A NET-ZERO CARBON ROADMAP FOR BELFAST

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PREFACE

Background

Belfast signed its climate emergency declaration in October of 2019, and is due to set a target date in 2021 for the city to reach net-zero emissions. Produced by the ESRC Place-Based Climate Action Network for the Belfast Climate Commission, this net-zero roadmap is designed to feed into Belfast's deliberations on its target date for net-zero, and to inform how it can work towards an ambitious target in the coming years, including through the adoption of a green recovery programme.

Policy Change and the Need to Deliver

In June 2019, the UK Government passed legislation with a commitment to reach net-zero emissions by 2050. The Northern Ireland Assembly declared a climate emergency in February of 2020.

At the local level, 2019 saw a wave of local climate emergency declarations, with many local authorities setting their own, usually more ambitious targets to reach net-zero emissions. By February 2020, 68% of UK district, county, unitary and metropolitan councils including 3 authorities in Northern Ireland had declared a climate emergency*. It is clear though that declaring a climate emergency is just the first step – declarations need to be turned into action plans, and these need to be delivered before we can claim to have responded effectively.

Covid and a Green Recovery

Clearly the world changed dramatically with the Covid pandemic. From a climate perspective, the first, and we hope main phase of national lockdown in the spring and early summer of 2020 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 Belfast could apply some guiding principles for a green recovery – to go faster, to build better, to think bigger, to be bolder - to 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.

John Barry and Grainia Long, Co-Chairs, Belfast Climate Commission

Belfast Climate Commission

The Belfast Climate Commission was established in 2020 to support the city 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.

The Belfast 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://www.belfastclimate.org.uk

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

BELFAST CARBON ROADMAP
PATHWAY TO NET-ZERO*

PCAN | BELFAST 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

CO_2

14m tonnes

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

Belfast is emitting

1.5m tonnes

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

2030

BASELINES AND TARGETS

42%

The decline in Belfast's carbon emissions since 2000

This needs to be increased to

66% by 2025
80% by 2030
100% by 2050

Belfast has committed to work towards being

CARBON NEUTRAL

by

2050

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

35%

These would reduce Belfast's energy bill by

£263m

per year, and would create nearly

4,779

years of extra employment

MORE AMBITIOUS OPTIONS

More ambitious but expensive options could

close the 2030 gap by

51%

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

H_2 O_2

Doing all of the above leaves a

41%

shortfall to reach by

2050

REACHING OUR TARGET

Belfast can close the gap by

100% by 2033

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

*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 1.5°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 Belfast a total carbon budget of 14 million tonnes from 2020. Based only on the fuel and electricity used within its boundaries, Belfast currently emits c.1.5 million tonnes of carbon a year, and as such it would use up its carbon budget by 2030.
- 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 Belfast (i.e. its Scope 3 emissions).

Baselines and Targets

- Scope 1 and 2 carbon emissions from Belfast have fallen by 42% 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 Belfast's 2000 level of annual emissions output will have fallen by a total of 51% in 2050.
- If it is to stay within its carbon budget, Belfast needs to add to the emissions reductions already achieved to secure 66% reductions on its 2000 level of emissions by 2025, 80% by 2030, 88% by 2035, 93% by 2040, 97% by 2045 and 100% by 2050. In short, the majority of all emissions reductions across the city need to be delivered within the next ten years.
- Without further activity to address its carbon emissions, we project that Belfast's annual emissions will exceed its carbon budget by 1.4 million tonnes in 2030, and 1.3 million tonnes in 2050.

[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.

Cost-Effective Options

- To meet these carbon reduction targets, Belfast 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 Belfast could close the gap between its projected emissions in 2050 and net-zero emissions by 35% purely through the adoption of cost-effective options in houses, public and commercial buildings, transport and industry.
- Adopting these options would reduce Belfast's total projected energy bill in 2050 by £263 million per year whilst also creating 4,779 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 Belfast could close the gap to net-zero emissions in 2050 by 51% 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, Belfast still has to identify other more innovative interventions that could deliver the last 41% of shortfall between projected emissions in 2050 and a net-zero target.
- Options identified elsewhere that could be considered in Belfast 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 city, 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.

A NET-ZERO CARBON ROADMAP FOR BELFAST

EXECUTIVE SUMMARY

Next Steps

- Belfast 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 city.
- 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 Belfast's direct (Scope 1 and 2) carbon footprint as these emissions are most directly under the city'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 Belfast 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 city and the active support of the public, private and third sectors. Establishing an independent Belfast Climate Commission has already helped to draw actors together and to build capacities to take and track action.
- Driven by the Belfast 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 city should also be asked to match broader carbon reduction commitments and to report back on progress.

A NET-ZERO CARBON ROADMAP FOR BELFAST

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.

(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.

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 Belfast's 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, 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 BELFAST

Analysis shows that Belfast's baseline (Scope 1 and 2) emissions have fallen by 42% 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 Belfast's baseline (Scope 1 and 2) emissions will only fall by a further 6% by 2030, 10% by 2040, and 11% by 2050. This is a total of just over 51% between 2000 and 2050.

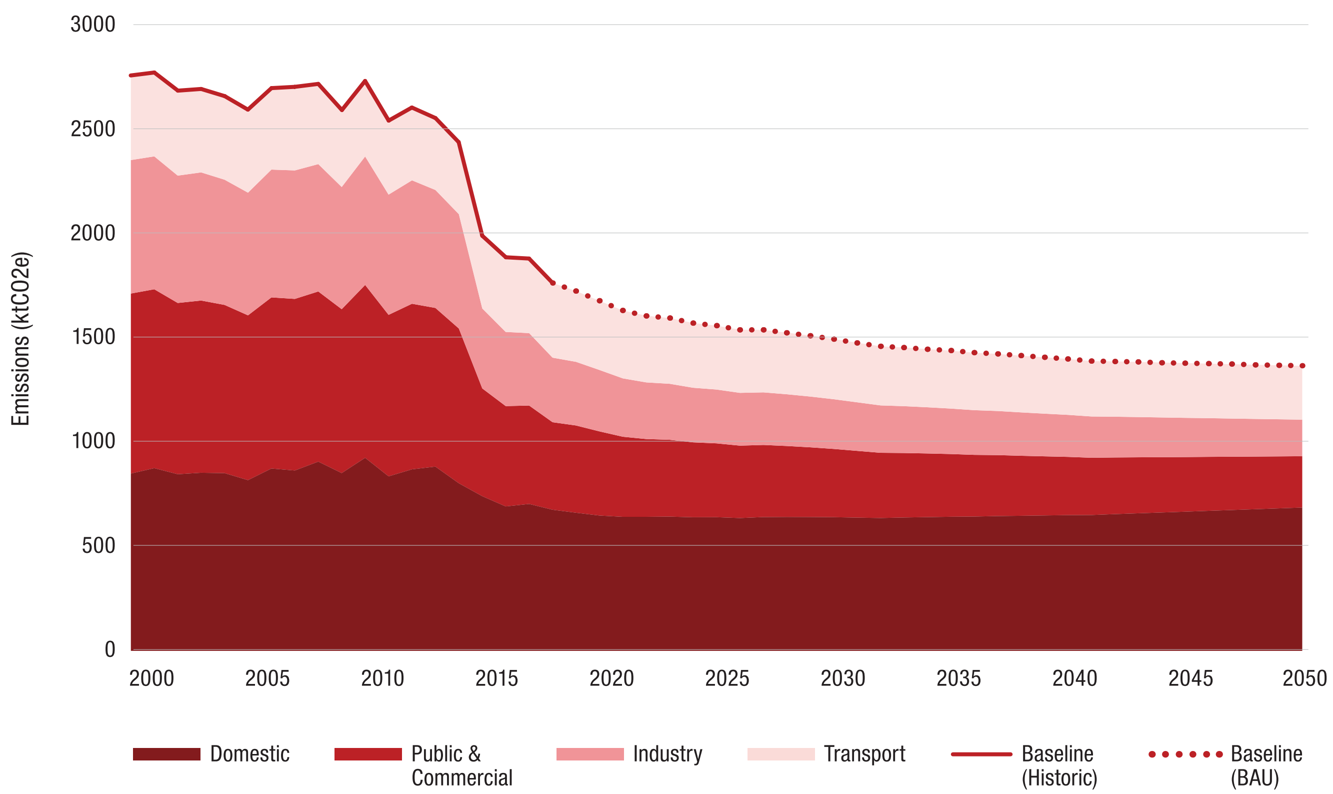


Figure 1: Belfast's Scope 1 and 2 Carbon Emissions (2000-2050)

Currently, 39% of Belfast's emissions come from the domestic housing sector, with transport responsible for 20% of emissions, public and commercial buildings for 24% and industry 18%. 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.19%) with a significant 11% 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.

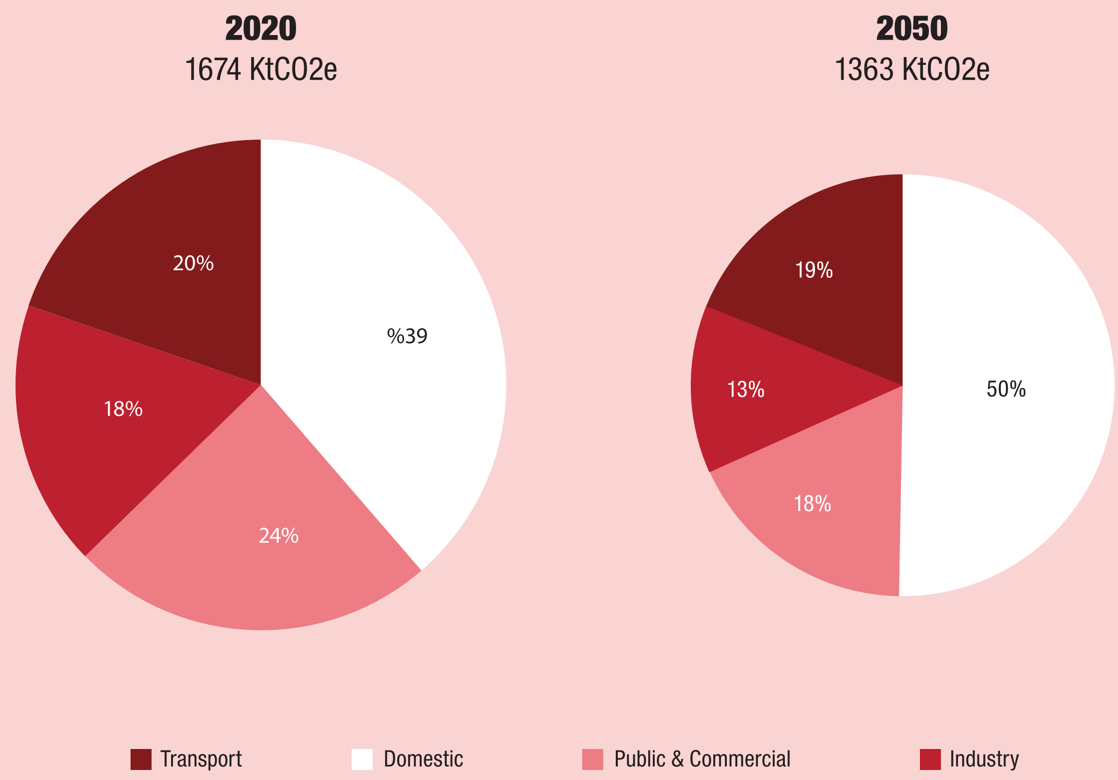


Figure 2: Belfast's Present and Projected Emissions by Sector

A NET-ZERO CARBON ROADMAP FOR BELFAST

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

Related to this emissions baseline, after evaluating the range of energy sources Belfast consumes (spanning electricity, gas, all solid and liquid fuels across sectors) we find that in 2019, £296 million was spent on energy across the city. Transport fuels generated the majority of this demand (52%), followed by domestic buildings (30%) then public and commercial buildings and industry (15% and 3% 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 Belfast's business-as-usual (BAU) energy expenditure will likely grow to just over £332 million per year in 2030 and c.£466 million per year in 2050, with transport expenditure growing slightly (53%) in Belfast's total (see Figure 3 below).

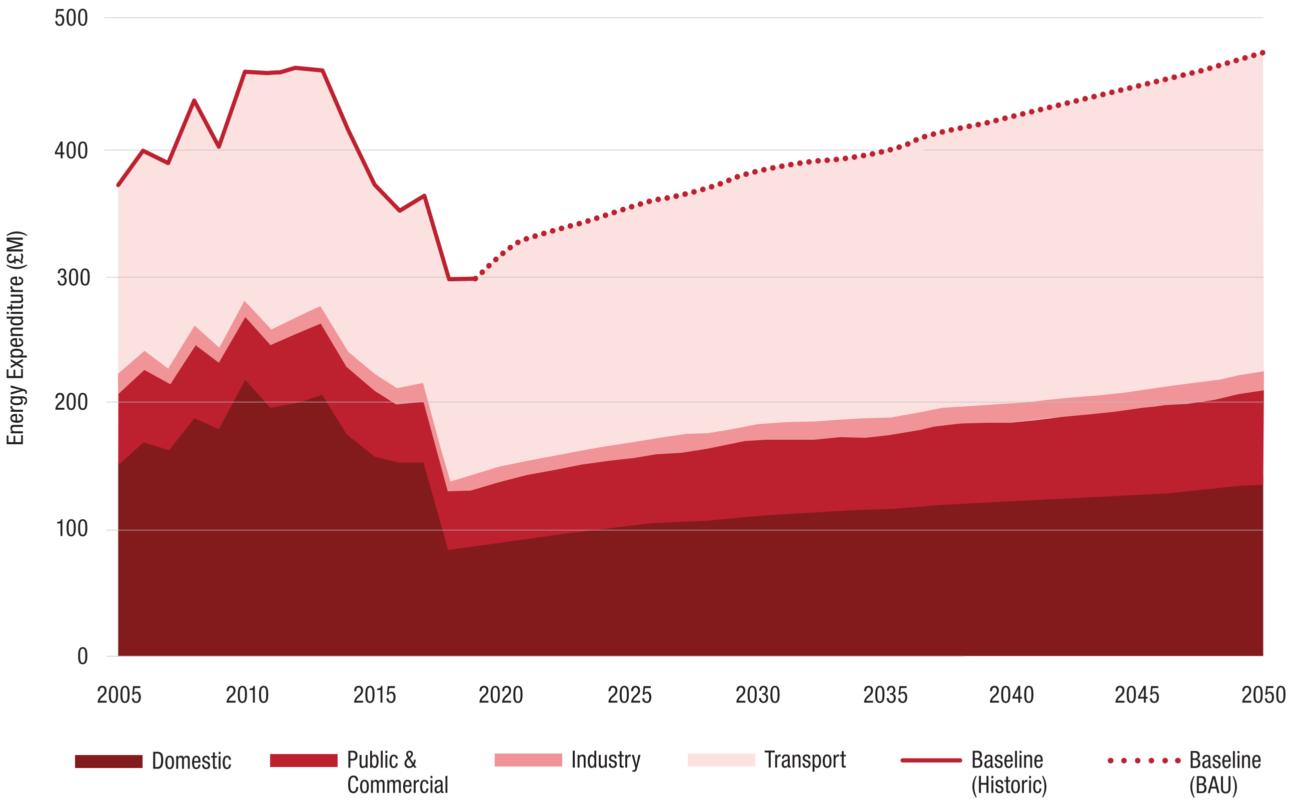


Figure 3: Belfast's Present and Projected Energy Expenditure by Sector

SETTING SCIENCE-BASED CARBON REDUCTION TARGETS FOR BELFAST

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 Belfast a total carbon budget of c.14 megatonnes over the period between the present and 2050.

At current rates of emissions output, Belfast would use up this budget in just over a decade at some point during the winter of 2030. However, Belfast could stay within its carbon budget by reducing its emissions by c.8.4% year on year. This would mean that to transition from the current position where emissions are 42% 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, Belfast should adopt the following carbon reduction targets (on 2000 levels):

66%
by 2025

80%
by 2030

88%
by 2035

93%
by 2040

97%
by 2045

100%
by 2050

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

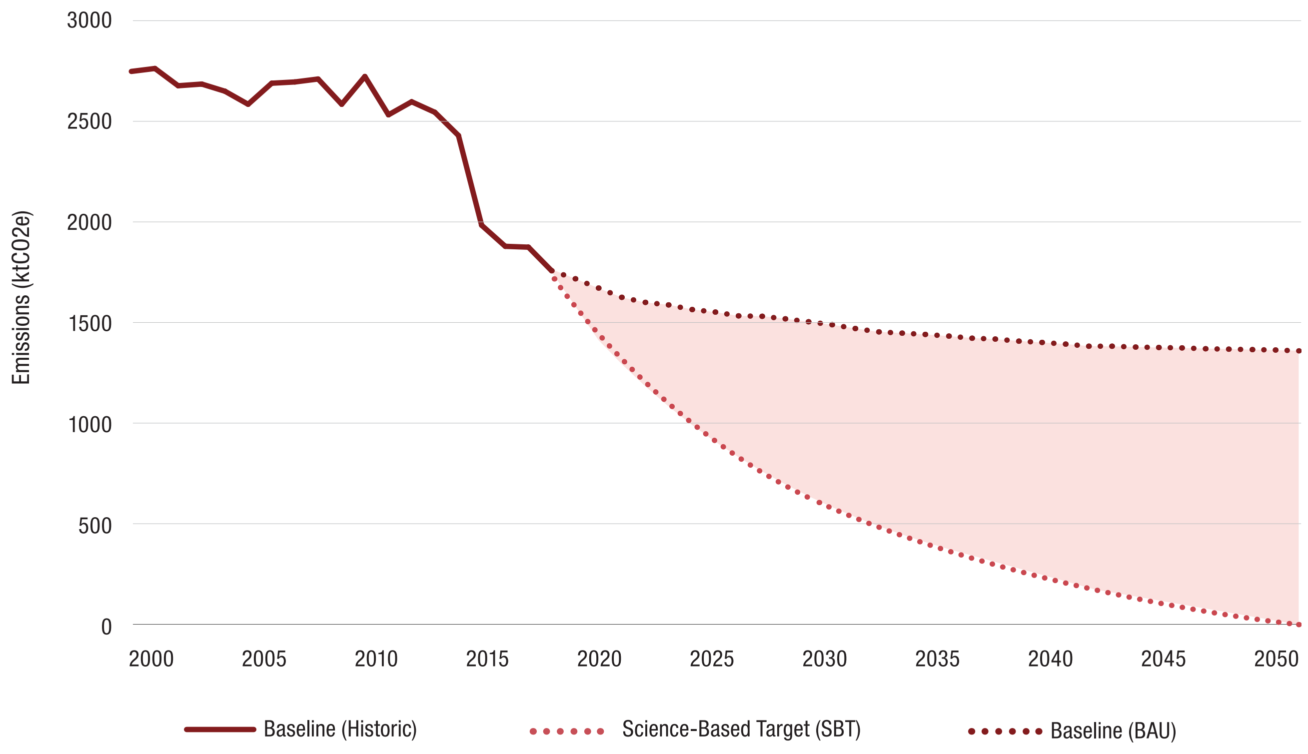


Figure 4: Belfast's Baseline and Science-Based-Target Emissions Pathways

AGGREGATING UP: THE BIGGER PICTURE FOR BELFAST

a) Emissions reductions

Our analysis predicts that the gap between the Belfast business-as-usual (BAU) emissions in 2050 and the net-zero target could be closed by 41% (513 ktCO2e) through the adoption of Cost-Effective (CE) options, by a further 11% (139 ktCO2e) through the adoption of additional Cost-Neutral (CN) options at no net cost, and then by an additional 7% (93 ktCO2e) through the further adoption of all technically viable (TP) options. This means that Belfast still has to identify the innovative or stretch options that could deliver the last 41% (512 ktCO2e) of the gap between the business-as-usual scenario and net-zero in 2030 following science-based targets (SBT).

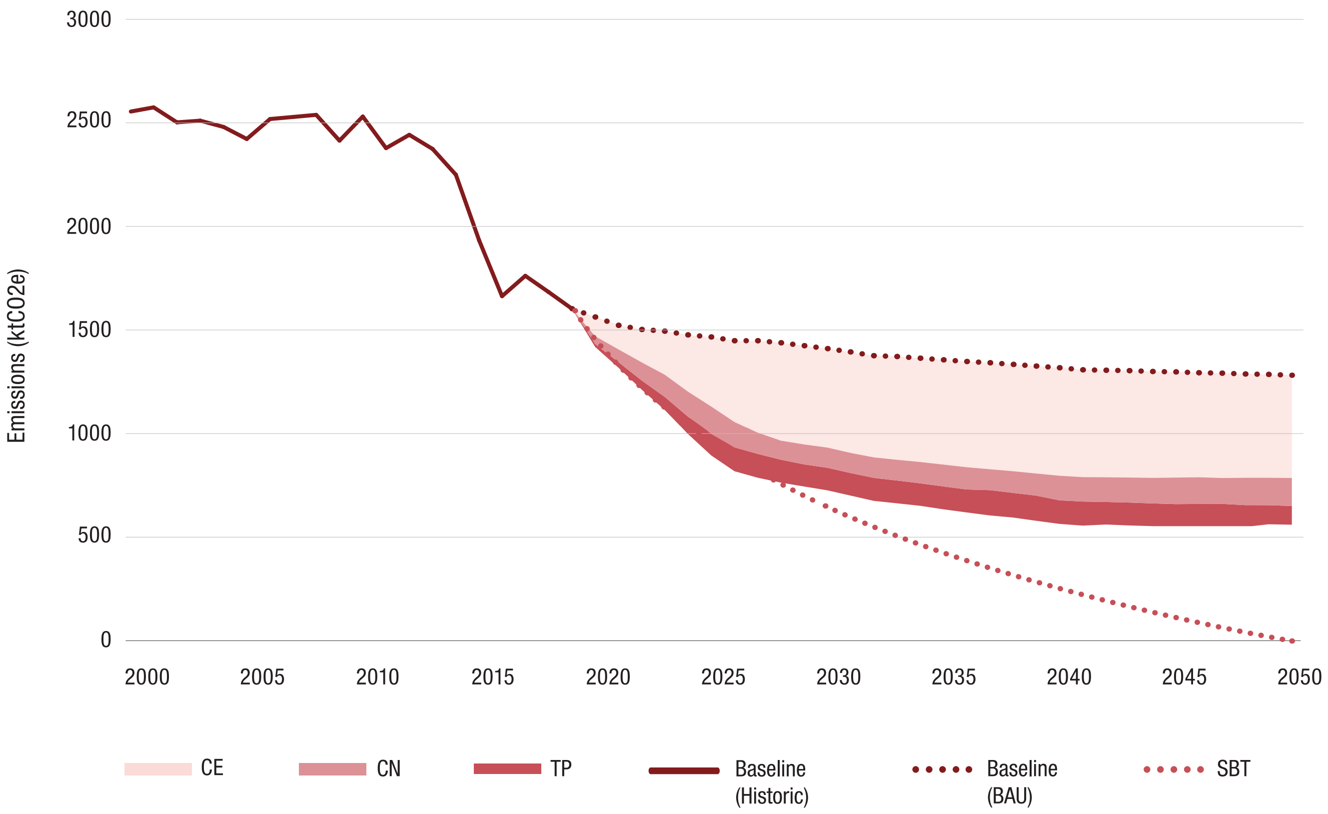


Figure 5: Belfast's BAU Baseline with Cost-Effective (CE), Cost-Neutral (CN), & Technical Potential (TP) Scenarios

		2025	2030	2035	2040	2045	2050
Reduction on BAU Baseline (2050)	**CE**	24%	35%	39%	42%	41%	41%
	CN	33%	43%	47%	51%	52%	52%
	TP	41%	51%	56%	60%	61%	59%
Reduction on 2020 Emissions	**CE**	22%	32%	34%	35%	34%	33%
	CN	31%	38%	41%	43%	43%	42%
	TP	38%	46%	48%	50%	50%	48%

Table 1: Belfast's Potential Five-Year Emissions Reduction Percentages

b) The most carbon- and cost-effect options

Figure 6 (see p26) presents the emissions savings that could be achieved through different groups of measures in Belfast. Appendices 1 and 2 present league tables of specific measures and their potential emissions savings over this period.

AGGREGATING UP: THE BIGGER PICTURE FOR BELFAST

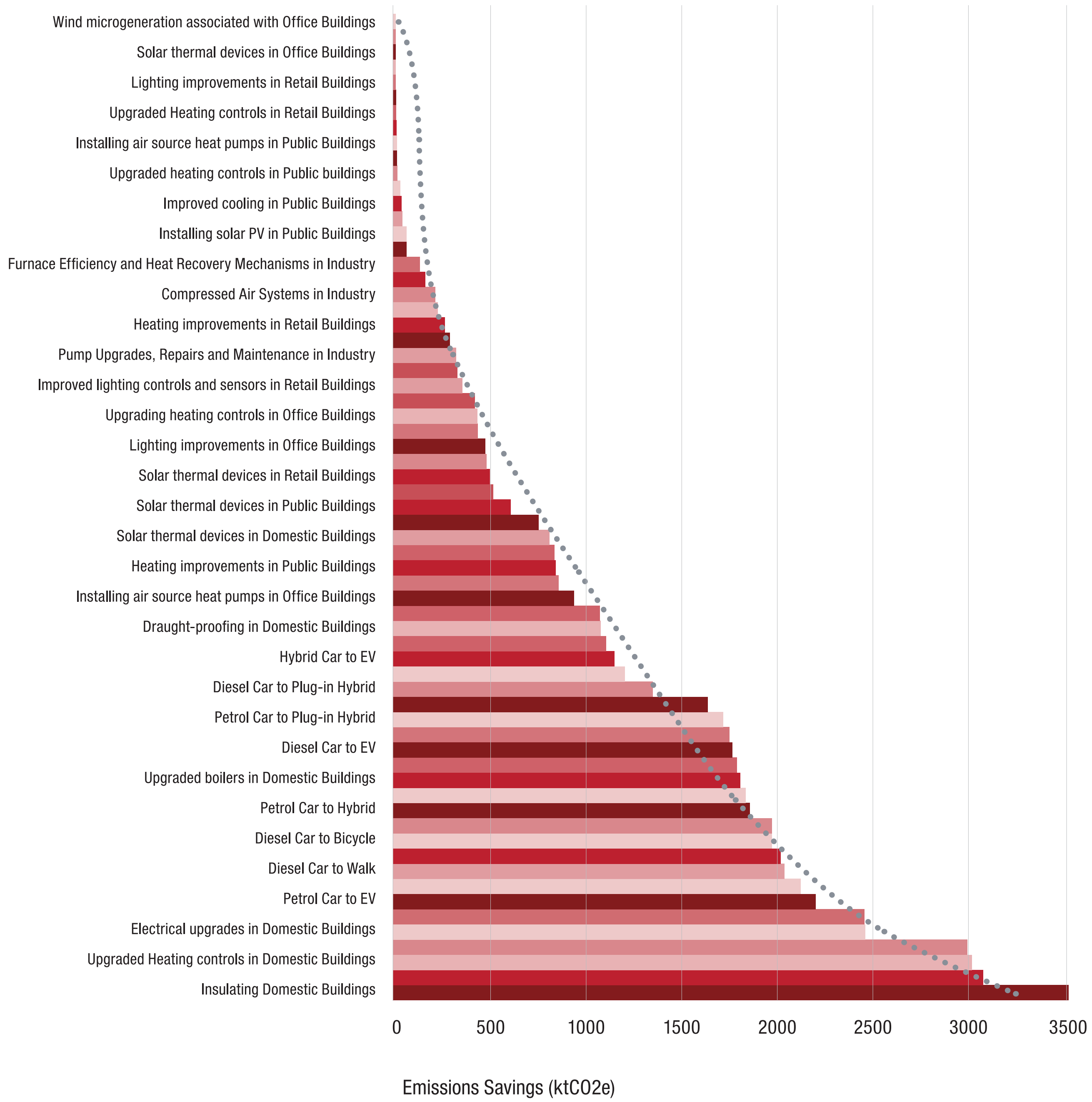


Figure 6: Simplified Emissions Reduction Potential by Measure for Belfast

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

Rank	Measure	Cost Effectiveness (£/tCO2e)
1	Compressed Air Systems in Industry	-603
2	Diesel Car to Diesel Bus Journeys	-492
3	Pump Upgrades, Repairs and Maintenance in Industry	-478
4	Fabric improvements in Retail Buildings	-432
5	Petrol Car to Diesel Bus Journeys	-376
6	Fabric improvements in Public Buildings	-367
7	Diesel Car to Walk Journeys	-362
8	Petrol Car to Walk Journeys	-356
9	Improved Cooling in Retail Buildings	-326
10	Diesel Car to Bicycle Journeys	-322

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

Rank	Measure	Emissions Reduction Potential (ktCO2e)
1	Insulating Domestic Buildings	1,162
2	Petrol Car to Bicycle Journeys	1,014
3	Upgraded Heating controls in Domestic Buildings	998
4	Petrol Car to Walk Journeys	982
5	Electrical upgrades in Domestic Buildings	811
6	Installing heat pumps in Domestic Buildings	808
7	Petrol Car to EV Journeys	725
8	Petrol Car to Electric Bus Journeys	700
9	Diesel Car to Walk Journeys	675
10	Fabric improvements in Public Buildings	663

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

AGGREGATING UP: THE BIGGER PICTURE FOR BELFAST

Some of the ideas for innovative options identified elsewhere, that could also be considered for Belfast, 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 Belfast").

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 around £1.6 billion over their lifetimes (equating to investments of £160m a year across all organisations and households in the city for the next decade), once adopted they would reduce Belfast's total energy bill by £286 million p.a. in 2050 whilst also creating 4,779 years of employment (239 full-time jobs for 20 years).

By expanding this portfolio of measures to at no net cost to Belfast's economy (the Cost-Neutral scenario), investments of £4 billion over their lifetimes (or £400m a year for the next decade) would generate 11,751 years of employment (587 full-time jobs for 20 years) whilst reducing Belfast's emissions by 52% of projected 2030 levels.

Exploiting all technically viable options would be more expensive (at least at current prices, c.£5 billion or £500m a year for the next decade) but realise further emissions savings – eliminating 59% of the projected shortfall in Belfast's 2050 emissions, whilst saving hundreds of millions of pounds on an annual basis.

		2025	2030	2035	2040	2045	2050
Cumulative Investment (£M)	**CE**	1,126	1,604	1,623	1,625	1,625	1,625
	CN	2,454	3,846	3,924	3,944	3,952	3,952
	TP	2,691	4,572	4,630	4,650	4,657	4,657
Annual Energy Expenditure Savings (£M)	**CE**	172	263	318	349	325	286
	CN	177	241	293	337	306	255
	TP	185	283	326	343	317	200

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

Sector	Scenario	Investment (£M)
Domestic	**CE**	676
	CN	1,450
	TP	1,519
Public & Commercial	**CE**	451
	CN	925
	TP	935
Industry	**CE**	258
	CN	1,043
	TP	1,670
Transport	**CE**	240
	CN	534
	TP	534

Table 5: Potential Investments by Sector & Economic Scenario

		Total	Domestic	Industry	Transport	Public & Commercial
Years of Employment	**CE**	4,779	1,445	884	329	2,122
	CN	11,751	3,100	3,568	731	4,352
	TP	14,089	3,247	5,713	731	4,398
Jobs (20-year Period)	**CE**	239	72	44	16	106
	CN	588	155	178	37	218
	TP	704	162	286	37	220

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 Belfast 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	91,166	5,065
Glazing Upgrades	74,163	4,149
Solar PV	72,002	3,984
Floor Insulation	71,004	3,972
Gas Boiler Upgrades & Repairs	66,390	3,672
Solar thermal	53,604	2,960
Thermostats & Heating Controls	53,343	2,940
Loft insulation	50,745	2,833
Wall Insulation	35,228	1,961
Cavity wall Insulation	31,188	1,722
Draught Proofing	29,442	1,649
Heat Pumps	6,056	334

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

Public & Commercial Buildings

Measure	Floorspace Applied (m^2)	Mean Annual Rate of Installation (m^2)
Lighting/Heating Controls and Sensors	2,678,717	154,695
Retail Heating Upgrades	2,654,476	155,070
Wind Turbines	1,901,359	105,631
Office Lighting Upgrades	747,819	41,923
Office Fabric Improvements	715,552	41,025
Office Solar PV	317,287	17,932
Office Heat Pumps	298,623	16,843

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

Transport

Measure	Deployment
High Quality Protected Cycling Highways Built	6 kilometres
Additional Electric Buses Procured and In Service	40 per annum
Increase in Public Transport Ridership	2M trips per annum
Additional EVs Replacing Conventional Private Cars	3000 per annum

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

FOCUSING ON KEY SECTORS IN BELFAST

At full deployment (technical potential) across Belfast, we calculate that there is potential to avoid 21 MtCO2e in emissions that will otherwise be produced in the city between 2020 and 2050. The domestic sector will contribute most significantly toward this total, with a decarbonisation potential of between 6 MtCO2e (cost-effective scenario) and 9 MtCO2e (technical potential) through the period.

However, transport, industry and public and commercial buildings also play a major role; upgrading and retrofitting of Belfast's built environment (including public and commercial sectors) could reduce emissions by up to 5 MtCO2e over the same period at full technical potential, with transport similarly showing the potential to decarbonise over 5 MtCO2e under the same conditions.

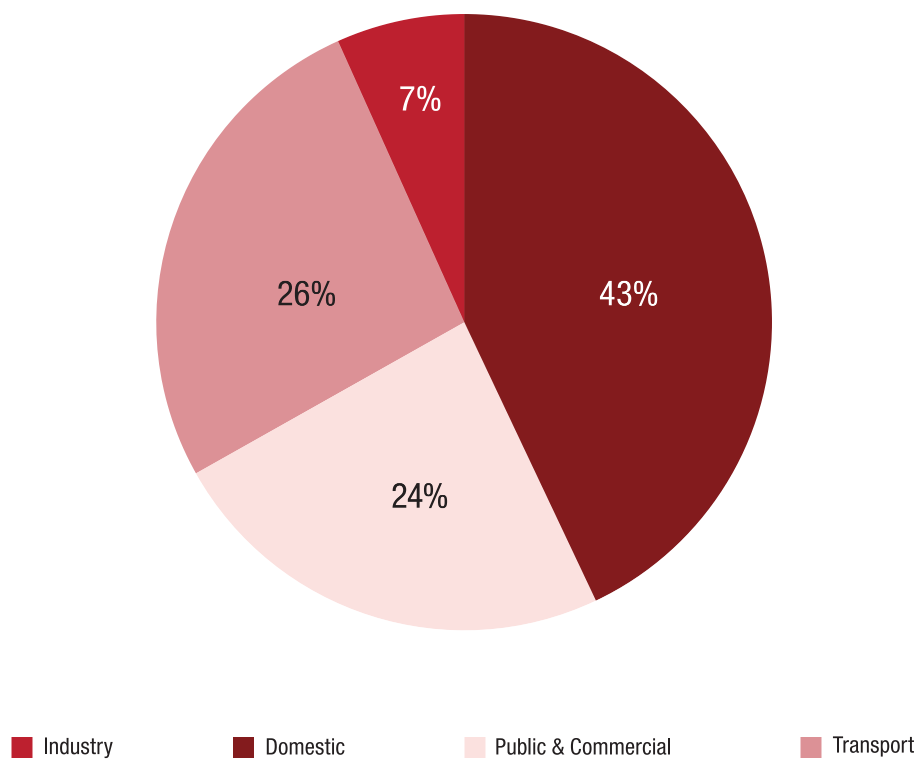


Figure 7: Belfast's Emissions Reduction Potential (2020-2050) by Sector

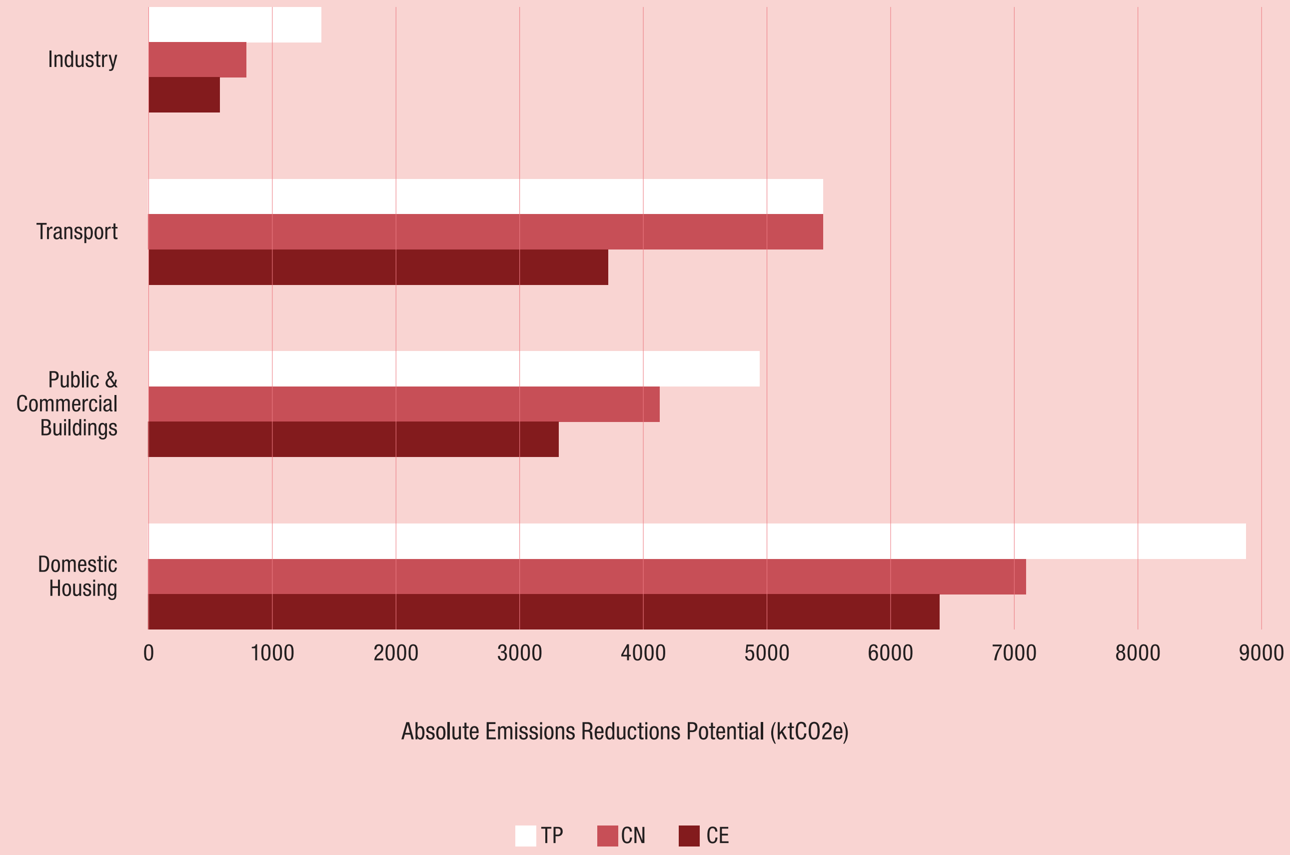


Figure 8: Belfast's Emissions Reduction Potential By Sector & Economic Scenario (2020-2050)

FOCUSING ON KEY SECTORS IN BELFAST

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 Belfast.

(a). Domestic Housing

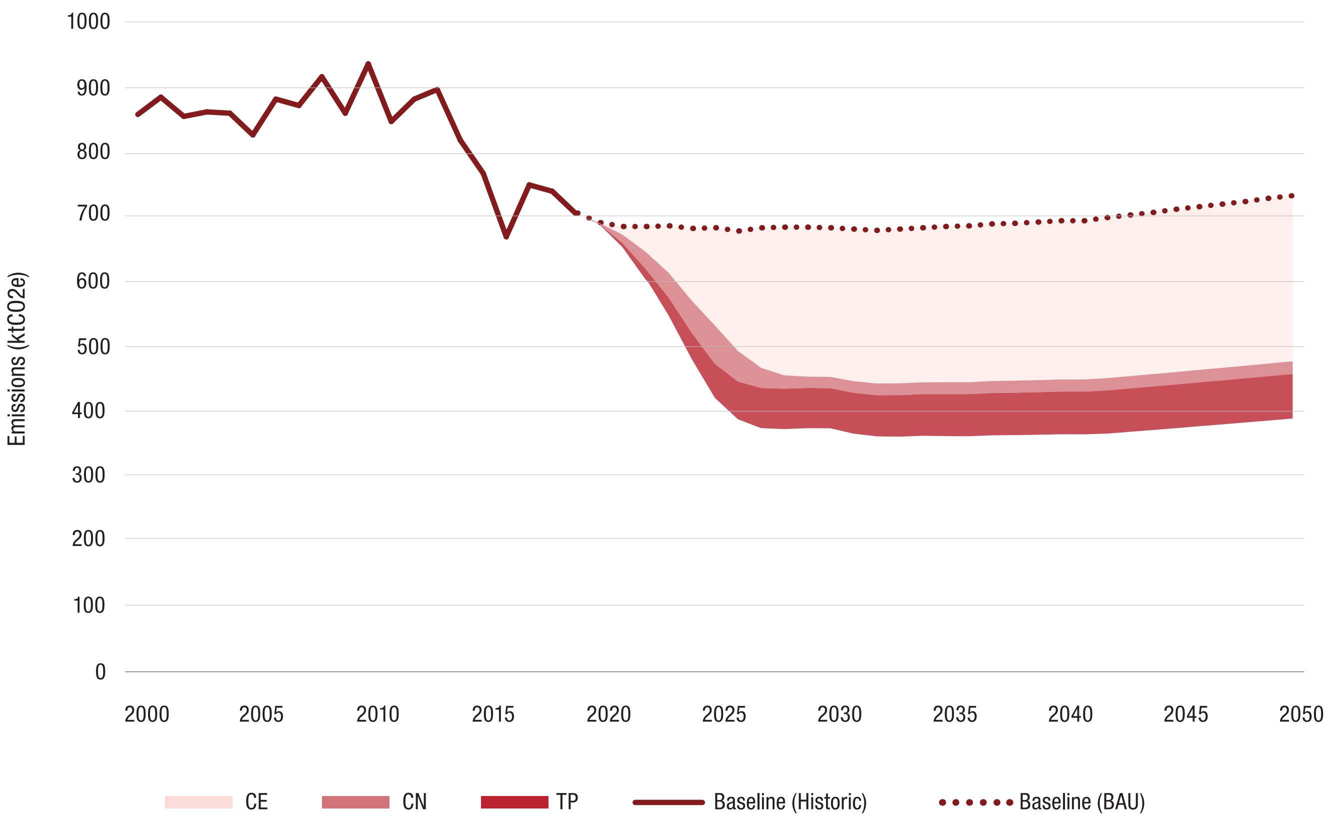


Figure 9: Housing BAU Baseline with Cost-Effective, Cost-Neutral and Technical Potential Scenarios

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	151	231	241	245	252	256
	CN	210	248	260	264	271	276
	TP	263	310	325	330	338	345
Annual Energy Expenditure Savings (£M)	**CE**	73	109	143	165	165	169
	CN	72	92	120	152	147	143
	TP	77	124	148	161	152	83
Cumulative Investment (£M)	**CE**	480	665	676	676	676	676
	CN	950	1,418	1,450	1,450	1,450	1,450
	TP	959	1,503	1,519	1,519	1,519	1,519

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

Rank	Measure	Cost Effectiveness (£/tCO2e)
1	Lighting improvements and Efficiency Upgrades	-172
2	Electrical Appliance & Fixture Upgrades	-167
3	Electricity Demand Reduction	-111
4	Insulatiion (various forms)	-59
5	Draught-proofing and Fabric Improvements	-34
6	Glazing Improvements and Installations	-31
7	Installing Heat Pumps	-29
8	Upgraded Heating Controls	-27
9	Installing Biomass Boilers	-17
10	Solar Thermal Devices	-15

Table 9: The Most Cost-Effective Measures for Housing

FOCUSING ON KEY SECTORS IN BELFAST

(b). Public & Commercial Buildings

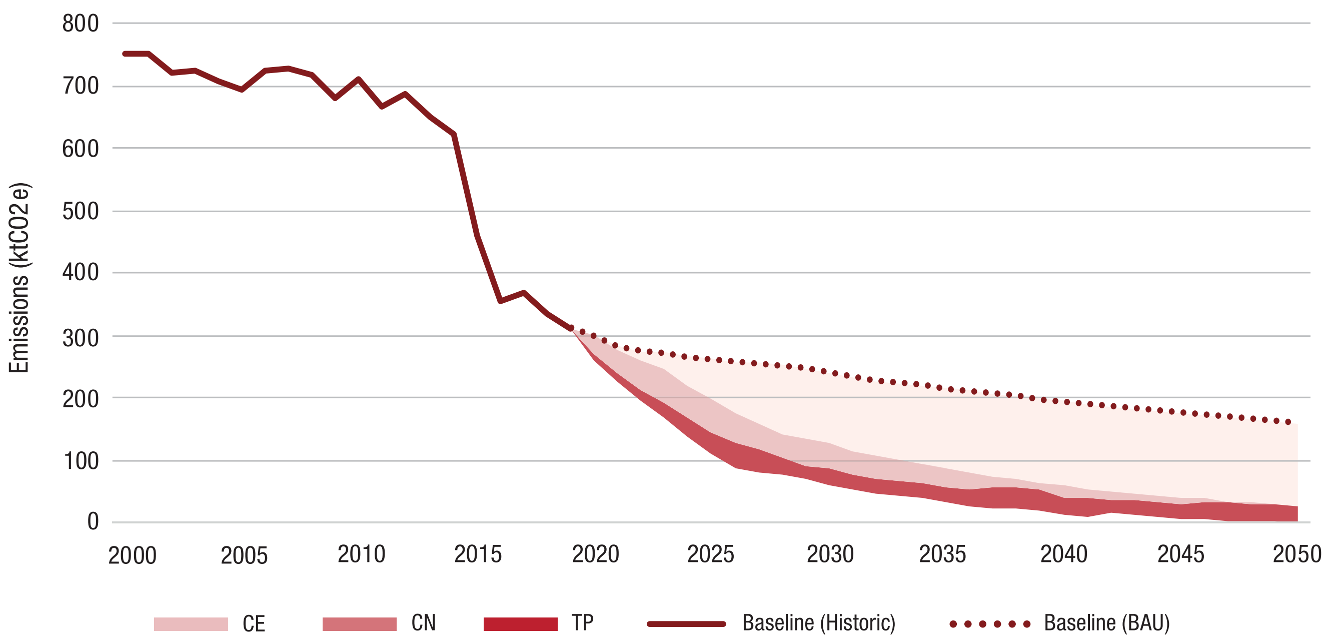


Figure 10: Public and Commercial Buildings BAU Baseline with Cost-Effective, Cost-Neutral and Technical Potential Scenarios

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	65	114	129	135	136	133
	CN	116	155	159	154	147	135
	TP	152	180	183	181	170	159
Annual Energy Expenditure Savings (£M)	**CE**	40	74	86	96	88	73
	CN	44	66	80	91	83	68
	TP	48	76	85	88	89	73
Cumulative Investment (£M)	**CE**	303	447	451	451	451	451
	CN	572	912	925	925	925	925
	TP	591	925	935	935	935	935

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

Rank	Measure	Cost Effectiveness (£/tCO2e)
1	Fabric Improvements in Retail Buildings	-432
2	Fabric Improvements in Public Buildings	-367
3	Improved Cooling in Retail Buildings	-326
4	Lighting Improvements in Public Buildings	-207
5	Improved Cooling in Office Buildings	-163
6	Lighting Improvements in Retail Buildings	-138
7	Heating Improvements in Public Buildings	-115
8	Improved Cooling in Public Buildings	-97
9	Heating Improvements in Office Buildings	-62
10	Lighting Improvements in Office Buildings	-62

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

FOCUSING ON KEY SECTORS IN BELFAST

(c). Transport

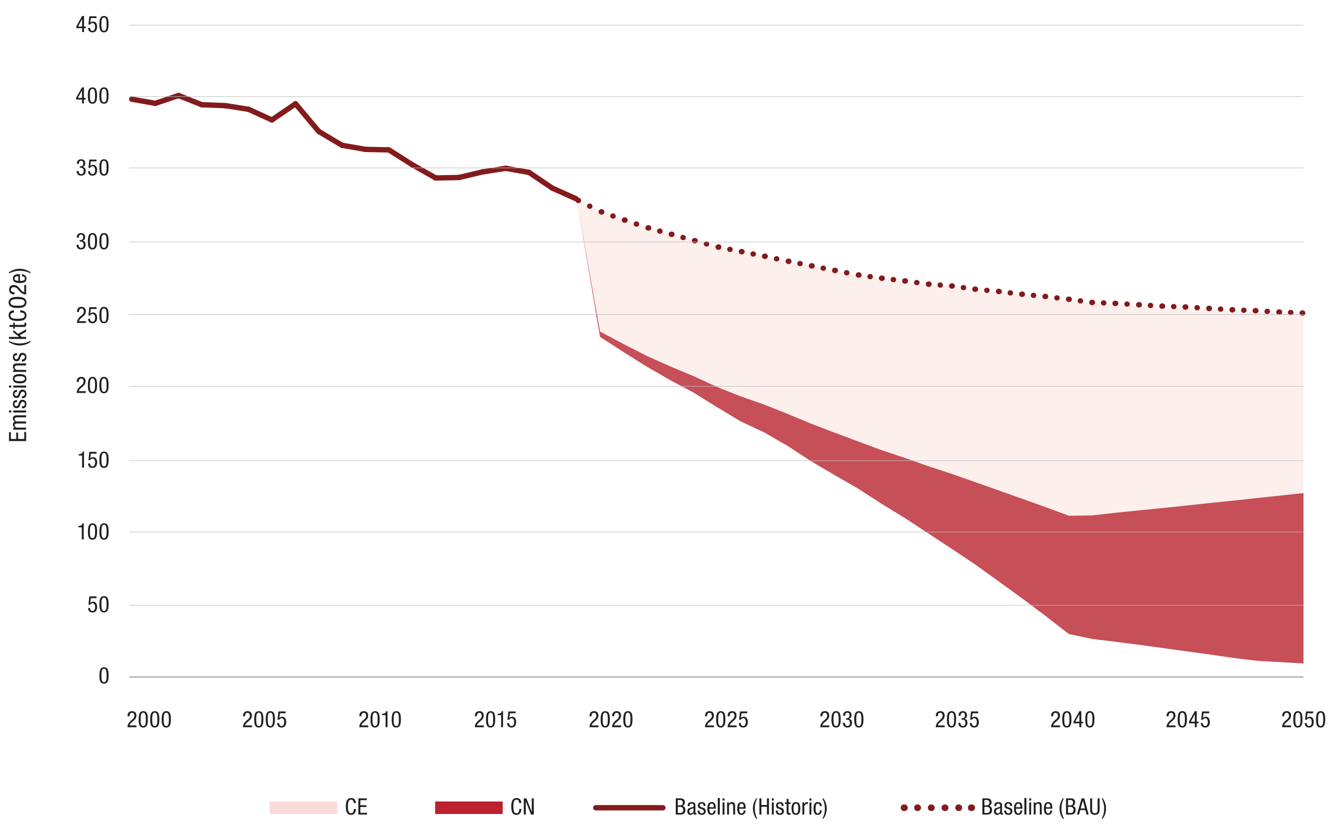


Figure 11: Transport BAU Baseline with Cost-Effective and Cost-Neutral Scenarios[3]

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	97	112	129	149	136	123
	CN	111	141	181	230	237	241
	TP	111	141	181	230	237	241
Annual Energy Expenditure Savings (£M)	**CE**	40	45	49	53	51	45
	CN	42	48	54	59	55	44
	TP	42	48	54	59	55	44
Cumulative Investment (£M)	**CE**	187	234	238	240	240	240
	CN	307	473	506	527	534	534
	TP	307	473	506	527	534	534

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	-492
2	Petrol Car to Diesel Bus Journey	-376
3	Diesel Car to Walk Journey	-362
4	Petrol Car to Walk Journey	-356
5	Diesel Car to Bicycle Journey	-322
6	Petrol Car to Bicycle Journey	-304
7	Petrol Car to Plug-in Hybrid Journey	-249
8	Diesel Car to Plug-in Hybrid Journey	-159
9	Petrol Car to EV Journey	-153
10	Petrol Car to Hybrid Journey	-152

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 BELFAST

(d). Industry

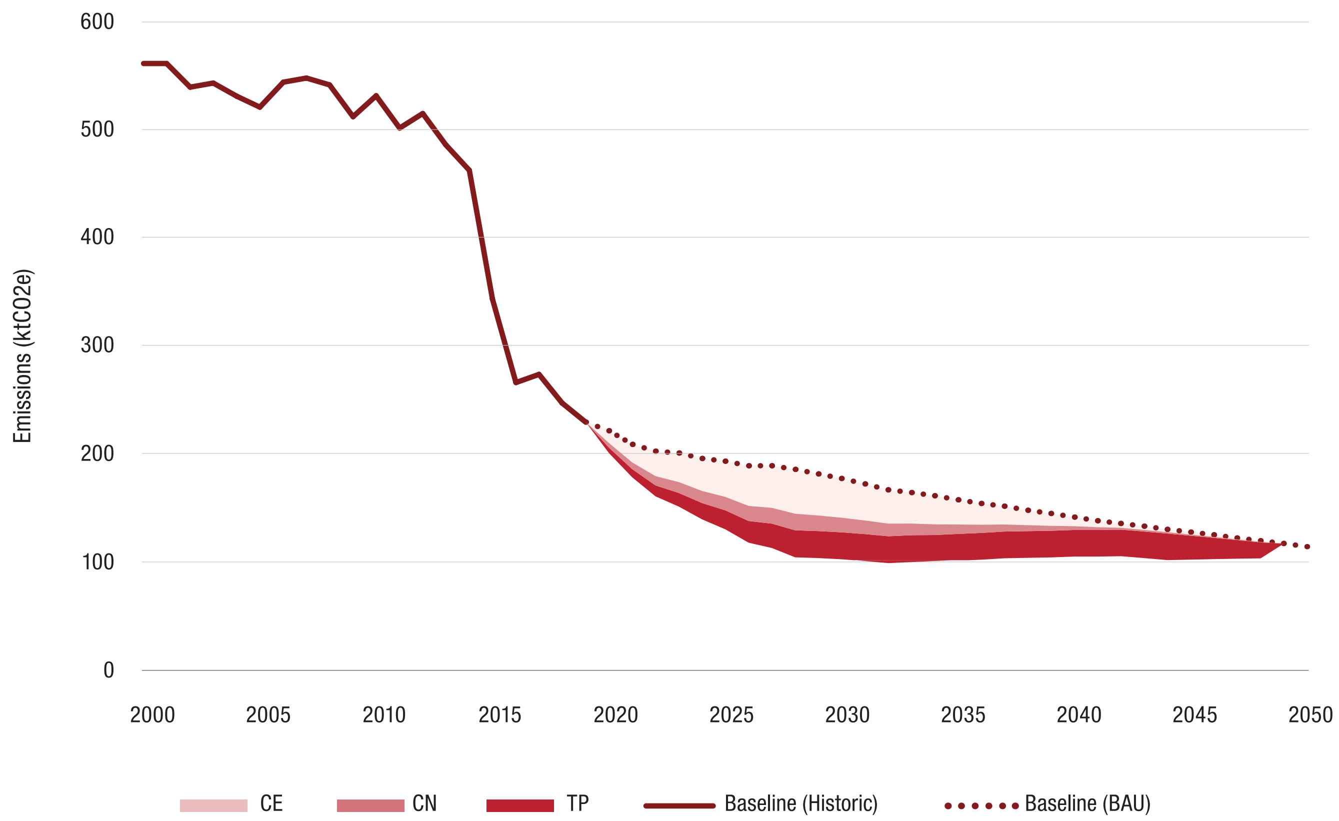


Figure 12: Industry BAU Baseline with Cost-Effective, Cost-Neutral and Technical Potential Scenarios

		2025	2030	2035	2040	2045	2050
Emissions Reductions (ktCO2e)	**CE**	33	36	23	9	2	1
	CN	46	50	32	12	3	2
	TP	63	75	56	37	25	16
Annual Energy Expenditure Savings (£M)	**CE**	19	35	39	35	22	11
	CN	19	35	39	35	22	11
	TP	19	35	39	35	22	11
Cumulative Investment (£M)	**CE**	155	258	258	258	258	258
	CN	626	1,043	1,043	1,043	1,043	1,043
	TP	835	1,670	1,670	1,670	1,670	1,670

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

Rank	Measure[4]	Cost Effectiveness (£/tCO2e)
1	Compressed Air Systems in Industry	-603
2	Pump Upgrades, Repairs and Maintenance in Industry	-478
3	Fan Correction, Repairs, & Upgrades in Industry	-293
4	Compressors and Variable Speed Systems in Industry	-239
5	Improving Efficiency of Boilers and Steam Piping in Industry	-70
6	Refrigeration Efficiency and Technical Upgrades in Industry	16
7	Condensing & Insulation Measures to Boilers & Steam Piping in Industry	45
8	Furnace Efficiency and Heat Recovery Mechanisms in Industry	540

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 BELFAST

Even with full delivery of the broad programme of cross-sectoral, city-wide low carbon investment described above, there remains an emissions shortfall of 41% between Belfast's 2050 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 Belfast's targets in future.

		2025	2030	2035
Annual Emissions Reduction Potential (ktCO2e)	Zero Carbon Heavy Goods Transport	31	145	143
	Industrial Heat and Cooling Electrification	18	17	10
	1,400 Ha. Reforested Annually 2020-29*	66	172	209
	Electrification of Domestic Heat	12	60	87
	Electrification of Domestic Cooking	4	20	29
	Electrification of Commercial/Public Heating	6	19	6

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 Belfast's carbon emissions, with the black dotted line showing the business-as-usual baseline, the red 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 Belfast would still have some residual emissions through to 2050. For illustration, the grey shaded area shows that in theory Belfast could offset its residual emissions through a UK based tree planting scheme; however this would require the planting of 62 million trees, which even with the densest possible planting would require 14000 hectares of land, equivalent to 122% 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.

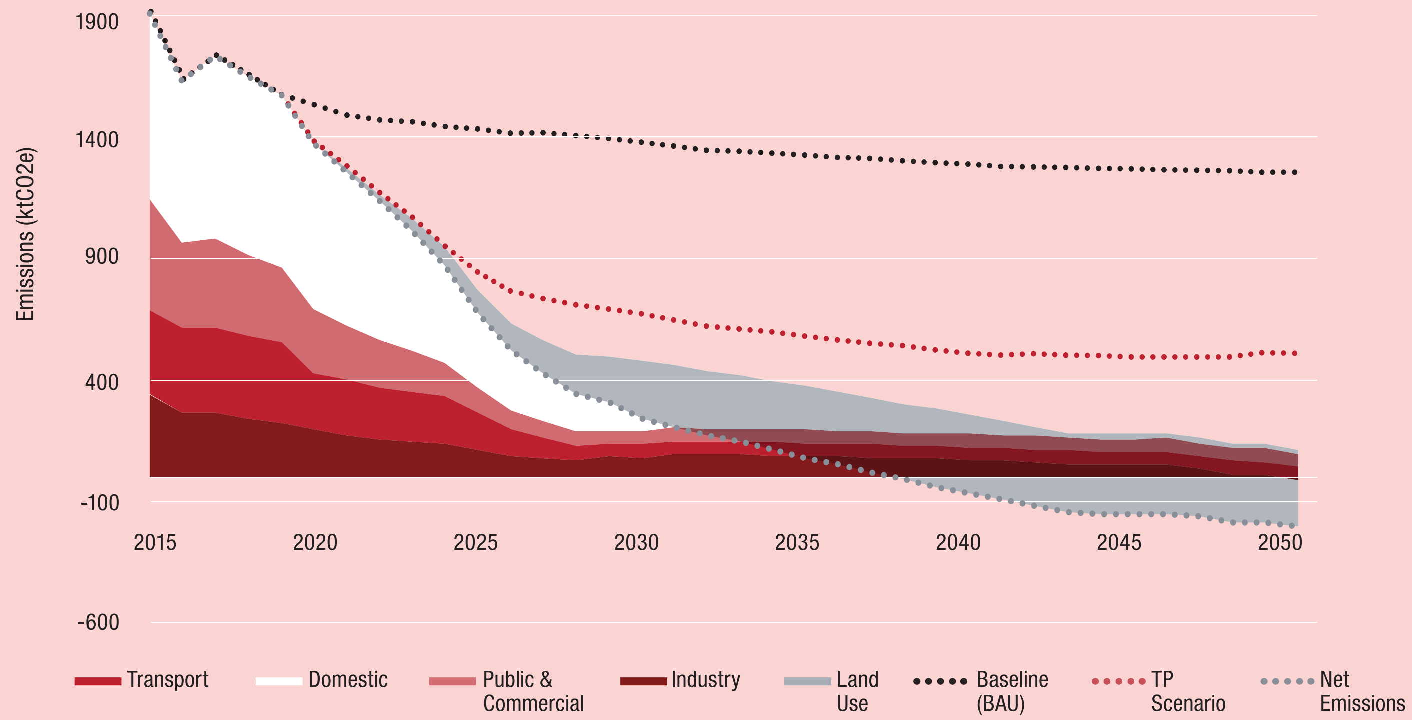


Figure 13: Sectoral Emissions Shortfall Reduction with Stretch Measures

NEXT STEPS FOR BELFAST

Based on the analysis presented here we recommend that if Belfast 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 city.

A climate action plan for Belfast 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 Belfast's direct (Scope 1 and 2) carbon footprint as these emissions are most directly under the city's influence, but in time it should also widen its scope to consider its broader (Scope 3) carbon footprint.

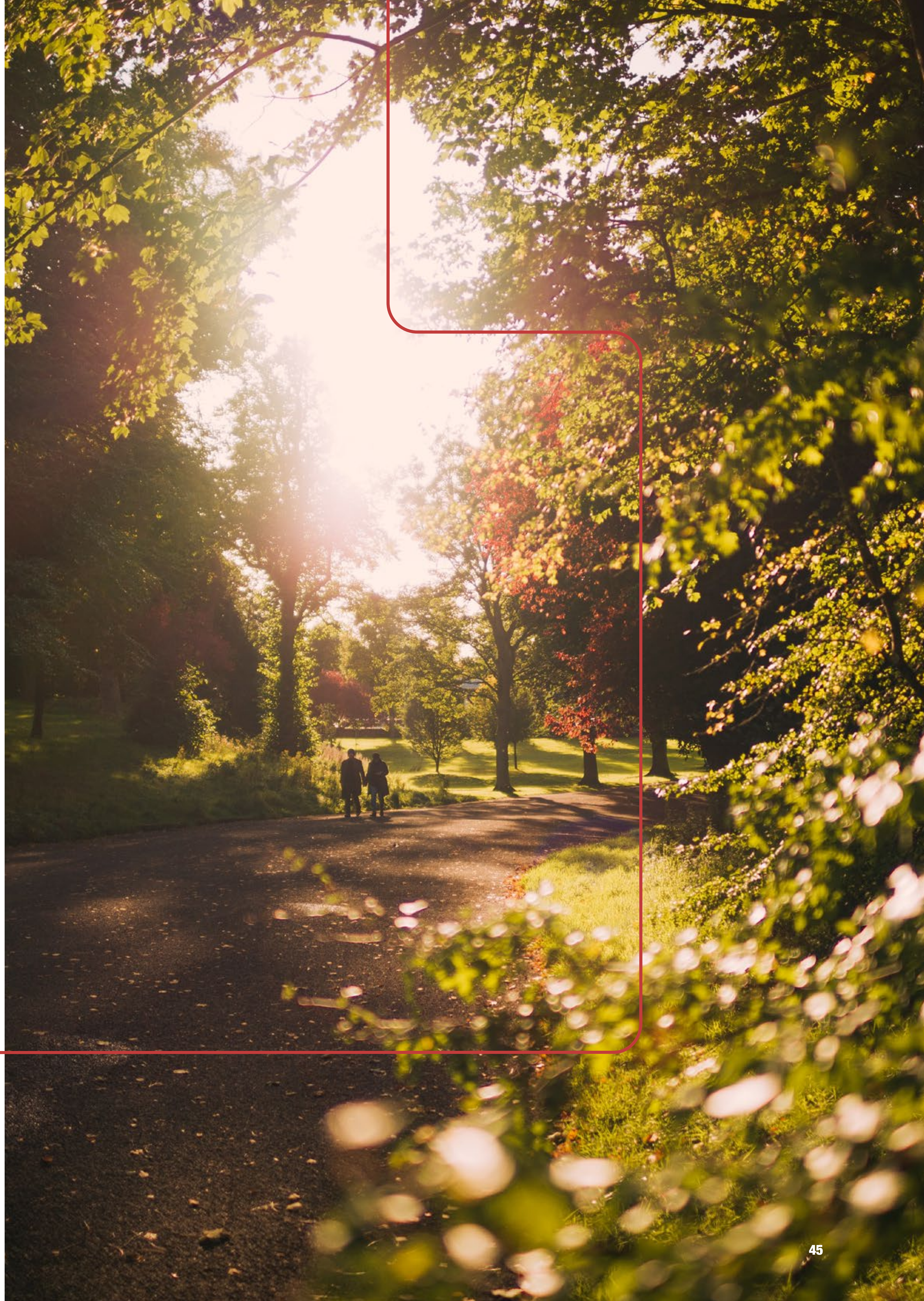
The action plan should clearly set out the ways in which Belfast will work towards achieving these targets, drawing on the deployment KPIs listed in this report. Action should also be taken to monitor and report progress on emissions reductions.

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

Establishing an independent Belfast Climate Commission is helping 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 city and the active support of the public, private and third sectors. The Belfast Climate Commission is acting as a critical friend to the city, 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, Belfast 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, Belfast 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 city's low carbon transition.



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

Measure	Emissions Reduction Potential (ktCO2e)
Insulating Domestic buildings	1,162
Petrol Car to Bicycle Journeys	1,014
Upgraded Heating controls in Domestic buildings	998
Petrol Car to Walk Journeys	982
Electrical upgrades in Domestic buildings	811
Installing heat pumps in Domestic buildings	808
Petrol Car to EV Journeys	725
Petrol Car to Bus (electric) Journeys	700
Diesel Car to Walk Journeys	675
Fabric improvements in Public buildings	663
Diesel Car to Bicycle Journeys	651
Fabric improvements in Retail buildings	647
Petrol Car to Hybrid Journeys	613
Petrol Car to Bus (diesel) Journeys	608
Upgraded boilers in Domestic buildings	597
Installing solar PV in Domestic Buildings	590
Diesel Car to EV Journeys	584
Diesel Car to Bus (electric) Journeys	578
Petrol Car to Plug-in hybrid Journeys	567
Electricity demand reduction in Domestic buildings	539
Diesel Car to Plug-in hybrid Journeys	444
Diesel Car to Bus (diesel) Journeys	398
Hybrid Car to EV Journeys	380
Condensing & Insulation Measures to Boilers & Steam Piping in Industry	366
Draught-proofing in Domestic buildings	358
Lighting improvements in Domestic buildings	354
Installing air source heat pumps in Office buildings	311
Installing biomass boilers in Domestic buildings	284
Heating improvements in Public buildings	278
Glazing improvements in Domestic buildings	277
Solar thermal devices in Domestic buildings	267
Improving Efficiency of Boilers and Steam Piping in Industry	249
Solar thermal devices in Public buildings	203

Measure	Emissions Reduction Potential (ktCO2e)
Improved lighting controls and sensors in Public buildings	172
Solar thermal devices in Retail buildings	166
Improved cooling in Office buildings	161
Lighting improvements in Office buildings	158
Wind microgeneration associated with Public buildings	147
Upgrading heating controls in Office buildings	144
Diesel Car to Hybrid Journeys	140
Improved lighting controls and sensors in Retail buildings	119
Improved lighting controls and sensors in Office buildings	111
Pump Upgrades, Repairs and Maintenance in Industry	108
Lighting improvements in Public buildings	98
Heating improvements in Retail buildings	89
Fan Correction, Repairs, & Upgrades in Industry	77
Compressed Air Systems in Industry	65
Compressors and Variable Speed Systems in Industry	55
Furnace Efficiency and Heat Recovery Mechanisms in Industry	46
Refrigeration Efficiency and Technical Upgrades in Industry	23
Installing solar PV in Public buildings	23
Fabric improvements in Office buildings	16
Improved cooling in Public buildings	15
Improved cooling in Retail buildings	13
Upgraded heating controls in Public buildings	8
Installing solar PV in Office buildings	7
Installing air source heat pumps in Public buildings	7
Heating improvements in Office buildings	6
Installing air source heat pumps in Retail buildings	5
Upgraded heating controls in Retail buildings	5
Lighting improvements in Retail buildings	5
Wind microgeneration associated with Retail buildings	5
Solar thermal devices in Office buildings	4
Installing solar PV in Retail buildings	4
Wind microgeneration associated with Office buildings	4
TOTAL	**20,686**

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

Measure	Cost Effectiveness (£/tCO2e)
Compressed Air Systems in Industry	-603
Diesel Car to Bus (diesel) Journeys	-492
Pump Upgrades, Repairs and Maintenance in Industry	-478
Fabric improvements in Retail buildings	-432
Petrol Car to Bus (diesel) Journeys	-376
Fabric improvements in Public buildings	-367
Diesel Car to Walk Journeys	-362
Petrol Car to Walk Journeys	-356
Improved cooling in Retail buildings	-326
Diesel Car to Bicycle Journeys	-322
Petrol Car to Bicycle Journeys	-304
Fan Correction, Repairs, & Upgrades in Industry	-293
Petrol Car to Plug-in hybrid Journeys	-249
Compressors and Variable Speed Systems in Industry	-239
Lighting improvements in Public buildings	-207
Lighting improvements in Domestic buildings	-172
Electrical upgrades in Domestic buildings	-167
Improved cooling in Office buildings	-163
Diesel Car to Plug-in hybrid Journeys	-159
Petrol Car to EV Journeys	-153
Petrol Car to Hybrid Journeys	-152
Petrol Car to Bus (electric) Journeys	-147
Lighting improvements in Retail buildings	-138
Heating improvements in Public buildings	-115
Electricity demand reduction in Domestic buildings	-111
Improved cooling in Public buildings	-97
Improving Efficiency of Boilers and Steam Piping in Industry	-70
Heating improvements in Office buildings	-62
Lighting improvements in Office buildings	-62
Insulating Domestic buildings	-59
Diesel Car to Bus (electric) Journeys	-58
Heating improvements in Retail buildings	-47
Diesel Car to EV Journeys	-45

Measure	Cost Effectiveness (£/tCO2e)
Draught-proofing in Domestic buildings	-34
Fabric improvements in Office buildings	-31
Glazing improvements in Domestic buildings	-31
Installing heat pumps in Domestic buildings	-29
Upgraded Heating controls in Domestic buildings	-27
Upgrading heating controls in Office buildings	-19
Installing biomass boilers in Domestic buildings	-17
Solar thermal devices in Domestic buildings	-15
Upgraded heating controls in Public buildings	-13
Diesel Car to Hybrid Journeys	-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 Journeys	3
Installing air source heat pumps in Public buildings	8
Refrigeration Efficiency and Technical Upgrades in Industry	16
Solar thermal devices in Retail buildings	24
Installing air source heat pumps in Office buildings	30
Installing solar PV in Public buildings	38
Improved lighting controls and sensors in Retail buildings	41
Condensing & Insulation Measures to Boilers & Steam Piping in Industry	45
Installing solar PV in Office buildings	52
Installing solar PV in Retail buildings	60
Solar thermal devices in Public buildings	64
Improved lighting controls and sensors in Office buildings	68
Solar thermal devices in Office buildings	74
Improved lighting controls and sensors in Public buildings	148
Wind microgeneration associated with Public buildings	207
Wind microgeneration associated with Office buildings	208
Wind microgeneration associated with Retail buildings	271
Furnace Efficiency and Heat Recovery Mechanisms in Industry	540

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

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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