walk journeys	-352.00
8	Petrol car to bicycle journeys	-349.00
9	Diesel car to bicycle journeys	-348.25
10	Fabric improvements in public buildings	-341.08

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

Rank	Measure	Carbon Effectiveness (ktCO2e)
1	Installing heat pumps in domestic buildings	1,789
2	Insulating domestic buildings	1,573
3	Petrol car to bicycle journeys	1,377
4	Upgraded heating controls in domestic buildings	1,347
5	Petrol car to walk journeys	1,340
6	Petrol car to train journeys	1,158
7	Installing air source heat pumps in office buildings	1,117
8	Electrical upgrades in domestic buildings	1,113
9	Diesel car to train journeys	1,081
10	Petrol car to ev journeys	982

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

AGGREGATING UP: THE BIGGER PICTURE FOR KIRKLEES

c) Investment needs, paybacks and employment creation

Exploiting the cost-effective options in households, public and commercial buildings, transport and industry could be economically beneficial. Although such measures would require total investments of around £2.6 billion over their lifetimes (equating to investments of £260m a year across all organisations and households in the district for the next decade), once adopted they would reduce Kirklees' total energy bill by £157 million p.a. in 2050 whilst also creating 8,080 years of employment (e.g. 404 full-time jobs for 20 years).

By expanding this portfolio of measures that could be adopted at no net cost to Kirklees' economy (the Cost-Neutral scenario), investments of £4.2 billion over their lifetimes (or £416m a year for the next decade) would generate 12,112 years of employment (e.g. 606 full-time jobs for 20 years) whilst reducing Kirklees' emissions by 58% of projected 2030 levels.

Exploiting all technically viable options would be more expensive (at least at current prices, c.£5.7 billion or £572m a year for the next decade) but realise further emissions savings – eliminating 70% of the projected shortfall in Kirklees' 2050 emissions, whilst saving hundreds of millions of pounds on an annual basis.

		2025	2030	2035	2040	2045	2050
Cumulative Investment (£M)	**CE**	1,202	2,292	2,440	2,496	2,557	2,609
	CN	1,781	3,672	3,899	3,983	4,076	4,155
	TP	2,278	4,946	5,376	5,490	5,616	5,724
Annual Energy Expenditure Savings (£M)	**CE**	204	230	231	206	185	157
	CN	162	214	219	201	175	153
	TP	146	203	216	197	174	154

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

Sector	Scenario	Investment (£M)
Domestic	**CE**	1,257
	CN	2,151
	TP	2,707
Public and Commercial	**CE**	980
	CN	1,267
	TP	1,701
Industry	**CE**	134
	CN	265
	TP	842
Transport	**CE**	239
	CN	472
	TP	473

Table 5: Potential Investments by Sector & Economic Scenario

		Total	Domestic	Industry	Transport	Public and Commercial
Years of employment	**CE**	8,080	2,687	457	328	4,608
	CN	12,112	4,599	908	647	5,959
	TP	17,321	5,789	2,881	648	8,004
Jobs (20-year Period)	**CE**	404	134	23	16	230
	CN	606	230	45	32	298
	TP	866	289	144	32	400

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 Kirklees through to 2050. We also give an indication of the rate of deployment required in the district 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 district.

Homes

Sector	Total Homes Applied	Mean Annual Rate of Installation (homes)
Lighting upgrades	100,092	6,673
Floor insulation	94,204	6,280
Gas boiler upgrades & repairs	90,622	6,041
Glazing upgrades	88,349	5,890
Solar thermal	70,696	4,713
Solar PV	69,485	4,632
Thermostats & heating controls	67,935	4,529
Loft insulation	62,551	4,170
Wall insulation	44,708	2,981
Draught proofing	35,522	2,368
Cavity wall insulation	29,706	1,980
Heat pumps	7,219	481

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

Public & Commercial Buildings

Measure	Floorspace Applied (m^2)	Mean Annual Rate of Installation (m^2)
Lighting/heating controls and sensors	2,972,702	198,180
Retail heating upgrades	2,881,896	192,126
Wind turbines	1,649,039	109,936
Office lighting upgrades	748,028	49,869
Office fabric improvements	729,488	48,633
Office heat pumps	251,165	16,744
Office solar PV	251,007	16,734

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

Transport

Measure	Deployment (total to 2035)
Additional EV's replacing conventional private cars	137,014
Increase in public transport ridership	6 million
High quality protected cycling highways built	56 kilometers

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


Prime Time
THE YORKSHIRE REGIMENT
Prime Time

FOCUSING ON KEY SECTORS IN KIRKLEES

At full deployment (technical potential) across Kirklees, we calculate that there is potential to avoid 31 MtCO2e in emissions that will otherwise be produced in the area between 2020 and 2050. The domestic sector will contribute most significantly toward this total, with a decarbonisation potential of between 9 MtCO2e (cost-effective scenario) and 13 MtCO2e (technical potential) through the period.

However, transport, industry and public and commercial buildings also play a major role; upgrading and retrofitting of Kirklees' built environment (including industry, public and commercial sectors) could reduce emissions by up to 8 MtCO2e over the same period at full technical potential, with transport similarly showing the potential to decarbonise over 10 MtCO2e under the same conditions.

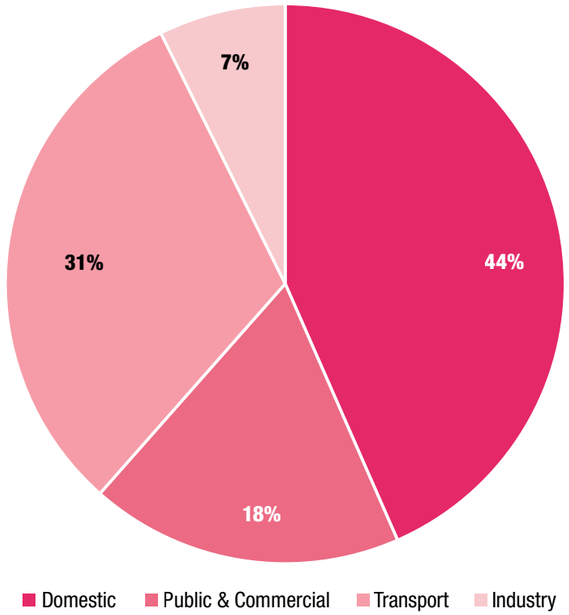


Figure 7: Kirklees' Emissions Reduction Potential (2020-2050) by Sector

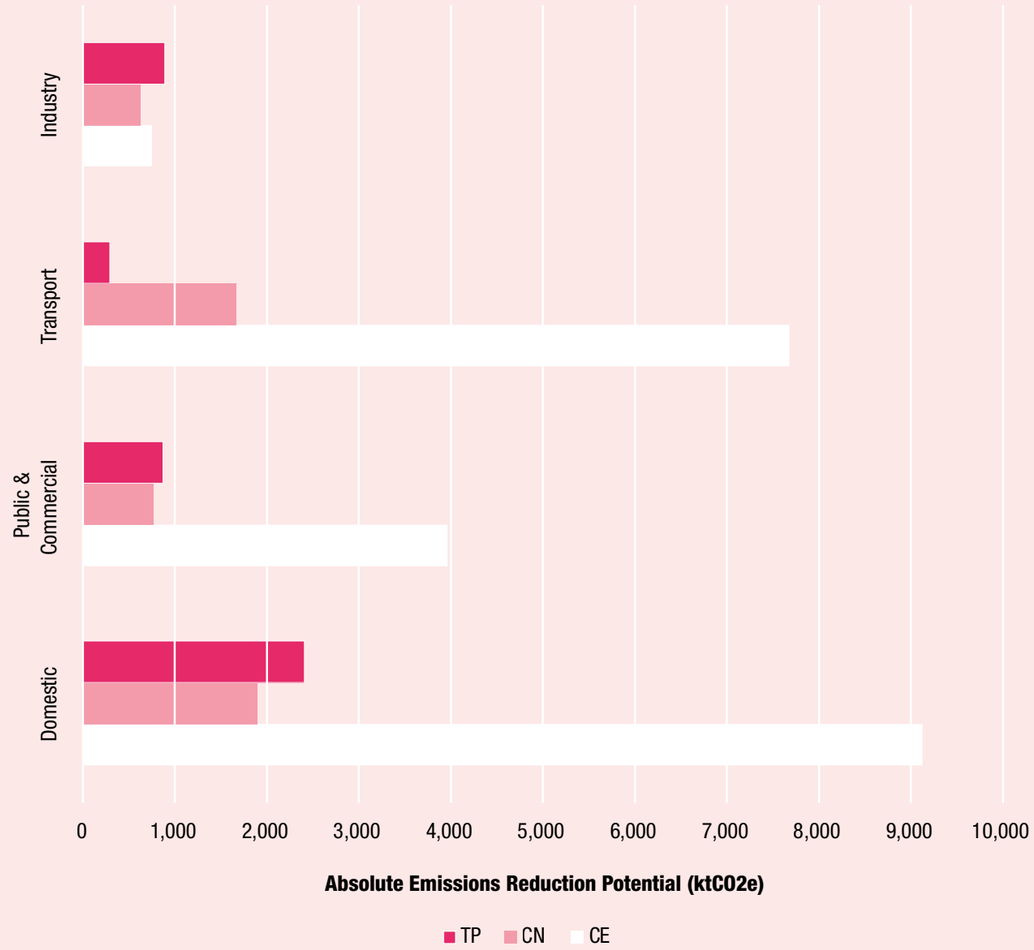


Figure 8: Kirklees' Emissions Reduction Potential by Sector & Economic Scenario (2020-2050)

FOCUSING ON KEY SECTORS IN KIRKLEES

In the following section summaries of the emissions reduction potential and economic implications of investment are presented for the four main sectors. 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 Kirklees.

(a). Housing

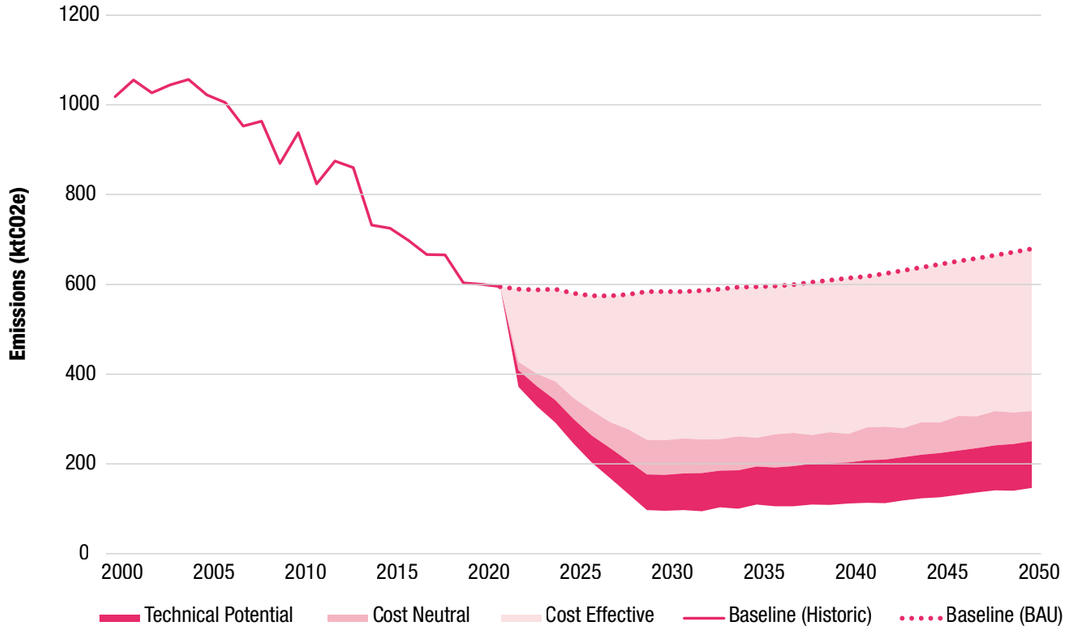


Figure 9: Housing BAU Baseline with Cost-Effective, Cost-Neutral and Technical Potential Scenarios

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	233	331	336	348	353	361
	CN	280	408	401	411	420	429
	TP	334	489	485	503	519	533
Annual Energy Expenditure Savings (£M)	**CE**	67	81	72	73	70	66
	CN	86	100	88	90	87	80
	TP	75	82	73	74	72	67
Cumulative Investment (£M)	**CE**	496	1,101	1,257	1,257	1,257	1,257
	CN	891	1,910	2,151	2,151	2,151	2,151
	TP	1,125	2,403	2,707	2,707	2,707	2,707

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

Rank	Measure	Cost Effectiveness (£/tCO2e)
1	Electrical upgrades	-178
2	Lighting improvements	-155
3	Electricity demand reduction	-121
4	Insulation (various forms)	-60
5	Draught-proofing	-41
6	Glazing improvements	-38
7	Installing heat pumps	-36
8	Upgraded boilers	-24
9	Upgraded heating controls	-19
10	Solar thermal devices	-16

Table 9: The Most Cost-Effective Measures for Housing

FOCUSING ON KEY SECTORS IN KIRKLEES

(b). Public & Commercial Buildings

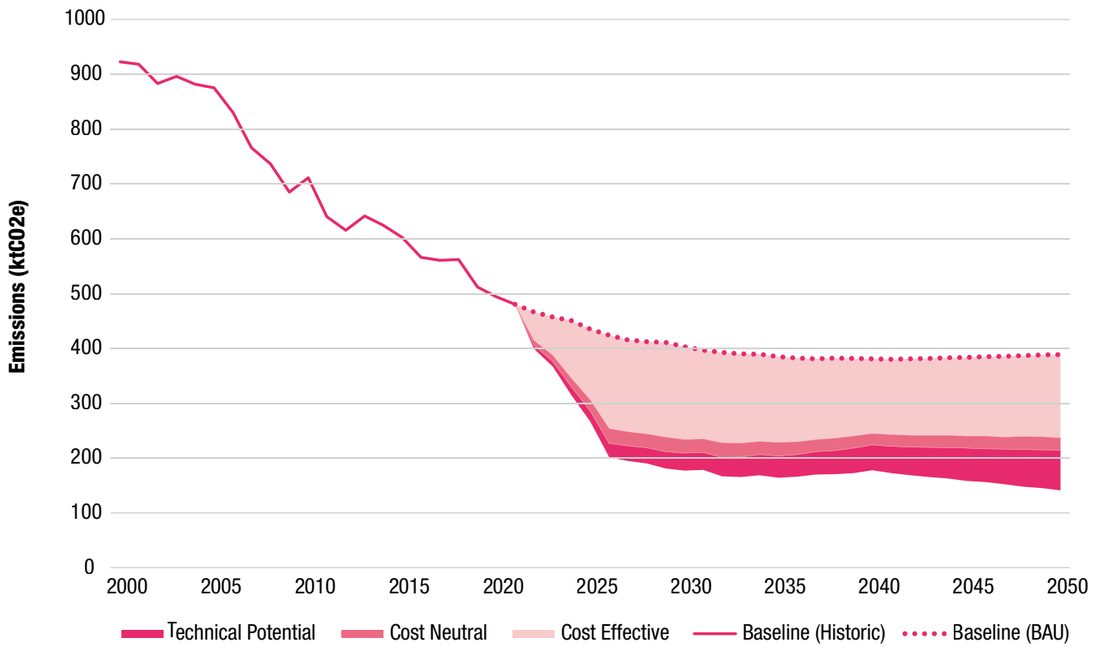


Figure 10: Public and Commercial Buildings BAU Baseline with Cost-Effective, Cost-Neutral and Technical Potential Scenarios

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	123	161	148	129	136	144
	CN	147	190	177	154	163	171
	TP	157	210	205	189	210	231
Annual Energy Expenditure Savings (£M)	**CE**	102	105	94	73	63	47
	CN	35	48	49	35	24	18
	TP	28	53	55	41	30	24
Cumulative Investment (£M)	**CE**	498	756	811	866	927	980
	CN	572	928	1,011	1,095	1,187	1,267
	TP	761	1,242	1,353	1,468	1,594	1,701

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

Rank	Measure	Cost Effectiveness (£/tCO2e)
1	Fabric improvements in retail buildings	-445
2	Fabric improvements in public buildings	-341
3	Improved cooling in retail buildings	-305
4	Lighting improvements in public buildings	-178
5	Improved cooling in office buildings	-160
6	Lighting improvements in retail buildings	-140
7	Heating improvements in public buildings	-100
8	Improved cooling in public buildings	-93
9	Lighting improvements in office buildings	-65
10	Fabric improvements in office buildings	-49

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

FOCUSING ON KEY SECTORS IN KIRKLEES

(c). Transport

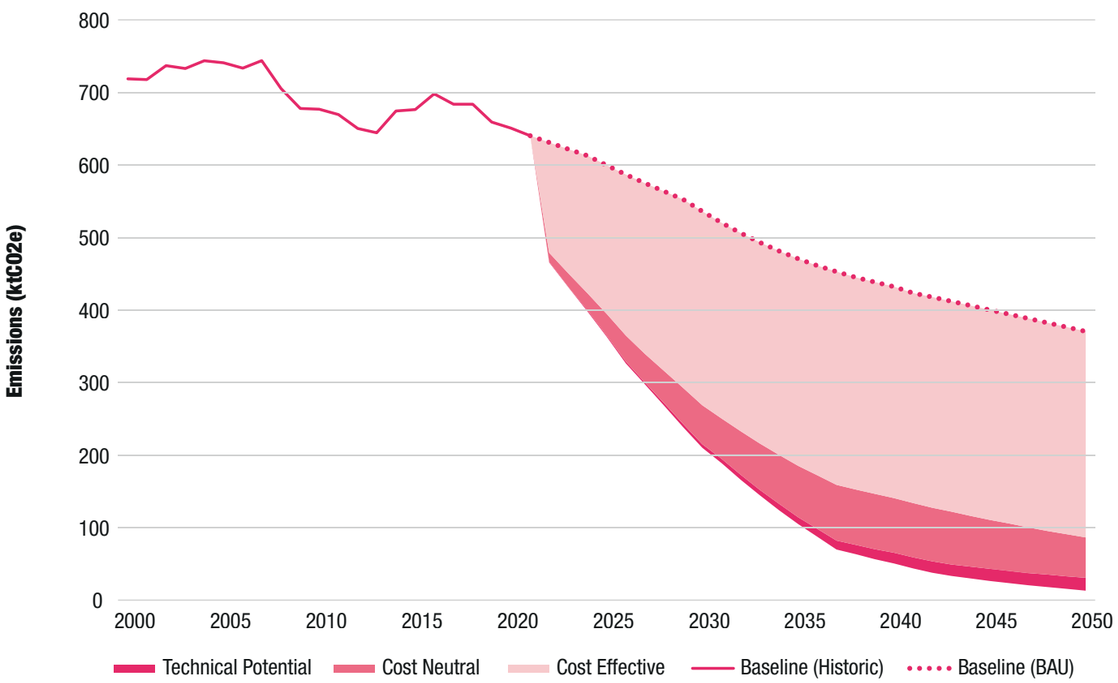


Figure 11: Transport BAU Baseline with Cost-Effective and Cost-Neutral Scenarios[3]

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	205	267	286	291	289	289
	CN	235	321	356	367	357	354
	TP	237	326	366	381	374	371
Annual Energy Expenditure Savings (£M)	**CE**	31	52	53	47	38	31
	CN	37	64	67	61	48	38
	TP	37	64	68	61	49	38
Cumulative Investment (£M)	**CE**	183	235	236	239	239	239
	CN	271	451	464	472	472	472
	TP	272	452	465	473	473	473

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

Rank	Measure	Cost Effectiveness (£/tCO2e)
1	Diesel car to bus journey	-459
2	Petrol car to bus journey	-407
3	Diesel car to walk journey	-371
4	Petrol car to walk journey	-352
5	Petrol car to bicycle journey	-349
6	Diesel car to bicycle journey	-348
7	Petrol car to plug-in hybrid journey	-263
8	Petrol car to train journey	-162
9	Diesel car to plug-in hybrid journey	-153
10	Diesel car to train journey	-147

Table 13: The Most Cost-Effective Measures for Transport

[3] 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 KIRKLEES

(d). Industry

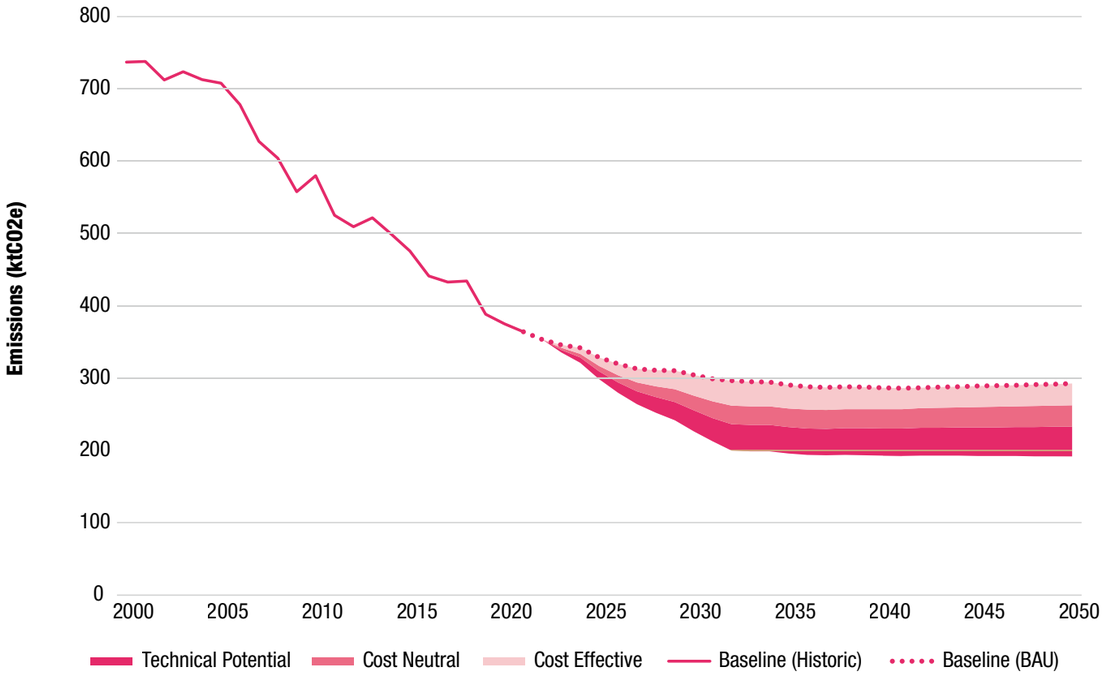


Figure 12: Industry BAU Baseline with Cost-Effective, Cost-Neutral and Technical Potential Scenarios

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	12	29	32	30	29	29
	CN	20	49	54	56	57	58
	TP	30	78	87	94	96	97
Annual Energy Expenditure Savings (£M)	**CE**	4	3	12	12	13	14
	CN	4	3	14	15	16	16
	TP	5	4	21	22	23	24
Cumulative Investment (£M)	**CE**	25	89	134	134	134	134
	CN	46	193	265	265	265	265
	TP	120	563	842	842	842	842

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

Rank	Measure	Cost Effectiveness (£/tCO2e)
1	Compressed air systems	-603
2	Pump upgrades, repairs and maintenance	-575
3	Fan correction, repairs, & upgrades	-314
4	Compressors and variable speed systems	-212
5	Improving efficiency of boilers and steam piping	-69
6	Refrigeration efficiency and technical upgrades	3
7	Condensing & insulation measures to boilers & steam piping	52
8	Furnace efficiency and heat recovery mechanisms	534
9	Diesel car to plug-in hybrid journey	-153
10	Diesel car to train journey	-147

Table 15: The Most Cost-Effective Measures for Industry

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

INNOVATIVE STRETCH MEASURES FOR KIRKLEES

Even with full delivery of the broad programme of cross-sectoral, district-wide low carbon investment described above, there remains an emissions shortfall of 30% between Kirklees' 2050 BAU baseline and the net-zero target. Here we briefly consider the potential contribution 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 if Kirklees is to meet its carbon reduction targets.

		2025	2030	2035
Annual Emissions Reduction Potential (ktCO2e)	Zero carbon heavy goods transport	1	3	5
	Electrification of industrial heating	14	31	48
	Electrification of domestic heating	14	31	48
	Electrification of domestic cooking	4	9	14
	Electrification of commercial and public heating	11	25	39
	19500 total ha reforested (2021-30)*	-80	-213	-320

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 Kirklees' carbon emissions, with the black dotted line showing the business-as-usual baseline, the pink dotted line showing emissions after adoption of all technically viable options and the top of the grey shaded area showing emissions after all technically viable and stretch options other than off-setting are adopted.

This indicates that without offsetting, Kirklees would still have some residual emissions through to 2050. However, the bottom of the grey shaded area shows that in theory Kirklees could offset its residual emissions through a UK based tree planting scheme. It is important to note though that this would require the planting of 86 million trees, which even with the densest possible planting would require 19,500 hectares of land, equivalent to 48% of the total Kirklees area.

Crucially, as the bottom of the grey shaded area cuts through the zero axis in 2037, the analysis shows that Kirklees can meet its target to reach net zero by 2038 through the adoption of all of these measures – including the stretch and offsetting measures.

It is important to note that there may be other carbon cutting options that have not been included in this analysis. For example, Kirklees' 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 district – should be the focus of future work.

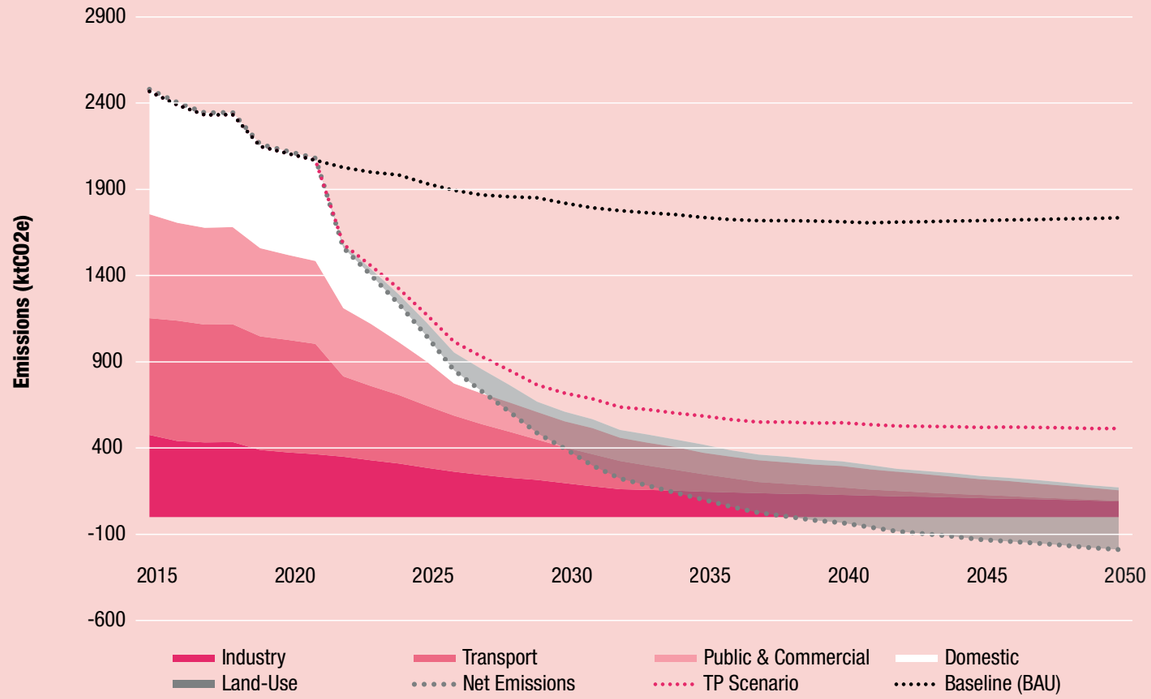


Figure 13: Sectoral Emissions Shortfall Reduction with Stretch Measures

NEXT STEPS FOR KIRKLEES

Based on the analysis presented here we recommend that if Kirklees wants to stay within its share of the global carbon budget, it needs to adopt a clear and ambitious climate action plan.

The case for the adoption of such a plan is supported by the evidence that much – but not all – of the action that is required can be based on the exploitation of win-win low carbon options that will simultaneously improve economic, social and health outcomes across the district.

A climate action plan for Kirklees that builds on and takes forward the analysis in this report should adopt science-based targets for emissions reduction, including both longer term targets and five-yearly carbon reduction targets.

The action plan should focus initially on Kirklees' direct (Scope 1 and 2) carbon footprint as these emissions are most directly under the district's influence, but in time it should also widen its scope to consider its broader (Scope 3) carbon footprint.

As is shown in Figure 14 below, consumption-based emissions for Kirklees are c80% higher than the direct (Scope 1 and 2) emissions. Although very few areas have yet adopted clear plans to address consumption-based or scope 3 emissions, and the options for addressing consumption-based emissions are poorly developed, there is a clear need to address these broader impacts.

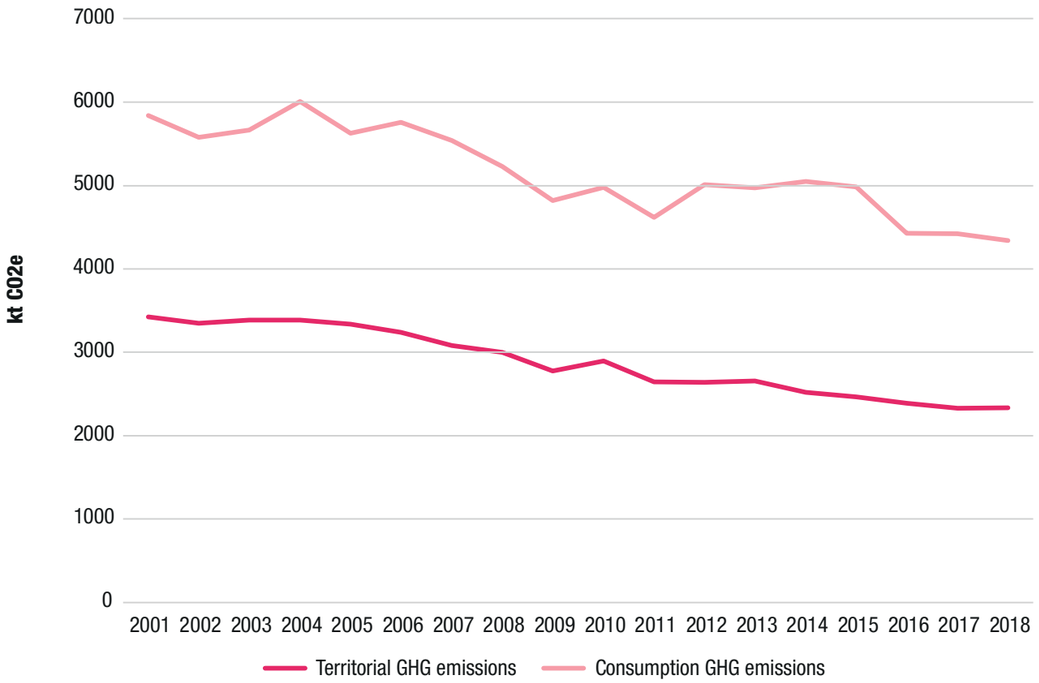


Figure 14: Comparison of Direct/Territorial and Consumption-based Emissions for Kirklees

More specifically, a climate action plan for Kirklees should clearly set out the ways in which Kirklees will work towards achieving these targets, drawing on the deployment KPIs listed in this report. Action should also be taken to monitor and report progress on emissions reductions.

It is important to stress that delivering on these targets will require action across the district and the active support of the public, private and third sectors.

The establishment of an independent Kirklees Climate Commission will continue to draw actors together and to build capacities to take and track action.

It is important to stress that delivering on these targets will require action across the district and the active support of the public, private and third sectors. The Kirklees Climate Commission will act as a critical friend to the district, helping to promote stakeholder engagement and build buy-in and a sense of common ownership for the climate action plan, as well as in supporting, guiding and tracking progress towards its delivery.

For the future, Kirklees Climate Commission can help to establish leadership groups for key sectors such as homes, public and commercial buildings, transport and industry, and to prepare clear plans for the delivery of priority actions in each sector. Working with other Commissions in the Place-Based Climate Action Network, Kirklees Climate Commission can also support the development of low carbon projects and programmes and the preparation of a low carbon investment prospectus to encourage new forms of climate finance to accelerate the district's low carbon transition.

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

Measure	Absolute Emissions Reduction (ktCO2e)
Installing heat pumps in domestic buildings	1,789
Insulating domestic buildings	1,573
Petrol car to bicycle journeys	1,377
Upgraded heating controls in domestic buildings	1,347
Petrol car to walk journeys	1,340
Petrol car to train journeys	1,158
Installing air source heat pumps in office buildings	1,117
Electrical upgrades in domestic buildings	1,113
Diesel car to train journeys	1,081
Petrol car to EV journeys	982
Petrol car to bus (electric) journeys	933
Diesel car to walk journeys	916
Diesel car to bicycle journeys	894
Fabric improvements in public buildings	878
Fabric improvements in retail buildings	870
Petrol car to bus (diesel) journeys	833
Petrol car to hybrid journeys	833
Upgraded boilers in domestic buildings	787
Installing solar PV in domestic buildings	782
Diesel car to EV journeys	782
Petrol car to plug-in hybrid journeys	773
Diesel car to bus (electric) journeys	765
Electricity demand reduction in domestic buildings	731
Diesel car to plug-in hybrid journeys	614
Diesel car to bus (diesel) journeys	535
Hybrid car to EV journeys	527
Condensing & insulation measures to boilers & steam piping in industry	499
Lighting improvements in domestic buildings	477
Draught-proofing in domestic buildings	464
Heating improvements in public buildings	374
Glazing improvements in domestic buildings	363
Solar thermal devices in domestic buildings	355
Improving efficiency of boilers and steam piping in industry	342

Measure	Absolute Emissions Reduction (ktCO2e)
Solar thermal devices in public buildings	281
Lighting improvements in office buildings	231
Improved lighting controls and sensors in public buildings	226
Solar thermal devices in retail buildings	225
Improved cooling in office buildings	221
Diesel car to hybrid	191
Upgrading heating controls in office buildings	188
Improved lighting controls and sensors in retail buildings	168
Lighting improvements in public buildings	139
Pump upgrades, repairs and maintenance in industry	136
Improved lighting controls and sensors in office buildings	131
Heating improvements in retail buildings	117
Compressed air systems in industry	110
Fan correction, repairs, & upgrades in industry	96
Compressors and variable speed systems in industry	69
Furnace efficiency and heat recovery mechanisms in industry	63
Installing solar PV in public buildings	28
Improved cooling in public buildings	28
Heating improvements in office buildings	27
Refrigeration efficiency and technical upgrades in industry	21
Installing solar PV in retail buildings	21
Fabric improvements in office buildings	19
Improved cooling in retail buildings	17
Upgraded heating controls in public buildings	12
Lighting improvements in retail buildings	9
Upgraded heating controls in retail buildings	3
Solar thermal devices in office buildings	-1
Installing air source heat pumps in public buildings	-4
Installing solar pv in office buildings	-6
Installing air source heat pumps in retail buildings	-7
Wind microgeneration associated with retail buildings	-8

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

Measure	MAC Value (£/tCO2e)
Compressed air systems in industry	-603
Pump upgrades, repairs and maintenance in industry	-575
Diesel car to bus (diesel) journeys	-459
Fabric improvements in retail buildings	-445
Petrol car to bus (diesel) journeys	-407
Diesel car to walk journeys	-371
Petrol car to walk journeys	-352
Petrol car to bicycle journeys	-349
Diesel car to bicycle journeys	-348
Fabric improvements in public buildings	-341
Fan correction, repairs, & upgrades in industry	-314
Improved cooling in retail buildings	-305
Petrol car to plug-in hybrid journeys	-263
Compressors and variable speed systems in industry	-212
Electrical upgrades in domestic buildings	-178
Lighting improvements in public buildings	-178
Petrol car to train journeys	-162
Improved cooling in office buildings	-160
Lighting improvements in domestic buildings	-155
Diesel car to plug-in hybrid journeys	-153
Diesel car to train journeys	-147
Petrol car to bus (electric) journeys	-144
Lighting improvements in retail buildings	-140
Petrol car to EV journeys	-131
Electricity demand reduction in domestic buildings	-121
Petrol car to hybrid journeys	-120
Heating improvements in public buildings	-100
Improved cooling in public buildings	-93
Improving efficiency of boilers and steam piping in industry	-69
Lighting improvements in office buildings	-65
Insulating domestic buildings	-60
Diesel car to bus (electric) journeys	-60
Fabric improvements in office buildings	-49

Measure	MAC Value (£/tCO2e)
Heating improvements in office buildings	-46
Draught-proofing in domestic buildings	-41
Glazing improvements in domestic buildings	-38
Installing heat pumps in domestic buildings	-36
Diesel car to EV journeys	-32
Heating improvements in retail buildings	-28
Upgrading heating controls in office buildings	-27
Upgraded boilers in domestic buildings	-24
Upgraded heating controls in domestic buildings	-19
Upgraded heating controls in public buildings	-19
Solar thermal devices in domestic buildings	-16
Diesel car to hybrid	-13
Installing air source heat pumps in retail buildings	-7
Upgraded heating controls in retail buildings	-6
Hybrid car to EV	0
Refrigeration efficiency and technical upgrades in industry	3
Installing air source heat pumps in public buildings	5
Installing solar PV in domestic buildings	5
Solar thermal devices in retail buildings	22
Improved lighting controls and sensors in retail buildings	34
Installing solar PV in public buildings	39
Installing solar PV in office buildings	40
Installing air source heat pumps in office buildings	48
Improved lighting controls and sensors in office buildings	49
Condensing & insulation measures to boilers & steam piping in industry	52
Installing solar PV in retail buildings	54
Solar thermal devices in public buildings	70
Solar thermal devices in office buildings	83
Improved lighting controls and sensors in public buildings	174
Wind microgeneration associated with retail buildings	260
Furnace efficiency and heat recovery mechanisms in industry	534

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. The network commenced in January 2019 with the aim of establishing an agile, effective and sustainable network for climate action embedded in localities and based around partnerships with local authorities. Its 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 climate commissions we are delighted to support new 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

Kirklees COUNCIL

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UKRI Economic and Social Research Council

PCAN

Contact

pcan@lse.ac.uk

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Published January 2022