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Leicester Carbon Neutral Roadmap Evidence Base

Report for Leicester City Council

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05	10.02.22	HR	JH	JH	Final draft
06	17.02.22	KS	HR	JH	Final draft with minor revisions

Table of contents

1 Introduction

1.1 Overview

On 1st February 2019, Leicester City Council (LCC) declared a climate emergency, stating an ambition of becoming a carbon neutral city by 2030 or sooner. There then followed some extensive stakeholder engagement, through the Leicester Climate Emergency Conversation, which ultimately led to the 'Leicester Climate Emergency Strategy' and 'Leicester City Council's Climate Emergency Action Plan: April 2020 - March 2023', both published in October 2020. [1,2]

This roadmap represents the next step in Leicester's journey towards carbon neutrality. It looks specifically at reducing those greenhouse gases emitted directly from within the city (Scope 1 emissions) and those outside the city caused by its use of energy generated elsewhere (Scope 2 emissions). Building on the work undertaken so far, this report presents a series of indicative pathways to 2030. In doing so, it will provide the evidence needed to understand the scale of the challenges and the key actions required to achieve carbon neutrality, also known as net zero emissions, for Leicester as a whole. It aims to address the following questions:

- What is the best strategic pathway for Leicester to become carbon neutral as quickly and cost-effectively as possible within a Paris-compliant carbon budget?
- What key actions will the council and other stakeholders need to take, when and at what scale?
- What are the main uncertainties, constraints, barriers, risks and opportunities? How should we respond to them?
- What measures and support will be needed from central Government or other external agencies?
- How can we maximise the co-benefits of climate action for our other strategic priorities and address any policy conflicts?
- What role would we need carbon sequestration, carbon offsetting or carbon removal technologies to play if Leicester is to become carbon neutral by 2030 and to remain within a Paris-compliant carbon budget?

The report is structured as follows:

- Section 1 gives an overview of the project, and key issues and terminology.
- Section 2 looks at current GHG emissions in Leicester, along with other key parameters.
- Section 3 sets out potential pathways to carbon neutrality.
- Section 4 considers who needs to do what to drive the transition to carbon neutrality.
- Section 5 sets out the costs and benefits from delivering carbon neutrality in Leicester.

[1] leicester-climate-emergency-strategy-2020-2023-final-version.pdf
[2] leicester-city-council-4ea2a6c.pdf (climateemergency.uk)

1.2 Definitions and scope

Carbon neutrality, also known as net zero, simply means achieving a balance between emissions of greenhouse gases (GHG) to the atmosphere and removals of carbon dioxide (the most widespread GHG) from the atmosphere, for example by nature-based solutions such as tree planting or by technological means such as carbon capture and storage. If the emissions and removals balance out, carbon neutrality has been achieved.

When looking at the emissions side of the equation, we are considering all greenhouse gases, so not just carbon dioxide from combustion of fuels, but also other gases such as methane emissions from waste or nitrous oxide emissions from agriculture.

The roadmap only covers scope 1 and 2 emissions. Scope 1 covers the direct emissions from within the City of Leicester (for example, from cars, gas boilers, industrial processes etc) while scope 2 covers the emissions from the generation of electricity consumed in Leicester. Scope 3 emissions – emissions taking place outside of the city boundary, but which may be created by activity in Leicester (for example disposal of waste outside of the city that is generated by residents and businesses in Leicester) is not covered. Nor are embedded emissions, for example emissions from the creation and transportation of products purchased and consumed in Leicester. That is not to say that tackling these sources of emissions is not important – it is. But they will be dealt with through other work streams.

Similarly, whilst the scope of this work is the city itself, joined-up working will clearly be important to tackle the climate emergency, for example working with Leicestershire County Council and its district and borough councils.

2 Baseline assessment

This section of the report establishes the baseline situation regarding fuel consumption and greenhouse gas emissions (GHG) emissions in Leicester. Consideration is also given to the energy efficiency of the building stock, deployment of local renewable and low carbon energy technologies, and electric vehicle (EV) uptake. These factors provide useful context to inform the assessment of potential future trends in later sections of this report.

Key messages

- Scope 1 and 2 **GHG emissions** for Leicester in 2019 were approximately 1,300 ktCO_2e. This includes carbon dioxide (mostly associated with energy use), methane (mostly associated with waste and agriculture), nitrous oxide (mostly associated with fossil fuel combustion and fertiliser), and f-gases (used in refrigeration technologies). Energy use in domestic buildings accounts for around 32% of these emissions, while energy use in non-domestic buildings (all sectors) accounts for around 39% and road transport 24%.

- In the domestic sector, a significant majority of emissions are associated with gas, which is used to supply space heating and hot water. This suggests that a key challenge will be **decarbonising the heat supply**. Although the same issue applies to energy use in non-domestic buildings and facilities, emissions from those sectors include a higher proportion of other **sector-specific energy uses**, due to specialist equipment, industrial activities, and so on. In many cases there is limited data available on those types of energy end uses, which makes it harder to identify suitable mitigation measures. This is another key challenge that will require particular engagement from businesses and local stakeholders.

- **Fuel consumption** in Leicester has decreased by around 20% since 2005, which is more than the national average of 16%. In the same time period, CO_2 emissions have decreased by more than 40%. The reason for this disproportionate change is due to **electricity grid decarbonisation**. This highlights the fact that, in addition to reducing fuel consumption, Leicester's ability to meet the net zero ambition will depend in significant part on how much fuel can be switched towards electricity and how much of that electricity is supplied via renewable energy.

- The **energy efficiency of the building stock** in Leicester, as measured by EPC ratings, is broadly in line with the national average. The efficiency varies by tenure, age and use. Maps have also been provided that show the average rating by postcode, which can potentially assist in targeting energy efficiency initiatives. The EPC ratings suggest that there is considerable scope to improve the current level of energy efficiency and doing so should be seen as a key priority for reaching net zero because it helps to alleviate pressure on grid infrastructure, minimise energy bills, improve thermal comfort, and reduce the amount of renewable technologies that need to be deployed.

- There are currently a range of **renewable and low carbon technologies** in Leicester producing both electricity and heat. The vast majority are roof-mounted PV arrays, but public statistics indicate that there are also a small number of micro wind turbines, biomass boilers, and heat pumps. At present, the amount of renewable electricity generated from these sources is equivalent to around 2% of the annual electricity demand for the whole city. In future, this amount will need to increase dramatically; the future renewable potential has been assessed as part of a separate study.

- There is also a **city centre heat network** and some smaller heat networks on council housing estates which between them serve thousands of council homes and other major civic buildings. Heat networks can offer carbon savings compared with individual heating systems, and offer the advantage of potentially switching multiple buildings on to renewable sources of energy at the same time.

- Around 70% of emissions from **road transport** are associated with petrol and diesel cars. Of these, around 30% are short journeys, some of which could potentially switch to active travel or public transport. The remaining emissions are primarily associated with light goods vehicles (16%), heavy goods vehicles (9%) and buses (4%). All of these vehicle types aside from HGVs can in principle be replaced with electric vehicles, which will be a key method of reducing road transport emissions. However, by 2030, it is unlikely that a technological solution such as green hydrogen will be available for HGVs, and as a result it is probably not possible to reduce transport emissions by 100% by 2030.
- Uptake of **ultra-low emission vehicles** (ULEVs) has increased dramatically in recent years, rising from 181 in 2011 to 1,235 at the beginning of 2021. However, this only represents <1% of total vehicles in Leicester, and in order to meet the net zero ambition, in addition to radically decreasing demand for travel, nearly all vehicles would need to be zero emission.
- A very rough estimate of **Scope 3 emissions from waste and wastewater** indicates that this accounts for emissions in the region of c. 100 ktCO_2e per year. The majority of biodegradable municipal waste in Leicester (though not all) is processed at an anaerobic digestion plant in Wanlip and, compared with landfill, this reduces emissions considerably. However, when accounting for the amount that *is* landfilled, alongside other commercial & industrial (C&I), construction demolition and excavation (CD&E) and hazardous waste, the total is still equivalent to 5-7% of Scope 1 and 2 emissions.

2.1 Overview of the methodology

The following baseline assessment draws from a wide range of public datasets. In particular, it includes information about fuel consumption and CO_2 emissions which is disaggregated to a Local Authority level and published by the Department for Business, Energy and Industrial Strategy (BEIS). Where relevant, this information has been supplemented with local data and further analysis to provide a more detailed sectoral breakdown of the results.

Note that, due to the publication schedule of these datasets, a mix of 2018 and 2019 data has been used. In particular, at the time of writing, 2019 data on CO_2 emissions at local authority level has been published, whereas 2019 fuel consumption data at local authority level has not. This is not expected to affect any of the key take-home points, assuming that there were no radical changes in fuel consumption patterns in that time period.

2.2 Greenhouse gas (GHG) emissions

2.2.1 Scope of the assessment

Leicester City Council has set an ambition of becoming carbon neutral by 2030 or sooner. As explained in Leicester's Climate Emergency Strategy, the term 'carbon neutral' is understood to include not only carbon dioxide (CO_2), but all of the major GHGs, which include methane (CH_4), nitrous oxide (N_2O) and fluorinated gases or f-gases. Because these have different impacts on global warming, known as global warming potential or GWP, both the GHG emissions baseline and associated targets will be reported in units of CO_2 equivalent (CO_2e) to allow measurement and comparison of different gases.

In line with international reporting standards, GHG emissions from different sources are categorised into different 'scopes', as defined in the table below.

Type	Definition	Examples
Scope 1	Direct emissions from fuel combustion and fugitive emissions within the city boundary	• Fuel combustion in buildings and road vehicles • Emissions from agriculture, waste and wastewater treatment, or landfill activities taking place within Leicester
Scope 2	Indirect emissions from purchased electricity, heat, steam or cooling that is generated elsewhere	• Use of grid electricity within Leicester
Scope 3	Other indirect emissions	All other indirect emissions, such as: • Waste or wastewater treatment outside of Leicester • Transport of fuels that are used within the city • Supply chains for food, products and materials • Journeys to/from the city that are outside the Local Authority boundary • Shipping and aviation

This roadmap covers Scope 1 and 2 emissions from activities taking place within the City of Leicester Local Authority boundary. Most Scope 3 emissions are excluded from the assessment. Reliable figures are not readily available for most Scope 3 emissions, although a further study could seek to identify key sources and recommend opportunities to reduce them. Including Scope 3 emissions would represent a significant challenge for the Council, requiring the body to exert authority in areas where it already has limited influence. However, this report does include an estimate of Scope 3 emissions from waste and wastewater treatment. The vast majority of wastewater treatment takes place in Wanlip, which is outside the Local Authority boundary. Organic Municipal Solid Waste (MSW) is also treated in Wanlip, and the remaining waste is sent to several other locations. These Scope 3 emissions are reported in the interest of transparency, given the role that people and organisations in Leicester will need to play in reducing them.

2.2.2 Baseline emissions

2.2.2.1 City-wide total

Information on CO_2 emissions at a local authority level is published annually by BEIS, two years in arrears.[3] The dataset covers sectors and activities that emit CO_2. However, at a national level, CO_2 only accounts for around 80% of total GHG emissions, meaning that a significant portion of GHG emissions is excluded.[4] The remaining 20% comes from:

- Methane (CH_4), which is mostly associated with agriculture (e.g., livestock digestion) and waste management (e.g., organic waste decomposing in landfill);
- Nitrous oxide (N_2O), which is mostly associated with the use of fertilisers but is also emitted during combustion of fossil fuels and some forms of industrial activities; and
- Fluorinated gases (f-gases), which are used in refrigerants and air conditioning systems and can leak out during the manufacturing, operation or disposal process.

[3] BEIS, 'Emissions of carbon dioxide for Local Authority Areas; (published 2021). Available at: Emissions of carbon dioxide for Local Authority areas - data.gov.uk

[4] BEIS, '2019 UK Greenhouse Gas emissions' (published 2021). Available at: 2019 UK Greenhouse Gas Emissions, Final Figures (publishing.service.gov.uk)

Therefore, in order to provide a more comprehensive GHG emissions inventory for Leicester with a more detailed breakdown of emissions by fuel type and sector, we have taken the BEIS CO_2 data as a starting point and supplemented it with more detailed analysis based on various underlying and additional datasets such as sub-national fuel consumption, waste collection, and renewable energy statistics. These have been used to develop a CO_2e baseline for the City with our proprietary Net Zero Projections (NZP) tool.

Results are presented in Table 1 below. These have been split according to sector to facilitate a like-for-like comparison with the BEIS CO_2 dataset (illustrated in Figure 1).

Table 1. GHG emissions in Leicester by sector and fuel type, 2019

	Natural Gas ($ktCO_2e$)	Grid Electricity ($ktCO_2e$)	Petrol/ Diesel ($ktCO_2e$)	Other/Not Specified[1] ($ktCO_2e$)	Grand Total ($ktCO_2e$)
Scope 1 & 2 Emissions					
Sectors in the BEIS CO_2 dataset:					
Light industry	140.46	85.80		65.88	292.15
Large industrial installations	0.14	0.09		0.23	0.46
Agriculture (CO_2 from energy use) [2]				0.70	0.70
Commercial	54.73	69.20		0.14	124.07
Public sector	56.92	28.71		0.05	85.69
Domestic	317.08	92.72		7.30	417.09
Road transport			305.86		305.86
Railways			1.66		1.66
LULUCF net emissions [3]				-3.12	-3.12
Sectors not in the BEIS CO_2 dataset:					
Agriculture (non-CO_2 gases) [2]				4.68	4.68
F-gases [4]				71.24	71.24
TOTAL	569.32	276.52	307.52	147.11	1,300.47
Scope 3 emissions [5]					
Waste and wastewater treatment [4] [5]				c. 100	

Notes:

1. For some sectors, such as agriculture, emissions from energy use are not reported by fuel type, so these are listed in the 'Other/Not Specified' category, even though in reality they are likely to include some natural gas, grid electricity, petrol or diesel. The 'Other/Not Specified' category also includes some emissions that do not result from fuel use. For example, methane emissions in the waste sector arise due to the decomposition of biological material in landfill. Similarly, LULUCF emissions are affected by soil and plants absorbing CO_2 during respiration. In the case of light industry, the BEIS CO_2 dataset does not explicitly state what 'other fuels' contain, but by cross-referencing the fuel consumption data for Leicester, it is likely to include a significant proportion of petroleum products.[5]
2. The BEIS CO_2 data includes CO_2 emissions from energy use – that is, fuel use in agricultural facilities and processes – but does not include emissions from methane or nitrous oxide. In the agricultural sector, emissions are dominated by non-CO_2 gases. Total emissions from

[5] Examples of petroleum products used in the industrial sector include: Combustion plant for cement production, chemicals, food, drink and tobacco, pulp, paper and print; lime production; use in off-road machinery; For more information, see, 'UK sub-national residual fuel consumption: Methodology summary' (2021) available at: [UK sub-national residual fuel consumption for 2025-2019 (publishing.service.gov.uk)]

agriculture were therefore estimated by assuming that the ratio of CO_2 to other gases in Leicester matches the national average for this sector.

3. LULUCF stands for 'land use, land use change, and forestry'. This category represents the movement of CO_2 between the atmosphere and different natural 'reservoirs' such as forests, soil, etc. Some human-induced effects, such as tilling the soil, result in CO_2 being emitted to the atmosphere, while others, such as planting trees, result in CO_2 being absorbed from the atmosphere. This category quantifies the net impact of all such activities taking place within the Local Authority boundary.
4. Two estimates were made based on two different methods; results ranged from approximately 65 ktCO_2e to 103 ktCO_2e. See Section 2.6 for further details.
5. Some or all of the emissions from this category, such as those arising from the transportation of waste, may occur within the Local Authority boundary, in which case they would be classified as Scope 1 or 2 emissions and counted in the transport figures elsewhere in the table. However, it is not possible to determine the proportion based on available public information.

Overall, these calculations indicate that Scope 1 and 2 GHG emissions for Leicester as of 2019 were c. 1,300 ktCO_2e.

Energy use in domestic buildings accounts for the largest portion of the total, at around 32%, followed by road transport (24%) and energy use in light industrial buildings and facilities (22%).

Emissions from commercial buildings are estimated to account for roughly 10% of GHG emissions while public sector buildings account for around 7%. Emissions from f-gases account for roughly 5% of emissions, although it should be noted that these have been estimated based on national datasets rather than information specific to Leicester.

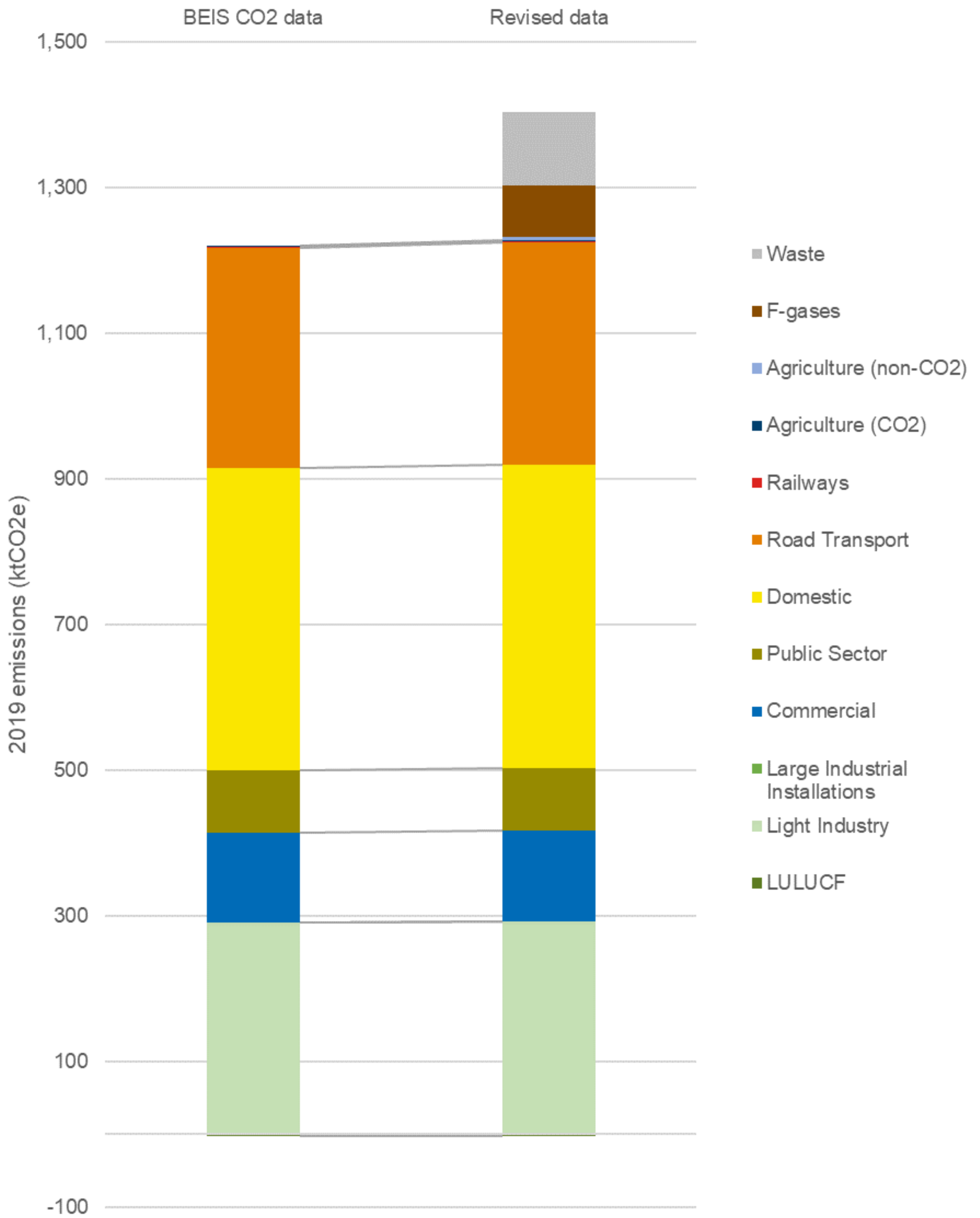
The remaining Scope 1 and 2 emissions are associated with agriculture, large industrial installations, railways, and LULUCF activities, all of which make up less than 1% of the total. The LULUCF sector results in net CO_2 *removals* from the atmosphere, rather than emissions to the atmosphere. However, these are very small, reflecting the urban setting. The constrained land area means that there may be less scope for additional CO_2 sequestration to be achieved via tree planting and other land management practices.

Emissions from waste and wastewater treatment combined are estimated to be roughly 100 ktCO_2e. These are assumed to be Scope 3 emissions and are therefore excluded from the total. However, for context, they are roughly the same order of magnitude as all emissions from commercial buildings.

Further details relating to the domestic, non-domestic and road transport sectors are provided in the following sections of this report.

Figure 1 below shows the gross GHG emissions for Leicester, and also highlights differences between the BEIS LACO_2 inventory and revised estimate.

Figure 1. Gross GHG emissions in 2019, comparing the BEIS CO_2 data and the revised GHG inventory



There are a few notable differences between the BEIS CO_2 data and the revised inventory:

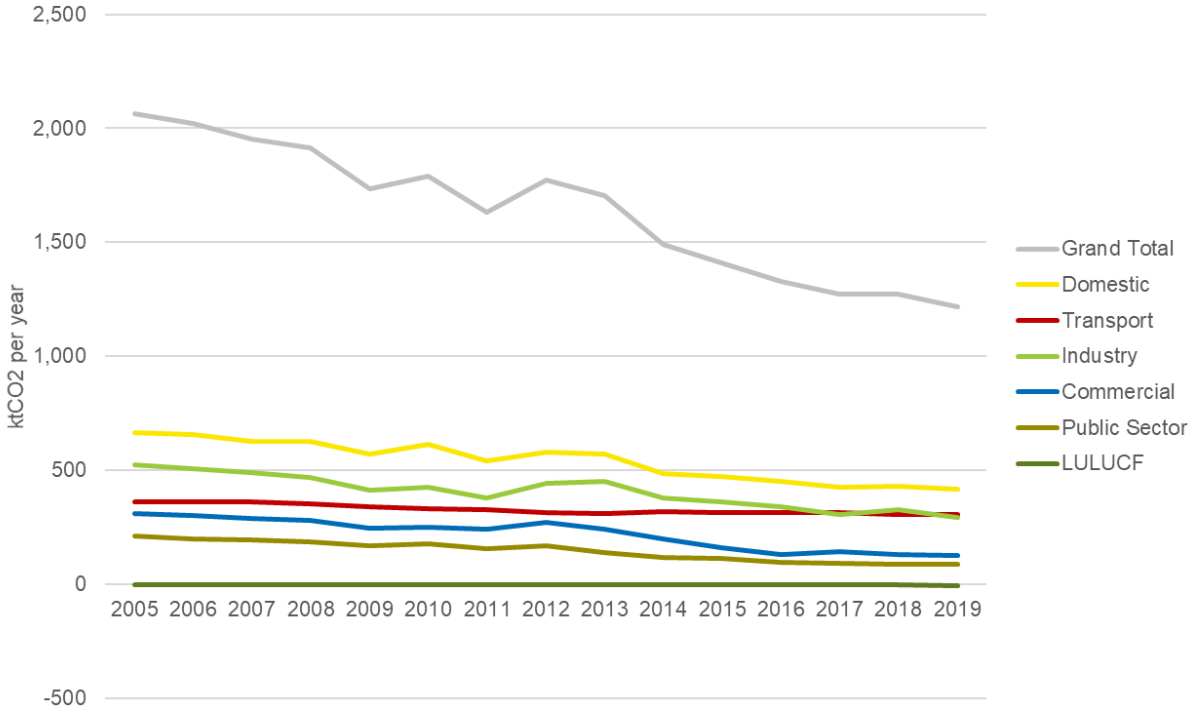
- For most sectors, there are small (<1%) differences simply due to the use of CO_2e conversion factors rather than CO_2 conversion factors.
- For agriculture, there is a large difference in the results which is due to the inclusion of methane and nitrous oxide. However, because emissions from agriculture are low, this makes a very small difference to the overall total.
- F-gases and waste/wastewater treatment are additional sources of emissions that were not included in the BEIS data.

In order to consider trends over time, we have referred to the BEIS Local Authority CO_2 dataset. As stated previously, this only considers CO_2 rather than all GHGs; however, it still offers useful insight into major changes that have occurred since 2005.

As shown in Figure 2 below, total CO_2 emissions in Leicester decreased by around 41% from 2005-2019. This is higher than the national and county-wide changes in the same time period, which saw decreases of around 36% and 30%, respectively. Part of this change is due to the decrease in fuel consumption, which was higher in Leicester than the UK as a whole (see Figure 8).

Another significant change in emissions was due to decarbonisation of the national electricity grid, which is associated with the phasing out of coal and increase in renewable power generation. While electricity use in Leicester decreased by around 20% in that time, CO_2 emissions per unit of grid electricity dropped by 55%, so emissions from electricity use decreased by nearly 70% overall. This highlights the importance that grid decarbonisation will play in the future when there is likely to be a widespread shift to the use of electricity for other purposes such as heating and transportation. The carbon intensity ($kgCO_2/kWh$) of most fuels other than electricity remains comparatively stable, so changes in emissions from sectors that rely on fossil fuels (such as transport) generally scale with changes in fuel consumption.

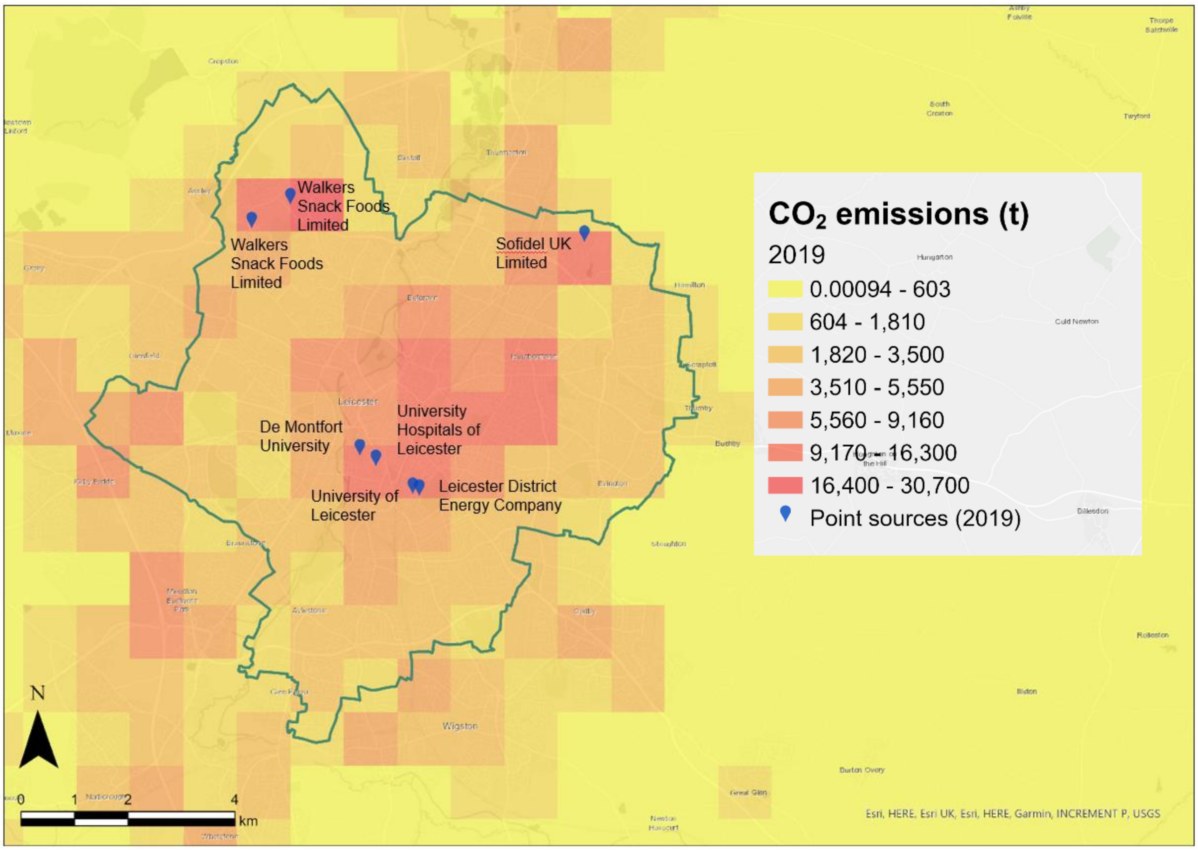
Figure 2. Trends in CO_2 emissions in Leicester, 2005-2019



The maps on the following pages show the spatial distribution of CO_2, nitrous oxide (N_2O) and methane (CH_4) emissions at a 1x1km grid level, as published within the National Atmospheric Emissions Inventory (NAEI) mapping database.[6] The gases are presented separately because the NAEI does not report f-gases, but these three GHGs in combination account for the majority of emissions.

[6] NAEI, 'UK Emissions Interactive Map' (2021). Available at: UK Emissions Interactive Map (beis.gov.uk)

Figure 3. Total CO_2 emissions in Leicester, 2019. Source: NAEI



CO_2 emissions in Leicester are generally higher in the city centre and tend to decrease nearer to the Local Authority boundary, which is unsurprising given the density of buildings and other activities in the city centre. Emissions are also slightly higher to the East of the city centre, which could be associated with the higher emission from manufacturing in those areas (see Figure 4). The NAEI also reports several point sources[7] of CO_2 emissions, which are shown on the map. The ones in the city centre include the Leicester District Energy Company, the University of Leicester, De Montfort University and the Leicester Royal Infirmary. As described in Section 2.3, these are associated with the district heating scheme and combined heat and power (CHP) plants. Around the perimeter of the city, there are several point sources associated with individual manufacturing or commercial facilities.[8]

[7] For an explanation of what types of facilities count as point sources and how the information is collected, refer to the NAEI website: [Emissions from NAEI large point sources - NAEI, UK (beis.gov.uk)]

[8] [UK Emissions Interactive Map (beis.gov.uk)]

Figure 4. CO_2 emissions from the manufacturing sector in Leicester, 2019. Source: NAEI

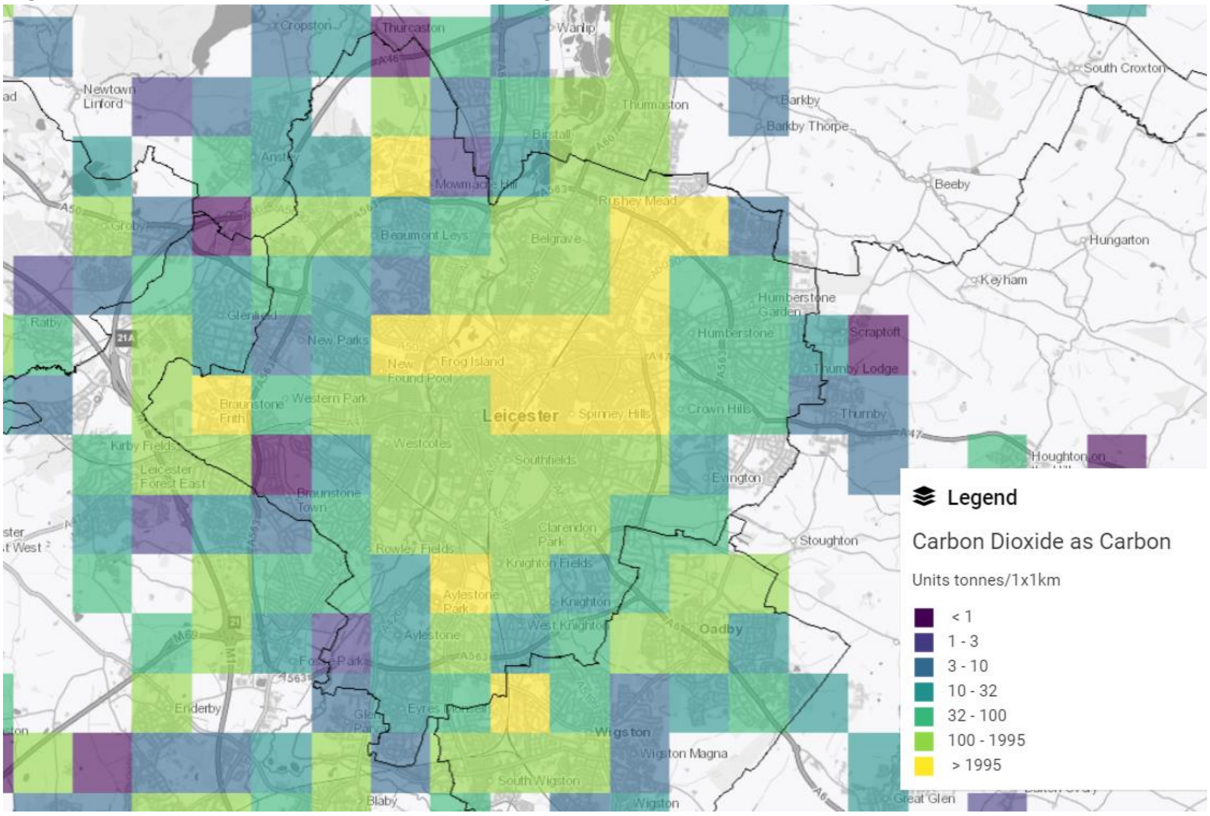
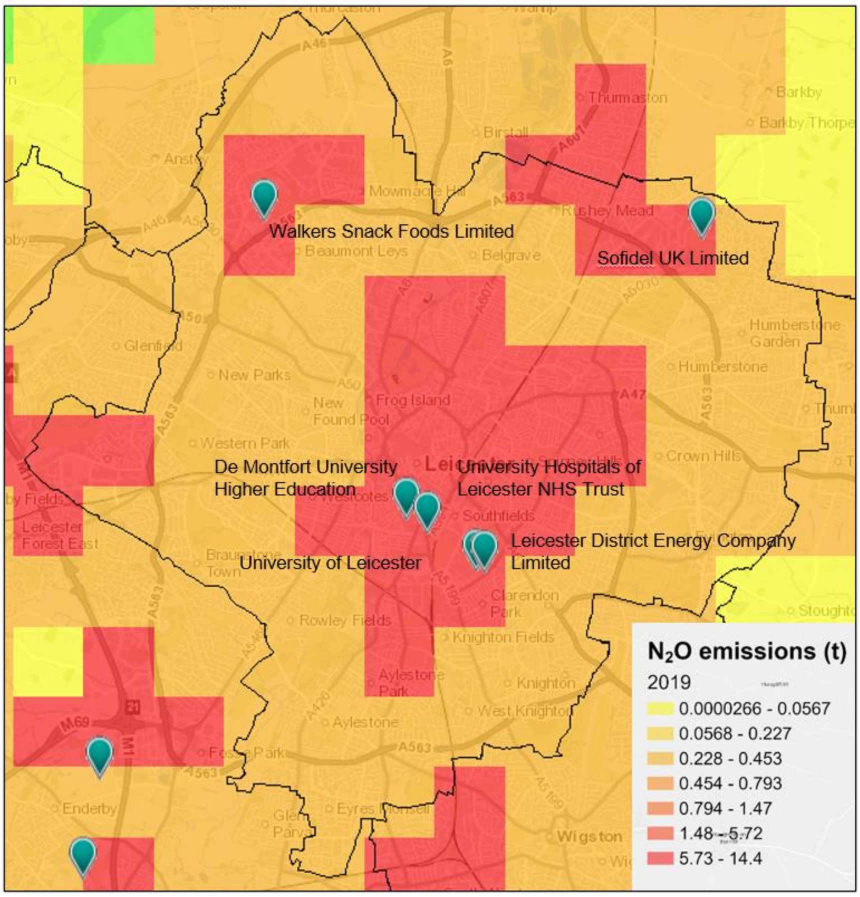
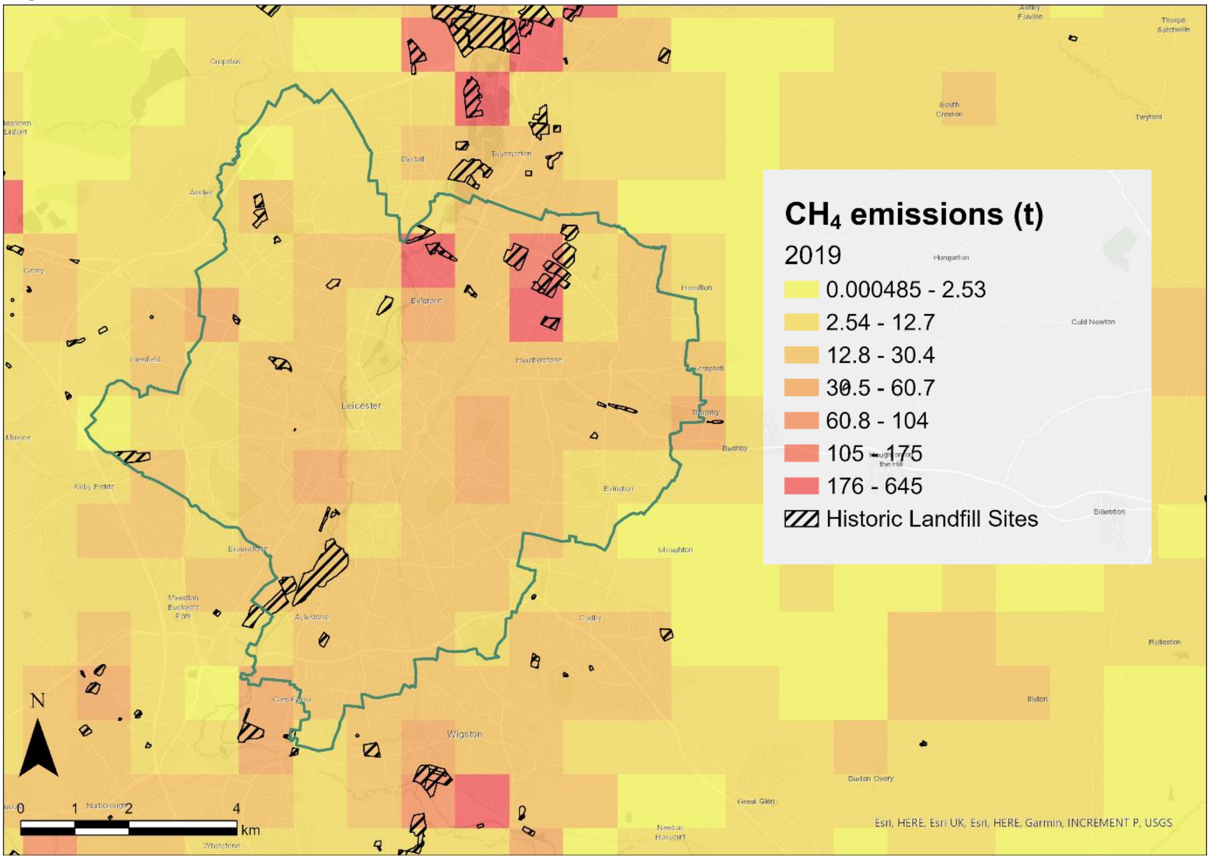


Figure 5. Total nitrous oxide emissions in Leicester, 2019. Source: NAEI



As is the case with CO_2 emissions, nitrous oxide emissions in Leicester are higher in the city centre. Since there is relatively little agricultural activity in Leicester, it stands to reason that N_2O emissions are more likely to come from fossil fuel combustion rather than fertiliser use. Outside of the Leicester boundary, there are slightly higher emissions in Wanlip which are assumed to be associated with the wastewater treatment plant, and also along the western edge of the city, due to the presence of the M1. Similar to the spread of carbon dioxide emissions, the map also demonstrates nitrous oxide emissions are higher to the east of Leicester's city centre.

Figure 6. Total methane emissions in Leicester, 2019. Source: NAEI



The map of methane emissions shows localised hotspots around the northern part of the city. This is potentially associated with the historic landfill sites in those areas, which will continue to emit methane while the organic material undergoes anaerobic decomposition. The outlines of historic landfill sites are shown on the map as well for information only, as it is not possible to directly attribute methane emissions to a specific site based on publicly available datasets.

As with nitrous oxides, there are also areas of significantly higher methane emissions around Wanlip likely due to the AD and wastewater treatment plants.

When interpreting GHG emissions data it is helpful to refer to the underlying information on fuel consumption. Emissions do not directly scale with fuel consumption because different fuels have different ‘carbon intensities’, but they can point to underlying trends and activities taking place.

The most recent fuel consumption data published by BEIS is for 2018.[9] Results are shown below. (Note that the ‘Non-Domestic’ category includes the following categories reported in the BEIS dataset: ‘Industrial’, ‘Commercial’, ‘Public Sector’ and ‘Agriculture’. ‘Other Fuels’ includes ‘Coal’, ‘Manufactured Fuels’ and ‘Bioenergy & Wastes’.)

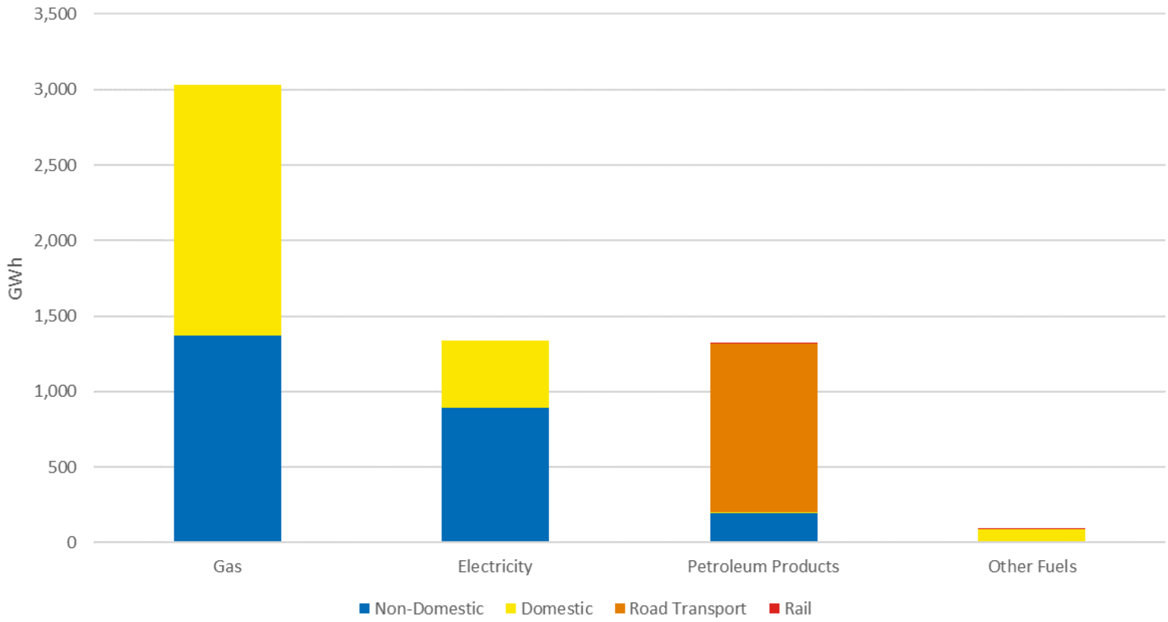
Table 2. Fuel Consumption by Sector, 2018. Source: BEIS

	Gas (GWh)	Electricity (GWh)	Petroleum Products (GWh)	Other Fuels (GWh)	Total (GWh)	% of total
Non-Domestic	1,368	891	196	4	**2,459**	43%
Domestic	1,665	446	6	85	**2,202**	38%
Road Transport	0	0	1,115	0	**1,115**	19%
Rail	0	0	6	0	**6**	<1%
Total	**3,033**	**1,337**	**1,323**	**89**	**5,782**	**100%**
% of total	52%	23%	23%	2%	**100%**	

These statistics show a relatively even split between fuel consumption in domestic (38%) and non-domestic (43%) buildings. Within the domestic sector, natural gas accounted for 76% of total fuel consumption, which typically supplies space heating and hot water, followed by electricity with 20%. Within the non-domestic sector, natural gas still makes up the majority fuel consumption with 56%, although electricity has a higher share with 36%. The remaining 8% are primarily from petroleum products. The road transportation sector accounted for around 19% of total fuel consumption in Leicester in 2018.

Figure 7. Fuel Consumption by Fuel Type, 2018

[9] BEIS, ‘Sub-national total final energy consumption data 2005-2018’ (published 2020). Available at: [Sub-national total final energy consumption data - data.gov.uk](https://data.gov.uk)



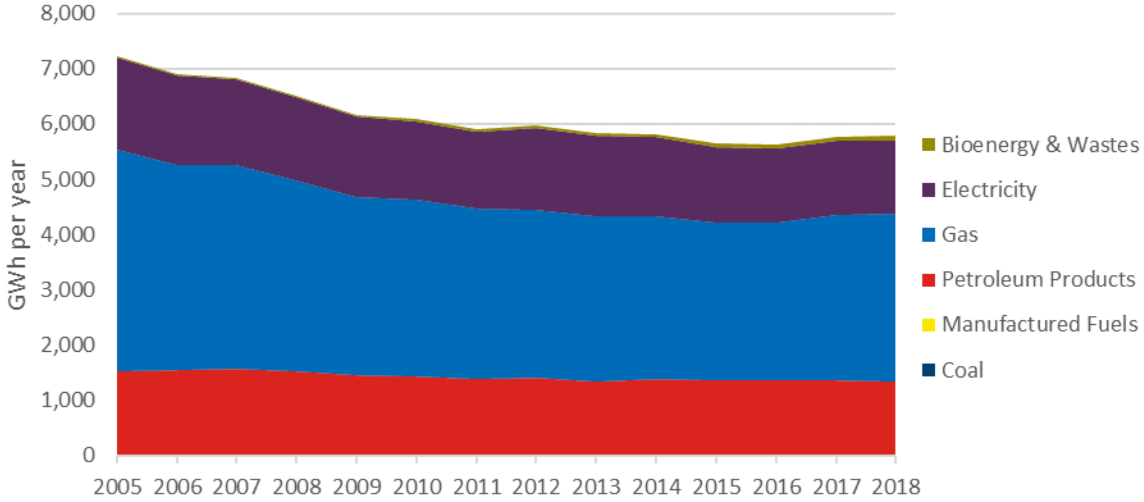
When considering fuel consumption by fuel type, gas was by far the largest contributor, accounting for 52% of all fuel used in 2018. Electricity and petroleum products each made up 23% of overall usage while other fuels (such as coal and manufactured fuels) only made up 8%. Gas use could be predominantly attributed to domestic use with 55%, followed by non-domestic buildings with 45%. The vast majority of petroleum products were used in the road transport sector (84%). This fuel type distribution is unsurprising considering the urban character of Leicester City.

As shown in Figure 8, total fuel consumption in Leicester decreased by around 20% between 2005 and 2018 for all sectors and all fuel types, with the exception of fuels derived from bioenergy and waste. (For comparison, the UK as a whole saw a roughly 16% decrease in total fuel consumption.) In particular, the use of natural gas decreased by around 24% in that time while petroleum products saw a reduction of 12%. This trend is likely due to a wide range of factors, including economic trends (which would have different impacts depending on the specific types of commercial and industrial activities taking place in Leicester, along with household incomes and residential energy use, but could also indicate an increasing prevalence of energy efficiency measures in buildings and industry. The change in fuel consumption was higher in the industrial and commercial sectors (25% decrease) than in the domestic sector (19% decrease) and transport (8% decrease).

It is worth recalling that CO_2 emissions fell by more than 40% in the same time period, which is disproportionate compared with the changes in fuel use. This highlights the importance of electricity grid decarbonisation on total GHG emissions. On one hand, it can be viewed as a positive factor, because so much progress has been made due to changes in the energy sector. On the other hand, it highlights that the actual levels of improvement from demand reduction are comparatively small. In essence, the reductions in this time period are low-hanging fruit; going forward, there will need to be a much greater emphasis on demand reduction in all sectors.

When looking at total fuel consumption over this period, the largest reduction occurred between 2005 and 2009. The rate slowed after that, but consumption still generally decreased until 2016, after which a small increase can be observed.

Figure 8. Trends in fuel consumption, 2005-2018. Source: BEIS



The maps below show the spatial distribution of domestic and non-domestic gas and electricity consumption, by Lower Super Output Area (LSOA) and Middle Super Output Area (MSOA) respectively.[10,11] They broadly reinforce the messages in Section 2.2.2 regarding the spatial distribution of CO_2 emissions.

The amount of gas and electricity used per LSOA or MSOA will depend in part on the number of domestic or non-domestic buildings and facilities in that geographic area, as well as the types of activities and level of energy efficiency. Note that BEIS allocates gas meters to ‘domestic’ or ‘non-domestic’ categories based on a threshold for annual consumption, not based on specific information about the building or facility. This means that, in principle, some small non-domestic buildings (e.g. corner shops) could be allocated to the ‘domestic’ sector and some large domestic buildings could be allocated to the non-domestic sector.

[10] BEIS, ‘Sub-national gas consumption data 2019’ (published 2021). Available at: Sub-national gas consumption data - GOV.UK (www.gov.uk)
[11] BEIS, ‘Sub-national electricity consumption data 2019’ (published 2021). Available at: Sub-national electricity consumption data - GOV.UK (www.gov.uk)

Figure 9. Domestic electricity consumption by LSOA, 2019. Source: BEIS

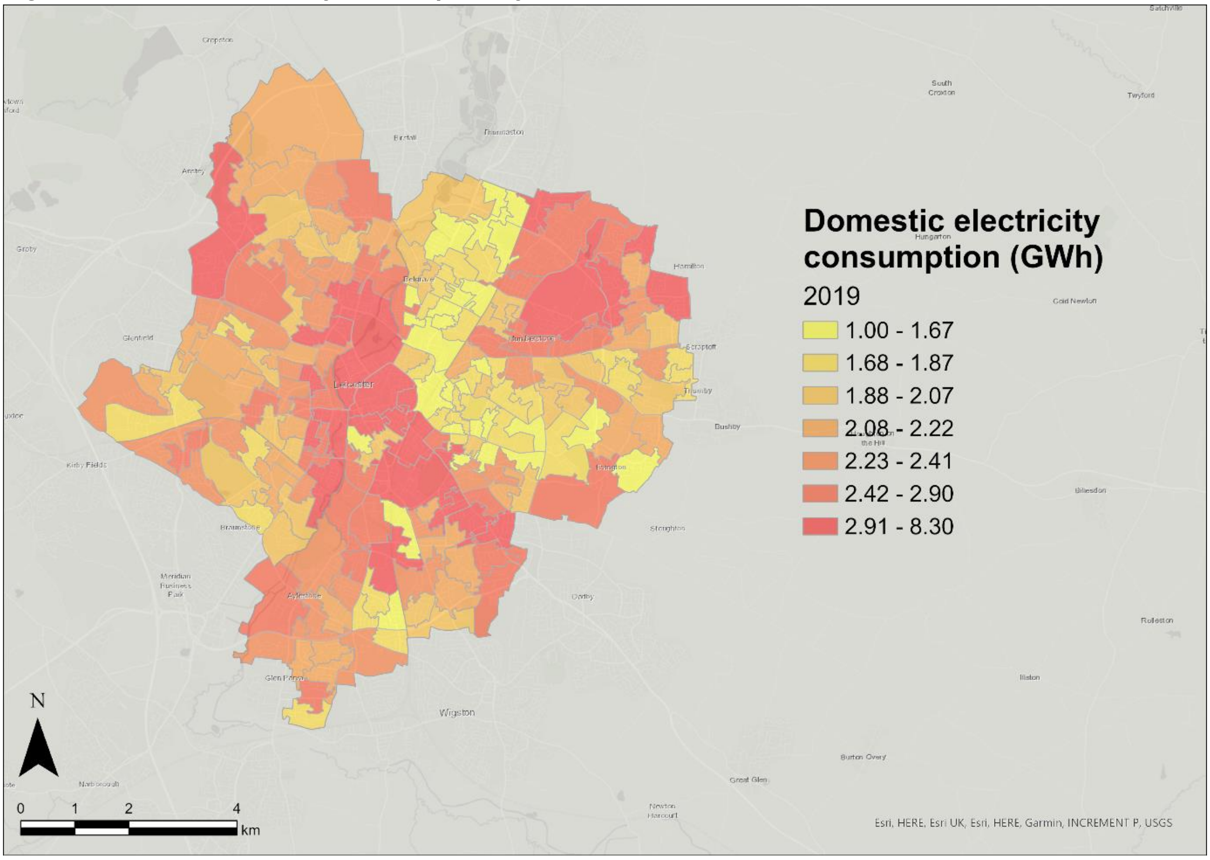


Figure 10. Domestic gas consumption by LSOA, 2019. Source: BEIS

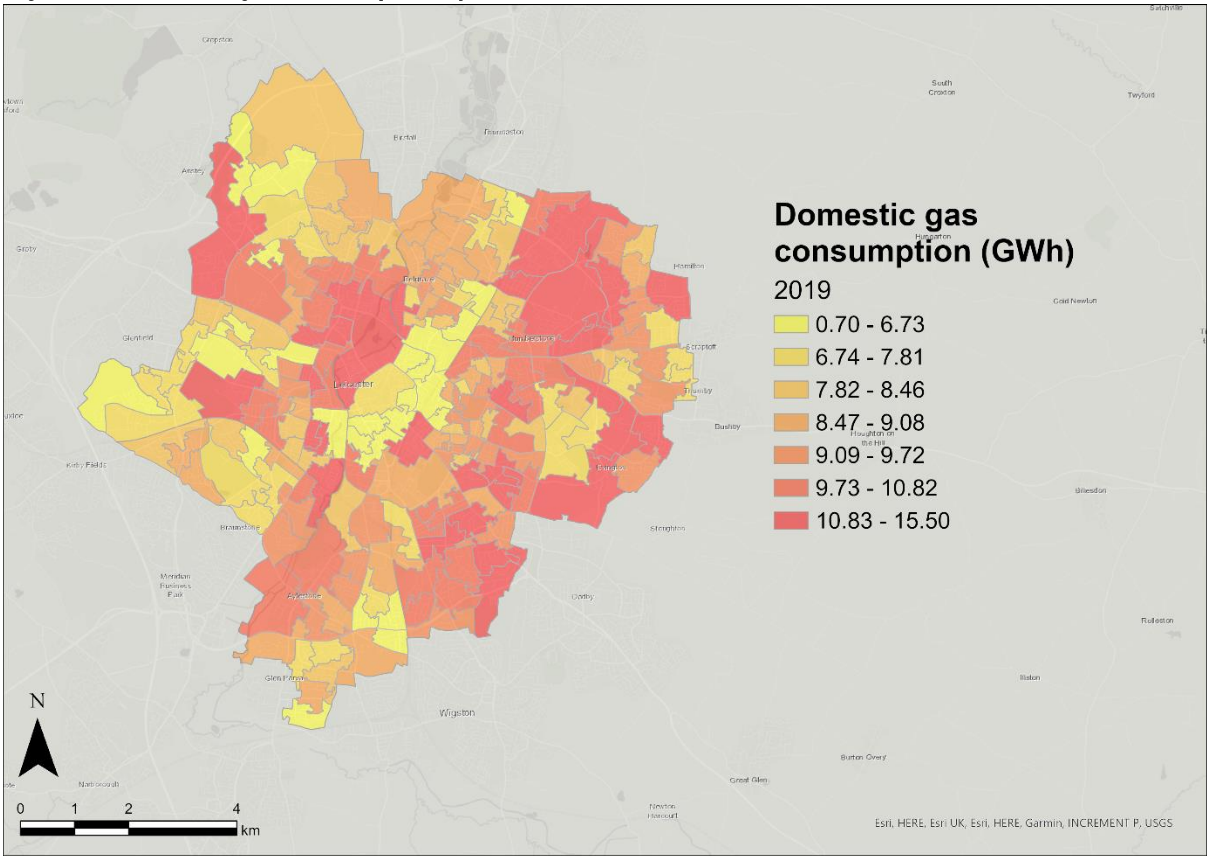


Figure 11. Non-domestic electricity consumption by MSOA, 2018. Source: BEIS

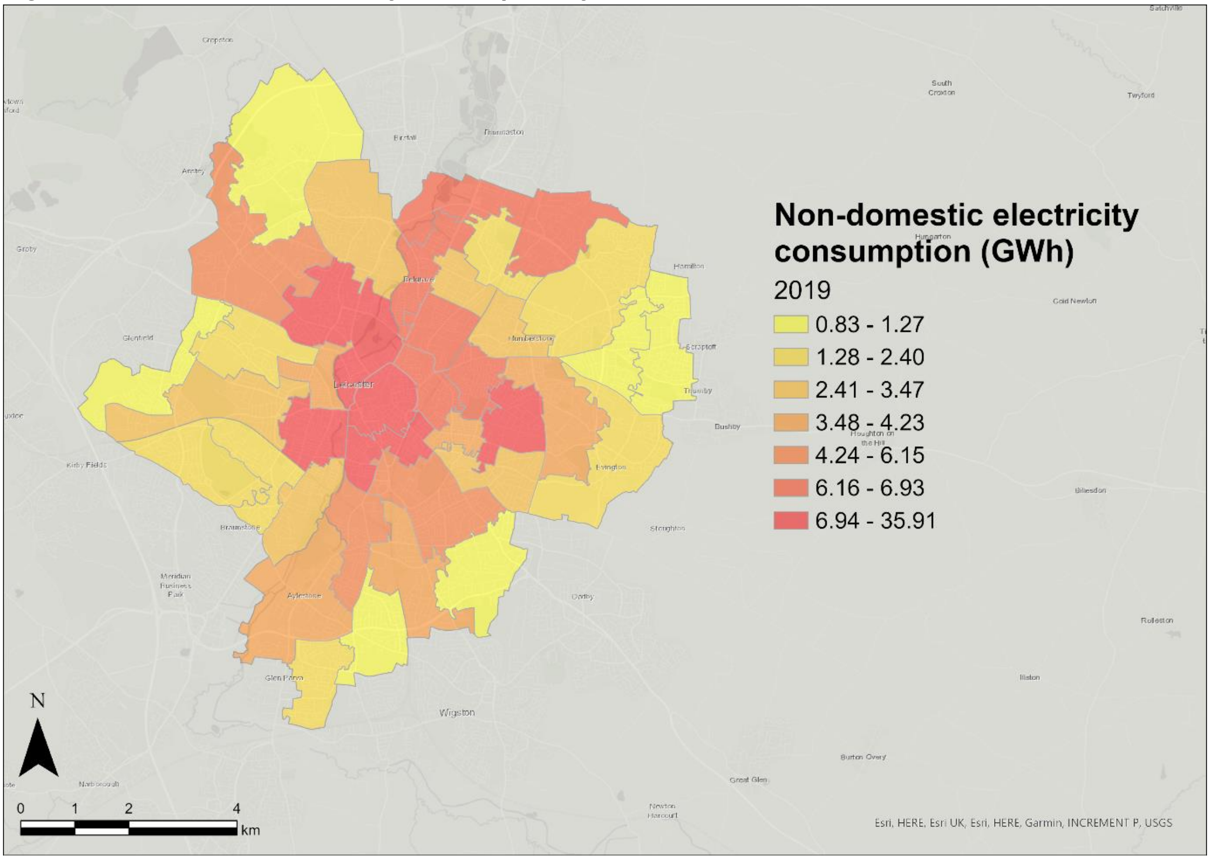
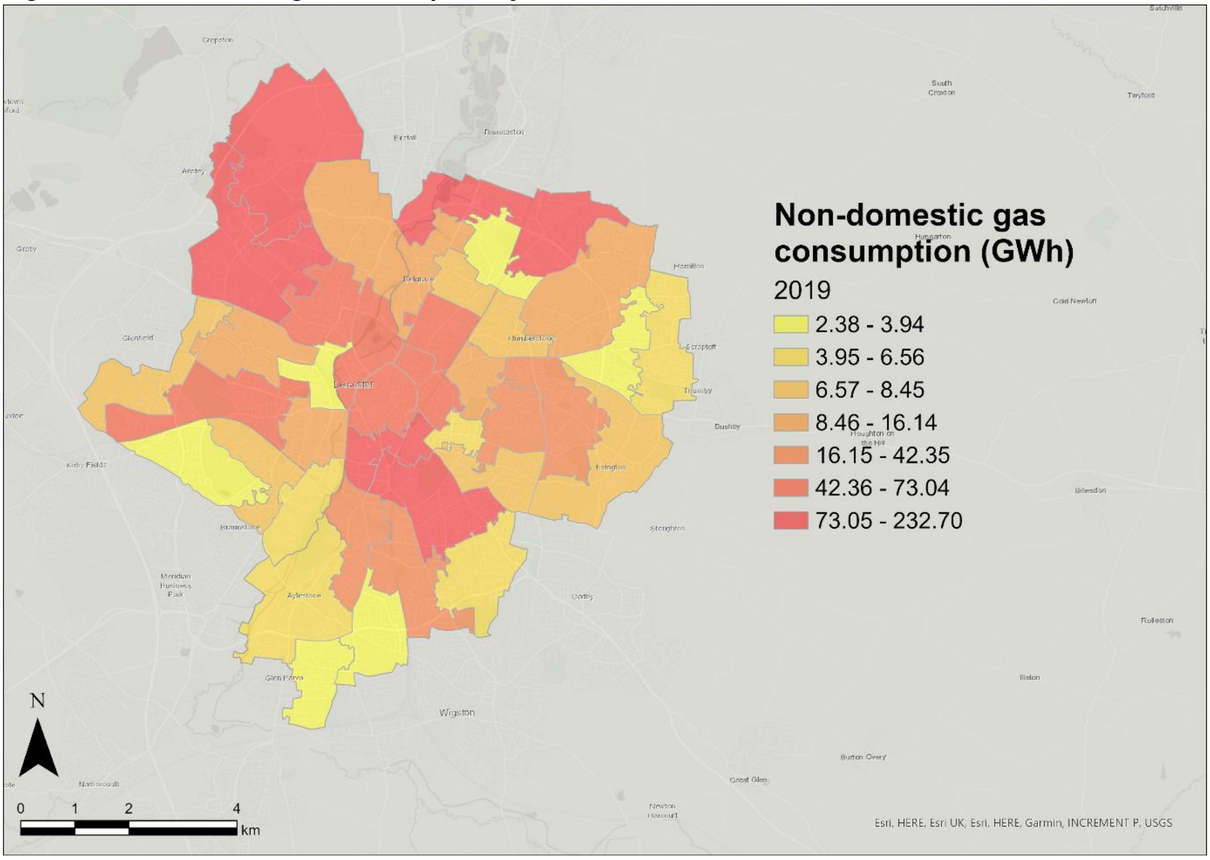


Figure 12. Non-domestic gas consumption by MSOA, 2018. Source: BEIS

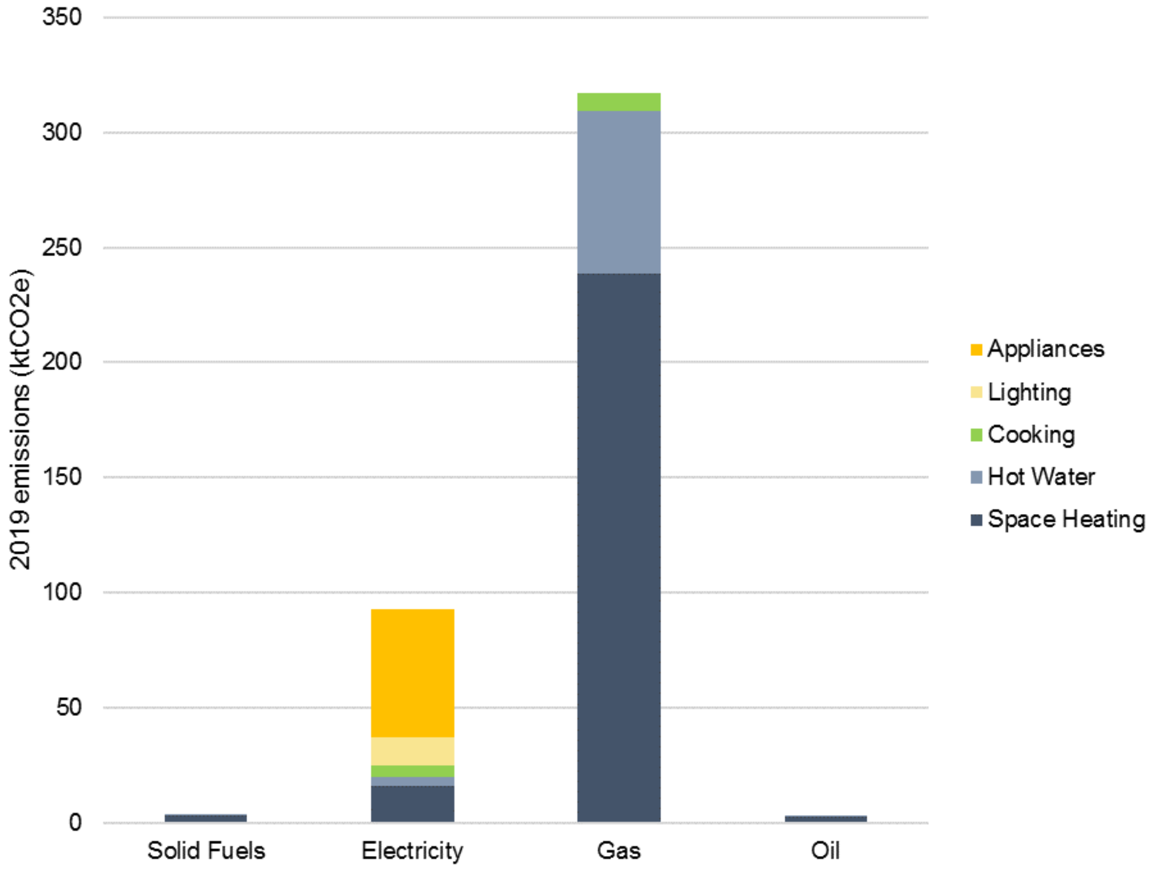


2.2.2.2 Emissions: Domestic buildings

To provide a more detailed understanding of the sources of domestic emissions in Leicester, the data presented in Figure 1 have been disaggregated by end use. This is based on national statistics for typical energy end uses in domestic buildings as set out in the BEIS publication, *'Energy Consumption in the UK'* (ECUK), which have then been applied to Leicester's GHG emissions inventory.[12]

As shown in Figure 13, the vast majority of emissions in the domestic sector stem from natural gas, roughly three-quarters of which is likely to be used for space heating, with the remainder used for water heating; a small proportion is also used for cooking. Electricity accounts for around 22% of emissions in the domestic sector in Leicester. The majority of emissions from electricity stem from appliances (60%), followed by space heating (17%) and lighting (14%). Fuel consumption data for Leicester indicates that only a very small amount of solid fuels and gas oil are used within the domestic stock.

Figure 13. Estimated split of domestic GHG emissions in Leicester by end use, 2019. Source: BEIS



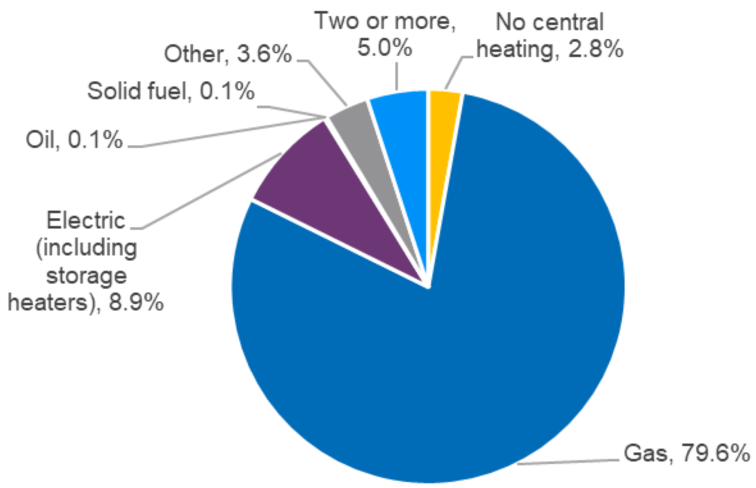
Over time, the emissions from electricity will continue to decrease due to grid decarbonisation. The emissions from gas, on the other hand, would generally remain stable assuming there is no major change in energy demand for heating, hot water and cooking. This shows that the major challenge of

[12] BEIS, Energy Consumption in the UK, [Energy consumption in the UK - GOV.UK (www.gov.uk)]

decarbonising the domestic stock is associated with decarbonising heat demand – something that is acknowledged within the UK's 2017 industrial strategy and CCC studies.[13,14]

Another indicator of the current sources of emissions in the domestic building stock, and the types of interventions that might be required to mitigate these, is the split of heating systems. 2011 Census data was used to generate a rough estimate of how people in Leicester tend to heat their homes.[15] The vast majority of properties are heated using gas, with electric heating being the next major contributor. These results, which align very closely with national figures, suggest that in order for Leicester to achieve net zero emissions by 2030, it will be necessary to replace roughly 90% of all existing domestic heating systems in the city – essentially, all those that use fossil fuels – since it is unlikely that an alternative technology such as hydrogen gas would become available in that time period. Doing this would also result in a large increase in electricity demand which would need to be mitigated via energy efficiency measures and behaviour change.

Figure 14. Types of domestic heating systems in Leicester. Source: Census 2011



There is a significant difference in types of heating system across the city, as shown in the map below, which was developed by Kiln in 2015 for Affordable Warmth Solutions in association with BEIS. Properties in the city centre are much less likely to use gas heating systems, suggesting that a geographically targeted approach may be required.

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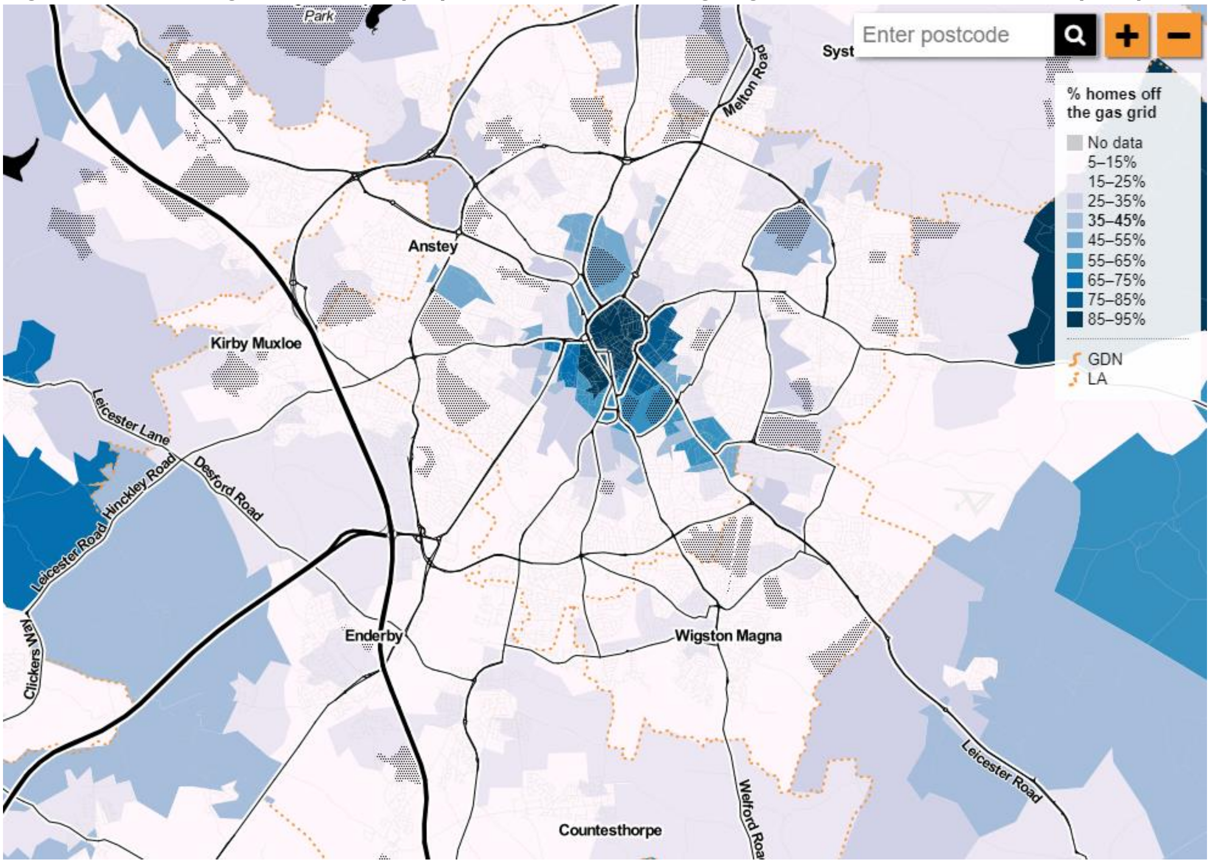
[13] The UK's Industrial Strategy - GOV.UK (www.gov.uk)
[14] CCC, *'Net Zero – The UK's Contribution to Stopping Global Warming'* (2019). Available at: Net Zero - Technical Report - Climate Change Committee (theccc.org.uk)
[15] Office for National Statistics, *'2011 Census, Table QS415EW'* (2011). Available at: QS415EW (Central heating) - Nomis - Official Labour Market Statistics (nomisweb.co.uk) Note that, although it is somewhat out of date, and is subject to some uncertainty due to the self-reported information, the Census data is nonetheless expected to capture the majority of the existing stock.

Figure 15. Percentage of domestic properties that are off the gas grid as of 2015. Source: Kiln (2015)



To understand the relative level of energy efficiency of the existing building stock in Leicester and put this into context with the rest of the UK, energy performance certificate (EPC) data was retrieved from the Ministry of Housing, Communities and Local Government website.[16]

As shown in Figure 16, the median 'current' EPC rating for buildings in Leicester is D, which is the same as the national average. The median 'potential' EPC rating is B. Although it is not possible to directly translate this into an equivalent carbon saving, for context the National Energy Efficiency Database indicates that adopting common, cost-effective energy efficiency measures can result in a c. 5-15% reduction in heating demands.[17] More ambitious retrofitting schemes can achieve much greater improvements, reducing heating bills by 80% or more. This suggests that there is considerable scope for improvement within the domestic stock, although it also highlights that there will be a significant challenge in achieving the Government's ambition for all homes to eventually reach a minimum rating of 'C'.[18]

Note, an explanation of EPCs is provided on the following page.

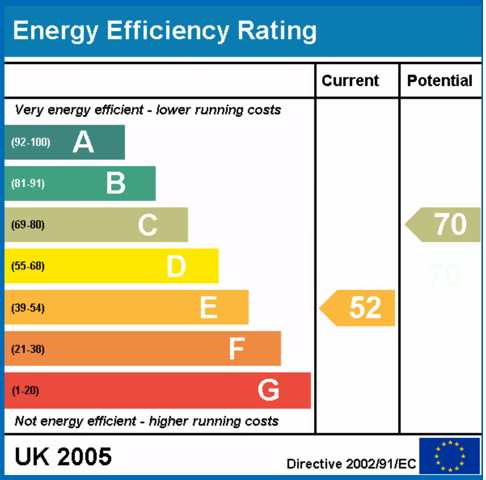
[16] https://epc.opendatacommunities.org/

[17] EPCs provide recommendations for energy efficiency measures that are tailored to each building. These include measures such as wall, roof, or floor insulation; upgrading to double or triple glazing; upgrading the heating system; installation of PV or solar thermal technologies, etc.

[18] The actual carbon savings would depend on which energy efficiency measures are implemented. In practice, these modifications are often costly, and uptake has historically been low in the absence of government or Local Authority funding / subsidies. Local Authorities generally have limited influence over the existing building stock, although it is possible to reduce barriers via permissive Local Plan policies and permitted development rights.

What are EPCs and why are they important?

EPCs provide a modelled estimate of the annual fuel consumption and CO_2 emissions from buildings, based on observations about their size, layout and construction. Although the results do not necessarily indicate the actual fuel consumption or emissions from a given building – this depends on many factors including occupant habits – EPCs allow a like-for-like comparison between buildings with equivalent geometry.



EPCs present an energy efficiency ranking for the building, based on a scale from A (best) to G (worst), as illustrated in the image on the right. Note that domestic EPCs show the potential rating that could be achieved if energy efficiency measures were introduced, but this is not the case for non-domestic EPCs.

The publicly available datasets are updated regularly and, at the time of writing, span the time period from 2008 through March 2021. Collectively, they cover the majority of the existing stock, as all buildings are required to undergo an assessment to obtain an EPC when they are constructed, sold, or rented; however, *it is likely to exclude buildings constructed prior to 2008 that have not been sold or rented in that period.* The dataset also contains some duplicate entries, where buildings have undergone multiple assessments. Duplicates were removed after being sorted by date, to ensure that only the most recent assessment was included in this analysis.

EPC ratings are not only useful to get a sense of the overall energy efficiency levels of existing buildings, but also because they underpin the Minimum Energy Efficiency Standards (MEES) regulations that came into effect in 2018. The MEES regulations are intended to encourage property owners and landlords to improve the energy performance of their buildings by making it unlawful to grant new tenancies for properties with an EPC rating less than 'E'.[19] (Exemptions apply and consideration is given to the maximum improvement that can be achieved via cost-effective measures.) The requirement was extended to all (new and existing) domestic tenancies in 2020, and it is expected that the same will apply for commercial tenancies from April 2023. Over time, the minimum EPC rating will progressively increase. The Government has set out an ambition that, by 2030, most rented non-domestic properties will be required to achieve a 'B' rating and homes will achieve a 'C' rating.[20,21] Local Authorities are responsible for ensuring compliance in the domestic sector and have the ability to issue fines for non-compliance with MEES. Responsibility for the non-domestic sector lies with the Local Weights and Measures Authorities.

The MEES regulations are relevant to this study because, as shown in Section 2.2.2.1, existing buildings account for a large proportion of total GHG emissions, and there are relatively few other mechanisms for Local Authorities or the Government to influence the energy performance of such buildings at present.

[19] Minimum Energy Efficiency Standards (MEES) for Landlords (elmhurstenergy.co.uk)
[20] Improving the energy performance of privately rented homes - GOV.UK (www.gov.uk)
[21] Non-domestic Private Rented Sector minimum energy efficiency standards: EPC B implementation - GOV.UK (www.gov.uk)

Figure 16. Current domestic EPC ratings in Leicester City

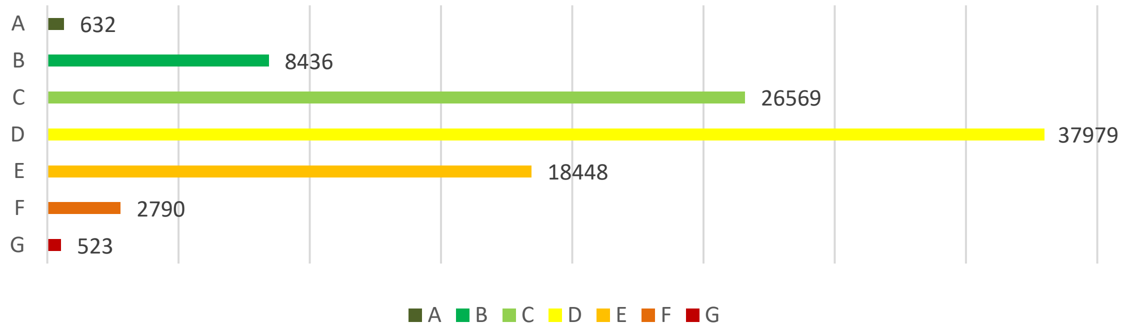
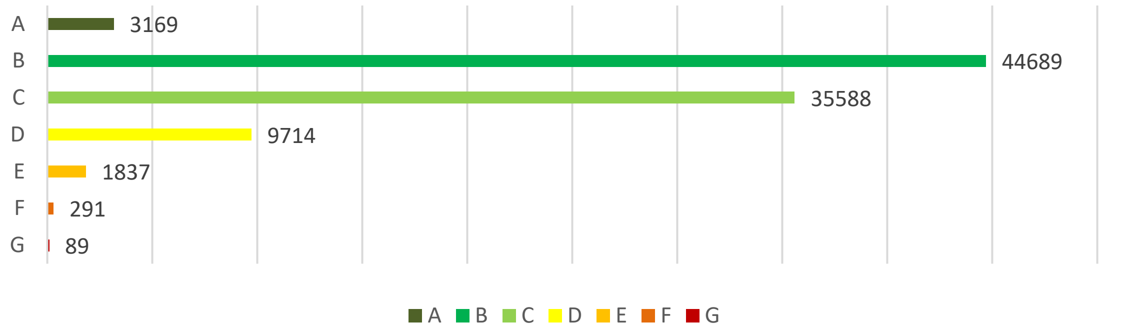
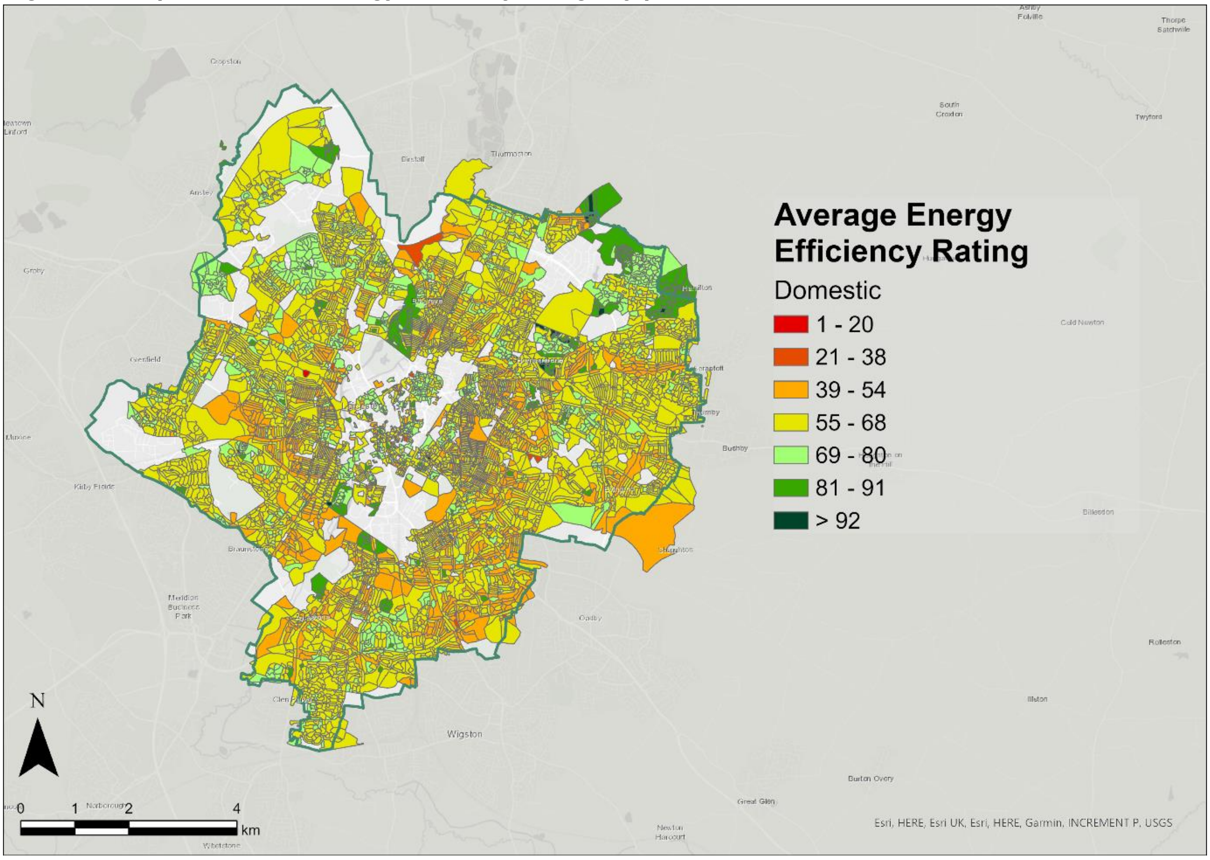


Figure 17. Potential domestic EPC ratings in Leicester City



The map below shows the average domestic energy efficiency rating by postcode, as listed in domestic EPCs. Higher energy efficiency ratings correlate to better EPC ratings although the latter also considers energy costs and CO_2 emissions. (Not all buildings have EPCs; see previous page.)

Figure 18. Map of domestic energy efficiency ratings by postcode, based on EPC data



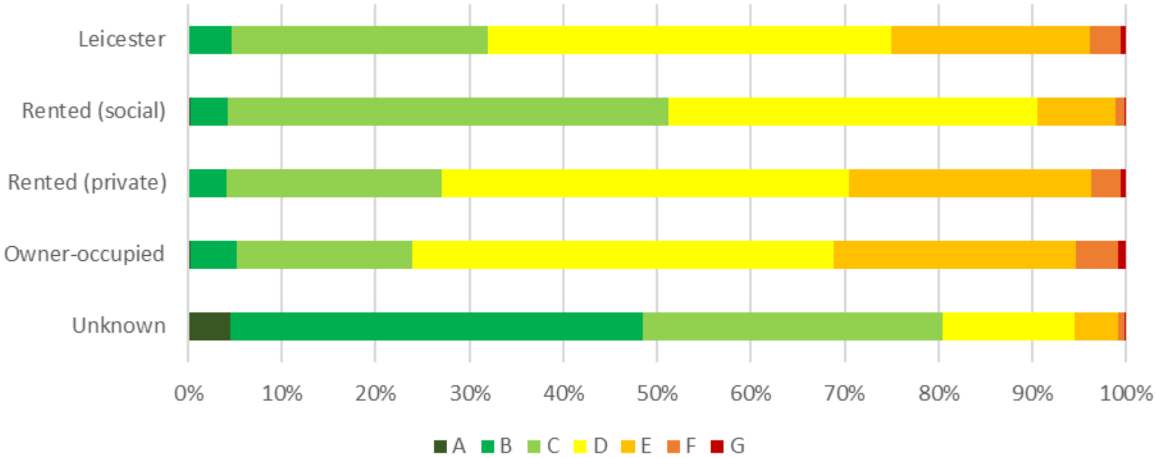
Note that some postcodes extend outside the Leicester city boundary. Gaps indicate that there are no domestic EPC records for that area. Areas shown with particularly good energy efficiency ratings will likely include newer developments and/or a high number of properties that have been retrofitted to a high standard.

Considering energy efficiency by tenure, the domestic EPC data for Leicester suggests that social rented housing tends to be more efficient than owner-occupied or private rentals, as shown in Figure 19. This is also true across the country as a whole, due to a variety of factors, which are likely to include differences in the typical type and age of property but could also relate to the availability of funding for energy efficiency improvements.

Taken as a whole, the EPC data indicates there is most potential for efficiency gains in private rented housing stock, where the average EPC rating is lower. In addition, as demonstrated in Figure 17, there is significant potential to upgrade a significant number of homes from EPC D to EPC B. Identifying data to help identify where these homes are concentrated in the council and their ownership could allow the council to deliver a targeted scheme to maximise the impact on efficiency, thermal comfort and emissions.

(Note that the ‘Unknown’ category includes EPCs where there is no record of tenure, but mostly comprises new buildings where the tenancy is not yet determined. This likely explains the higher level of energy efficiency in this category. New buildings are more energy efficient than older buildings, due to the progressive increase in standards set out within the Building Regulations; statistics for 2019 suggest that energy costs for new build homes are roughly half that of existing homes.[22])

Figure 19. Current domestic EPC ratings by tenure



[22] Office for National Statistics, 'Energy efficiency of housing in England and Wales' (2021). Available at: [Energy efficiency of housing in England and Wales - Office for National Statistics (ons.gov.uk)]

2.2.2.3 Emissions: Non-domestic buildings and facilities in Leicester City

As mentioned previously, there is greater variability in the way that energy is used in non-domestic buildings and facilities when compared with the domestic sector.
Figure 20 below shows a breakdown of fuel consumption in industrial buildings, and Figure 21 shows the same breakdown for other non-domestic buildings, based on national statistics as set out in the BEIS ECUK publication (see previous section). This does not necessarily represent the situation in Leicester but provides further insight into how energy use differs in these sectors. In both cases, heat accounts for the majority of energy use. However, whereas in most non-domestic buildings this comprises space heating, hot water and cooking/catering – as for domestic buildings – in industrial buildings most of the heat is used for other purposes. This indicates that:

- decarbonisation of heat will need to be a major area of focus for all sectors; and
- some uses of heat are industry- or sector-specific, which makes it difficult to identify suitable mitigation measures, both because of a lack of reliable information on how the energy is used in Leicester specifically, and because there might not be suitable alternative technologies as there are for space heating, hot water and cooking.

Figure 20. Industrial fuel consumption by end use in 2019. Source: BEIS

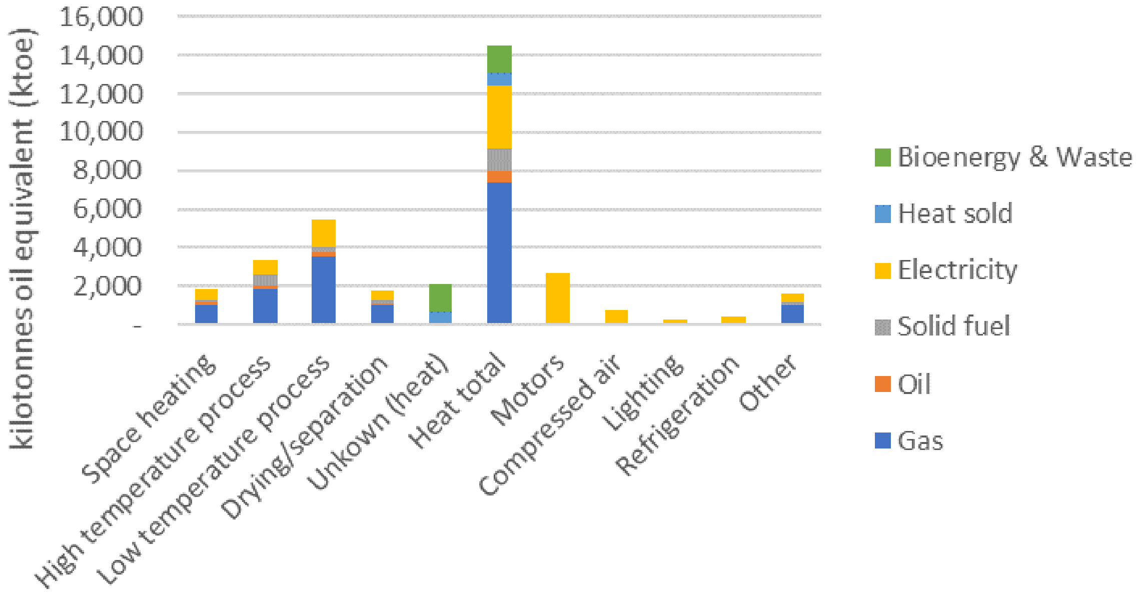
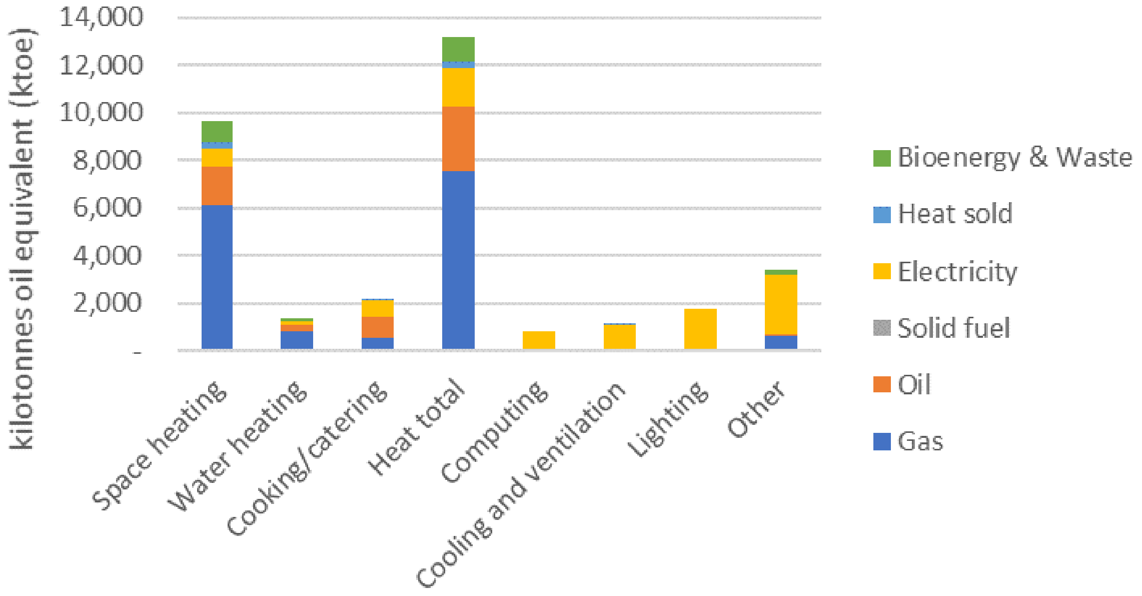


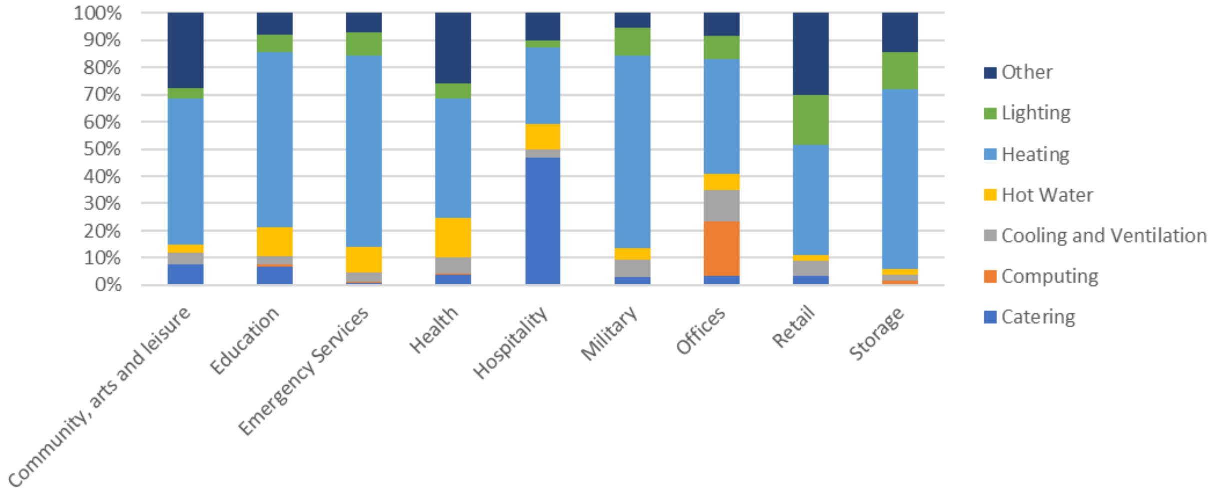
Figure 21. Other non-domestic fuel consumption by end use in 2019. Source: BEIS



Some of the energy end uses shown above are impacted by retrofitting the 'building fabric' by improving the insulation, windows, draughtproofing, and so on. For the most part this affects space heating and cooling demand although other energy end uses can have an indirect effect (think of waste heat in IT rooms). Others would need to be mitigated via other types of efficiency improvements, such as switching to LED lighting, better cooling and ventilation systems, smart controls, and so on.

The graph below provides more detail on how energy is used in different commercial and public sector buildings and facilities nationally.

Figure 22. Split of fuel consumption by end and sub-sector. Source: BEIS

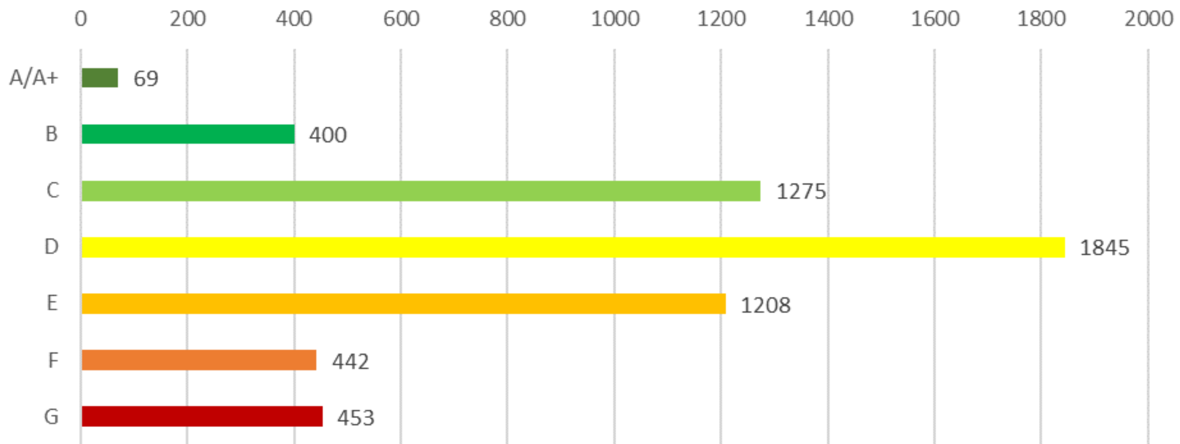


As will be discussed on the following pages, a significant majority[23] of non-domestic properties in Leicester are retail, restaurants, and offices, so based on this graph some general observations can be made about opportunities for reducing emissions from these sectors in Leicester:

- In retail, nearly half of energy use is for lighting and 'other' unspecified uses. This means that retrofitting measures will have proportionally less of an impact in this sector.
- For restaurants and hospitality, energy use is dominated by catering (which mostly uses gas) and hot water. Catering would need to switch to electric systems in order to reduce emissions in this sector.
- Offices use a significant amount of energy for computing, as well as cooling and ventilation. Rather than decreasing, these could in fact increase over time, depending on future trends in the use of electronic equipment, as well as future changes in weather and heatwaves. These are examples of energy uses that are difficult for LAs to influence.

Considering the energy performance of buildings themselves, which would primarily impact energy use for space heating, the median non-domestic EPC rating in Leicester is D, and the majority (nearly 70%) have a D rating or below. Perhaps unsurprisingly, the distribution is not symmetrical; there are more buildings with lower ratings than higher ratings. As with the domestic stock, this broadly mirrors the national picture.

Figure 23. Non-domestic EPC ratings



The maps below show the average EPC asset rating for non-domestic buildings, and the average display energy certificate (DEC) operational rating for public buildings. The terminology is slightly different from that used for domestic EPCs but all of these broadly indicate the energy performance of the building. Note that, whereas higher ratings for domestic buildings indicate better performance, for non-domestic and public buildings better performance is indicated by lower ratings.[24]

[23] Based on the numbers of EPC certificates, which can be used as a proxy for numbers of buildings (including tenanted properties). It is not necessarily based on their relative contribution to total energy use or emissions in Leicester since these businesses can vary dramatically in size.
[24] In rare cases this can include negative numbers, indicating an A+ rating, i.e. a building that reduces or offsets more CO_2 than it emits.

Figure 24. Average EPC Asset Rating for non-domestic buildings, by postcode

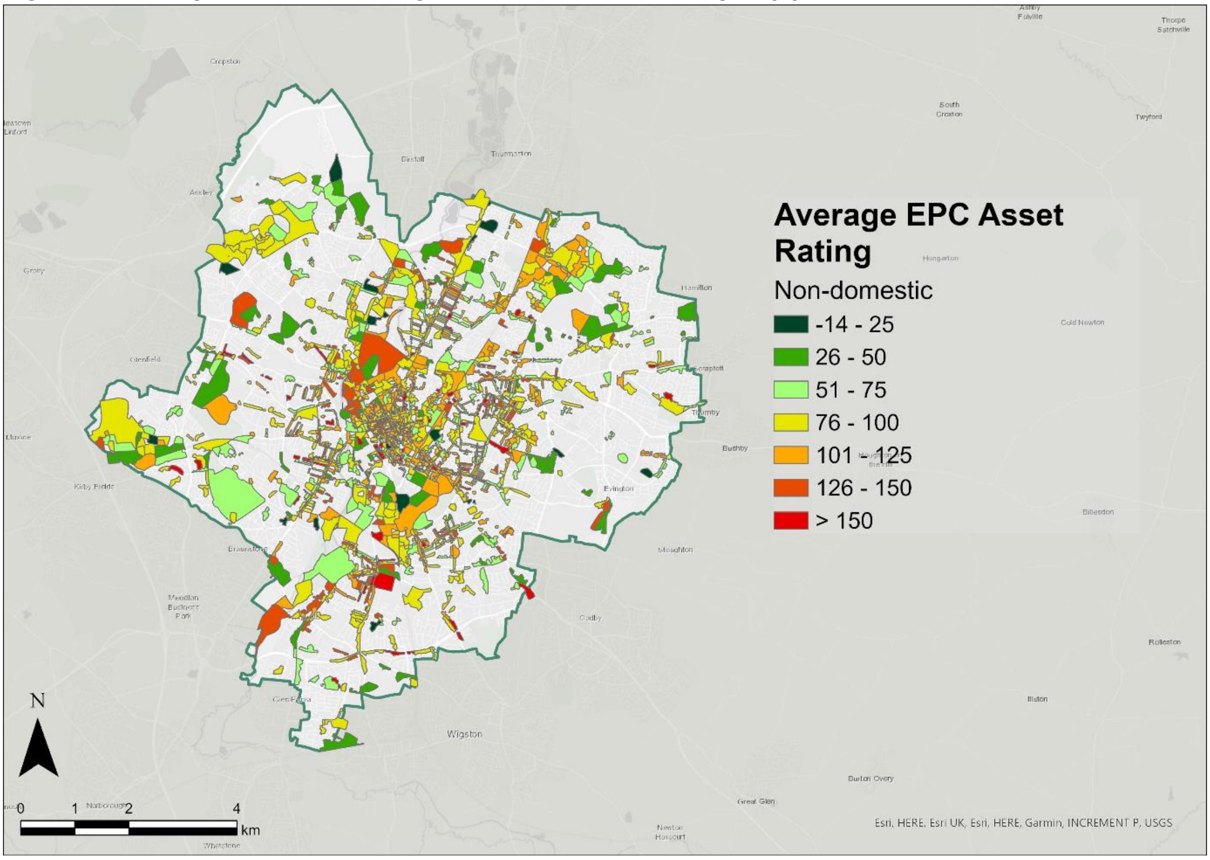
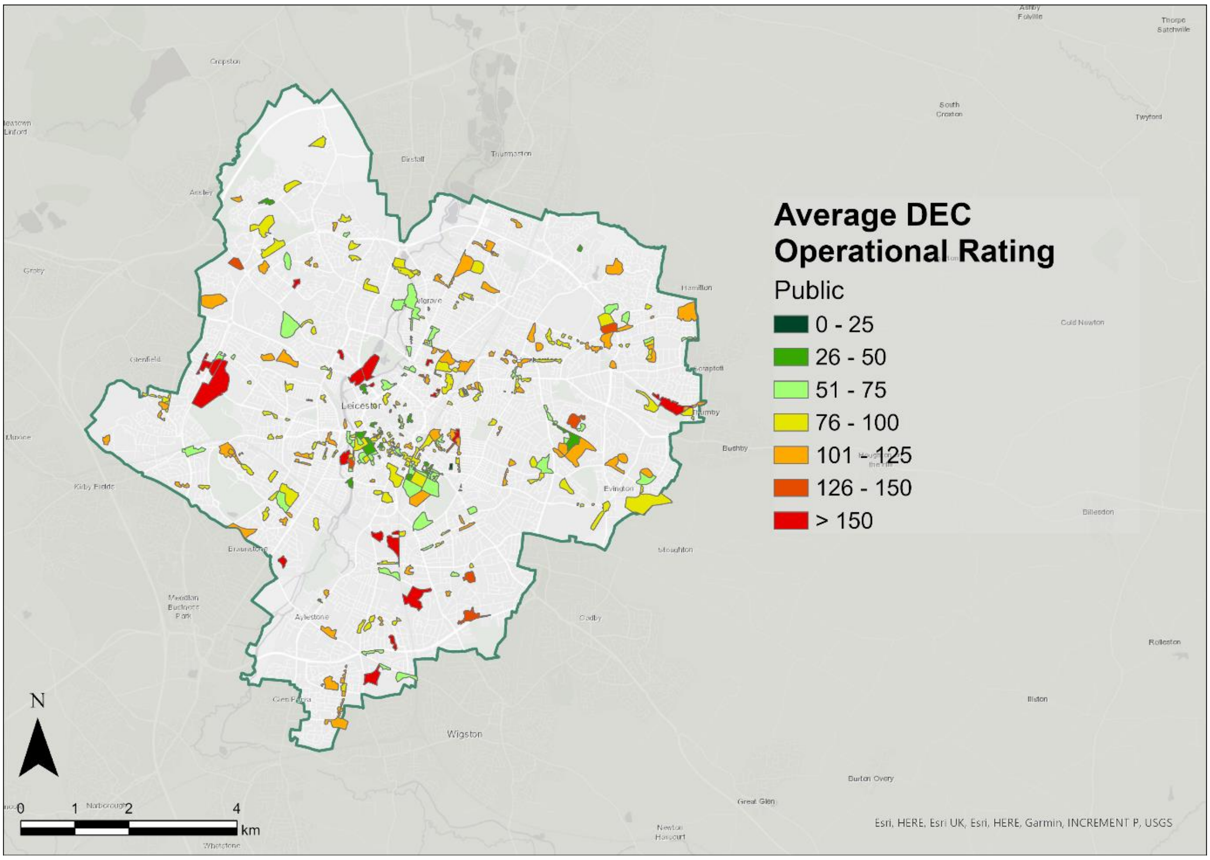


Figure 25. Average DEC Operational Rating for large public buildings, by postcode



Non-domestic EPCs report the planning use category of a property, rather than tenure. Figure 26 shows a breakdown of results by use category, indicating the proportion of buildings that achieve different ratings. (Note that this is affected by how many buildings of each type are included in the dataset. For instance, the result for 'D1 Non-residential institutions – Libraries Museums and Galleries' is based on the EPC records for just two buildings.) These results reinforce one of the key messages of the domestic EPC analysis, which is that a significant portion of the existing stock would need to be upgraded by 2030 in order to meet the Government's 'B' rating requirement.

Figure 26. Non-domestic EPC ratings by use category (# per sub-sector)

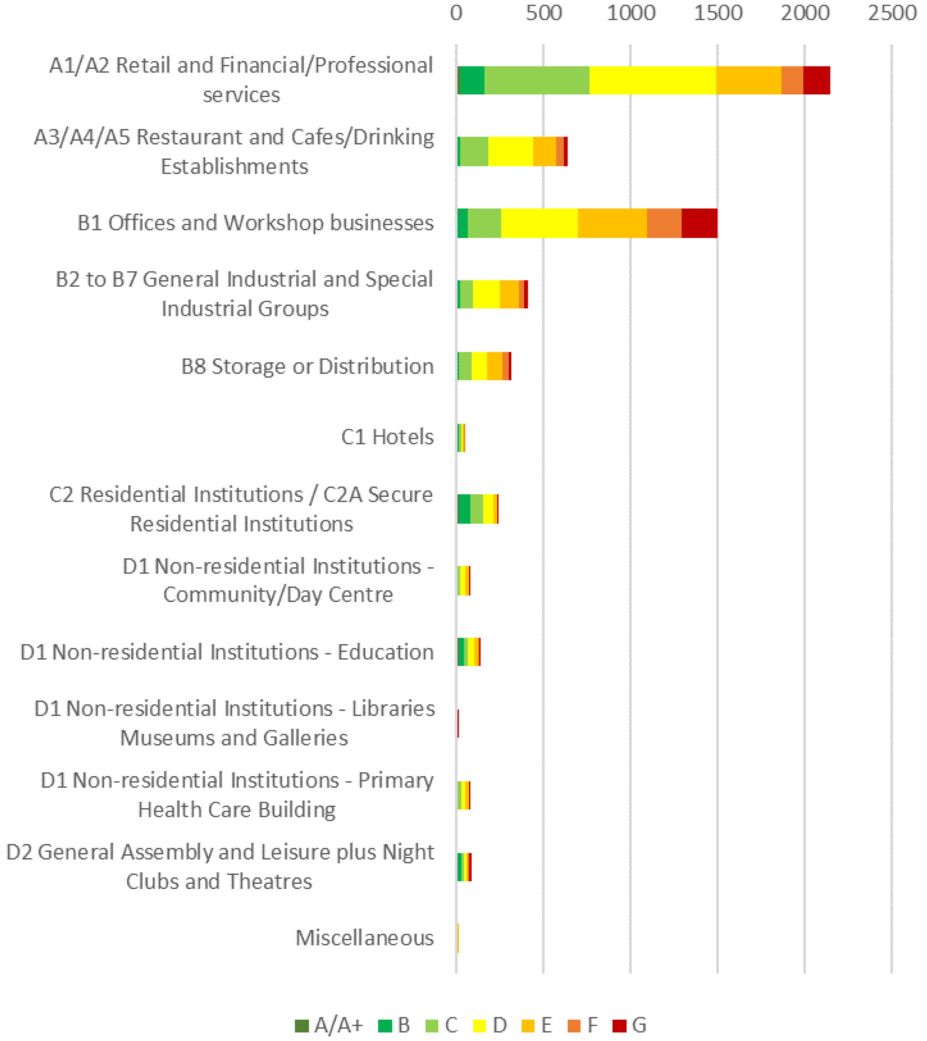
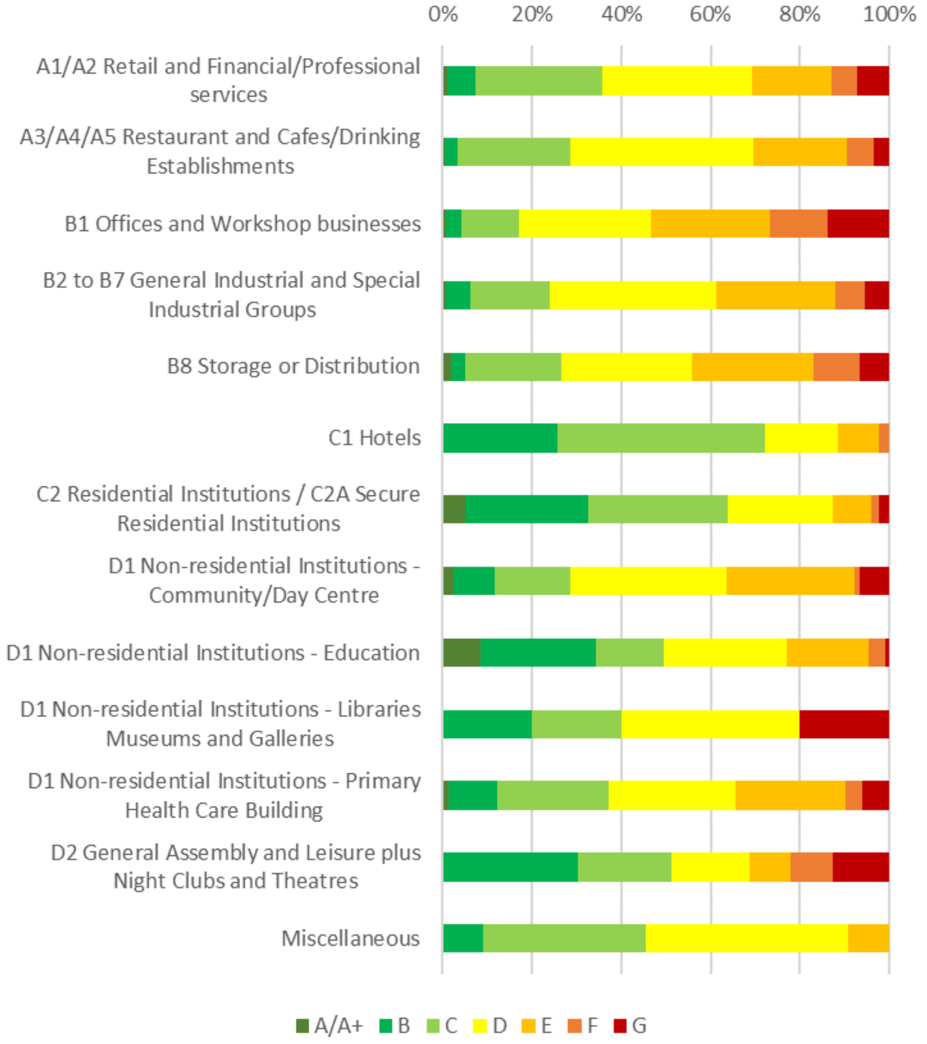


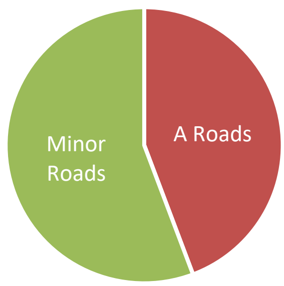
Figure 27. Non-domestic EPC ratings by use category (% of total per sub-sector)



2.2.2.4 Emissions: The transport sector

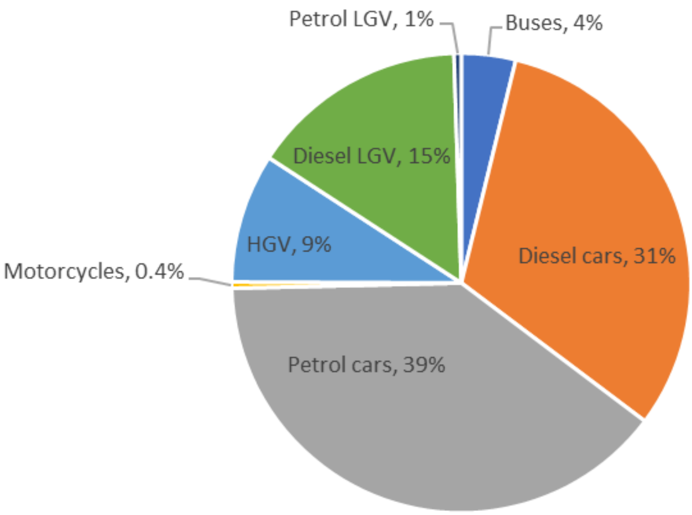
As shown in Figure 28, based on the BEIS CO_2 statistics, there is a relatively even split between emissions from A roads and minor roads in Leicester. There is no motorway within the administrative boundaries.

Figure 28. Road transport emissions by road type, 2019. Source: BEIS



Although not reported in the BEIS dataset, it is assumed that road transport emissions will broadly mirror the split of road transport fuel consumption. As shown in the pie chart below, around 70% of fuel is used in petrol or diesel cars. Around 15% is used for diesel light goods vehicles (LGVs) and 9% is used for heavy goods vehicles (HGVs). The remainder is associated with buses, petrol LGVs, and motorcycles.[25]

Figure 29. Split of road transport fuel use by vehicle type, 2019. Source: BEIS



Aside from HGVs, all of these vehicle types can be replaced with battery electric vehicles (BEVs) based on current technology. In principle, if these were supplied with 100% renewable electricity, this would reduce emissions from road transport by roughly 90% (the remainder being associated with HGVs). The scale of emissions reductions in road transport by 2030 will therefore depend in significant part on the proportion of vehicles that switch to EV, and the scale of electricity grid decarbonisation. There are several potential implications:

- Consumers are likely to start to shift towards EVs as the costs come down, so LCC could potentially focus efforts on areas other than promoting EV uptake. The key challenge here is that these trends are not expected to result in full adoption of EVs by 2030.
- If the grid does not decarbonise as rapidly as anticipated, the benefits of switching to EVs will decrease. Therefore, it will be important to guard against this risk by promoting measures that reduce demand for vehicle journeys in the first place, and also maximising local renewable electricity generation.
- Emissions from HGVs will be extremely difficult to mitigate by 2030, so the focus will need to be more on marginal efficiency improvements in HGV technologies, driver training, freight consolidation and optimising logistics.

2.3 Renewable electricity

At present, renewable electricity technologies provide only a small portion of Leicester's electricity demands. However, in a net zero future, both large- and small-scale renewable capacity will need to increase radically in order to meet higher electricity demands in a sustainable way.

To estimate the current number, size, and type of renewable energy installations within Leicester, we have referred to the following sources:

[25] BEIS, 'Sub-national road transport consumption data 2005-2019' (published 2021). Available at: Sub-national road transport consumption data - GOV.UK (www.gov.uk)

- The Regional Renewable Statistics (RRS) – Published annually by BEIS, this dataset only includes renewable electricity technologies and excludes those that only produce heat. The most recent data is for the end of 2019.
- Renewable Heat Incentive (RHI) statistics – This dataset covers technologies that provide renewable heat, including ground and air source heat pumps, biomass, and solar hot water.
- The Renewable Energy Planning Database (REPD) – An up-to-date list of renewable energy planning applications published quarterly by BEIS.
- The Heat Networks Planning Database (HNPD) – An up-to-date list of heat network planning applications published quarterly by BEIS.

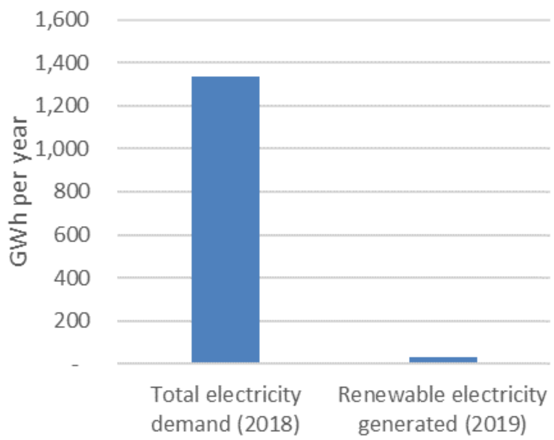
Results are shown in Table 3 below.

Table 3. Renewable electricity technologies in Leicester, at end of 2019. Source: BEIS (RRS)

	No. Installations (#)	Installed Capacity (MW)	Generation (MWh per year)
Photovoltaics	4,606	17.86	17,510
Onshore Wind	4	0.02	51
Anaerobic Digestion	1	2.0	11,038
Plant Biomass	2	0.27	1,190
Total	4,613	20.16	29,788

As of the end of 2019, there were 4,613 renewable electricity-producing installations in Leicester. Almost all of these (99.8%) were solar photovoltaics (PV). It is likely that most PV installations are small, roof-mounted systems given the urban nature of Leicester City. However, according to the REPD, there is one large-scale renewable energy site (PV) at the National Space Centre in Leicester with an installed capacity of 0.2 MW, which is operated by Leicestershire County Council.[26]

In addition to PV, the RRS indicates that there are four wind turbines with a total capacity of around 0.02 MW. The small capacity suggests that these are small- or micro-scale turbines; there are known to be two vertical axis turbines at Leicester College sites, but it is not clear whether these are in fact operational. Two other types of electricity-producing installations in Leicester are one anaerobic digestion (AD) facility and two plant biomass facilities.



To put these figures into context, Leicester's electricity demand in 2018 was 1,337 GWh, but renewable technologies in the city only produced around 30 GWh, which is around 2% of Leicester's total annual electricity demand.

In practice, some of this electricity feeds into the national grid, so it is not possible to state the exact proportion of demand that is met through renewables. Although it is not necessary for each Local Authority to meet all of its own electricity needs via technologies that are installed within the red line boundary, it is nonetheless clear that energy demands would need to reduce significantly, and renewable uptake would need to radically increase, in order for Leicester to achieve net zero emissions.

[26] BEIS, Renewable Energy Planning Database, [Renewable Energy Planning Database | BEIS & Barbour ABI (barbour-abi.com)]

The RRS lists one AD plant in Leicester, which may refer to a facility at the Walkers factory.[27]

[27] https://www.summers-inman.co.uk/projects/anaerobic-digester-project/

2.4 Renewable and low carbon heat

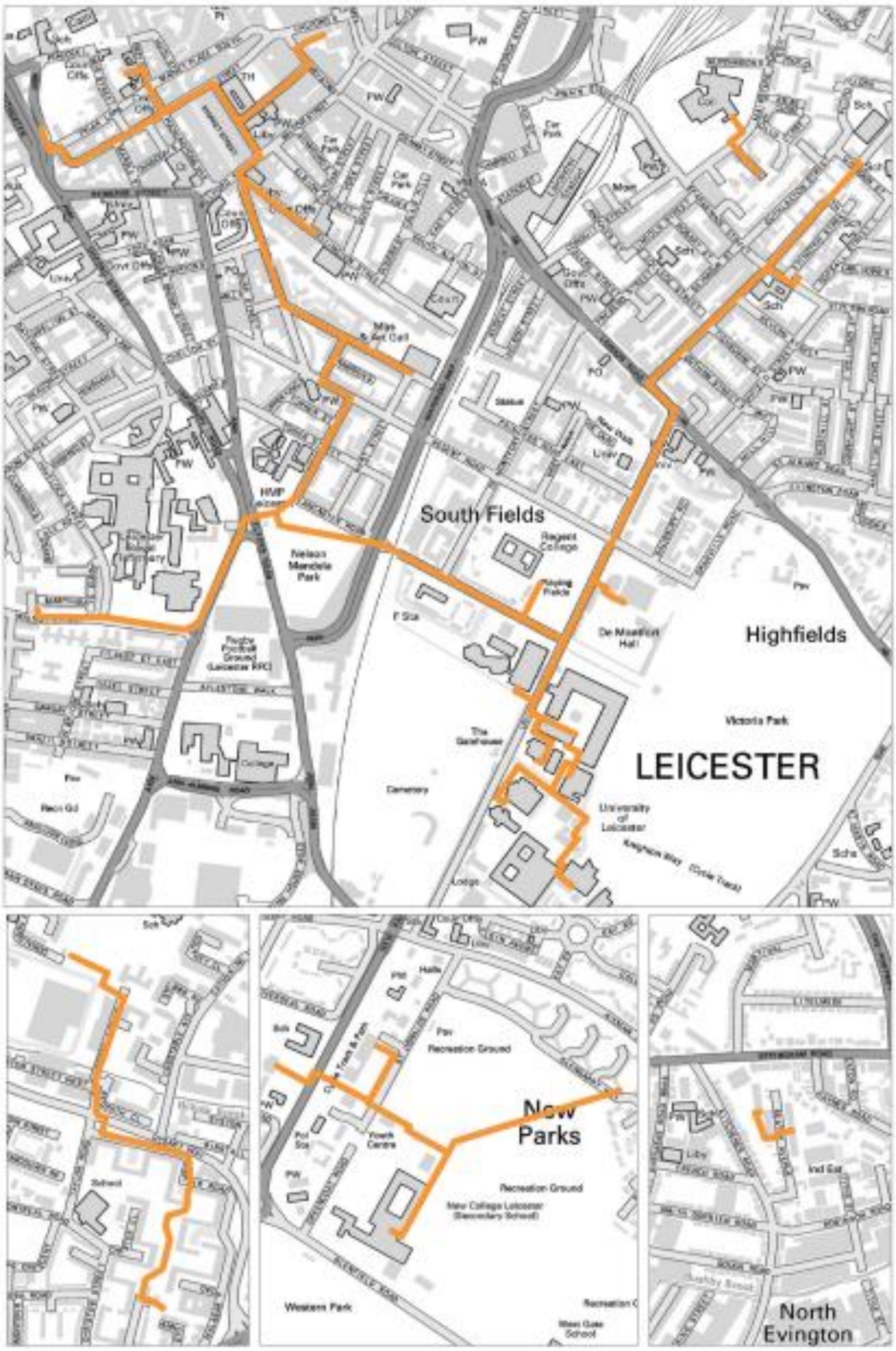
Regarding renewable heat technologies, RHI statistics suggest that there are 7 non-domestic RHI installations in Leicester, with a total installed capacity of around 1MW, and 123 domestic RHI installations, for which the capacity is not reported.[28]

In addition, there are existing and planned district or communal heat networks. These are not classed as renewable energy per se because they are powered by fossil fuels (or a mix of fossil fuels and biomass). However, they can offer low carbon heat compared with individual heating systems on account of the efficiency gained from operating a centralised heating system. They also have the benefit of being able, in principle, to switch to alternative energy sources such as heat pumps or green hydrogen, achieving carbon savings without the need to further replace the heating systems in each individual building.

There is a city centre heat network in Leicester operated by Engie which has a capacity of 79 GWh of heat per year according to the operator. It supplies at least 19 civic buildings with heating and warm water, including the Town Hall, schools, libraries, the University of Leicester and around 3,000 council homes. Part of this energy is produced by a Combined Heat and Power (CHP) plant at the University of Leicester, which has joined the city-wide scheme.[29]

[28] Public RHI statistics do not include details of the types and sizes of individual RHI installations in Leicester. However, to gain a rough indication of the likely technology split, it is useful to refer to the nation-wide RHI statistics: For non-domestic RHI installations, the vast majority of applications (over 80%) are for biomass boilers, mostly small (<200kW) or medium (200-1000kW) scale. Most of the other applications are for water or ground source heat pumps (GSHPs). For domestic RHI installations, the majority of applications are for ASHPs, with the remainder roughly evenly split between GSHPs, biomass boilers and solar thermal systems.
[29] Engie, Leicester, Leicester District Energy Scheme (engie.co.uk)

Figure 30. Map of the existing heat network. Source: Draft Leicester Local Plan (2020)



There are another two CHP engines separate from the city-wide scheme, located at Leicester Royal Infirmary and Glenfield Hospital, both operated by Vital Energi. Both locations already had CHP engines (in the case of Glenfield since the early 1990s) but recently commissioned upgrades. According to the operator, the plant at Leicester Royal Infirmary has a capacity of 1.6MWe which they estimate will result in a CO_2 saving of 2,701 tonnes per year. The plant at Glenfield Hospital has a capacity of 770kWe and is said to reduce CO_2 emissions by 1,474 tonnes each year.[30] Emissions savings from CHP installations depend on the GHG intensity of the fuels that are used to generate the heat and power, and the GHG intensity of the fuels that are displaced, so these figures may fluctuate.

Finally, we note that a planning application for a gas-fired communal heat network serving student accommodation was submitted in 2021, which would be operated by Urbanite Leicester Limited and located at All Saints Place. [31]

2.5 Transport

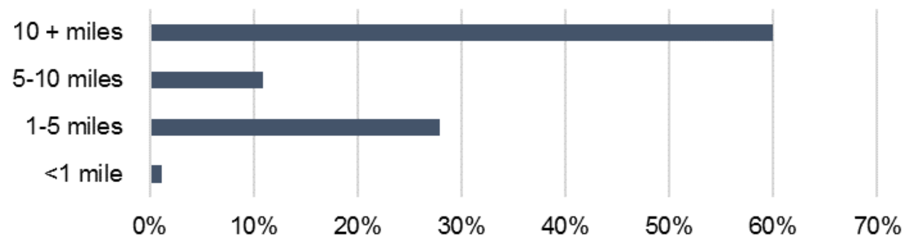
This section provides additional information on modes of travel and vehicle types, including recent rates of ULEV uptake, to provide further context regarding the GHG emissions for road transport.

2.5.1 Baseline situation in Leicester

According to evidence provided by LCC in support of the draft Local Transport Plan (see Figure 31), the majority of vehicle emissions in Leicester stem from trips with a length of 10+ miles (60%), followed by short trips of 1-5 miles. When disaggregating this further by vehicle type, cars make up 55% of emissions from the 10+ miles journeys, followed by HGVs with 28% and vans with 17%.

Roughly 30% of vehicle emissions are from journeys less than 5 miles long. This suggests that, while not the full solution, there could be scope for significant emissions reductions if these short journeys could switch to walking or cycling. Some could also be undertaken via e-bikes or e-scooters.

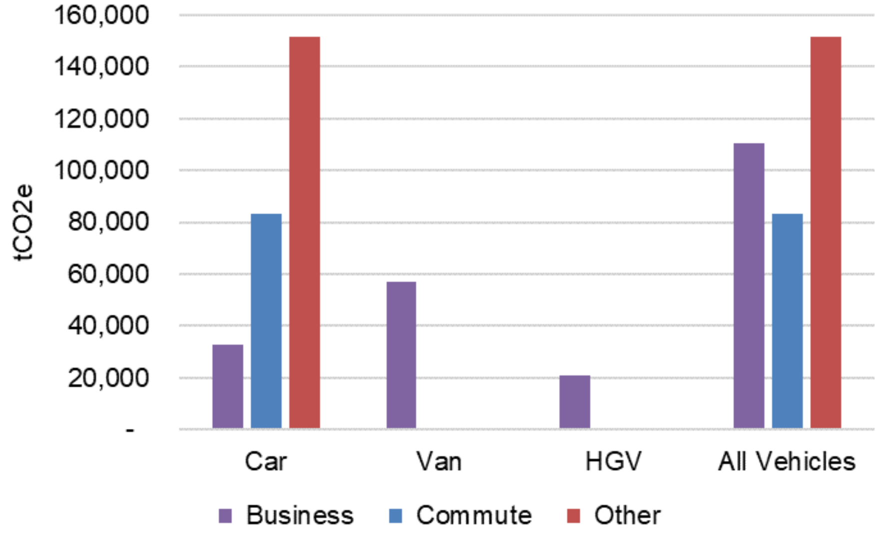
Figure 31. Vehicle emissions by trip length, 2019. Source: Midlands Connect



As shown in Figure 32, non-work-related journeys make up the majority of road transport emissions in Leicester with 44% overall, followed by business trip with 32% and commutes with 24%. Vans and HGVs only cause emissions on business journeys while cars are predominantly on the road for leisure or other non-work purposes, followed by commuting and finally business.

[30] Vital Energi, Leicester Royal Infirmary & Glenfield Hospital CH, Leicester Royal Infirmary & Glenfield Hospital CHP (vitalenergi.co.uk)
[31] BEIS, Heat Networks Planning Database, Heat Networks Planning Database: quarterly extract - GOV.UK (www.gov.uk)

Figure 32. Transport emissions by vehicle type and journey purpose, 2019. Source: Midlands Connect



These results can help to prioritise intervention measures to reduce transport emissions. For example, among car journeys, the majority are neither for business or commuting; these may comprise general shopping, errands, school runs and leisure trips. Therefore, it is possible that some of these can be avoided in future as technology changes and more activities and shopping take place online. The next highest proportion of emissions is from business travel, indicating that a combination of strategies aimed at improving logistics and/or encouraging individual business car journeys to consider active travel, public transport, ridesharing, e-scooters, and so on could be beneficial.

It should be noted that, at present, the BEIS sub-national fuel consumption statistics do not distinguish between electricity used in buildings and other stationary applications, and electricity used to charge electric vehicles (EVs). Depending on where the EV charging point is located, this electricity consumption would either be allocated to the domestic or non-domestic building sectors.

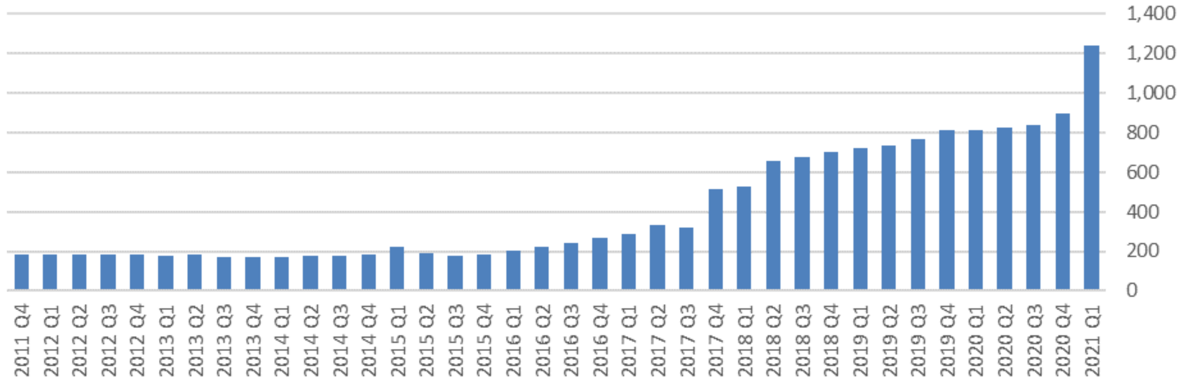
In terms of non-road transport, available data shows that there is a small contribution from diesel railways, which accounts for around 0.1% of total GHG emissions. Emissions from waterborne transport are also assumed to be very small although not disaggregated within the available datasets; depending on the type of fuel used and how it is purchased, this would be included within the GHG emission figures for ‘petrol/diesel’ or ‘other fuels’.

2.5.2 ULEV uptake

ULEV uptake has increased exponentially in recent years across the UK, albeit from a low base, and Leicester is no exception. As shown in Figure 33, by the beginning of 2021 there were 1,235 licensed ULEVs in the City, compared with just 181 in 2011.[32]

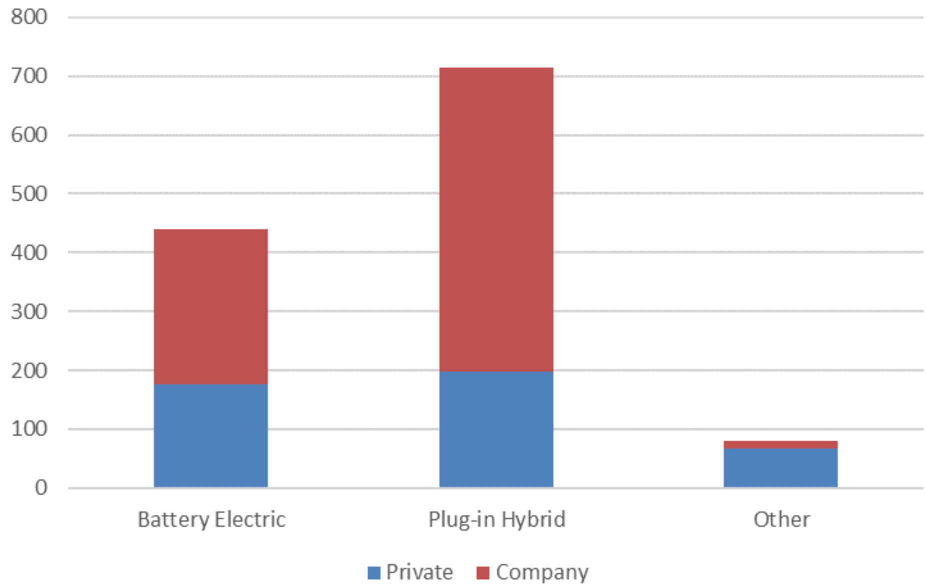
[32] DVLA/DfT, ‘Statistical data set. All vehicles’, VEH0132 Dataset, (last updated July 2021). Available at: [Vehicle Licensing Statistics - GOV.UK (www.gov.uk)]

Figure 33. Licensed ULEVs in Leicester, 2011-2021. Source: DVLA/DfT



A further breakdown of the latest figures shows that company cars make up 64% of all ULEVs in Leicester.[33] Plug-in Hybrid Electric Vehicles (PHEVs) are the most common type of company ULEVs with 72%. Private vehicles display a more even split between Battery Electric Vehicles (BEVs) and PHEVs as shown in Figure 34. The remaining 15% of private cars which fall into neither of the two categories cannot be broken down further at the city-level but could be any of the following ULEV types: Range-Extended Electric, Hybrid Electric, Fuel cell electric, or other fuels.[34]

Figure 34. Types of ULEVs in Leicester, 2021. Source: DVLA/DfT

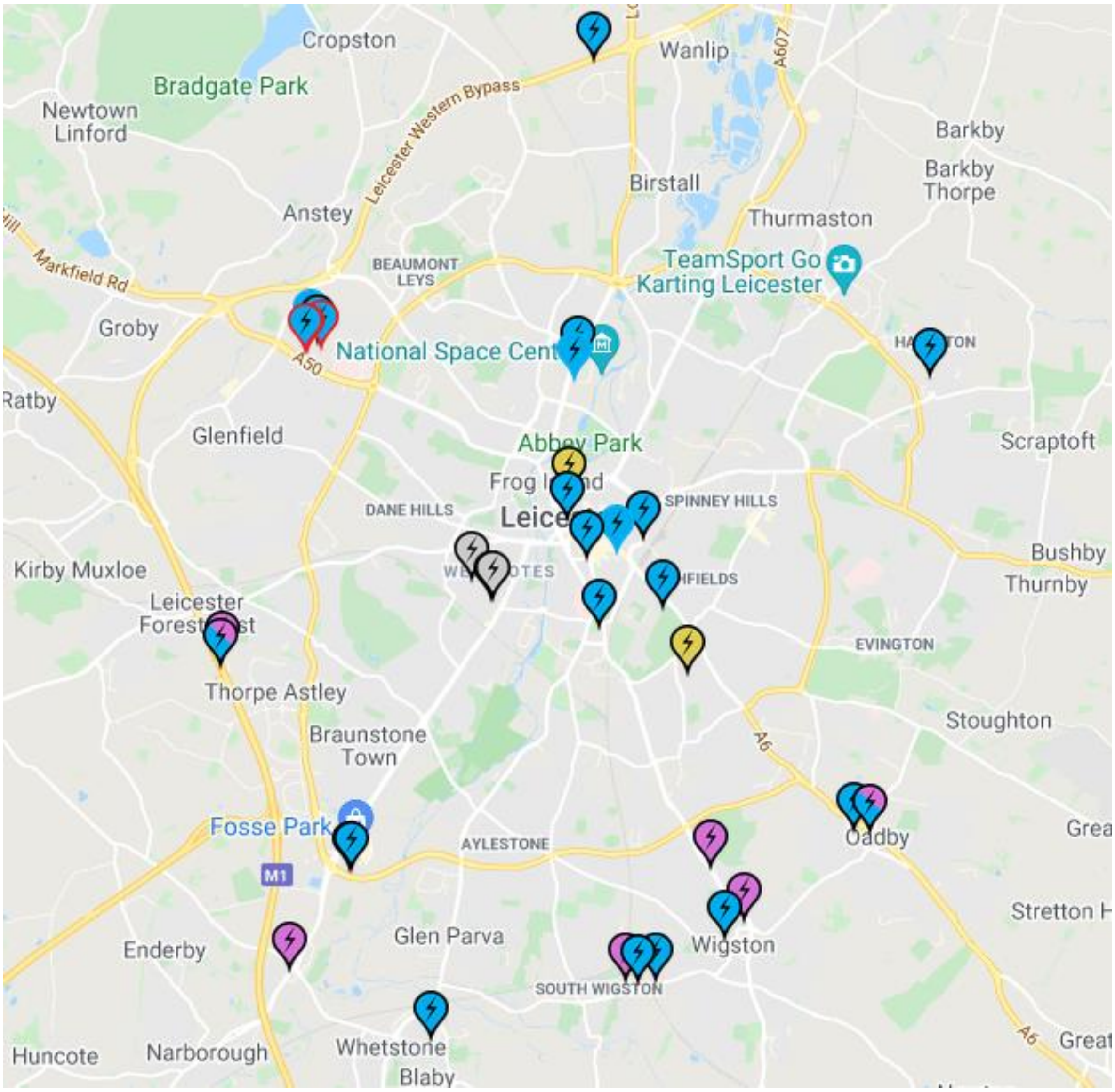


Although the increase in uptake is an encouraging trend, ULEVs still represent a tiny proportion (<1%) of licensed vehicles in Leicester. In order for Leicester to reach net zero emissions by 2030, there would need to be no use of fossil fuels in the transport sector – which would require not only a transformation in the use of renewable electricity and hydrogen powered vehicles, but also a decrease in the number of journeys travelled, and the rate of private vehicle ownership.

[33] DVLA/DfT, 'Statistical data set. All vehicles', VEH0132 Dataset, (last updated July 2021). Available at: [Vehicle Licensing Statistics - GOV.UK (www.gov.uk)]
[34] DVLA/DfT, 'Statistical data set. All vehicles', VEH0133 Dataset, (last updated July 2021). Available at: [Vehicle Licensing Statistics - GOV.UK (www.gov.uk)]

As of July 2021, there were 76 public charging points in Leicester, including 1 rapid charging point.[35] These are shown below.

Figure 35. Locations of public charging points in Leicester and surrounding area. Source: Zap-Map



Putting these figures into context, this equates to around 22 public charging points per 100,000 head of population.[36] As illustrated in Figure 36, this is somewhat lower than the average number of charging points per 100,000, with Leicester appearing in the bottom 20 to 40%.

[35] DfT/OZEV, 'Electric vehicle charging device statistics: July 2021' (published August 2021), Available at: [Electric vehicle charging device statistics: July 2021 - GOV.UK (www.gov.uk)]

[36] DfT, 'Electric vehicle charging devices by local authority' (published July 2021). Available at: maps.dft.gov.uk/ev-charging-map/

Figure 36. Number of public charging points per 100,000 by Local Authority. Source: DfT

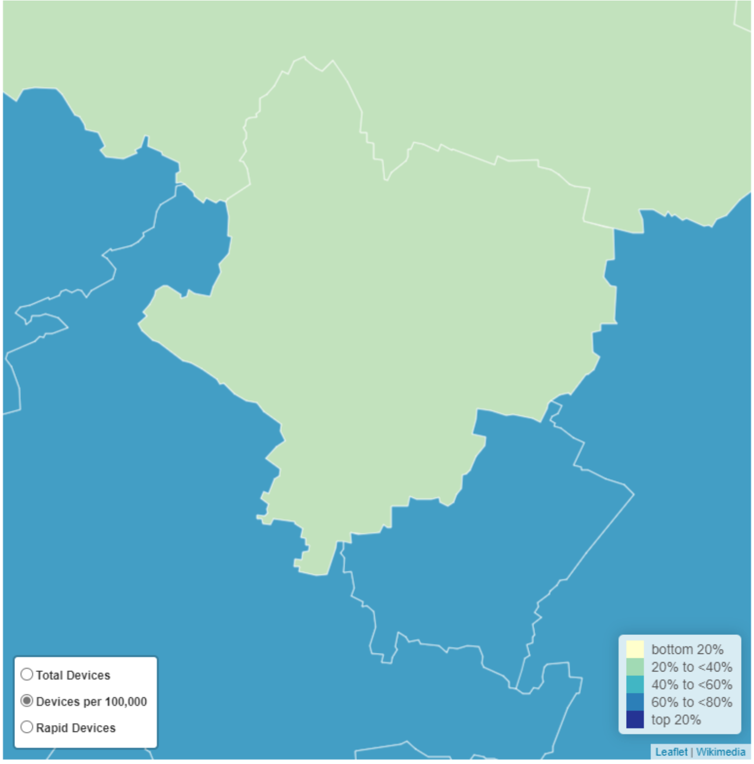
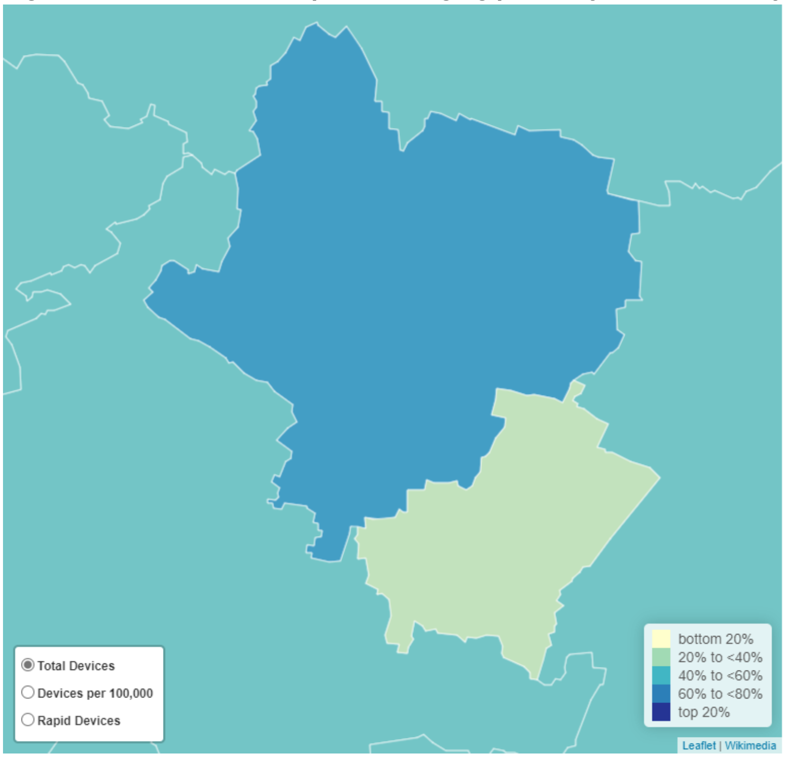


Figure 37. Total number of public charging points by Local Authority. Source: DfT



It is anticipated that the price of EVs could converge with that of traditional combustion engines within the next few years. This would create a 'tipping point' in consumer choices and require a huge increase in EV infrastructure and renewable energy provision within a very short timescale.

2.6 Waste

While this study was commissioned to principally look at Scope 1 and Scope 2 emissions (as there was insufficient data about Scope 3 emissions, these will be tackled in a future report), it was decided to include information about those Scope 3 emissions arising from the treatment and disposal of Leicester's waste. This is in recognition that these emissions are part of Leicester's net zero ambition even if they fall outside of the City boundary.

A rough estimate of emissions from waste and wastewater treatment has been made via two methods.

Method 1
Total figures for emissions from waste were taken from the national greenhouse gas emissions inventory and pro-rated by population. This includes emissions from wastewater treatment. On this basis, emissions are estimated to be c. 101 $ktCO_2e$ per year.

This is only a rough estimate, and it is important to note that the calculation does not account for the following:

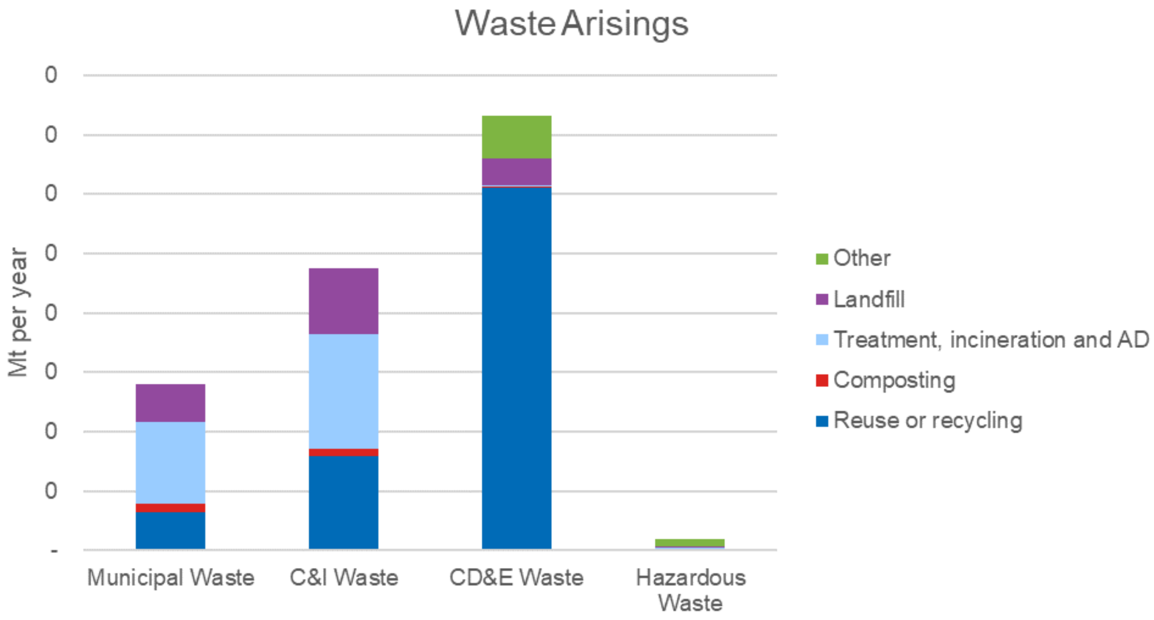
- Because it is based on population, it will include waste generated by residents of Leicester even if they leave the City boundary. Conversely it will not include waste generated by visitors to Leicester.
- It will also not reflect the specific types of economic activities, construction, and so on that takes place in the City.
- Recognising that a significant portion of Leicester's municipal waste is treated via anaerobic digestion rather than landfill, this does not account for the specific methods of waste management that are employed.

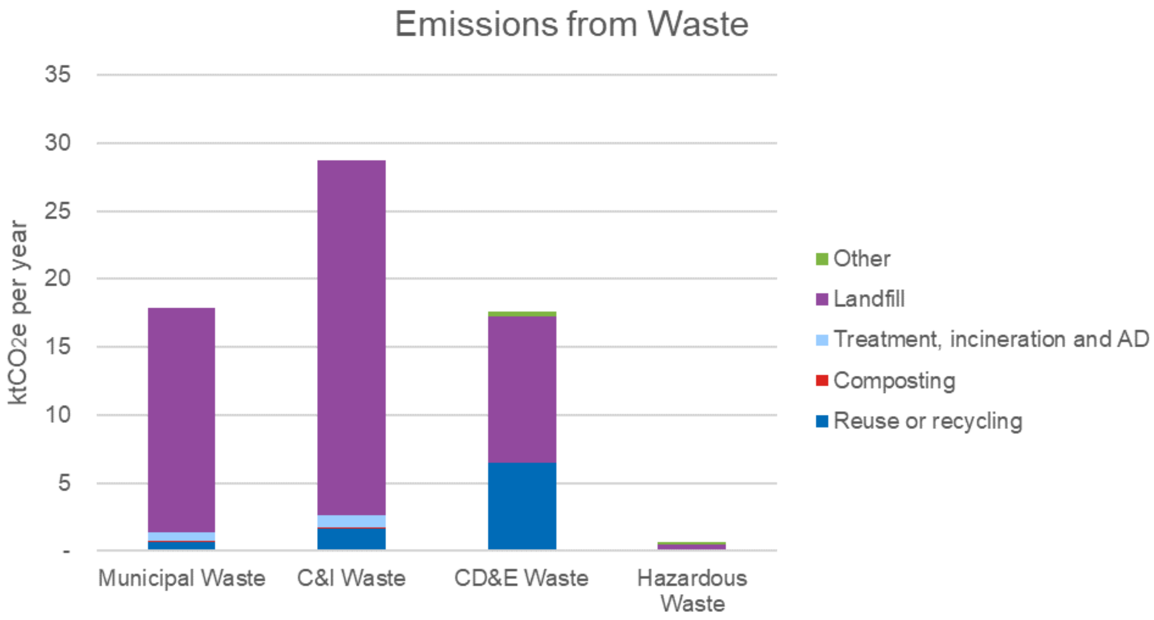
Method 2
Data on waste arisings in Leicester (excluding wastewater) were taken from the Waste Needs Assessment (2021) provided by LCC. An estimate of emissions from different sectors and waste management methods was then made by referring to the UK Government GHG Conversion Factors for Company Reporting.

On this basis, emissions from waste are estimated to be c. 65 $ktCO_2e$ per year. This is broken down by source of waste in Figure 38 below.

The conversion factors do not distinguish between commercial and industrial (C&I), construction, demolition and excavation (CD&E) or hazardous waste so assumptions had to be made in order to allocate conversion factors to each category reported in the Waste Needs Assessment. The figures also do not include wastewater so are not directly comparable with those presented for Method 1. Nonetheless, this can provide a rough breakdown of the relative contributions of different waste streams.

Figure 38. Estimated waste arisings and emissions from waste generated in Leicester in 2019





The main notable finding is that emissions per tonne of waste sent to landfill are very high in comparison with other waste treatment methods, so this accounts for the majority of emissions even though much of the biodegradable municipal waste is processed via AD. To sense-check the calculations, they were repeated, this time assuming that the municipal waste treated via AD was instead sent to landfill, and this resulted in emissions of c. 103 $ktCO_2e$.

Although these are very rough calculations, they confirm that a key option for reducing emissions from waste produced in Leicester – aside from demand reduction, which should be prioritised as a key first step – would be to ensure that it is treated and managed via AD or another form of energy recovery.

3 Potential routes to 2030… and beyond

This section of the report describes potential future GHG emissions trajectories for Leicester, based on a range of scenarios that consider various possible mitigation measures, levels of ambition, and implementation rates. These findings indicate the scale and direction of possible changes over time, which helps to identify and prioritise key actions for inclusion in the Roadmap.

Key messages

- **The major finding that emerges from this analysis is that, in order to stand the best chance of meeting the 2030 net zero ambition, there is very little scope to pick and choose mitigation measures and no scope to accommodate increases in emissions.** In blunt terms, all activity that is counter to net zero – such as installing new gas boilers, buying new petrol or diesel cars, and so on – will need to stop immediately, and even then, it will be necessary to retire some systems and vehicles earlier than planned. LCC will therefore need to exercise all available policy levers and other areas of influence.
- A **'Business as Usual' (BAU) scenario has been modelled** to show the potential scale of changes that could occur in the future. This takes the BEIS Energy and Emissions Projections as a starting point and tailors them to reflect local circumstances where needed. The BEIS projections account for future economic, population and technological trends, along with adopted Government policy, excluding ambitions which have not been enshrined in policy or law. Relative to the 2019 baseline, **the BAU scenario would result in a roughly 19% decrease in emissions by 2030 and 38% decrease by 2050**. This leaves a significant gap to achieving net zero emissions that would need to be addressed through other means. *[Note: This analysis was produced prior to the publication of the Net Zero Strategy on 19th October 2021. See Appendix A: for a discussion of the potential implications.]*
- **Four additional pathways have been modelled** using Ricardo's Net Zero Projections (NZP) tool. These scenarios **explore the impact of a range of behavioural and technological measures aimed at mitigating energy use and GHG emissions**. They represent different levels of ambition, and also contribute towards an understanding of key risks, sensitivities, and opportunities for Leicester. Some notable findings include:
    - **Electrification of heat and transport has the potential to deliver the largest reduction in GHG emissions.** However, this means that progress towards the 2030 ambition will rely heavily on the pace of national grid decarbonisation, given that there is limited scope for local renewables compared with the scale of energy demands. This is the major risk of adopting a strategy that includes high levels of electrification (i.e. switching from fossil fuels to electricity).
    - **Demand reduction on its own does not deliver such large emissions reductions in comparison – but it is a crucial prerequisite for fuel switching**, to reduce the strain on grid infrastructure, and mitigate the demand for materials needed to provide renewable electricity technologies. It also helps to mitigate against the risk of slower grid decarbonisation, rising energy prices/bills, and so on.
    - **All scenarios include some level of residual GHG emissions that are hard to address** based on current technologies and policy levers. They primarily include:
        - Energy use in homes and non-domestic buildings that falls outside the scope of Building Regulations (such as electrical appliances or other devices that

building users install but which are not crucial to the operation of the building's heating, hot water, lighting and ventilation systems);

- Energy uses associated with specific commercial and industrial sectors; and
- Non-CO_2 emissions, including methane and nitrous oxide (primarily associated with waste treatment and agriculture) and f-gases (primarily associated with refrigeration and cooling, and also present in heat pumps which are assumed to become more common in future).

➢ **Carbon offsetting and sequestration alone cannot deliver the scale of emissions reductions that is required.** In the timescales from now to 2030 or even 2040, carbon capture and storage (CCS) is not likely to be available at scale, and there is limited scope for tree planting. This is a further argument in favour of demand reduction.

3.1.1 Drivers of change

Achieving the GHG emissions reductions required to reach carbon neutrality in less than a decade, while also responding to the needs of a growing population, and maintaining economic development, poses a significant challenge to the City of Leicester. Economic growth, population increase, higher incomes, new buildings, electric vehicles, and greater use of electronic appliances all tend to increase energy demands. Although improvements in technology, energy efficiency measures, and better awareness of environmental issues can help to reduce energy demand in some sectors, these are at risk of being cancelled out without further policy interventions. Of course, there are many unknowns – factors such as energy prices and weather changes, for example, that are hard to predict and can influence energy demand in either direction.

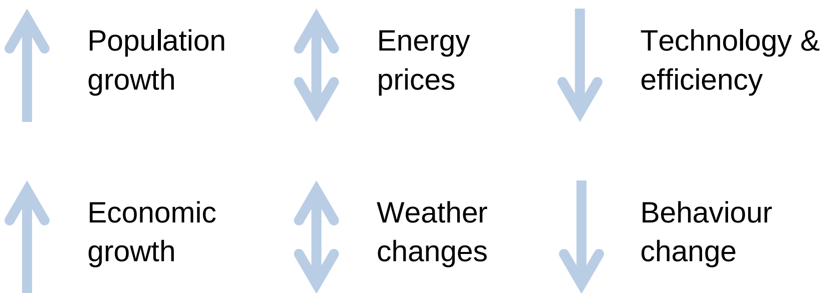


Figure 39. Drivers of changes in energy use and emissions

3.2 Overview of the methodology

3.2.1 Modelling approach

Future GHG pathways were modelled using the Ricardo Net Zero Projections (NZP) tool, which enables users to model the impact of implementing mitigation measures on a Local Authority's GHG emissions over time. It is a flexible tool that can be quickly configured to model the change in energy use and GHG emissions (including non-energy related emissions) by specifying the breakdown structure of the energy and non-energy related emissions that aligns with the area's base year datasets and reporting requirements, and factoring in changes in demand (e.g., due to growth) and emission factors over time.

The tool is designed to enable the development of scenarios for reaching net zero by any given target year and allows the users to define mitigation measures for each line in the energy and emissions inventory. These scenarios can be used to build a baseline projection, assess the likely impact of planned measures and model the impact of alternative strategies to reaching net zero. The scenarios can also be used to undertake sensitivity testing around the impact of changes in assumptions.

The tool is essentially a 'What if?' calculator tool that relies on external validation of inputs, assumptions and outputs to ensure its projections are sensible. At its core the tool is an accounting system that calculates the change in energy use and fuel mix as a result of series of mitigation measures.

It is important to understand that this modelling is based on assumptions about the magnitude of energy or emissions reduction that is technically achievable within each sector. However, it makes no assumptions about the types of policies that would be needed to achieve this. To give an example, the NZP tool can estimate the change in emissions that would result from a 10% reduction in miles travelled by private car, but it cannot assess the impact of specific policy measures, such as 'Introduce a workplace parking levy to discourage people from commuting in private cars' unless the user inputs an assumption about the quantitative impact this would have. That type of information must be established via separate modelling, research, case study evidence or expert judgment.

3.2.2 What pathways were explored and how were they developed?

This work has explored five future pathways for GHG emissions in Leicester: A 'Business as Usual' (BAU) scenario, and four additional net zero pathways.

The BAU scenario is intended to show the changes that could occur if no additional local action was taken to mitigate GHG emissions in Leicester, beyond those that are already planned and committed.

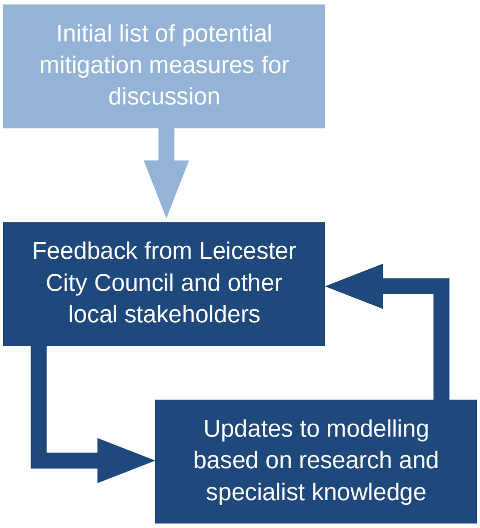
This primarily includes national-level economic and demographic trends, along with projected energy prices and likely technological improvements (e.g. better vehicle efficiency). Those assumptions are based on the BEIS Energy and Emissions Projections (EEP), which also considers the anticipated GHG reductions that are expected to occur due to adopted Government policies *'where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made'*.[37] Taking Leicester's baseline emissions as a starting point, growth curves based on the EEP data were then applied to each sub-sector and fuel type in Leicester. This means that the overall change in emissions reflects the baseline situation in the City.

A sense-checking exercise was carried out to assess whether it was appropriate to apply these national trends at a local level – for example, by cross-checking national population growth projections with those for Leicester (see Figure 40). Adjustments were then made to reflect local factors, most notably in the domestic sector, where growth rates are assumed to be lower, on the basis that up to half of Leicester's future housing need is likely to be met outside of the City boundary.

In addition to the BAU scenario, this work has explored four net zero pathways, which explore the impact of a range of behavioural and technological measures aimed at mitigating energy use and GHG emissions.

[37] For further information, see Energy and emissions projections - GOV.UK (www.gov.uk)

The net zero scenarios were developed through an iterative approach. After reviewing the baseline information for Leicester, the Ricardo team developed an initial set of mitigation measures based on technical research and expert knowledge of climate change actions that could be taken across different sectors. These were submitted to LCC and other stakeholders for feedback.



The modelling assumptions were then revised as necessary, to ensure that stakeholders' views on which measures were more or less likely to be achievable were accounted for wherever possible.

Scenarios 1-3 reflect increasing levels of ambition. The general approach to determining mitigation measures was as follows:

- **Scenario 1** generally assumes that mitigation measures will be implemented in line with the Climate Change Committee's (CCC) analysis of what can be achieved by 2030 on a national level.
- **Scenario 2** takes the CCC's assumptions for what can be achieved by 2050 and then shows what would happen if the same level of progress was to be achieved by 2030 instead. We have adjusted these where necessary to account for certain technologies not being widely available by 2030.
- **Scenario 3** is largely illustrative. It shows the scale of GHG emissions reduction that would be achieved through maximum levels of demand reduction and near-complete eradication of fossil fuels. It is important to note that this scenario makes some assumptions that are theoretically, but not practically, achievable. In particular, it assumes that nearly all industrial and commercial processes can switch to electricity, while this may not be the case.

Scenarios 1-3:
2030 target date
Scaling up the level of ambition and thereby reducing the need for offsetting

Scenario 4 is distinct from the others because it looks towards 2040 rather than 2030. The reason for including a scenario with a later target date is not to lower the level of ambition, but to consider the impacts of changes that are more likely to occur on a longer time horizon. Most of the assumptions are similar to those used for Scenario 2 (i.e. highly ambitious but technically feasible by 2050 according to the CCC). Key differences are:

Scenario 4:
2040 target date
Exploring the impact of further technological developments

(1) The national electricity grid is expected to decarbonise further, meaning that the GHG benefits of fuel switching will be amplified.
(2) Some technology assumptions are different, e.g. inclusion of hydrogen for vehicles and some buildings, and slightly better PV efficiency.

(3) From a practical standpoint, there will be more time to implement local mitigation measures (such as retrofitting), and there may be positive shifts in consumer behaviour that reduce the reliance on Government action (as in the case of EV uptake).

Appendix B contains a list of the mitigation measures and variables used in each scenario, along with references and commentary.

3.3 The Business-as-Usual scenario

3.3.1 Assumptions about future changes

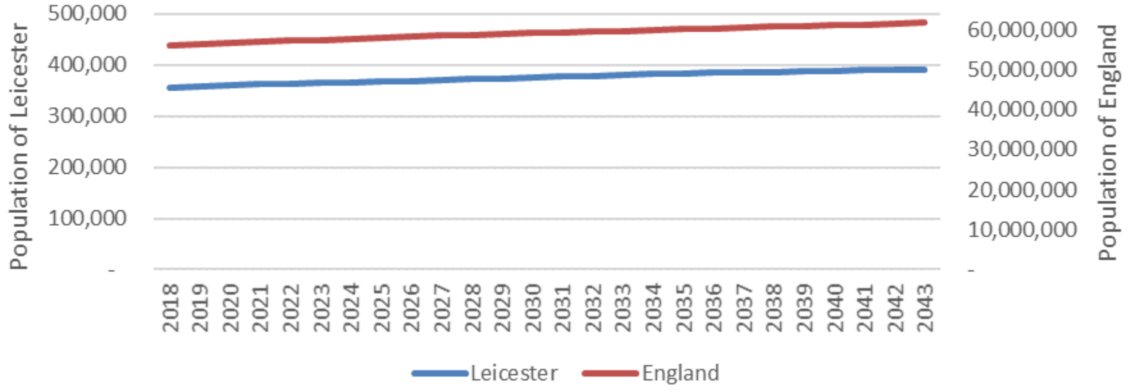
The EEP data incorporates a range of information, including projections for:

- Annual growth rates for population and number of households
- Annual growth rates for economic parameters:
  - Real UK GDP
  - GDP Deflator
  - Real household disposable income
  - Industrial production
- Weather changes (winter degree days)
- Retail and wholesale energy prices, carbon prices, and exchange rates

For more information, refer to the BEIS EEP Methodology Report.

The Office of National Statistics (ONS) projections indicate that the population of Leicester, which was 355,218 in 2018, could reach around 376,000 by 2030 (a 5.86% increase) and 389,000 by 2040 (a 9.4% increase). This closely aligns with the ONS forecasts for England as a whole (which would see population increases of 5.72% and 9.26% by 2030 and 2040, respectively), as shown in the chart below.

Figure 40. Population growth projections for Leicester and England, 2018-2043. Source: ONS



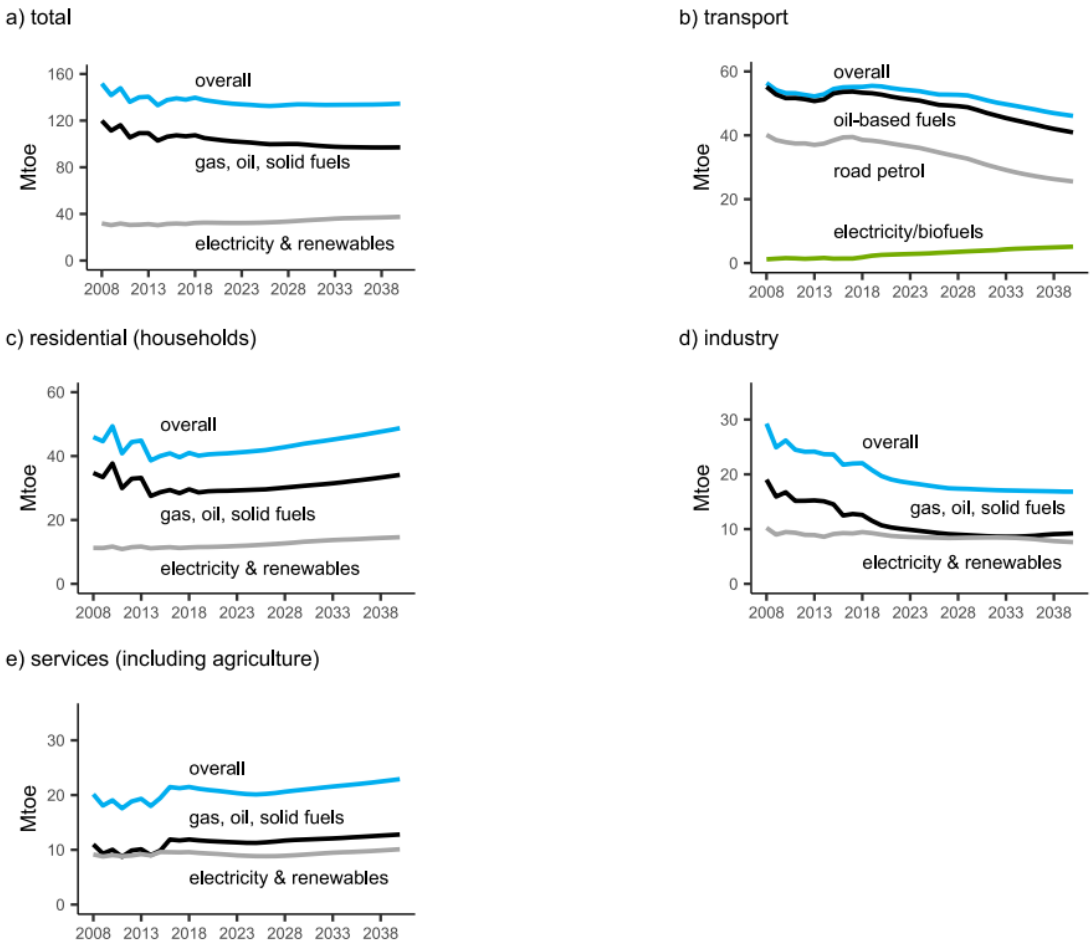
Note, the EEP data was developed prior to the publication of the Government's Net Zero Strategy on 19th October 2021 and, as such, does not account for any of the policy proposals set out in that report. It also does not account for various policy proposals that were announced previously, of which notable examples include:

- The proposed 2030 ban on the sale of new petrol and diesel vans and cars; and
- Future changes to UK Building Regulations for new developments

In practical terms, what this means for the Roadmap is that some of the mitigation measures modelled in Section 3.4 may in fact form part of the BAU scenario, i.e. they would not need to be delivered via additional policy measures and actions taken at a local or regional scale.

The charts below, which are extracted from the EEP Methodology Report, shows the future changes in fuel consumption that form the basis of the emissions projections. Broadly speaking, emissions from transport (primarily road transport) are expected to decline, emissions from the residential sector would tend to increase, and emissions from other non-residential sectors (including commercial, industrial and public sector buildings and facilities) exhibit an initial decline before tending to level out in the 2030s. Total fuel consumption would be slightly lower than it is at present, but this would lead to a proportionally larger change in GHG emissions which is primarily due to the effects of electricity grid decarbonisation.

Figure 41. Final energy demand by fuel and consumer sector. Source: BEIS



In the transport sector, there is a general shift towards the use of electric vehicles, and because these are more efficient than combustion engines, this leads to an even larger proportional reduction in the use of petroleum products. Demand for petroleum products will also tend to decrease, which is attributed to the introduction of more stringent emissions standards for cars, vans and HGVs.

Nationally, according to the EEP, the domestic sector would see a larger increase in both fuel use and emissions, driven by changes in population, income levels, weather and fuel prices. Note that our BAU pathway has reduced this growth rate by roughly 50% to account for the introduction of the

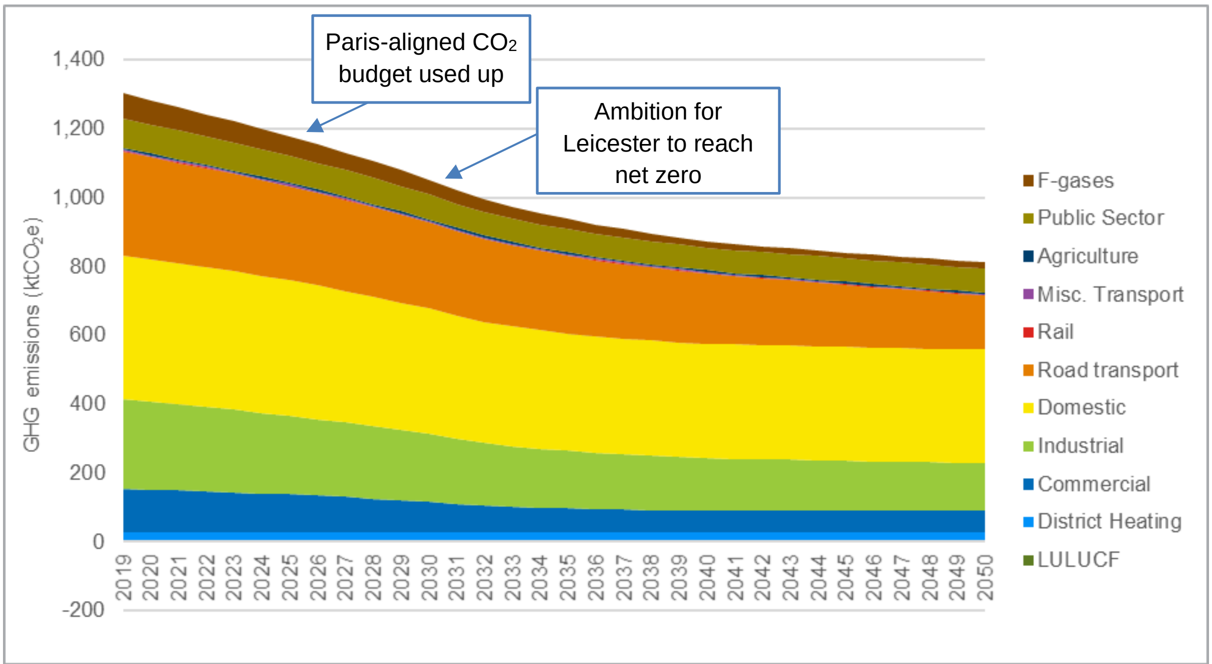
Future Homes Standards, as well as the fact that a significant proportion of new homes would be delivered outside of the area boundary.

In the industrial sector, demand for electricity and renewables would rise slightly, while demand for gas, oil and solid fuels would remain roughly the same. In other non-industrial sectors (referred to as ‘Services’ in the chart above), demand for all fuels would increase slightly. For these sectors, economic growth, weather, energy prices and changes in industrial production are key drivers.[38]

3.3.2 Impact on GHG emissions

In the BAU scenario, GHG emissions in Leicester would fall by roughly 19% by 2030, 33% by 2040 and 38% by 2050.

Figure 42. Changes in GHG emissions by sector in the BAU scenario



Although some of this change is attributed to falling energy consumption, the other major factor is decarbonisation of the electricity grid, which is assumed to fall from 0.2556 $kgCO_2e/kWh$ in 2019 to approximately 0.11 $kgCO_2e/kWh$ in 2030 and 0.02 to 0.03 $kgCO_2e/kWh$ in 2050. This can clearly be seen when comparing Figure 43 and Figure 44, which look at energy use and GHG emissions by fuel type. The change in emissions from grid electricity is disproportionately large compared with the change in electricity consumption.

[38] For more information, see Energy and emissions projections: methodology overview (publishing.service.gov.uk)

Figure 43. Energy use by fuel type in the BAU scenario

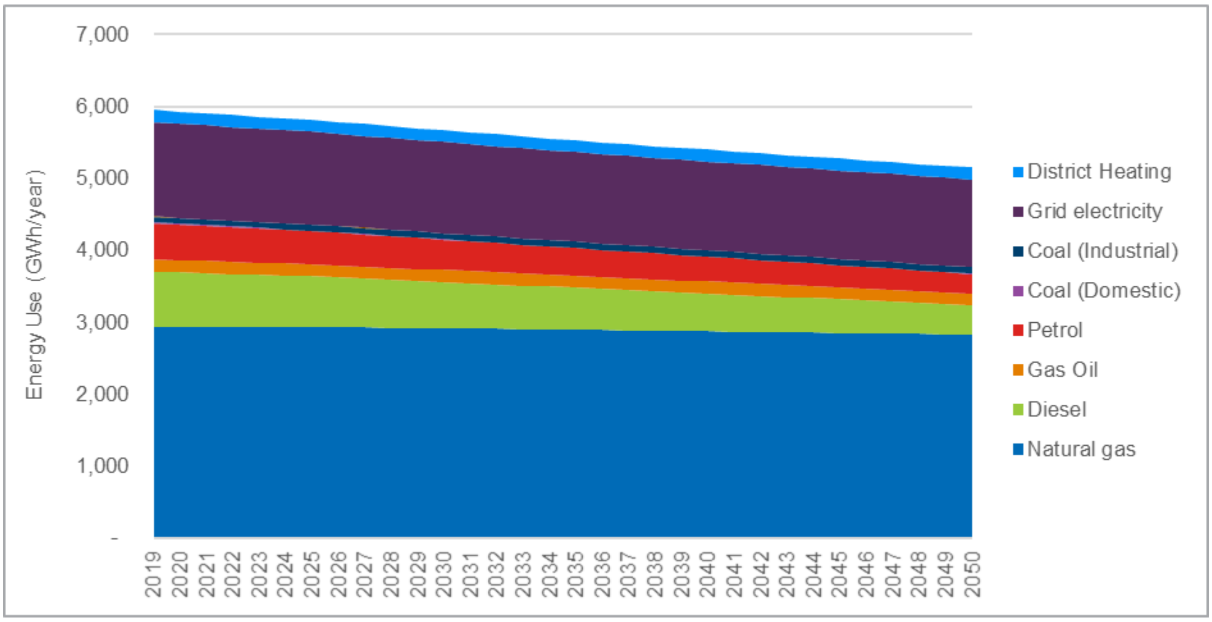
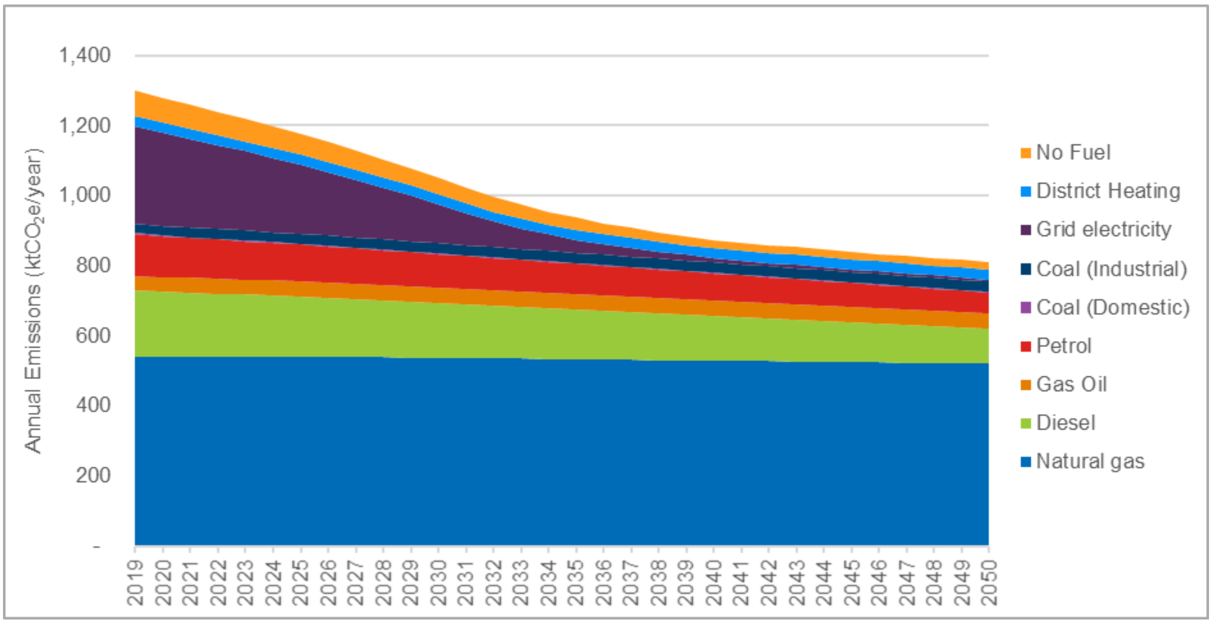


Figure 44. Emissions by fuel type in the BAU scenario



The cumulative emissions over this time period would be approximately 14,100 ktCO_2e, so the Paris-aligned carbon budget for the time period through the year 2100 would be used by 2025.

Although it is not within the timescale for Leicester's net zero ambition, it is also worth noting that the anticipated GHG reductions are generally steeper in the 2020s to early 2030s and then tend to taper off from the mid-2030s onwards. Again, this is due to the rate of grid decarbonisation over time; once grid electricity is largely decarbonised, most of the remaining improvements are due to relatively slow changes in fuel consumption. This emphasises that any mitigation measures introduced in Leicester will need to be sustained in the long term and there will be a need for continuing local action post-2030.

With this as a starting point, in broad terms, reaching net zero in Leicester prior to the national 2050 target date will require:

- Reducing demand for energy and other resources as much as possible via energy efficiency, behavioural change and technological means
- Switching all (or nearly all) fuel consumption to electricity instead of fossil fuels, including energy use in buildings and transport
- Radically decarbonising the electricity supply by increasing deployment of renewable power, phasing out fossil fuels, and delivering associated infrastructure upgrades
- For sectors or activities that cannot use electricity, mitigating emissions by using other renewable or low-carbon energy sources and making use of carbon capture and storage
- Changing agricultural practices and land uses to increase carbon sequestration and reduce emissions of other GHGs
- Offsetting residual emissions by delivering further GHG reductions outside the boundary of Leicester – *as a last resort*

Opportunities to achieve these changes are discussed as part of the net zero pathways analysis in Section 3.4.

3.3.3 Uncertainties, risks and opportunities

This section describes some of the uncertainties, risks and opportunities highlighted by the BAU analysis. This is not a comprehensive list but highlights some of the main points.

Uncertainties in the BAU scenario	
What are they?	**What are the implications?**
There are inherently high levels of uncertainty in any form of GHG or energy scenario modelling. Unforeseen events can have a major impact. The COVID pandemic is a good example, but others could include economic changes, major political events, extreme weather, etc.	It is important to acknowledge that the pathways are not forecasts. They are instead intended to highlight the scale and direction of changes that may occur, to help inform the development of local mitigation measures.
The Government has recently announced a range of policies and other ambitions as part of a nationwide net zero strategy that are not currently accounted for.	Many of the measures announced by the Government are modelled as additional mitigation measures in the subsequent sections of this report, so their effects are at least partially quantified. However, responsibility for achieving or implementing those measures may shift away from local stakeholders, to the central Government.
Changes in fuel consumption in the commercial and industrial sectors will be more dependent on	The lack of information makes it harder to comment on the likelihood that local trends

the specific types of industries and activities taking place in Leicester. As discussed in the Baseline chapter, there is less information available on this topic than, for example, on domestic and road transport energy use.	would align with the national trends in this regard. Findings relevant to the industrial and commercial sectors should therefore be treated with some additional caution.
The rate of national electricity grid decarbonisation in the model is based on Government figures but the speed of decarbonisation has been generally viewed as optimistic. On the other hand, this may now change in light of recent announcements on achieving a net zero electricity grid by 2035.	At the time of writing (October 2021) it is too early to comment on the potential rate of future grid decarbonisation. As will be discussed throughout this report, this is a key issue because it is one of the major sensitivities in the model.

Risks to achieving net zero	
What are they?	**What are the implications?**
The BAU scenario shows a very large gap to reaching net zero, which means there will be huge pressure to deliver additional mitigation measures locally or regionally.	LCC will need to collaborate with a range of stakeholders and utilise all available policy levers / areas of influence. This includes lobbying the Government for additional support.
If national grid decarbonisation is slower than assumed, the reduction in GHG emissions would be even lower than shown.	This is a particular challenge because there are very few ways that LCC or local stakeholders can have an influence. LCC should aim to maximise local renewable generation, which will help to provide zero carbon electricity locally, and facilitate this broader shift by supporting larger-scale renewables where possible.
Weather extremes, which are expected to be more likely due to climate change, could result in both short- and long-term changes in energy use. Heatwaves are an example as they could prompt more people to install artificial cooling systems.	LCC should consider developing strategies for adapting to climate change as well as mitigating climate change. In broad terms, for an urban setting such as Leicester, design and masterplanning of the built environment and green infrastructure will be key. However, detailed information on climate adaptation is outside the scope of this report.

Opportunities	
What are they?	**What are the implications?**
Changes in emissions in the domestic sector will depend in large part on consumer behaviour, income levels, and so on; however, the increase will also depend on the level of new housing that is delivered within the City and the energy and CO_2 performance standards that those buildings are required to meet.	LCC can influence the design of new developments and major refurbishment projects in its role as a Local Planning Authority. The updated Local Plan should include measures that would limit emissions from new developments while promoting uptake of local renewable energy technologies.
It is understood that LCC, the NHS, and other local public sector bodies have introduced, or are considering, plans to decarbonise their own assets and operations prior to the national 2050 deadline.	Although the public sector does not contribute very much to total GHG emissions, if there are any specific commitments then these could be incorporated into the BAU scenario. In practical terms this would mean that the Roadmap could

	focus more on defining interventions in other sectors.
It is likely that the BAU scenario shown above underestimates the potential changes in emissions from road transportation, in the event that EV uptake happens more rapidly. This would be the case if the proposed 2030 ban on new petrol and diesel cars and vans comes into place. Moreover, it is anticipated that the price of electric vehicles will reach parity with combustion engine vehicles in the next few years, which could have a major impact on consumer choices even without additional policy incentives.	In this instance, LCC would not need to do as much to promote local uptake of EVs and would play more of a facilitation role by helping to provide adequate charging infrastructure. The focus would also shift towards promoting active travel modes and use of public transport.

3.4 Net Zero pathways

3.4.1 Assumptions about future changes

The net zero pathways all include the same core assumptions about population, weather, fuel prices and economic trends as are used in the BAU scenario, which is used as the starting point for the analysis. All of the other changes are modelled as mitigation measures that would need to be adopted, whether via additional Government policies, local/regional initiatives, or through voluntary changes in consumer behaviour, business and industrial practices. The table below summarises the mitigation measures that are modelled in each scenario; further details are provided in Appendix B.

Category	Mitigation measures considered
Energy use in buildings	• Reducing heat and electricity demand due to fabric energy efficiency, smart heating controls, uptake of LED lighting and upgrades to non-domestic heating, ventilation, and air conditioning (HVAC) systems. • Connecting some buildings to heat networks, and then converting these to use renewable heat (e.g., electric heat pumps). • Buildings that do not connect to heat networks are assumed to switch to electric heating, heat pumps or (in Scenario 4 only) hydrogen gas to provide space heating and hot water. • Switching any remaining fossil fuel demands to electricity (in Scenario 3) or a combination of electricity and hydrogen (in Scenario 4). *Note, this is largely illustrative and only applies to industrial energy demands.*
Road transport	• Avoiding car journeys via behavioural and technological change, e.g., working from home • Replacing a proportion of remaining car journeys with walking, cycling and public transport • Reducing demand for LGV and HGV movements through trip consolidation and changes in logistics • Improving HGV efficiency through technology improvements and driver training initiatives • Uptake of electric vehicles (cars, vans, buses and motorcycles) • Uptake of hydrogen (buses and HGVs) – *Scenario 4 only*
Other transport	• Electrification of rail network
Energy system	• Electricity grid decarbonisation taking place in line with national projections • Massive increase in deployment of roof-mounted solar technologies on suitable buildings
Miscellaneous	• Increase in carbon sequestration via tree planting within Leicester

These pathways are intended to highlight the scale and direction of changes that could occur if the above measures were implemented. They are not intended as a projection or forecast of future energy use and emissions. It is also worth noting that, in reality, implementing these types of changes would almost certainly lead to dynamic impacts across different activities and sectors, thus affecting wider trends such as fuel prices. Those interactions are highly complex and have not been quantified in this study. Nonetheless, these scenarios provide a useful way to assess and prioritise potential interventions – and understand LCC's level of influence when it comes to achieving net zero emissions.

3.4.2 Impact on GHG emissions

Scenario 1

This scenario results in residual emissions of 896 $ktCO_2e$ per year by 2030, which is a 31% decrease compared with 2019. Emissions decrease in all sectors due to the mitigation measures selected, as illustrated in Figure 45.

Figure 45. Emissions by sector in Scenario 1

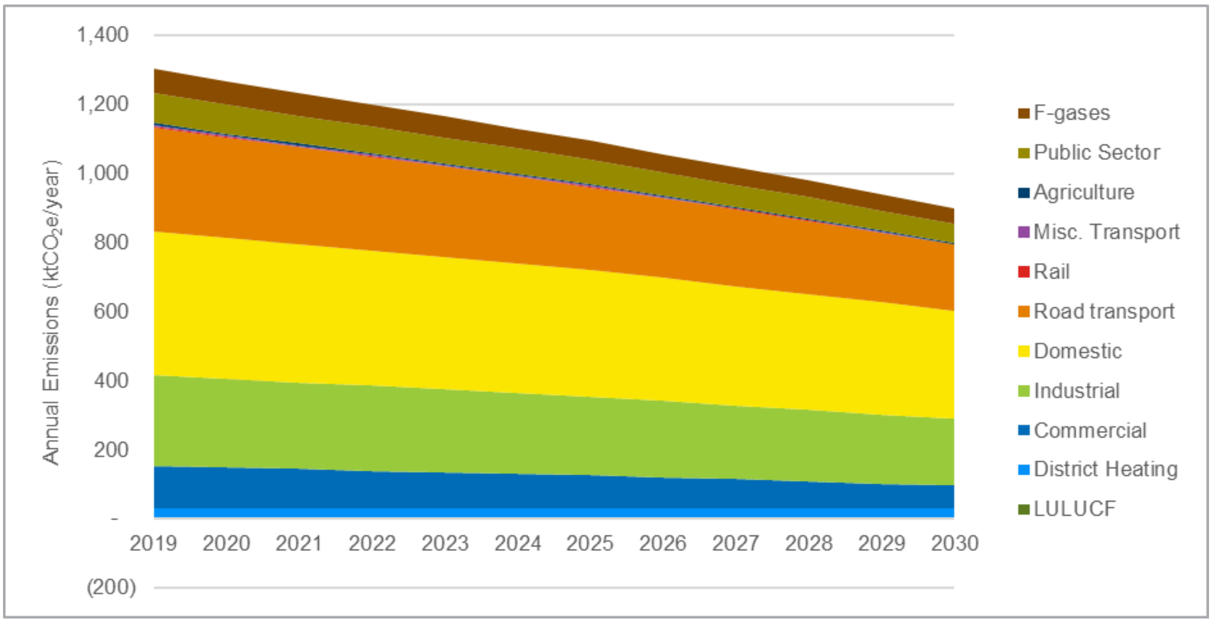


Figure 46 shows the changes in emissions by fuel type between 2019 and 2030, and Figure 47 shows the underlying changes in energy use. These graphs make it clear that electricity grid decarbonisation is a key driver of emissions reduction in this timeframe, because (as in the BAU scenario) the change in emissions from electricity is disproportionately large compared with the change in electricity consumption.

Figure 46. Emissions by fuel in Scenario 1

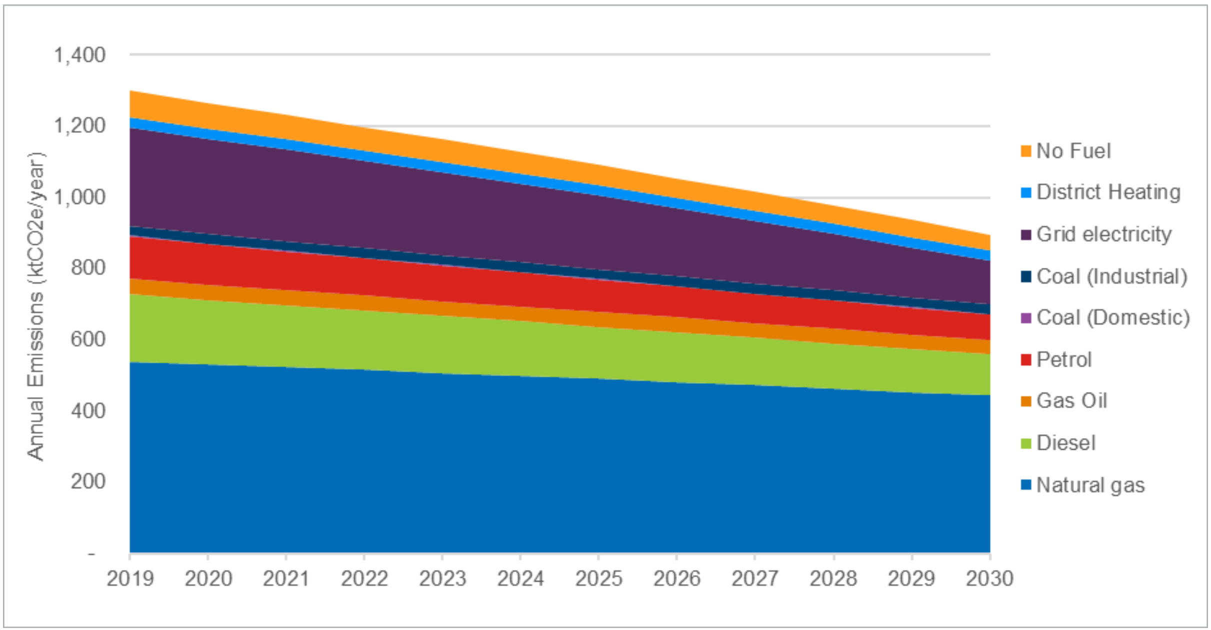


Figure 47. Energy use by fuel in Scenario 1

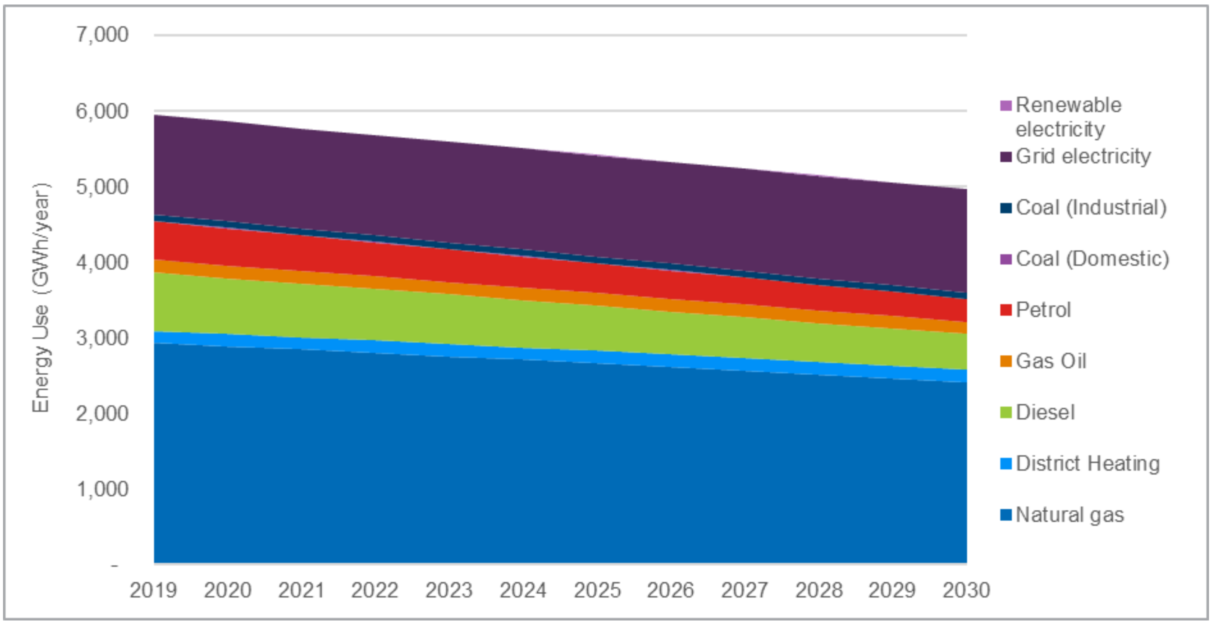
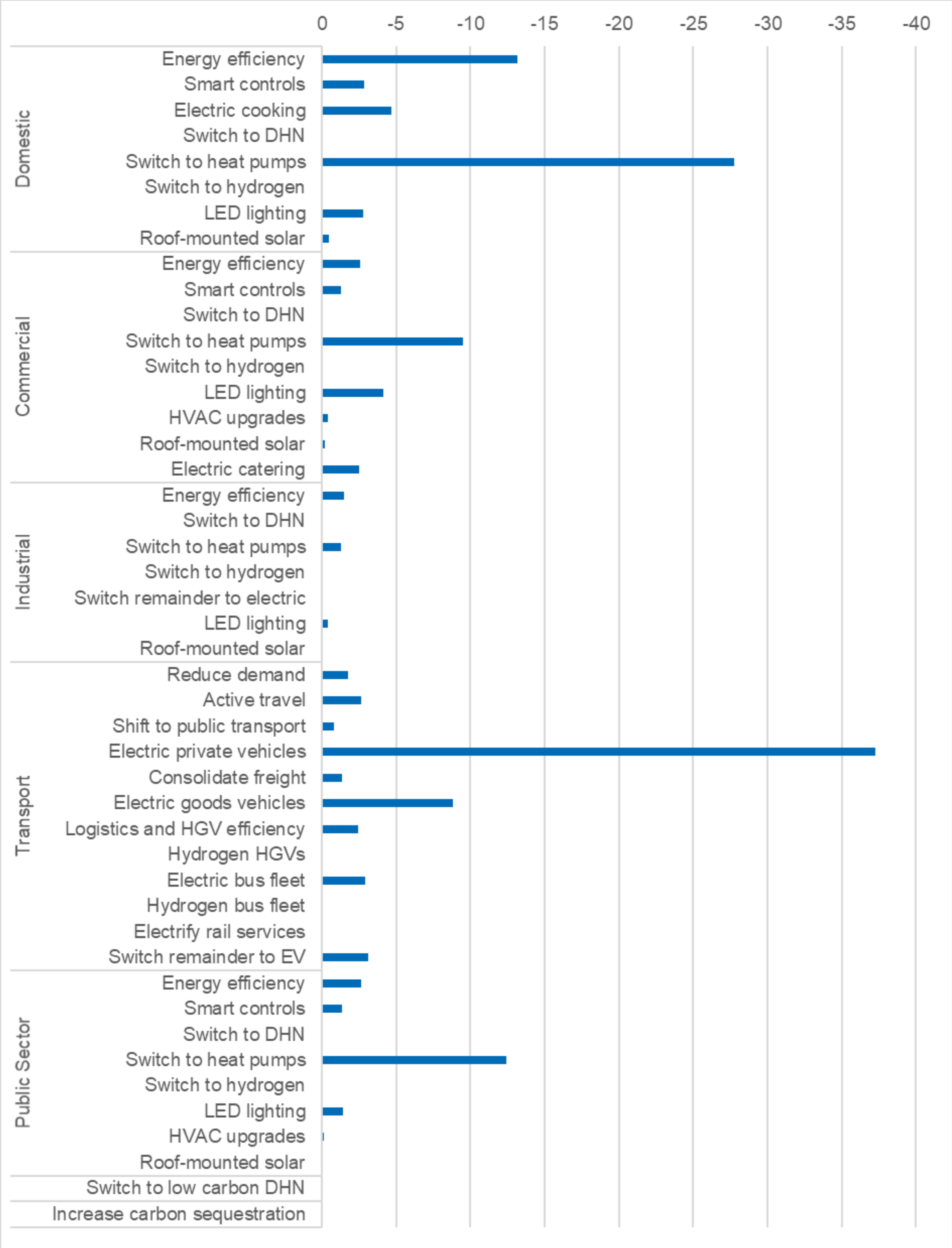


Figure 48 on the following page shows the estimated impact that each mitigation measure has on GHG emissions by 2030.

Figure 48. Impact of mitigation measures in Scenario 1 ($ktCO_2e$)



It is clear that the biggest reductions come from fuel switching. For buildings, 'fuel switching' is assumed to mean switching away from the use of natural gas for heating, towards the use of electrically powered heat pumps. These could either be individual heat pumps, or form part of a communal or district heat network. In the transport sector, it means switching from petrol, diesel and other fossil fuels, towards the use of electric vehicles wherever possible. This is why achieving net zero will rely heavily on grid decarbonisation: it amplifies the benefits of switching to electricity.

However, as mentioned previously, there are numerous challenges associated with such high levels of electricity demand. Energy demand reduction is therefore a crucial prerequisite for transitioning to a low carbon energy system – even though, in the net zero pathways presented here, demand reduction measures have a lower impact on GHG emissions than fuel switching.

The level of demand reduction modelled in buildings in this scenario, while low compared with the other net zero pathways, is considered achievable based on common and cost-effective retrofitting measures in buildings. At present Government or Local Authority funding for this is extremely limited, and Local Authorities have relatively few areas of policy influence, so achieving this would rely on owner-occupiers and landlords.

LCC would also need to ensure that the Local Transport Plan includes strong measures that can achieve this level of demand reduction, active travel, and use of public transport.

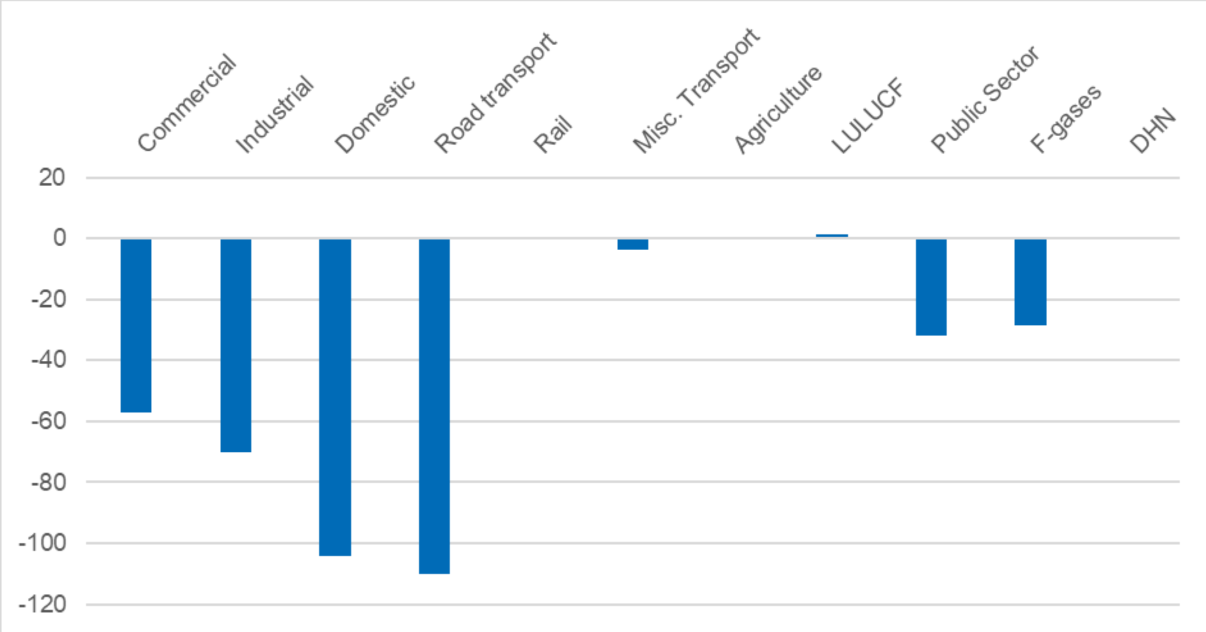
Some further points of clarification on Figure 48 are outlined below:

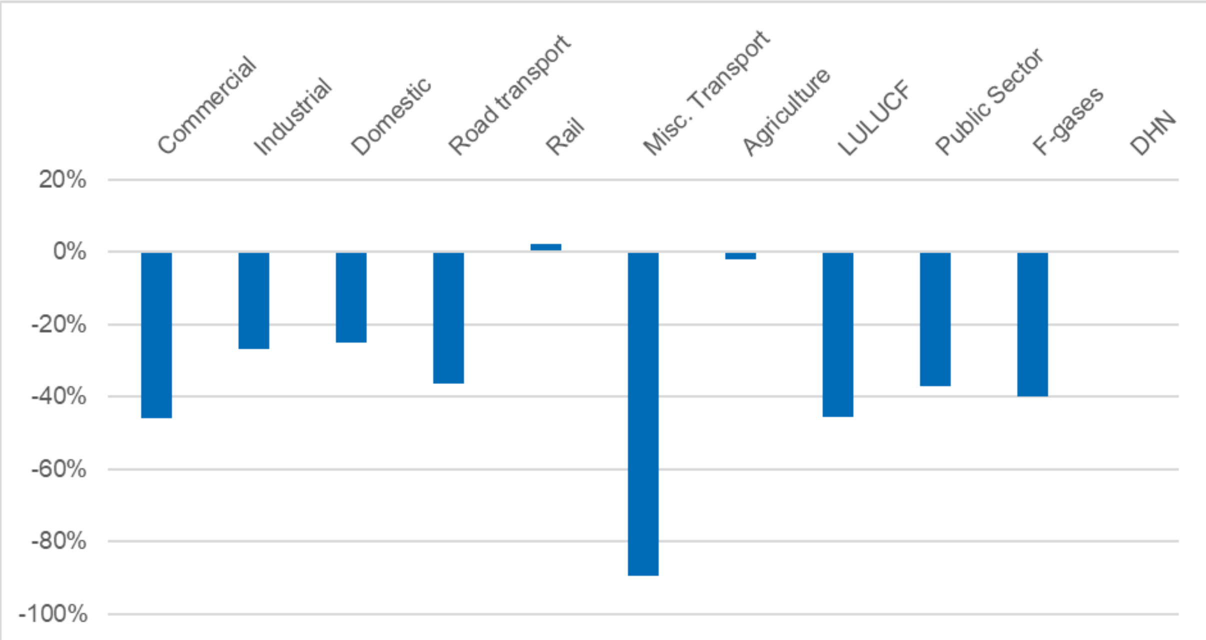
- Some measures show no GHG impacts because they are excluded from Scenario 1. This includes, for example, the use of hydrogen boilers or HGVs.
    - The exception is roof-mounted PV on public sector buildings, which at present is combined with commercial sector buildings.
- Although the same types of measures have been modelled for the industrial sector as for the commercial and public sectors, these have proportionally less of an impact. This is because a higher percent of fuel consumption is associated with industrial processes and, as mentioned in Section 2, there is comparatively limited data on precisely how the fuel is used. The most significant carbon reductions in the industrial sector in Scenario 1 are from roof-mounted PV. This assumes that there are larger roof areas, with shallower pitches that are less likely to create overshading, and that aesthetic or planning considerations will not present a barrier. It is worth noting that although the geometry of industrial roofs may be suitable, in many cases they would need reinforcement to accommodate this much PV, which presents a significant financial and practical challenge.

Below, Figure 49 shows the absolute and relative change in emissions by sector, by 2030. The highest reductions are from the domestic sector and road transport because these account for higher proportions of the current baseline emissions. The next largest reductions are in the industrial sector although as explained above, this is due to the assumptions around roof-mounted PV. Miscellaneous transport is assumed to switch to electricity by 2030, so this shows a large relative change in emissions despite having a small impact overall. Based on conversations with Engie, it is understood to be unlikely that the district energy network will switch to an alternative fuel source between now and 2030, so no change has been modelled for district heating. For the same reason, we have not assumed that the network will expand, since there would be other, lower carbon heating options available.

No additional mitigation measures have been modelled for agriculture or f-gases, so the changes shown are based on the BAU scenario and are in line with the BEIS EEP assumptions.

Figure 49. Change in emissions by sector in Scenario 1. ***(Top: Absolute change, $ktCO_2e$. Bottom: Relative change, %)***





Despite these improvements, it is clear that Scenario 1 does not come close to achieving Leicester's net zero ambition. The cumulative emissions in this time period would be roughly 13,250 $ktCO_2e$, meaning that the Paris-aligned carbon budget (recommended by the Tyndall Centre) would be used up by approximately 2025.

For context:

To offset the remaining annual emissions in 2030 (896 $ktCO_2e$) via tree planting would require roughly 25 km^2 of land area to be turned into new woodland, which is equivalent to roughly 34% of Leicester's land area. If that woodland was correctly maintained over the course of decades and centuries, this would be enough to offset those emissions – but to be clear, just that one year's worth of emissions.

Looking at the challenge another way, if all of the electricity demand in 2030 in Scenario 1 was to be met with 100% renewable electricity, this would require *approximately*:

- 1600 MW of PV (occupying c. 20 square kilometres, around 27% the area of Leicester); or
- 650 MW of onshore wind power (c. 325 large-scale turbines).

None of these offsetting options is feasible. Therefore, in order to credibly reach net zero, it is clear that Leicester would need to implement mitigation measures that are significantly more ambitious than those set out in the CCC pathways to 2030.

Scenario 2

This scenario results in residual emissions of 591 $ktCO_2e$ per year by 2030, which is a 55% decrease compared with 2019. Figure 50 shows the changes in emissions by sector. Along with the subsequent charts, it shows that the trends seen in Scenario 2 are broadly similar to those seen in Scenario 1. This is to be expected given that the same types of mitigation measures are included. The main difference is that the scale of emissions reduction is higher, due to higher rates of implementation. This is especially apparent for the domestic sector, which shows a notable difference to Scenario 1 primarily due to the higher uptake of heat pumps to replace gas boilers.

Figure 50. Emissions by sector in Scenario 2

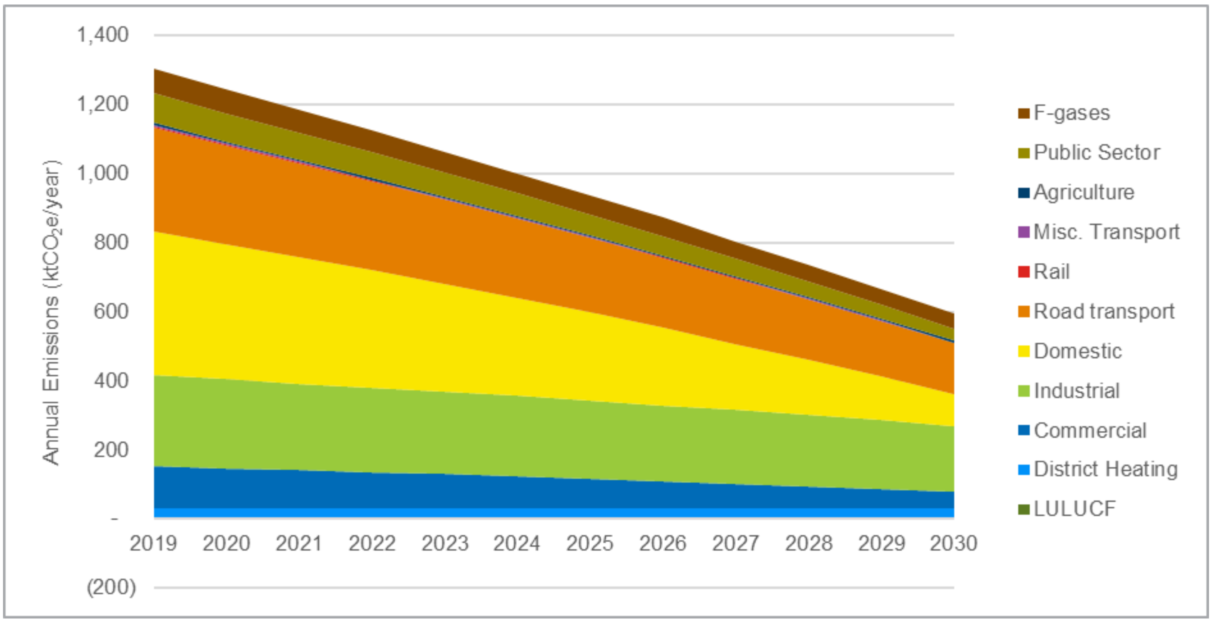


Figure 51. Emissions by fuel in Scenario 2

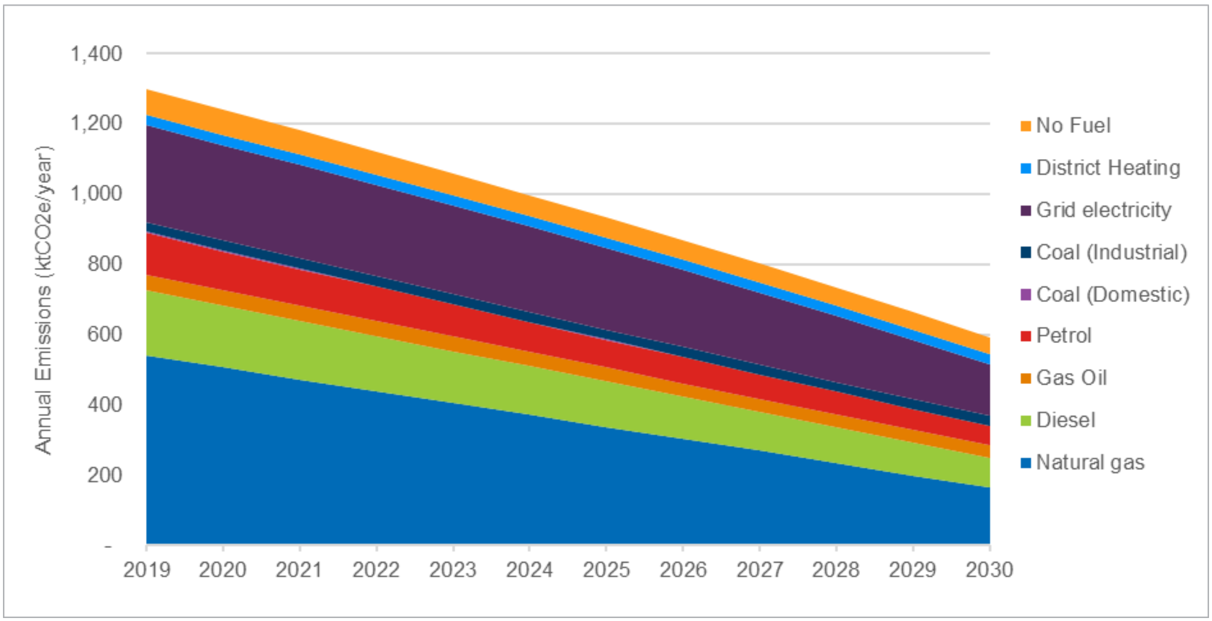
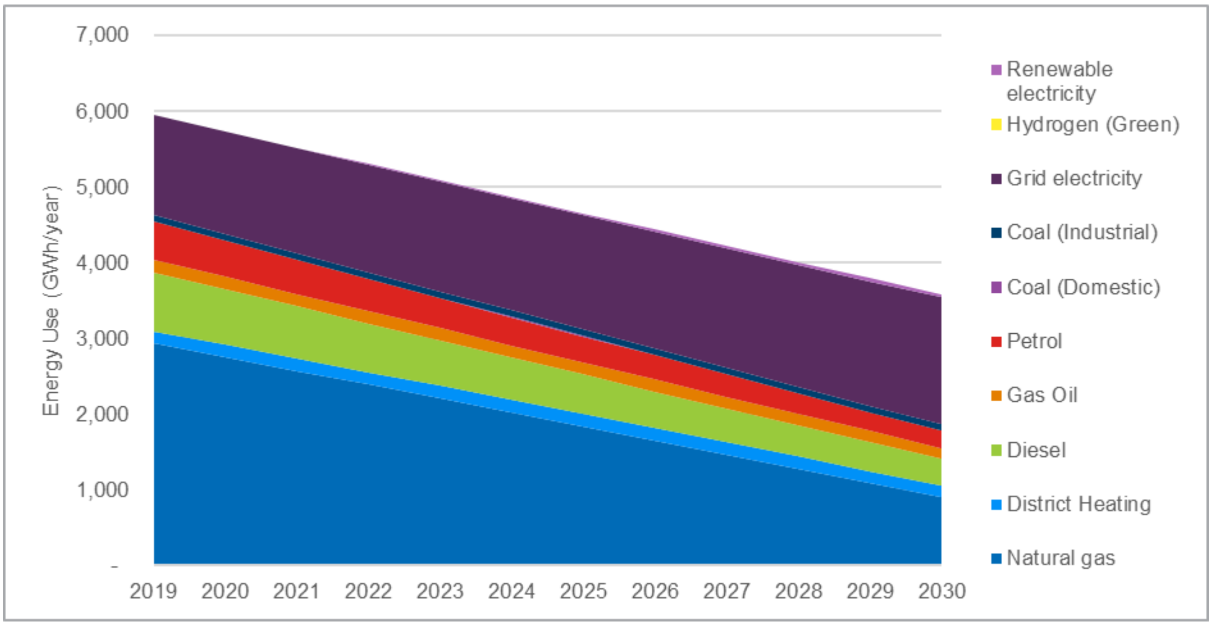


Figure 52. Energy use by fuel in Scenario 2

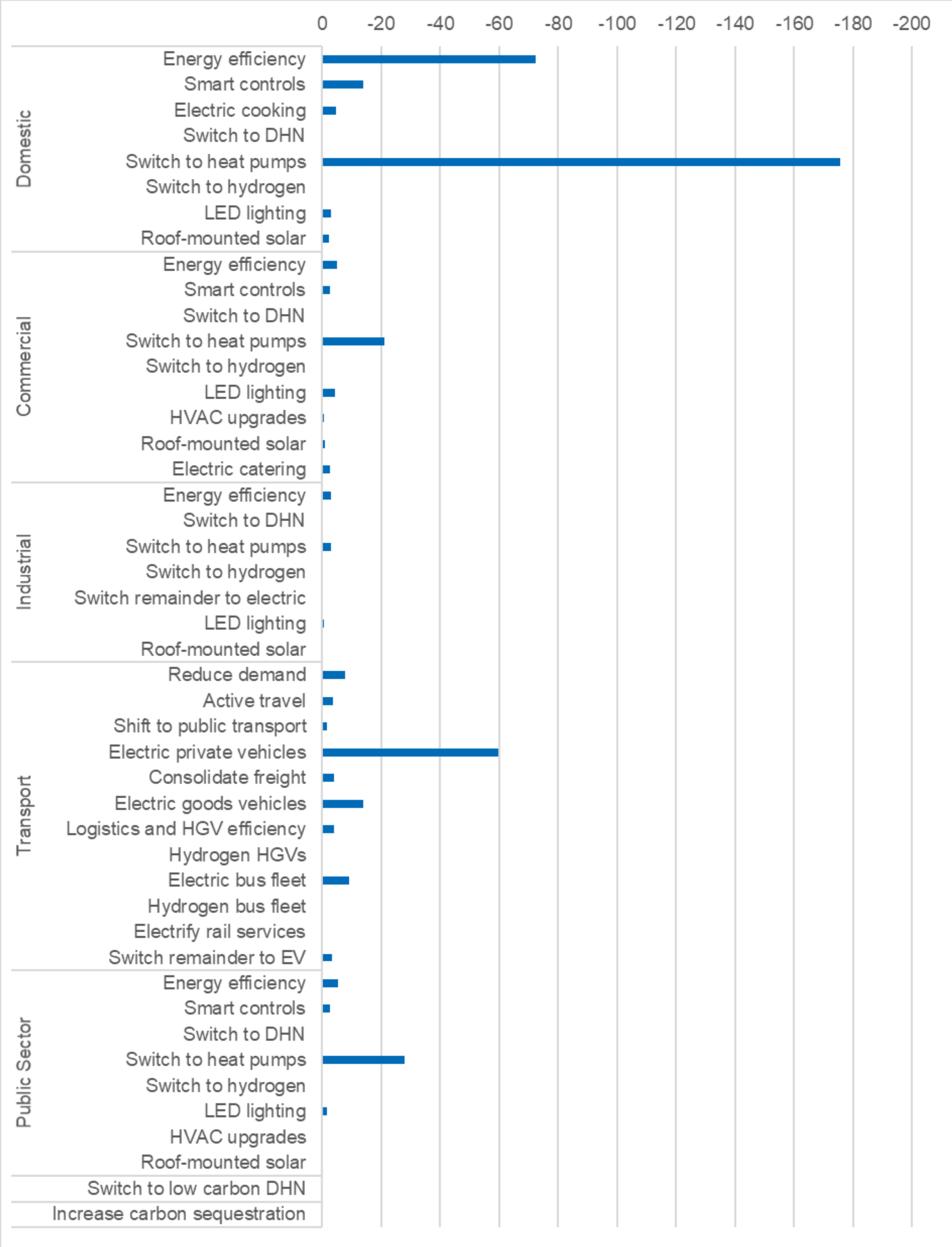


Looking at the chart of energy use by 2030 allows for a comparison between 2019 and 2030. By 2030, there is a much lower contribution from gas, and a higher contribution from grid and renewable electricity (supplied via roof-mounted PV on buildings within the City). Electricity demands will increase because of the electrification of heat and transport, but this is outweighed by the decrease in emissions due to grid decarbonisation. There is still some use of petrol and diesel in vehicles; in particular, the decline in use of diesel is proportionally lower than for petrol because it is assumed that HGVs cannot switch to electric.

By 2030 there is some remaining natural gas demand, which is associated primarily with heating in the domestic sector, and other industrial uses. As for Scenario 1, it is assumed that the district energy network does not decarbonise in this timescale and that no further connections are made. The residual quantities of coal, gas oil and fuel oil are primarily associated with light industry.

Figure 53 below shows the estimated impact that each mitigation measure has on GHG emissions by 2030. Compared with Scenario 1, the major difference is in the domestic sector, because it is assumed that there is a much higher standard of energy efficiency retrofitting, and a radical increase in the use of heat pumps (10% by 2030 in Scenario 1 and 86% by 2030 in Scenario 2). The reason for this is because Scenario 2 uses CCC assumptions for 2050, which anticipate much higher uptake of heat pumps post-2030 than pre-2030.

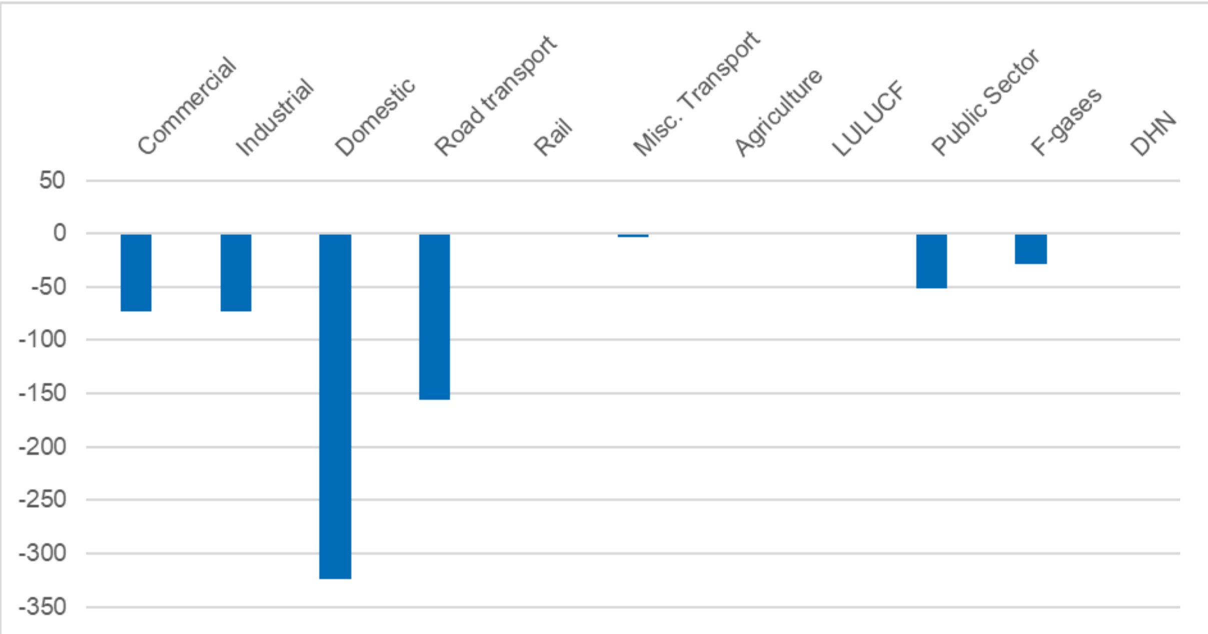
Figure 53. Impact of mitigation measures in Scenario 2 (ktCO2e)

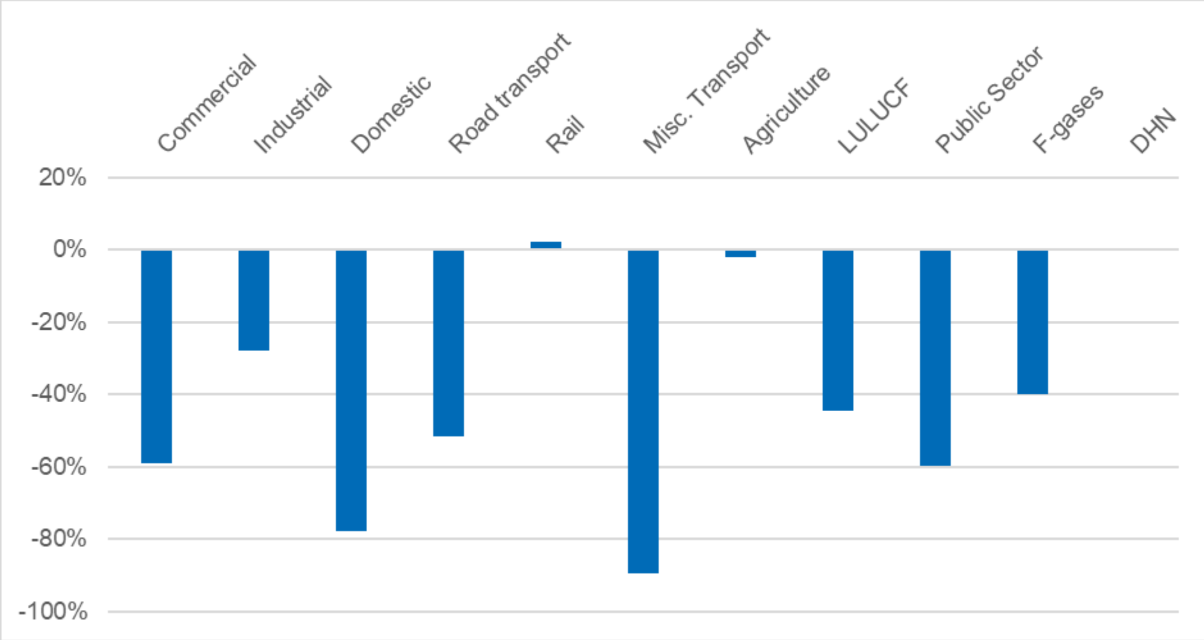


It is worth emphasising again that energy efficiency in buildings must be prioritised alongside fuel switching. Although heat pumps work in poorly insulated buildings, they operate much less effectively. The heat pump may struggle to maintain a comfortable temperature in the building during colder weather if the building is poorly insulated as it provides a lower temperature of hot water into the heating system and hence heats the building more slowly. Electricity consumption will be higher and the efficiency of the heat pump will drop, leading to greater demands on grid infrastructure. Furthermore, the current higher cost of electricity compared to natural gas per kWh will lead to higher heating bills if gas boilers are replaced like-for-like with heat pumps without any accompanying insulation, despite the much greater energy efficiency of heat pumps. Such issues would potentially cause consumers to have a negative view of heat pumps and thereby inhibit market growth. A key challenge for LCC will be to promote uptake as much as possible while also working to ensure that the wider conditions are suitable. This will also need to include a focus on developing a skilled local workforce that can correctly specify, install and maintain the heat pumps.

Below, Figure 54 shows the absolute and relative change in emissions by sector, by 2030. The most notable difference compared with Scenario 1 is the higher proportional improvement in the domestic, commercial and public sectors, for the reasons described above.

Figure 54. Change in emissions by sector in Scenario 2. (Top: Absolute change, $ktCO_2e$. Bottom: Relative change, %)





Overall, Scenario 2 results in greater reductions than Scenario 1, but still falls short of the net zero ambition. The cumulative emissions in this time period would be roughly 11,490 ktCO_2e, so the Paris-aligned carbon budget for the time period through the year 2100 would still be used up by approximately 2026.

For context:

To offset the remaining annual emissions in 2030 (591 ktCO_2e) via tree planting would require roughly 17 km^2 of land area to be turned into new woodland, or around 23% the land area of Leicester.

While the area of woodland would decrease compared with Scenario 1, due to the lower residual emissions, the amount of PV or wind energy that would be required to meet 100% of Leicester's electricity demands would increase, simply because there is more demand for electricity in Scenario 2 than in Scenario 1. This would require *approximately*:

- 1,950 MW of PV (occupying c. 25 square kilometres, around 34% the area of Leicester); or
- 800 MW of onshore wind power (c. 400 large-scale turbines).

Again, these figures are provided to highlight the scale of the challenge, not to suggest that either of these represents a feasible offsetting strategy.

Scenario 3

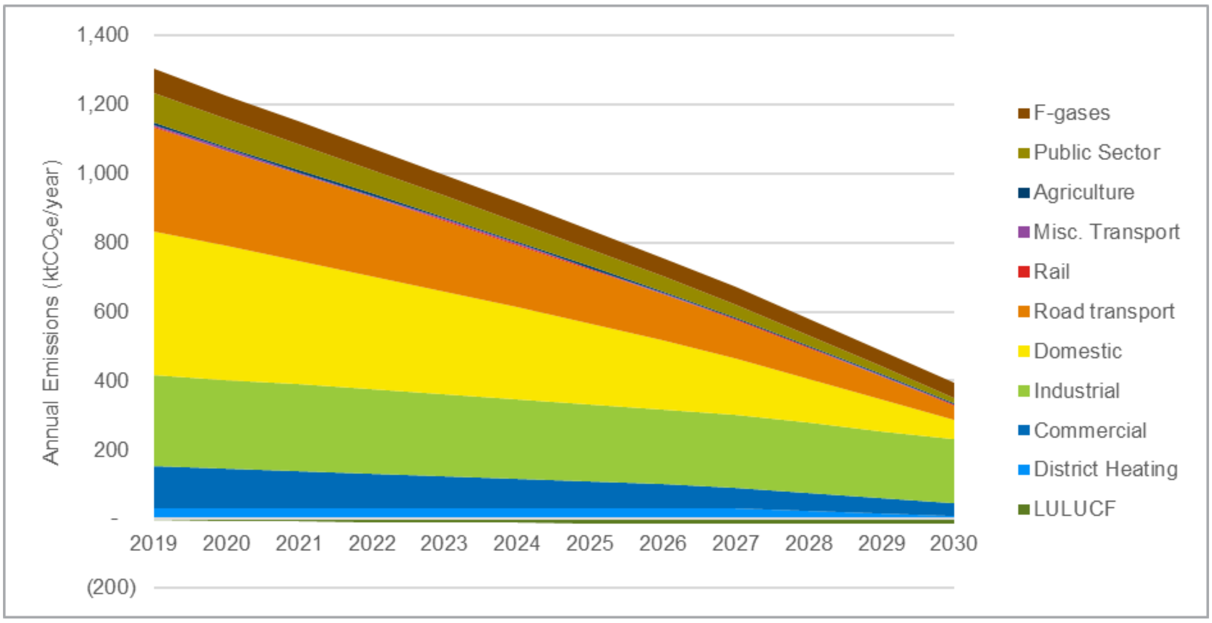
As mentioned previously, Scenario 3 aims to avoid the need for any type of offsetting as much as possible. Most of the assumptions therefore reflect the maximum **theoretical** GHG reductions that could be achieved in each sector, based on existing technologies as much as possible. The purpose of Scenario 3 is to understand how close Leicester could get to net zero, **if practical and cost considerations were no barrier.** Scenario 3 is useful insofar as it highlights what technical options would deliver the greatest reductions by 2030, but it is important to understand that **it is not a projection and does not imply the reductions are necessarily feasible. In practical terms many**

<u>of the interventions may be impossible to achieve without a step change in consumer behaviour, major additional funding, and wider changes in the energy system and economy.</u>

This scenario results in residual emissions of 379 ktCO_2e per year by 2030, which is a 71% decrease compared with 2019. The cumulative emissions in this time period would be roughly 10,260 ktCO_2e, meaning that the Paris-aligned carbon budget would be used up by approximately 2026 or 2027. The fact that even Scenario 3 fails to meet that carbon budget reflects the scale of the challenge in reducing emissions from their current levels, and the need to implement the deepest reductions in the next few years.

Figure 55 shows the changes in emissions by sector in Scenario 3. It shows that there are large GHG reductions in all sectors due to high levels of demand reduction and switching to the use of grid or renewable electricity. By 2030 the industrial sector accounts for the largest single proportion of emissions; this is because, aside from space heating and lighting, there are no specific demand reductions modelled, recognising that this is highly industry-specific.[39]

Figure 55. Emissions by sector in Scenario 3



A brief recap of some of the headline interventions for buildings and transport is provided below, with commentary on some of the major challenges that would need to be addressed.

Buildings:

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[39] 'Demand reduction' here is used as a description to distinguish energy efficiency measures that only reduce demand, such as fabric improvements and LED lighting, from those that also involve switching from one fuel type to another, which is referred to as 'fuel switching'. Due to the use of EEP data, the BAU scenario will implicitly include some energy efficiency improvements in the industrial sector where these are associated with adopted Government policies. The other specific measures modelled for the industrial sector (of which only the first two are classed as 'demand reduction') are:

- Reducing space heating via fabric improvements and smart controls (modelled together due to lack of data on their separate impacts)
- Switching to LEDs
- Uptake of heat pumps and (in Scenario 4 only) hydrogen boilers
- Scenario 4 also includes an illustrative scenario where the remaining industrial fossil fuel demand switches to electricity or an alternative zero carbon fuel source such as green hydrogen, to assess the scale of impact of future technological changes.

- Scenario 3 assumes a 30% reduction in demand for space heating and hot water across the domestic building stock, on average. In practical terms, given that different properties will be easier or harder to upgrade, this would require deep energy retrofits (achieving savings in excess of the average 30%) in as many buildings as possible. Case study evidence suggests that heating demand can be reduced by upwards of 75-80% in some instances, which would help to make up for cases where such a large reduction is unachievable. For domestic buildings, the cost of energy efficiency retrofits generally ranges from £10,000-65,000 per dwelling, with the higher end of the scale associated with greater levels of energy efficiency. The level of demand reduction in non-domestic buildings is generally lower (20% on average across the building stock) which reflects the greater variability in these types of buildings, but a similar principle applies, i.e. it will be necessary to retrofit nearly all buildings to a lesser or greater degree. Aside from the financial and logistical implications, this would significantly alter the appearance of many buildings. There is also a risk of unintended consequences if the measures are not installed correctly, which can lead to damp and moisture problems, or exacerbate the risk of overheating.
- Scenario 3 also involves replacing *all* non-electric domestic heating systems with heat pumps.[40] The main reason why Scenario 3 (in line with the Government's Net Zero Strategy) focuses on heat pumps is because the technology is already available, but nonetheless there are major financial and practical obstacles associated with doing this. Key issues include: (a) needing to improve the energy efficiency of buildings as a prerequisite, whether that happens first or at the same time as the heating system is replaced; (b) the high cost of heat pumps relative to other systems; (c) the high cost of electricity compared with natural gas and other fuels, and the associated impact on energy bills; (d) low levels of consumer awareness of, and confidence in, the product, which operates differently than boilers; and (e) a lack of skilled tradespeople to specify, install, and maintain the heat pumps. The Government has announced modest levels of funding to address these issues but the Net Zero Strategy appears to place a heavy reliance on market forces to bring costs down gradually.
- Although it does not include any further expansion of the district energy network, Scenario 3 assumes that the existing network switches away from the use of gas to an alternative low carbon heating source before 2030, resulting in a c. 65% decrease in emissions from the network. There are several technological options available to achieve this, which could include air or water source heat pumps.

Transport:

- Scenario 3 assumes that there is a 5% reduction in demand for car journeys due to a combination of behavioural and technological change such as working from home and internet shopping, along with the introduction of the Workplace Parking Levy. It further assumes that the Government's ambition for 50% of journeys to take place via active travel is achieved, which results in a large decrease in car journeys (32%). However, the model does not make any assumptions about the specific measures needed to achieve this. In practice it would require a major shift in the design and use of the road network and public realm to support a considerable change in behaviour, likely also requiring a large-scale awareness campaign and potentially other forms of support to encourage A further 10% of car journeys are assumed to switch to public buses, which for context would be roughly triple the current

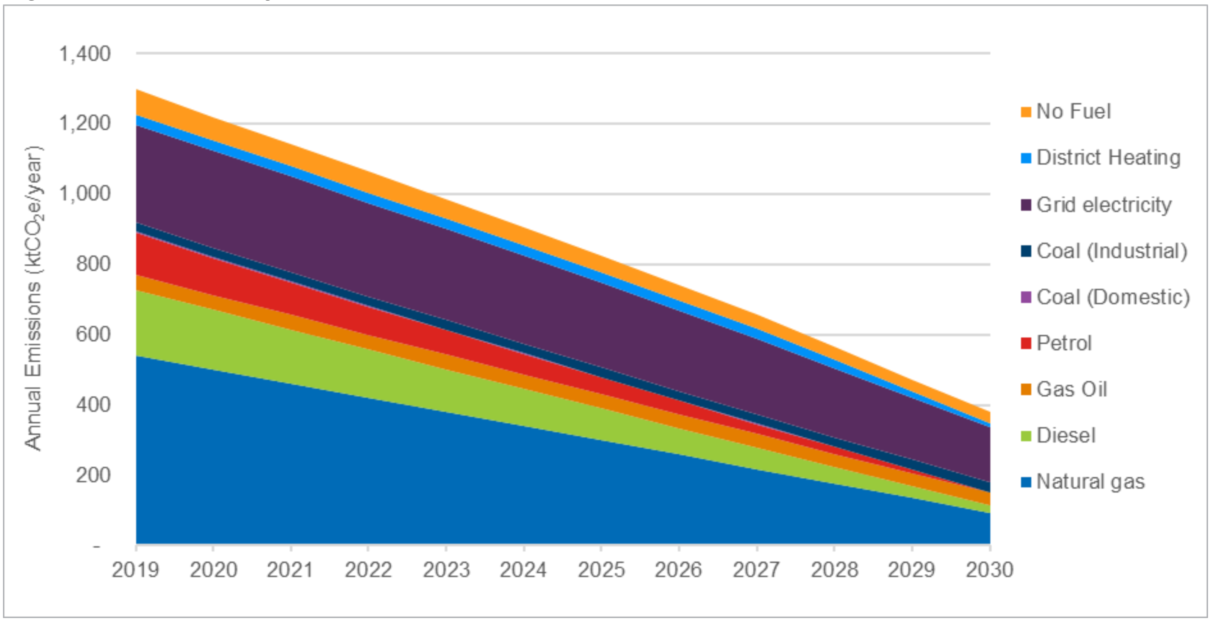
[40] These are likely to be individual heat pumps based on information provided by Engie, but the overall emissions reduction would be broadly the same if a small proportion of these were supplied via communal or district heat network(s).

proportion. **Based on conversations with LCC, the above measures are considered to significantly overestimate the realistic scale of demand reduction and mode shifting[41] that can be achieved in practice.** Cities and large towns generally offer better opportunities for reducing car use than rural areas, due to the relative density of amenities and public transport connections. However, in Leicester, around 40% of Leicester's population has no access to a private car, so the scope for *further* reductions in car journeys may be smaller than elsewhere. There is also a risk of unintended consequences or 'leakage', whereby reducing vehicle journeys in the City itself might increase emissions elsewhere, due to changes in travel patterns and/or higher traffic. So, this would need to be underpinned by a complete transformation in how people travel in Leicester, backed up by strong Local Transport Plan policies and targets, and urban planning design guidelines.

- After reducing demand for travel, this scenario assumes that nearly 100% of cars, vans, motorcycles, and buses are battery electric vehicles (BEVs) by 2030. Considering the average lifespan of vehicles, if this transition were to follow the natural replacement cycle, it would potentially require all new vehicles in Leicester to be BEVs starting almost immediately. There are no clear policy levers for LCC to make this happen – and, given that EVs are still more expensive than traditionally fuelled vehicles, it would require considerable financial incentives. LCC would also need to be able to guarantee that adequate charging infrastructure is in place to support the shift.

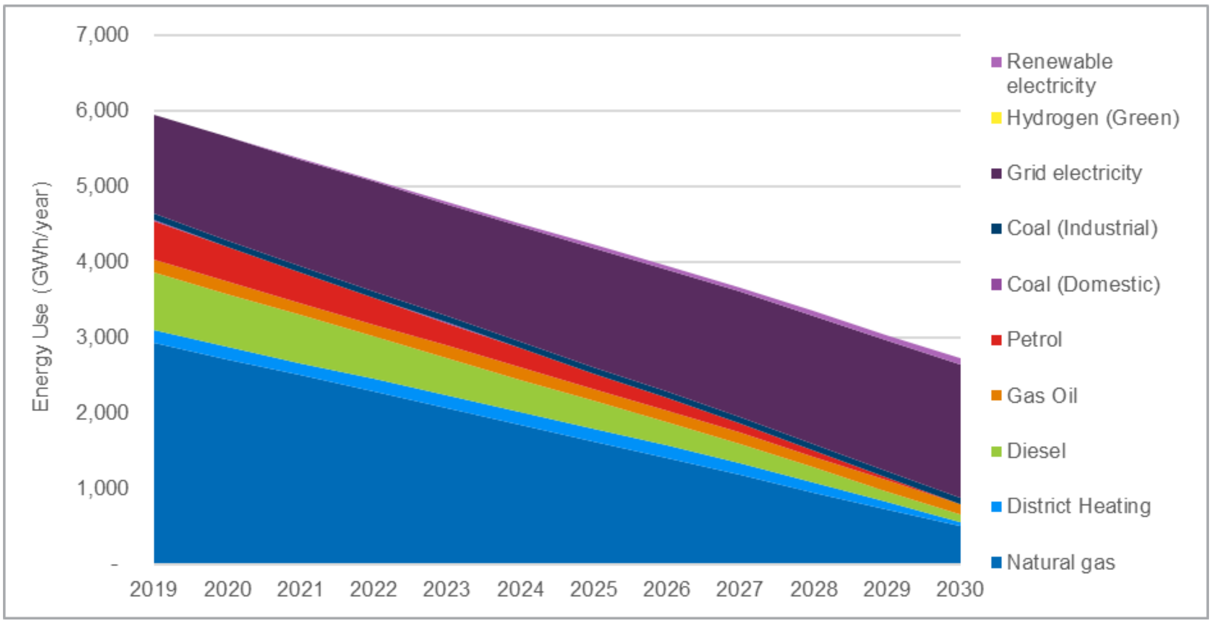
The challenge in reaching net zero even in this highly ambitious scenario is illustrated below. By 2030, as shown in Figure **56**, almost all energy use is either grid electricity or local renewable electricity (currently modelled as roof-mounted PV), and the former accounts for nearly all residual emissions, as shown in Figure 57. In other words, once all of the demand reduction and fuel/technological measures are adopted, the gap to net zero is almost entirely determined by the level of grid decarbonisation that is achieved by 2030.

Figure 56**. Emissions by fuel in Scenario 3**



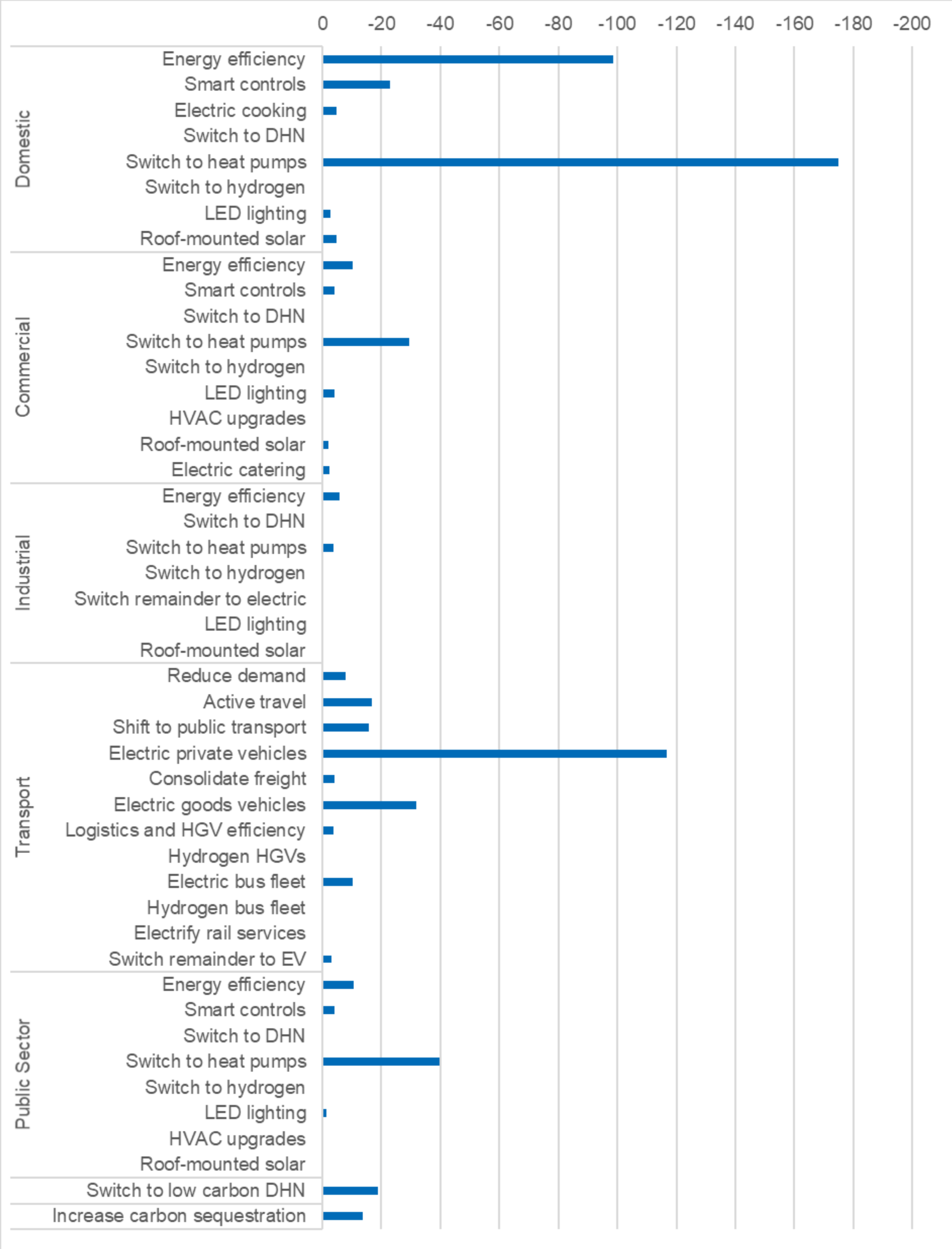
[41] Mode shifting refers to journeys that shift from one mode of transport to another, e.g. from private cars to cycling. This is distinct from fuel switching, which refers to switching from one source of fuel to another, e.g. from a petrol car to an EV.

Figure 57. Energy use by fuel in Scenario 3



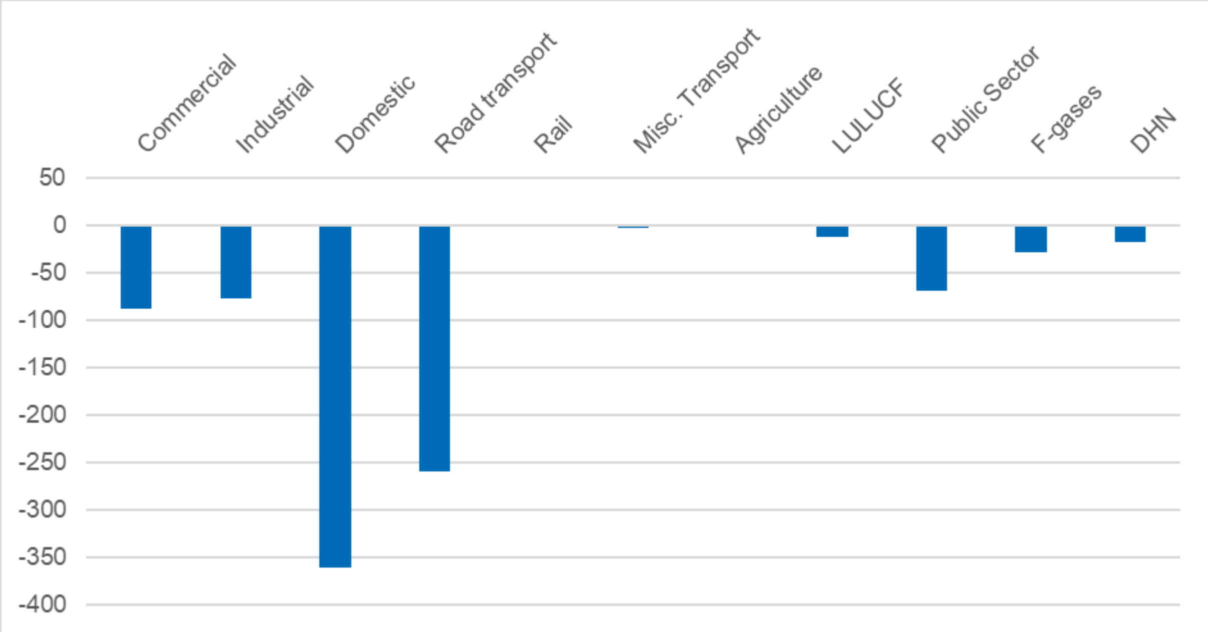
The chart below shows the estimated impact that each mitigation measure has on GHG emissions by 2030. Similar to previous scenarios, this shows that the biggest impacts come from demand reduction in the domestic stock and transport, and fuel switching.

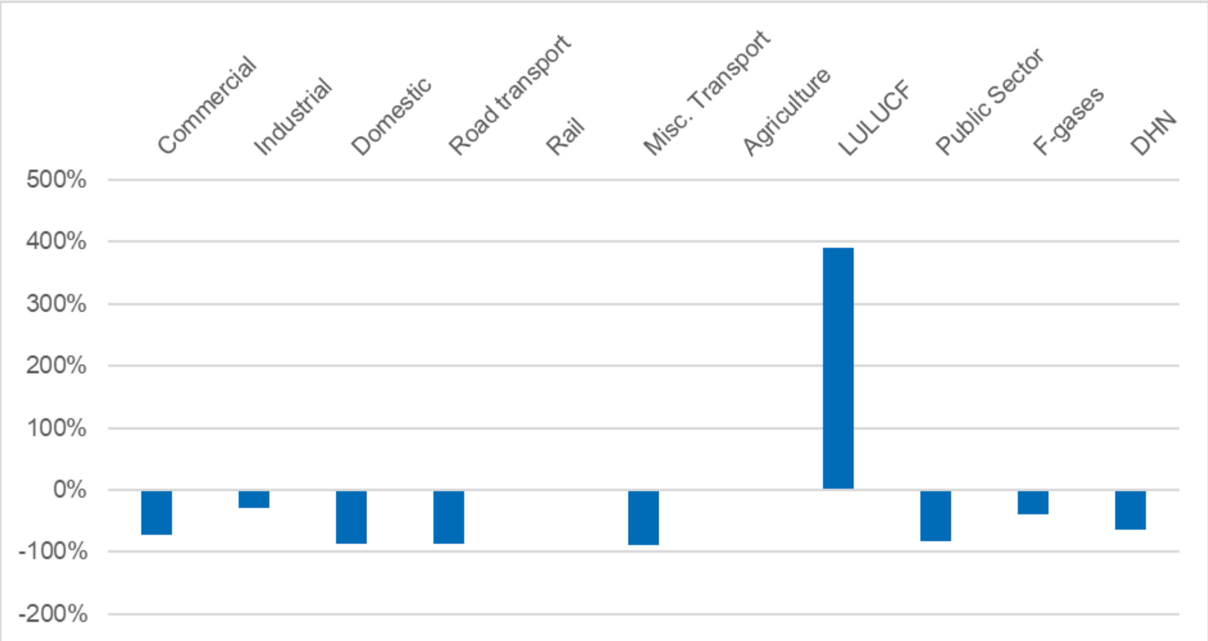
Figure 58. Impact of mitigation measures in Scenario 3 ($ktCO_2e$)



Below, Figure 59 shows the absolute and relative change in emissions by sector, by 2030.

Figure 59. Change in emissions by sector in Scenario 3. (Top: Absolute change, $ktCO_2e$. Bottom: Relative change, %)





Notes:

- The assumed changes in the LULUCF sector are based on maximising all potential opportunities within Leicester, as per a previous study on carbon sequestration. However, this is not considered feasible in reality. This is partly due the level of new development that is planned for the area, and partly because it would require all available land area to be managed to maximise carbon sequestration, whereas in practice, there are other competing requirements. Nature-based solutions such as woodland creation also take time to establish and sequester carbon and it is also not clear whether this could be achieved between now and 2030 – in other words, the trees would simply not grow fast enough. The measure has been modelled mostly to assess the maximum theoretical impact it could have – and this is shown to be small. Therefore, it is not considered a major part of Leicester's route to net zero

– although there are numerous other benefits associated with sustainable land management practices which support their adoption.

- These results show high GHG reductions in the non-domestic building sectors compared with other scenarios. However, in the industrial sector, this assumes that 100% of remaining energy uses are converted to electricity or green hydrogen. This has been included as an illustrative measure, to show how even if this was possible, it does not achieve net zero due to the national grid.
- Because rail electrification is very much outside of the control of organisations based in Leicester, it has not been modelled as part of Scenario 3. Even if the railway line was electrified in that timescale, it would not be possible to ensure that all railway services entering or passing through Leicester are 100% electric by 2030. Even if the railway was fully electric, it would not have a large impact on GHG emissions as rail represents a small portion of total emissions.
- Scenario 3 assumes no change in emissions from agriculture or f-gases aside from the declines that are already included in the BAU assumptions.
    - In the case of agriculture, this is because energy use in agricultural buildings (e.g. electricity and natural gas) is impossible to disaggregate from the other industrial and commercial sectors, and the majority of emissions are non-CO_2 gases from the use of fertiliser, livestock, and so on. Agriculture makes very little difference as it accounts for a small portion of total emissions.
    - The BEIS EEP assumes a decline in emissions from f-gases, partly on the basis that there will be greater use of low-GWP refrigerants. However, the EEP model does not account for a large-scale shift to heat pumps or a potential increase in the use of air conditioners due to more frequent hot weather. Therefore, it may be overly optimistic. This underlines the importance of minimising the demand for refrigeration and cooling where possible, using low-GWP refrigerants, and (in the case of larger systems such as would be needed to supply heat networks) refrigerant leakage prevention and alarm systems.

For context:

Offsetting the residual 268 ktCO_2e via tree planting would require roughly 8 km^2 of land area to be turned into new woodland, which is equivalent to around 10% of the land area of Leicester.

Given that this would only offset one year's worth of emissions (and that it would take over a decade for the woodland to reach maturity), an offsetting strategy based on woodland creation would still be extremely challenging, even though the requirement is much lower than in Scenarios 1 and 2.

Meeting 100% of the 2030 electricity demands would require *approximately*:

- 2,110 MW of PV (occupying c. 26 square kilometres); or
- 860 MW of onshore wind power (c. 430 large-scale turbines).

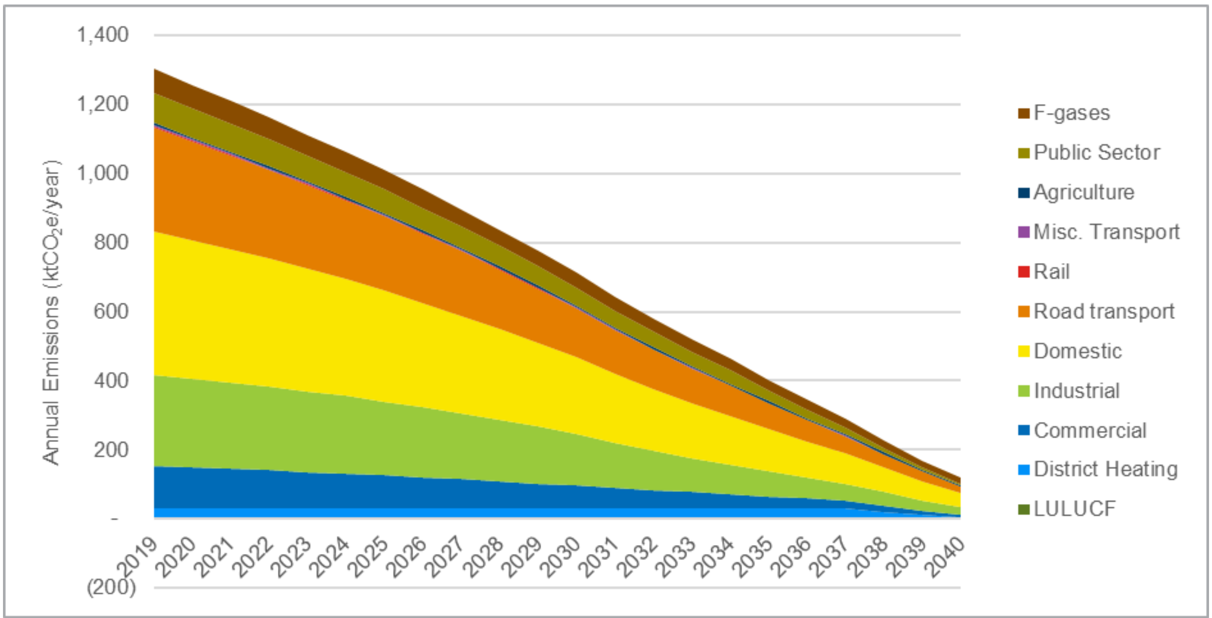
The overarching message in Scenario 3 is that even if almost all systems switched towards electricity, the constraint on reaching net zero by 2030 will primarily be due to emissions from the national electricity grid. (If the electricity grid was net zero by 2030, emissions in this scenario would decrease by 83% instead of 71%.) In that sense, Scenario 3 can be thought of as a 'net zero ready' scenario.

The remaining emissions are then dealt with by, over time, meeting 100% of electricity demands with renewables via the electricity grid, and looking towards other technological changes, carbon capture, offsetting, and so on to address the small amount of non-electricity GHG emissions.[42]

Scenario 4

The level of ambition for different intervention measures in Scenario 4 is generally similar to Scenario 2, but the impact of fuel switching is greater because of the additional electricity grid decarbonisation. The other main difference is the inclusion of some green hydrogen for space heating, hot water, HGVs and other industrial fossil fuel use. This scenario also assumes that c. 5% of public sector heat demand and 5% of domestic heat demand is met via an expanded district energy network, which also switches to electric heat pumps in the late 2030s.[43] Compared with Scenario 3, total energy use is higher due to the lower levels of demand reduction. This scenario results in residual emissions of 118 $ktCO_2e$ per year by 2030, which is a 91% decrease compared with 2019.

Figure 60. Emissions by sector in Scenario 4



In most instances, the level of ambition for energy demand and GHG reduction measures is the same in Scenario 4 as for Scenario 2; that is to say, it is based on the maximum level of ambition in the CCC scenarios and brings those changes forward to 2040. From a practical standpoint, however, Scenario 4 is likely to be more achievable overall, due to the longer timescales for implementation. This consideration needs to be weighed against the fact that the cumulative emissions until 2040 are 16,000 $ktCO_2e$, which is nearly twice as much as the Paris-compliant carbon budget through to the year 2100 (8.5 $MtCO_2e$).

The other major difference between this scenario and the others is that, by 2040, hydrogen would account for 5-10% of energy use. It is assumed to be green hydrogen, i.e. made by electrolysis using

[42] These would primarily comprise f-gases, HGVs, and various other sector-specific energy uses (i.e. energy uses other than space heating, hot water, lighting, ventilation and cooking/catering).

[43] It is understood that the heat network would likely only expand to include large public sector anchor loads although in principle it could supply denser residential developments nearby. In the absence of more detailed information 5% has been used as an indicative figure.

renewable electricity, and is therefore modelled as having zero GHG emissions. However, the actual emissions from hydrogen will depend on how it is produced. If it is produced using natural gas, emissions would be much higher than if it is produced using renewable electricity. Another possibility is that a UK hydrogen market would develop based on a mixture of technologies, so it would be produced using some combination of natural gas and electricity, which would again mean that emissions are non-zero. Therefore, assumptions about how the hydrogen is produced are an important sensitivity in the model. The possible supply of some hydrogen produced from natural gas *without* CCS would be a key risk for Leicester if pursuing a strategy that relies on hydrogen.

Figure 61 shows the changes in emissions by fuel type between 2019 and 2030, and Figure 62 shows the underlying changes in energy use. 'Renewable electricity' in this instance refers to roof-mounted PV located within Leicester.

Figure 61. Emissions by fuel in Scenario 4

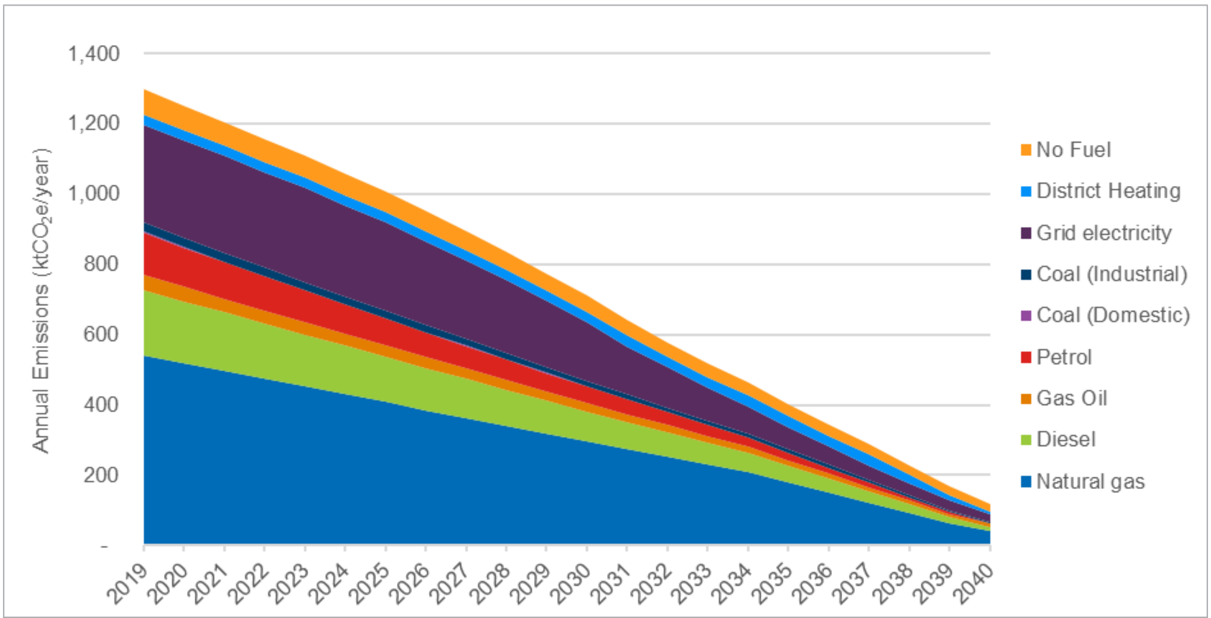
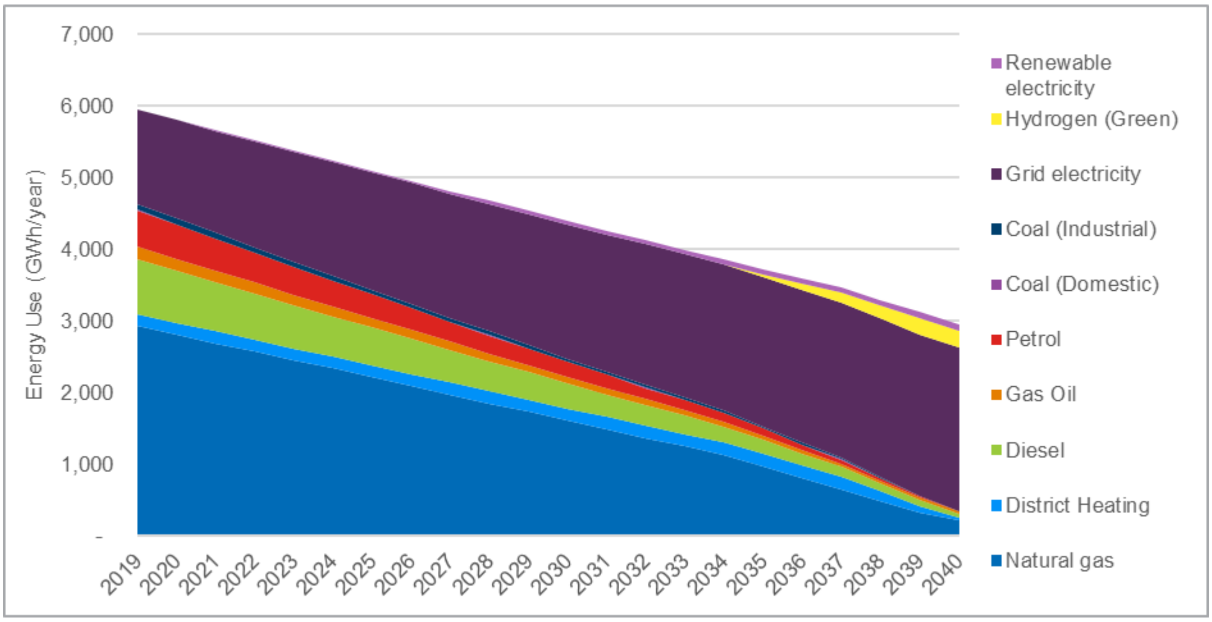


Figure 62. Energy use by fuel in Scenario 4



The same considerations related to the importance of demand reduction, and the sensitivity to electricity grid decarbonisation, apply to Scenario 4 as for the other scenarios that have been described previously.

Figure 63 shows the estimated impact that each mitigation measure has on GHG emissions by 2030.

Figure 63. Impact of mitigation measures in Scenario 4 ($ktCO_2e$)

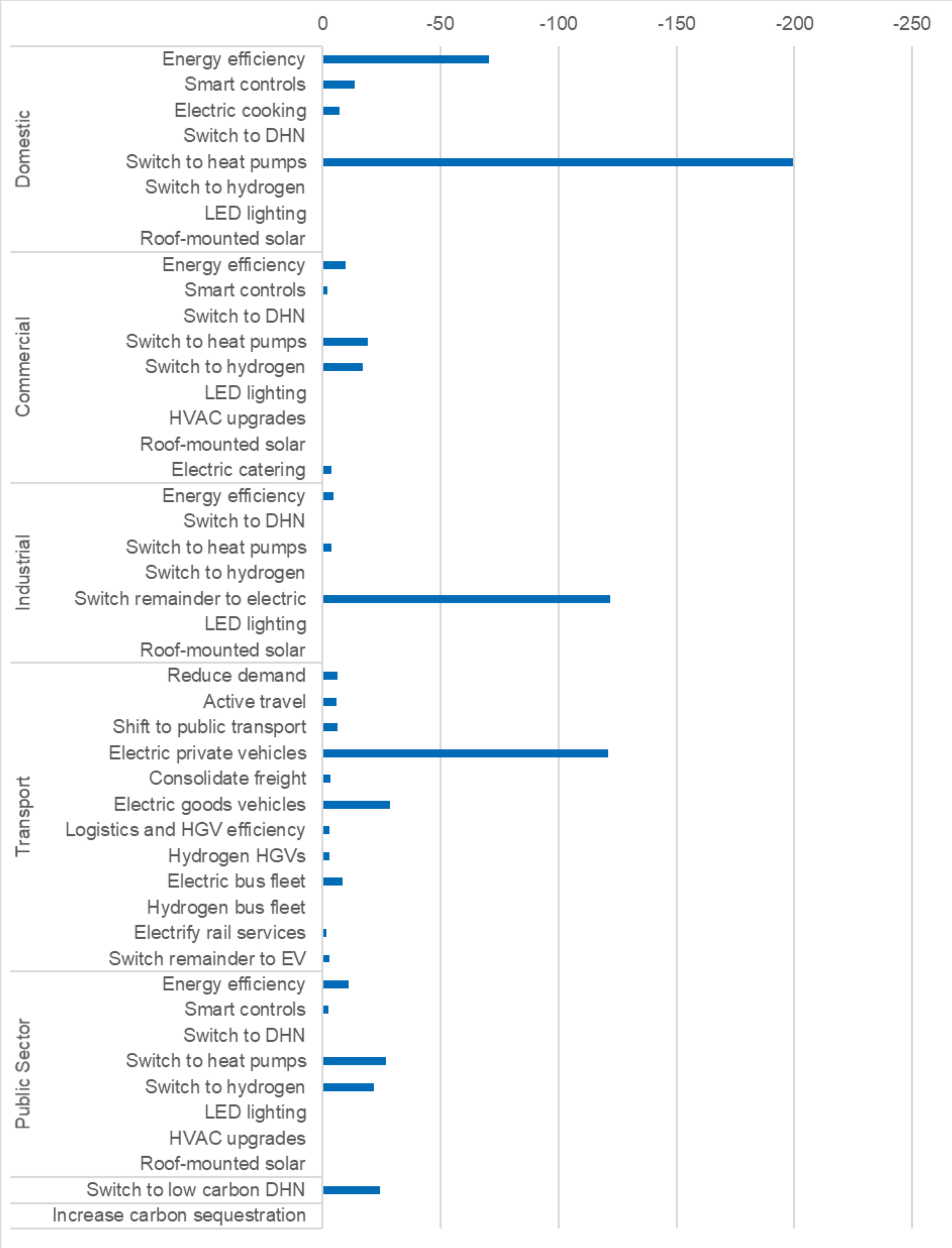
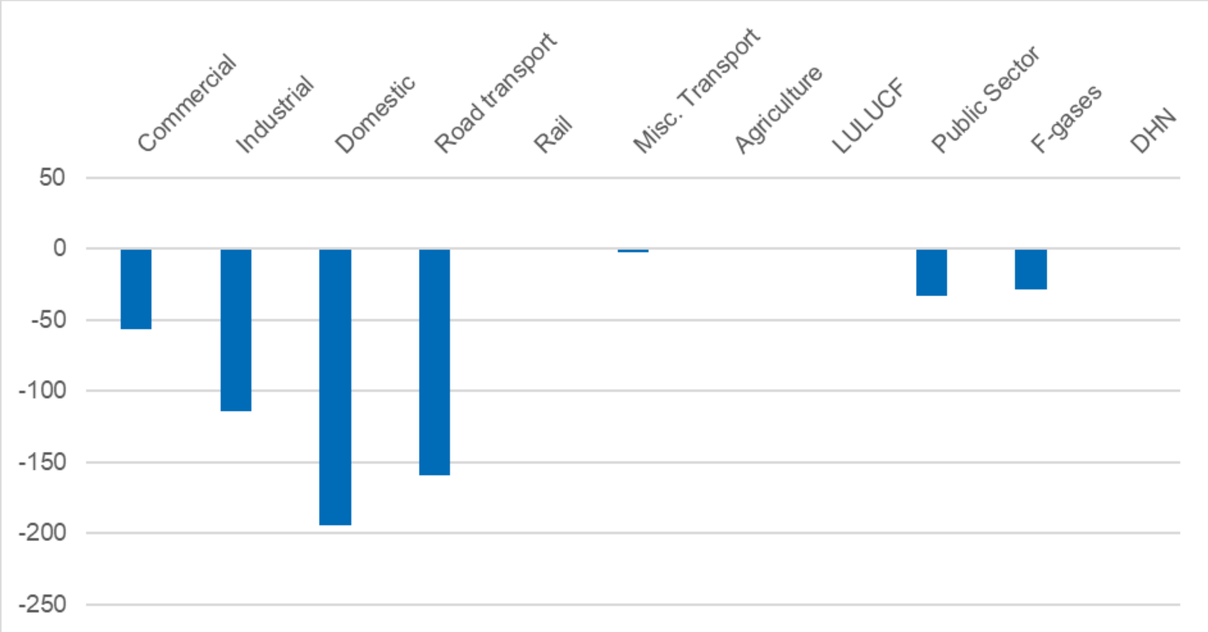
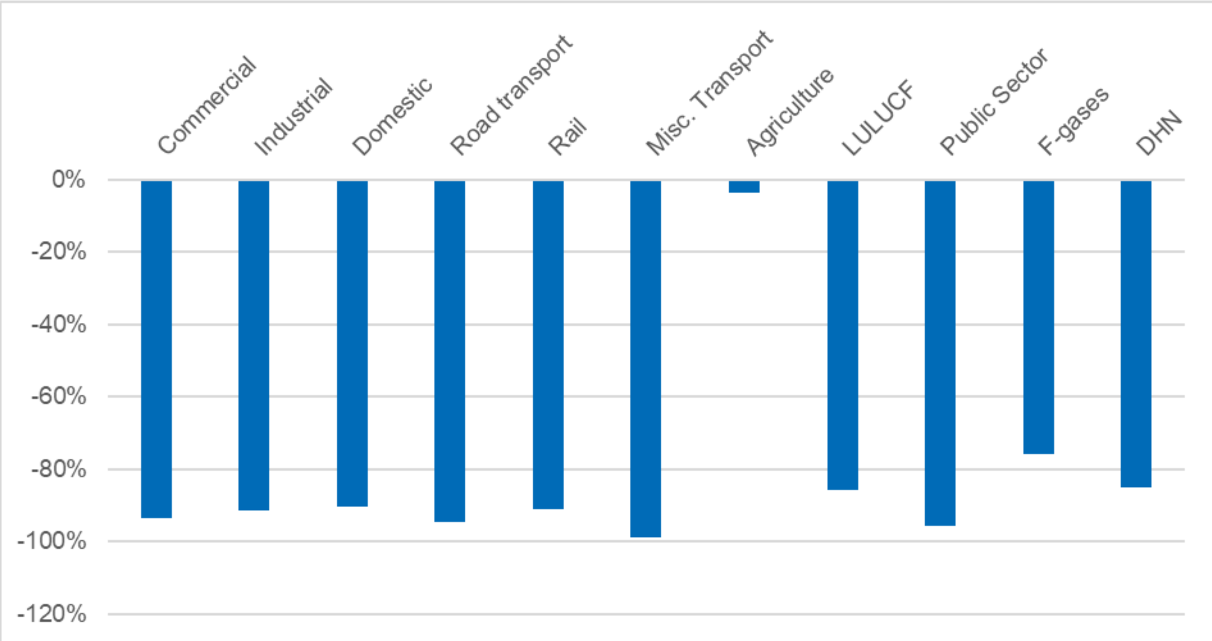


Figure 64 shows the absolute and relative change in emissions by sector, by 2030. Most sectors in Scenario 4 see emissions reduce by 80-95%. The exceptions are agriculture (for the reasons described previously, mitigation measures have not been modelled) and LULUCF, which only sees small improvements.

Figure 64. Change in emissions by sector in Scenario 4. ***(Top: Absolute change, ktCO₂e. Bottom: Relative change, %)***





For context:

Offsetting this much residual CO_2 via tree planting would require roughly 3 km^2 of land area to be turned into new woodland, which is equivalent to roughly 5% of Leicester's land area. If that woodland was correctly maintained over the course of decades and centuries, this would be enough to offset the annual emissions in 2030 – to be clear, just that one year's worth of emissions.

Looking at the challenge another way, if all of the electricity demand in Scenario 4 was to be met with 100% renewable electricity, this would require *approximately*:

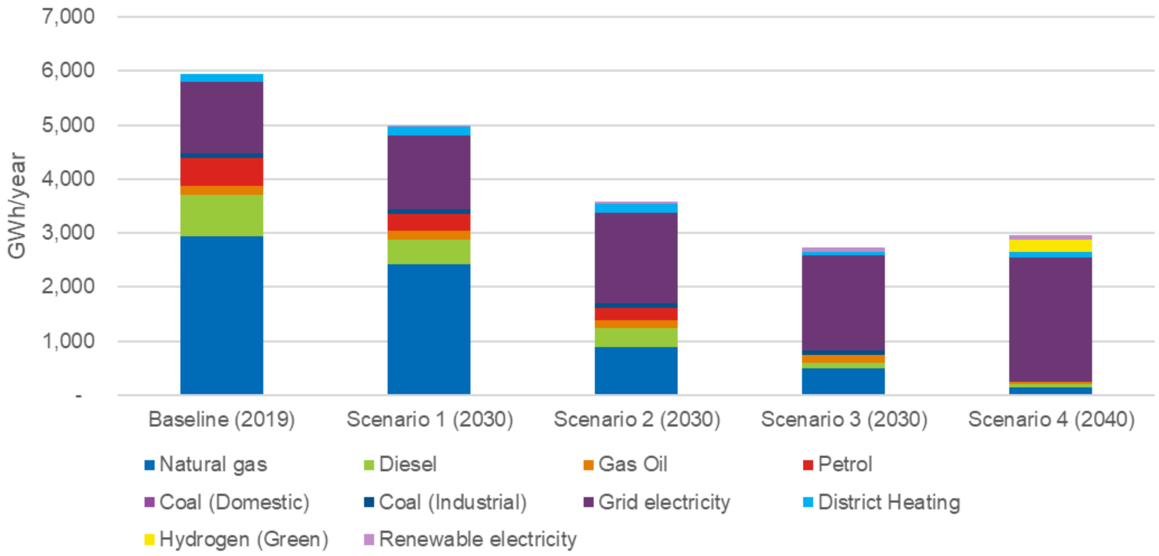
- 2,130 MW of PV (occupying c. 27 square kilometres); or

- 860 MW of onshore wind power (c. 430 large-scale turbines).

Changes in fuel consumption

Figure 65 below shows the levels of fuel consumption in the BAU and the four decarbonisation scenarios. It shows that in Scenario 3, the bulk of fuel consumption is from grid electricity, so this therefore is the biggest constraint in achieving carbon neutrality by 2030. Other fuel consumption, notably natural gas, are reduced significantly.

Figure 65. Fuel consumption in different carbon neutrality scenarios



Strategic decisions: Demand reduction vs. reliance on technological change

The following charts illustrate the implications of a strategic route to net zero that relies more heavily on demand reduction compared with one that places greater emphasis on technological solutions.

First, Figure 66 shows the impact of different mitigation measures in Scenario 3 as a waterfall chart, so their respective impact on GHG emissions can be clearly seen. In this chart, the most significant measures are demand reduction (energy efficiency in buildings and modal shift in transport), and electrification of both heating and transport. Figure 67, meanwhile, considers the impact of retrofitting the domestic building stock to a radically better standard. Perhaps counterintuitively, it shows that the overall level of decarbonisation achieved is roughly the same. That is because heat pumps are so much more efficient than gas boilers, and when they are supplied with renewable or decarbonised grid electricity, any remaining emissions will be very small. So, given the difficulty of retrofitting the building stock, does this mean that Leicester's residents can instead rely on technological solutions to reduce their space heating emissions?

Figure 66. Scenario 3, assuming 30% reduction in domestic space heating demand

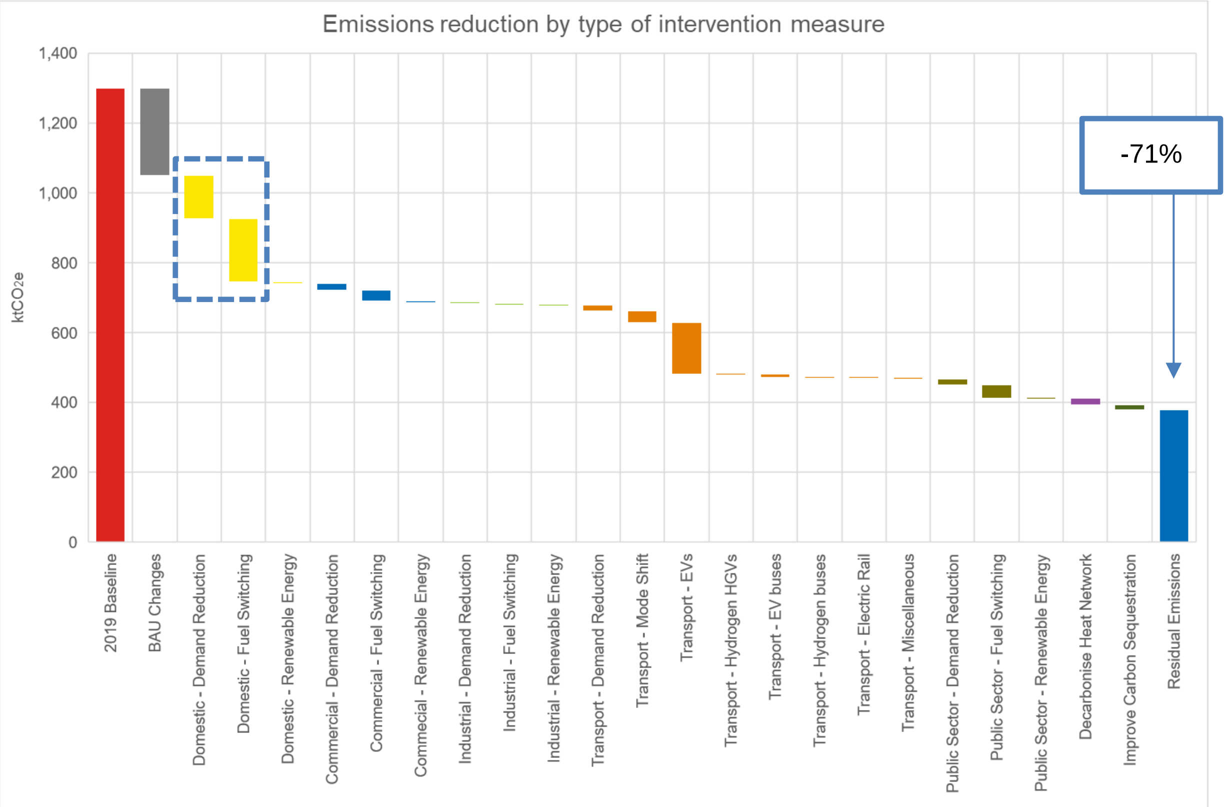
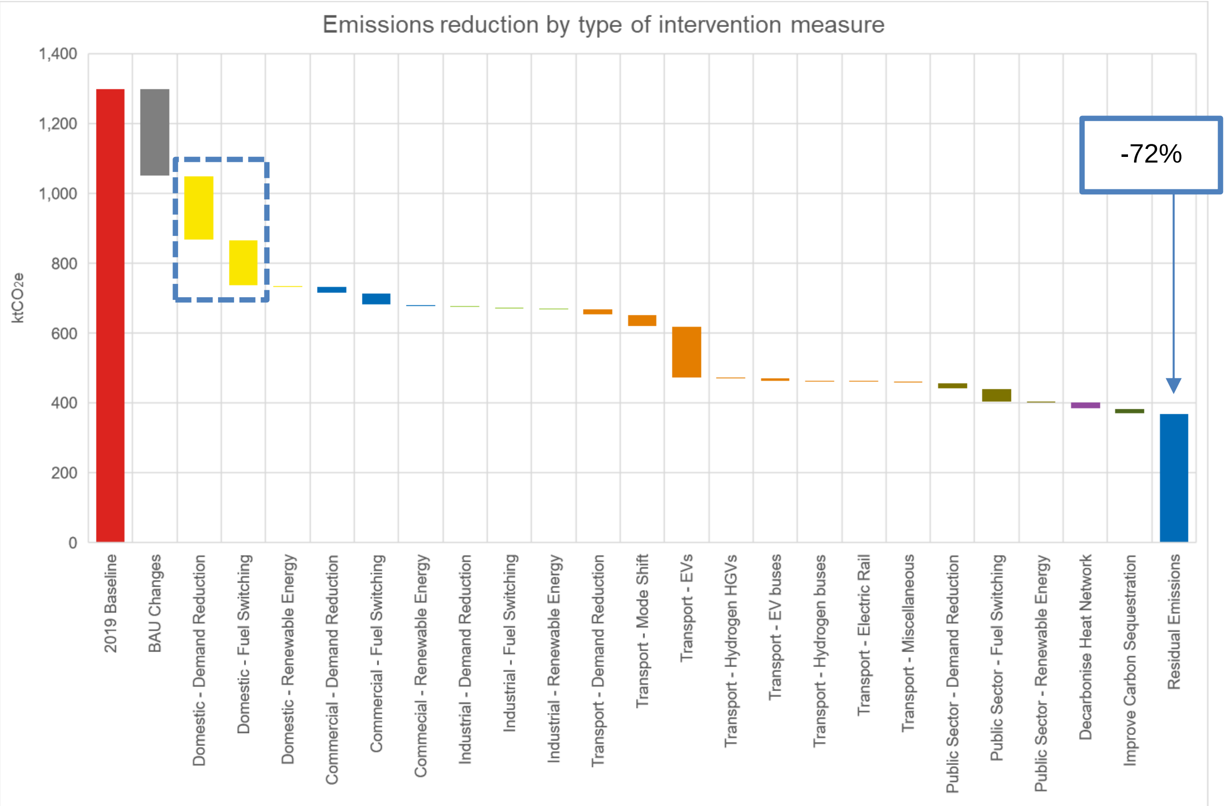
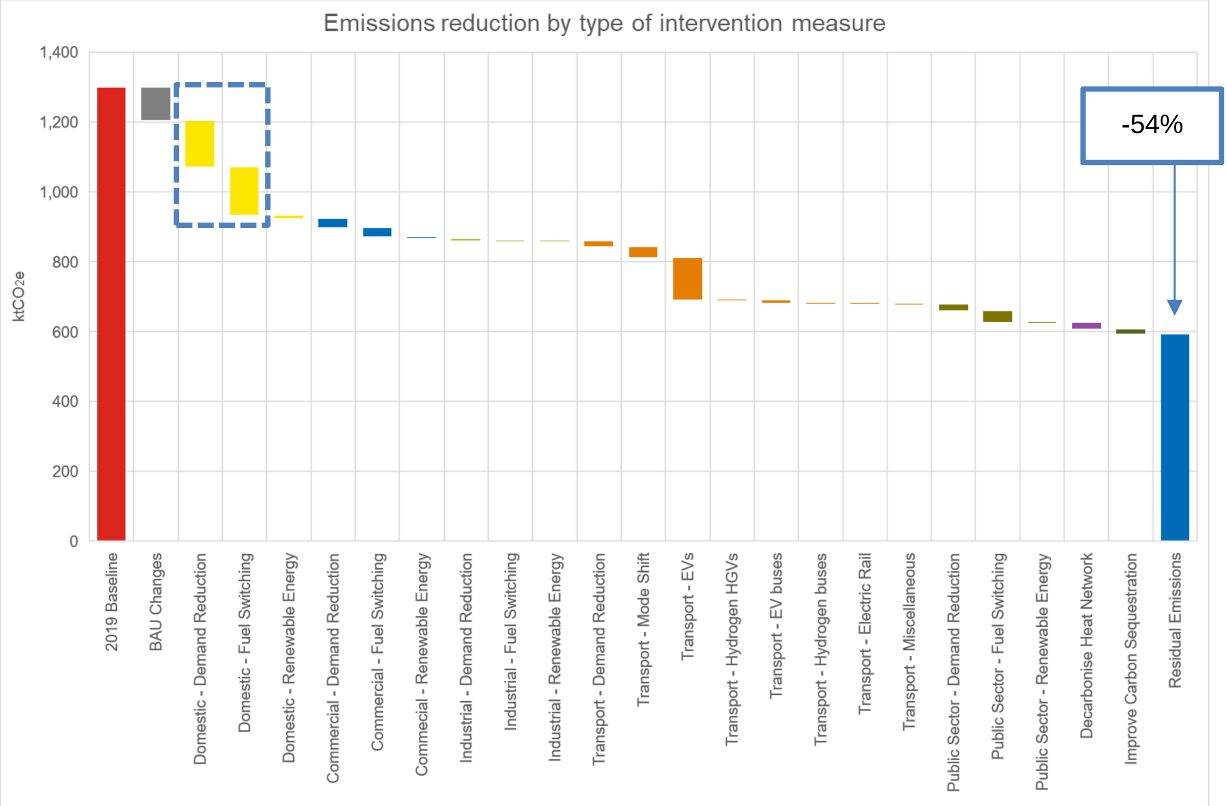


Figure 67. Scenario 3, assuming 50% reduction in domestic space heating demand



There are two very important reasons why demand reduction should still be a priority. The first is that grid decarbonisation is not guaranteed to occur at the necessary pace. A strategy that relies on technological solutions is inherently riskier – it involves more factors that are completely outside the influence of LCC, households, businesses and other stakeholders within Leicester. This is highlighted in Figure 68, which shows the same assumptions about demand reduction as in Figure 66, but without electricity grid decarbonisation. Whereas both of the previous graphs achieved a c. 71-72% reduction in emissions by 2030, this one only achieves a 54% reduction.

Figure 68. Scenario 3, assuming 30% reduction in space heating demand but no grid decarbonisation



The second reason is that, although there are different routes to reducing Leicester's own area-wide emissions, these calculations do not account for the wider resource implications, such as the need for more heat pumps, more batteries, more renewable energy and other materials. These all rely on finite resources, often coming from supply chains that do not promote the needs of workers and local communities, and have the potential to create waste at the end of the product lifecycle.

Similar issues apply to transport (in terms of EV uptake) as well as buildings. For these reasons, the pathways modelling presented in this report does not suggest that there is a certain minimum threshold for demand reduction that *must* be achieved. What it does highlight are the different levels of risk, along with other practical considerations, e.g. trade-offs in terms of who shoulders the cost burden and who the key players are in each of these scenarios. However, prioritising demand reduction should clearly be the preferred option in order to meet the target from a climate change mitigation standpoint, both for Leicester and more broadly.

3.4.3 Risks, opportunities, and uncertainties

This section describes some of the uncertainties, risks and opportunities highlighted by the net zero pathways analysis, considered as a whole.

Many of the same points apply as for the BAU scenario so the two sections should be read in conjunction; refer to Section 3.3.3 for details.

Uncertainties in the modelling	
What are they?	**What are the implications?**
The amount of evidence that is available to support assumptions about mitigation measures varies significantly. In many cases, estimates of the scale of GHG reduction that can be achieved draws from evidence relating to similar, but different, interventions. Sometimes this evidence is based on substantial, real-world datasets (e.g. the difference in heating bills when retrofitting domestic properties as measured by changes in metered energy bills) whereas sometimes it draws on case studies, (e.g. improvements in HGV efficiency due to driver training) or theoretical assumptions (e.g. switching to more efficient solar panels). Particularly for Scenario 3, some of the changes are based on policy 'ambitions' that are not backed up by specific measures (e.g. 50% of journeys in cities being made by active travel by 2030).	There are different levels of uncertainty associated with the modelled scale of impact of different mitigation measures, and across scenarios. There is also some risk of double counting the benefits of intervention measures, although expert opinion has been sought to avoid this wherever possible. An example would be when trying to establish the scope for demand reduction in car journeys. Some figures indicate the proportion that could switch to public transport, and the proportion that could be avoided entirely through behaviour change, but it is not always straightforward to establish whether these measures should be applied together or sequentially. As a general principle (and unfortunately), where we have made assumptions about the potential scale of GHG reductions, the lower/more modest/conservative assumptions are likely to be more realistic and achievable.
Different intervention measures are likely to have dynamic effects that are not accounted for in the model. There is also the potential that some could result in 'leakage', which is when a GHG reduction measure in one location results in an unintentional increase in emissions elsewhere. An example would be if businesses in Leicester are required to meet higher standards of energy and GHG performance, and consumers choose to purchase goods from places with fewer restrictions, even if these result in higher emissions.	Any mitigation measures that are adopted need to consider the potential for dynamic effects and unintended consequences as much as possible – recognising that these are major unknowns.
There is a trade-off between modelling scenarios that get closer to achieving Paris-compliant emissions reductions, and modelling	A significant part of LCC's net zero roadmap will need to rely on other stakeholders and, in particular, seeking Government support and funding. There is likely to be a gap between the

ones that are plausible given the political, social, and financial realities involved.	GHG reductions that Leicester can achieve via direct action/policy intervention, and the overall level of ambition, based on their current levers of influence.

Risks to achieving net zero	
What are they?	**What are the implications?**
The feasibility of reaching net zero, particularly where this requires fuel switching, depends on high levels of demand reduction which will be challenging to achieve.	LCC will need to make demand reduction a high priority. However, at the same time, it is important to make contingency plans (e.g. working with DNOs on infrastructure upgrades) to mitigate against the possibility that those measures do not deliver the scale of reduction needed.
As stated previously, assuming the intervention measures are adopted, the major obstacle to reaching net zero would be inadequate electricity grid decarbonisation.	Key options for addressing this include: • Maximising local renewable energy uptake • Working with stakeholders / lobby Government to support changes in the energy system that will accelerate grid decarbonisation • Potentially planning to focus on measures that make Leicester 'net zero ready', i.e. high electrification
Certain sectors and activities are more challenging to address, either because it is difficult to identify suitable measures (due to lack of data) or because of technical/practical challenges (e.g. lack of viable technological alternatives). These include non-CO_2 gases and energy uses in the industrial and commercial sectors.	If any offsetting measures are adopted, they should address the sources of emissions that are hardest to mitigate otherwise. As shown in the previous sections, due to the scale of offsetting that would be required, it will not be possible to rely on carbon offsetting for sectors or activities where alternatives exist. In some cases, technologies may become available in the future that can address these sources of emissions. LCC will need to keep abreast of developments in this area. Key examples include carbon capture and removal technologies and hydrogen gas.
There is the potential for a social and/or political backlash against many of the mitigation measures, which would have a major impact on spending and lifestyles. There is also a high risk that some of the intervention measures will place a disproportionate burden on vulnerable members of society, fuel poverty being one example. This is particularly important to consider in the context of the local and national response to the COVID-19 pandemic. (See also the previous point about 'leakage'.)	This should be a consideration up front when developing policies, but the potential response also needs to be considered on an ongoing basis as part of monitoring programmes.

Opportunities	
What are they?	**What are the implications?**
District heating, as Leicester already has a well-established network, and some clearly identified anchor loads.	An early decision will be needed on the role that expanding the network, and switching to low carbon sources, should play in achieving carbon neutrality in Leicester – is it OK if emissions reductions will only fully be realised after 2030?
Due to the compact urban nature of the city, there is more scope than in more rural local authorities to fully maximise scope for transport demand reduction and modal shift.	According to the (Draft) Transport Plan, 100,000 residents live within a 10-minute cycle of the city centre. Additionally, the average car journey has a distance of 5km and 25% of car trips are shorter than 2km. This means that uptake of walking and cycling should face fewer hurdles. It is upon LCC and other relevant stakeholders (see section 4.1.2) to ensure that active travel can be done safely and in an enjoyable way.
A shift to active travel instead of a focus on EV uptake reduces the associated energy demand and thereby reduces the challenge of installing EV infrastructure.	LCC will still need to support the uptake of EVs and EV infrastructure. However, a focus on active travel and – to some extent – public transport significantly reduces this challenge due to the much lower energy demand. Additionally, active travel has a vast number of co-benefits as shown in Table 17.
Synergies between carbon neutrality measures and wider public benefits, such as health, cleaner air, improved road safety etc.	To fully realise these benefits, LCC needs to consider them prior to implementation (e.g., green spaces with both carbon sequestration targets and biodiversity co-benefits). In the transport sector, it also means increasing the focus on active travel, perhaps more so than overarching government policies. More detail on co-benefits is provided in 4.3.

Concluding points regarding the net zero pathways analysis

This analysis highlights that the path to zero is extremely narrow, but achievable – if LCC, the Government, individuals, businesses and other stakeholders work together to take immediate action. However, there is very little scope to pick and choose mitigation measures and no scope to accommodate increases in emissions. LCC will therefore need to exercise all available policy levers and other areas of influence. While this is clearly a huge challenge, the scientific consensus is clear on the urgency of reducing emissions, and the cost of failing to act. These considerations should drive actions across all sectors.

Subsequent sections of this report will provide further discussion of the practical considerations, including LCC's level of influence over each of these factors. They will also set out the co-benefits of the measures that are being proposed and, where possible, quantify what these might be, to illustrate the broader reasons for pursuing net zero emissions.

4 Delivering Carbon Neutrality

This section looks at what needs to happen to deliver the level and pace of change outlined in Section 3 above. It considers who the key stakeholders are and what actions they might take and, in particular, what LCC's role will need to be. This is followed by a high-level discussion of the potential costs and wider co-benefits of action.

4.1 Influence mapping

As shown in Section 3.3, in the Business-as-Usual (BAU) scenario, by 2050 there would be a significant 'gap' to net zero emissions. Bridging the gap will require urgent action to be taken in all sectors, across all policy areas. This can only be achieved through close collaboration among national, regional, and local governments, public, private, and voluntary sector organisations, communities, individuals, businesses, researchers, and innovators.

Typically, UK Local Authorities are only directly responsible for a small proportion of GHG emissions. In Leicester, public sector emissions account for roughly 7% of the total (see Section 2.2), which is somewhat higher than the national average.[44] While this figure may still appear small, the opportunity for reaching net zero within the Council should not be disregarded – both because it has significant direct effects (emissions reduction) and because these efforts can exert influence over other sectors through leading by example.

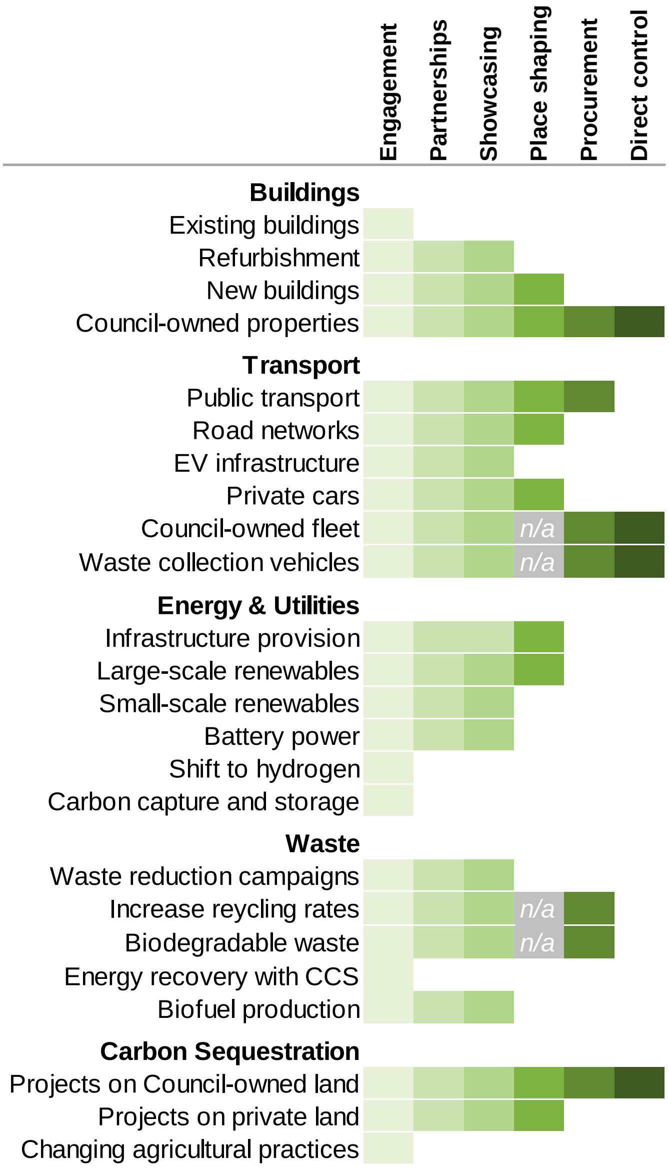
There is usually an inverse relationship between the level of control they exert and the scale of emissions reduction that they can achieve. However, Local Authorities have a wide range of options for exerting indirect influence over emissions that they do not directly control, as shown in Figure 69.

Figure 69. Ways in which local authorities can influence GHG emissions across the area. Adapted from CCC, '*Local Authorities and the Sixth Carbon Budget' (*2020)

[44] This figure includes all public sector buildings and facilities i.e. not just LCC. The Council's 2019/2020 emissions have previously been reported as c. 20 $ktCO_2e$, which is closer to 1-2% of the total.

Figure 70 below summarises how Leicester City Council can influence decarbonisation across key policy areas. The colour coding is used to indicate the ways that LCC can play a role. Indirect methods of influence are shown in lighter green and direct methods in darker green. Grey shading with ‘n/a’ means that a method is not applicable or not likely to be used.

Figure 70. LCC influence over emissions in different sectors



As highlighted in the figure, the Council has the most control over its own properties and vehicle fleet, although it is understood that not all of these are both owned and operated by LCC.

LCC also has an influential role in its capacity as a Local Planning Authority (LPA), setting planning policy and determining the spatial strategy for the City. This is primarily relevant to energy and sustainability standards for new developments, but development management policies can also affect the rate of retrofitting and uptake of small-scale renewables across the City. There is also an impact in terms of the design of the public realm and spatial strategy impacting the way that people travel, and goods are transported, around the City. Overall, however, much of the Council’s influence will be more reliant on engagement with stakeholders to promote carbon reduction projects, showcasing best practice, raising awareness, partnerships and lobbying for change. It is also important to note that local planning policies are required to meet a viability test, which places a significant limitation on what requirements can be put in place.

The following sections of this report provide more detail on each of the policy topic areas, describing the types of changes that need to occur to reach net zero, key policy drivers, major challenges, and important stakeholders. This will be used to inform the development of future carbon pathways for LCC and a feasibility assessment of reaching net zero.

Each section begins by summarising some of the major changes that need to happen to reach net zero, along with an overview of relevant national, regional, and local policy documents or strategies. Then, consideration is given to the key challenges, who are the key players, and finally, where the biggest opportunities are for LCC to play a role.

4.1.1 Buildings

What needs to happen to reach net zero?

- Energy demand in all buildings needs to decrease significantly – including both new and existing buildings. This will require much higher levels of insulation and airtightness and more efficient building services (e.g. heating, ventilation, hot water and cooling), along with smart controls and energy management systems. It is also likely to require changes in user behaviour.
- All buildings will need to be capable of operating with 100% renewable energy, which will involve replacing all heating systems and other building services that rely on fossil fuels. Until and unless hydrogen gas is commercialised, it is likely that heat pumps and district heating will be the main options for heat decarbonisation. Uptake of small-scale renewables and battery storage will also need to be radically scaled up.
- The construction industry as a whole, which is currently responsible for around 60% of waste produced in the UK, will need to adapt to new methods of design and construction that prioritise refurbishment, design for disassembly, and contribute towards a circular economy.

Table 4. Relevant policies and strategies in the buildings sector

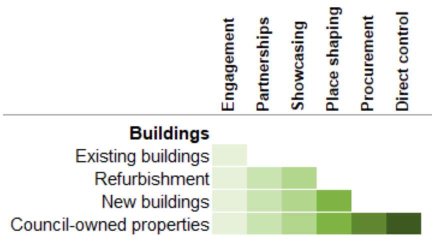
National	Regional	Local
UK Building Regulations (which will be revised in the coming years in line with the proposed Future Homes and Future Buildings Standards) Net Zero Strategy & Heat and Buildings Strategy: • Reach 600,000 heat pump installations per annum by 2028 • No new gas boilers sold by 2035 • Upgrade all rented properties to EPC Band C by 2028 and all homes to EPC Band C by 2035	N/a	Leicester Climate Emergency Strategy 2020-2023: • Promote the Green Homes Grants (Local Authority Delivery) • Warmer Homes, Green Homes Scheme • Continue to enforce national energy efficiency standards City of Leicester Local Plan – Draft for Consultation (March 2020) • All development must demonstrate how it will minimise energy demand and carbon emissions based on the energy hierarchy (Policy CCFR01) • In line with the energy hierarchy, where feasible, deploy low carbon heat networks such as district heating Leicester City Core Strategy (adopted 2014)

Key challenges and the relevant major players are shown in Table 5.

Table 5. Key challenges and major players in the buildings sector.

Key challenges include…	Major players
Reducing energy demand in the existing building stock	Owner-occupiers, landlords and (to a lesser extent) building tenants have the greatest ability to influence energy demand. The Government has introduced the Minimum Energy Efficiency Standards (MEES) to encourage uptake of energy efficiency measures in the private rented stock and Local Authorities are responsible for enforcement. The Government recently announced that it will provide £4.3 million to councils in an effort to clamp down on landlords not complying with energy efficiency regulations.
Decarbonising heat and switching away from natural gas and other fossil fuels	As with demand reduction, owner-occupiers, landlords and (to a lesser extent) building tenants have the greatest ability to influence the choice of heating systems. BEIS is responsible for setting energy policy at a national level. National, regional, and local governments can play a role by offering financial incentives to switch heating systems such as the Renewable Heat Incentive. For more information on energy, see Section 4.1.3.
Ensuring that new buildings are compatible with a net zero future	MCHLG is responsible for UK Building Regulations on energy and carbon emissions, and Local Authorities are responsible for certain aspects of enforcement. Most of the direct enforcement is done through private sector inspection companies that are regulated by Local Authorities. LPAs can currently set higher performance standards subject to viability considerations, but this may change in the future. Developers are also major players, and many have voluntarily adopted higher sustainability standards for their projects.
Adopting Circular Economy principles across the entire construction industry	County Councils and Unitary Authorities are responsible for waste management, but in practice there are few levers to achieve this type of fundamental shift in construction practice. LPAs can play a role through planning policy but most of the influence lies with industry bodies, developers, construction companies, manufacturers, and designers.

What areas can LCC influence the most?



- LCC's main area of influence will be in the Council-owned housing stock and other non-domestic properties. The Council will need to primarily rely on engagement and partnerships to reduce emissions in the rest of the building stock, e.g., continuing to provide energy saving advice. Local Authorities can enforce MEES regulations, although to date very few have done so due to lack of resources, local opposition, and other issues. This may improve in the near future as a result of additional funding.
- LCC has more influence over new buildings and major refurbishments via the Local Plan and building control, and direct influence over council-owned properties or developments.
- LCC can also play a coordinating role in helping to decarbonise and potentially expand the energy network, (e.g., feasibility studies and engaging with stakeholders), and developing a spatial strategy that facilitates the use of waste heat, where available.

4.1.2 Transport

What needs to happen to reach net zero?

- To reach net zero, all vehicles will need to utilise 100% renewable energy – whether that is renewable electricity, hydrogen, or biofuels. Based on current technologies, electric vehicles (EVs) are likely to be the first choice for cars, vans, and most other vehicles, with the exception of heavy goods vehicles (HGVs), which are more likely to run on biofuels or hydrogen.
- This transition will require a massive increase in the provision of EV charging facilities, along with much more renewable electricity generation. This will be much more achievable if there is a radical reduction in demand for travel, which includes changes in consumer habits and switching towards walking, cycling, car clubs/ridesharing, e-scooters (where appropriate) and public transport.

Table 6. Relevant policies and strategies in the transport sector.

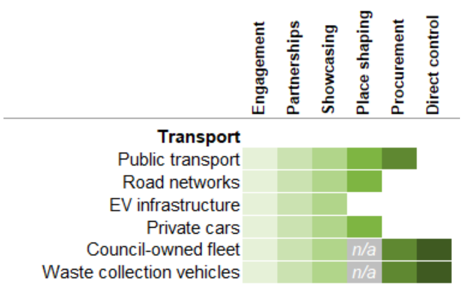
National	Regional	Local
The Transport Decarbonisation Plan • Ambition for half of journeys in towns/cities to be walking or cycling by 2030 • Delivery of 4,000 zero emission buses and associated infrastructure • Phase out diesel trains by 2040 and achieve a net zero rail network by 2050 • Increase average road vehicle occupancy • National e-scooter trials • Local Authority toolkit on sustainable transport expected to be released in 2022 • Ban sale of new petrol and diesel cars and vans by 2030, and all new cars and vans to be zero emission at tailpipe by 2035 • Consult on phase-out of internal combustion engine HGVs	'Leicester and Leicestershire Working Together - Strategic Transport Priorities 2020-2050' • Continue to promote rail as an alternative to private cars for travel between cities • Support commercial coach services to continue to deliver an alternative to rail for mid- and long-distance journeys. • Encourage active travel to and from stations	Leicester Transport Plan (Draft) 2021-2036: • Public transport, Park & Ride, cycling or personal e-mobility as the first choice for longer journeys for most people. • Active transport as the first choice for shorter journeys for most people. Leicester Climate Emergency Strategy 2020-2023: • Behavioural changes in businesses, schools, and through public campaigns • New bus lanes & services • 127 EV charging points planned for 2021/22 • 24km of new cycleway planned • E-bike hire scheme planned (500 bikes)

Key challenges and the relevant major players are shown in Table 7.

Table 7. Key challenges and major players in the transport sector.

Key challenges include…	Major players
Influencing consumers to choose low emission vehicles	National and local governments can play a role via awareness campaigns, but this is largely down to market forces. Analysis by organisations such as Cambridge Economics, Element Energy and Deloitte indicates that the price of traditional fuel vehicles and EVs will converge in the next few years. Local employers can also encourage faster uptake by the public if they bring ULEVs into their own fleets, as staff driving them will experience the technology first hand and become more comfortable with it.
Behaviour change and travel habits	As above, the role of local government may involve awareness campaigns and other initiatives – for example, LCC is already involved in a cycle training and e-bike hire scheme – but they can also have an influence by delivering towns and places that facilitate sustainable travel (see below).
Design of towns, cities, and roads to facilitate sustainable travel	Urban planning is within LCC's remit as an LPA, and the Council is also the Local Highways Authority for most of the roads in Leicester. Responsibility for the major road network lies with National Highways. DfT plays a strategic role in setting transport policy nationally while Local Transport Plans are produced by LCC.
Providing renewable electricity and other supporting infrastructure	LCC is likely to continue to be involved in the procurement of some EV charging infrastructure, but this will also be provided by businesses and home/landowners. For more information on energy, see section 4.1.3.

What areas can LCC influence the most?



- LCC will need to rely on showcasing, partnerships, and engagement to successfully encourage uptake of private EVs. This will include working with the County Council and National Highways to make sure that the road network prioritises pedestrians, cyclists, and public transport. The Council could also use parking policy or charges to incentivise uptake.
- Additionally, the Council needs to ensure that all new developments are located and designed to reduce demand for travel and encourage active/sustainable transport options, including via EV charging provision, and the Local Plan. This could involve, for example, setting maximum rather than minimum parking standards, and identifying sites for consolidation centres to reduce the number of commercial goods vehicles operating in town centres. This would have co-benefits for air quality, public health, etc.
- For assets directly controlled by LCC, the planned EV charging points (co-located with renewable power generation and battery storage) need to be rolled out and it needs to be ensured that the vehicle fleet is 100% low emission.
- It is understood that funding has already been granted to convert some buses to EV; LCC should continue to seek funding for the rest of the fleet to be EV by 2030. The 'Leicester Bus Services Improvement Plan' published in 2021 includes a target to do so.

4.1.3 Energy & Utilities

What needs to happen to reach net zero?

- A fundamental transformation of the UK energy system is needed to phase out fossil fuels by 2050 at the latest. In the Energy White Paper (2020) the Government envisions that electricity use could double in that timeframe, meaning that the deployment of renewable technologies – along with battery storage and improvements to grid infrastructure – will need to scale up at an unprecedented rate.
- The Government has announced an ambition to deliver 40GW of offshore wind power by 2030, potentially enough to power all homes in the UK. However, to ensure security of supply, it will be important to work towards a diverse system that includes large- and small-scale solar, wind, tidal power, hydropower, and bioenergy, among other technologies. This will require a shift in thinking such that there is a presumption in favour of renewable energy projects of all scales.

Table 8. Relevant policies and strategies in the energy sector.

National	Regional	Local
'Net Zero Strategy: Build Back Better' HM Government (2021) • Fully decarbonise the power system by 2035 • Increase offshore wind from 10GW (2019 levels) to 40GW by 2030 • Support renewables with nuclear power including small modular reactors	Energy Infrastructure Strategy for Leicester and Leicestershire (2018) • 100% clean energy by 2050	Leicester Climate Emergency Strategy 2020-2023: • Rapidly increase renewable energy generation in the city and encourage storage of surplus to help meet demand at peak times. • Carry out a feasibility study, secure funding and develop a programme to install solar PV panels on council housing.

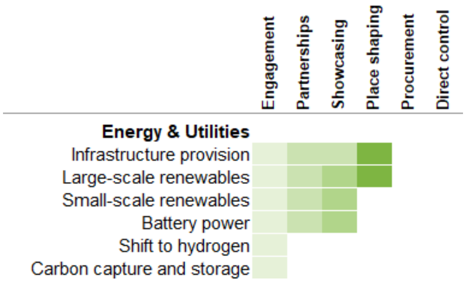
Key challenges and the relevant major players are shown in Table 9.

Table 9. Key challenges and major players in the energy sector.

Key challenges include…	Major players
Reducing costs and financial barriers to enable further uptake	At a national level, Ofgem regulates gas and electricity markets and funds certain types of energy infrastructure projects. It also manages financial incentive schemes such as the Renewables Obligation, Renewable Heat Incentive, and the Smart Export Guarantee. BEIS provides funding for emissions reduction projects (SALIX), heat network feasibility studies (via the Heat Network Deployment Unit), and other research.
Upgrading existing grid infrastructure	National Grid is in charge of transmission of both electricity and gas. The distribution network operator (DNO) for electricity in Leicester and surrounding areas is Western Power Distribution, while the DNO for gas is Cadent.

Identifying and allocating areas for large-scale renewable energy projects	There are very limited opportunities to deliver large scale renewable energy projects within Leicester itself. In general, Local Authorities play a role by identifying suitable areas for renewable energy projects and setting planning requirements. Other key players include community energy groups, along with organisations and businesses that deliver renewable energy projects.

What areas can LCC influence the most?



- LCC has relatively limited influence over the decarbonisation of the national grid, but can play an indirect role through engagement, partnerships and in its capacity as an LPA. For example:
    - Demonstrating and showcasing the feasibility and benefits of projects, particularly small-scale renewable energy and battery power projects on council-owned land or properties, or innovative pilot projects
    - Playing a coordinating role (e.g., through community energy projects)
- In terms of infrastructure provision and large-scale renewables, there are limited options within the City boundary. LCC should therefore seek to engage with neighbouring Local Authorities and the County Council and try to support or promote suitable projects where possible. This will also need to involve engaging with Western Power Distribution, energy companies, and landowners to identify any suitable locations and support infrastructure improvements.
- The Council should also seek to lobby the Government for additional support and funding.
- There are limited opportunities for LCC to influence the use of some technologies such as hydrogen gas and carbon capture usage and storage, initiatives which will be driven predominantly at the national level. LCC's role in this regard will primarily be to keep abreast of new developments. There could potentially be opportunities to engage in pilot schemes in future.

4.1.4 Land Use and Carbon Sequestration

What needs to happen to reach net zero?

- According to the Committee on Climate Change (CCC), some reduction in greenhouse gas emissions can be achieved by adopting low carbon farming practices e.g., better soil and livestock management, less use of fertilisers, and increased diversification. However, the CCC also states that a net zero future will require a large increase in natural carbon sequestration through afforestation, peatland restoration, and similar projects. This can only be achieved if large areas of agricultural land are released for alternative uses – which, in turn, would rely on shifts in consumer behaviours and diets, reducing food waste, and new farming technologies to maintain per capita food production.
- Land use policies will therefore need to recognise the value of natural capital and reward activities that deliver environmental benefits. Although carbon sequestration through land use is not a major part of Leicester's roadmap, it is vital that existing carbon sinks are protected and continue to be enhanced in line with biodiversity considerations. Green urban infrastructure further comes with a vast number of co-benefits (see Section 4.3).

Table 10. Relevant policies and strategies in the land use sector.

National	Regional	Local
The Environment Act The 25 Year Environment Plan • Embed environmental net gain as a principle for development (including housing and infrastructure) • Improve soil health and expand tree cover • Green towns and urban areas The England Trees Action Plan 2021-2024 • 12% woodland cover by mid-century Note, the CCC and Woodland Trust both recommend 19% tree cover Agriculture Bill (2020)	• n/a	Leicester Climate Emergency Strategy 2020-2023: • Use existing, or introduce new, planning policies which encourage the provision of green infrastructure and maximising the benefits it has to mitigate and adapt to a changing climate. • Identify suitable locations and tree species for mass tree and hedge planting to create new 'climate woodland' in the city. Leicester Biodiversity Action Plan 2021-2031 Leicester Tree Strategy 2018-2023 Leicester Green Infrastructure Strategy 2015-2025

Key challenges and the relevant major players are shown in Table 11.

Table 11. Key challenges and major players in the land use sector.

Key challenges	Major players
Protecting existing carbon sinks, while also protecting ecosystems, natural habitats, and biodiversity	DEFRA is responsible for Government policy on a range of environmental topics including but not limited to land management, conservation, biodiversity, and climate adaptation. Natural England is responsible for designating and managing certain nature reserves, parks, and other areas of the countryside. The Environment Agency (EA) is responsible for protecting the environment which includes regulating environmental pollution. Local Authorities play a part in their role as LPAs, with responsibility for areas protected for biodiversity. The Council is also the major landowner of most open space in Leicester, so can have a big influence on use and management of those spaces.
Low carbon agricultural practices (livestock and land management)	Policy, regulations, and enforcement are primarily the responsibility of DEFRA and the EA, but the decision to exceed minimum standards and adopt low carbon practices would largely fall to landowners. Farming tenants are key stakeholders but have less influence over land use.
Increasing tree cover and ensuring it is sustainably managed in the long term	Policy is set at a national level by DEFRA, although LCC can contribute directly as a major landowner within the City, and indirectly via its role as an LPA. The Council has already set out a number of relevant strategies such as the Leicester Biodiversity Action Plan (2021-2031) and the Leicester Tree Strategy (2018-2023).

Releasing agricultural land for alternative uses e.g., woodland or rewilding projects	As above, the spatial strategy for the City can have a small impact; however, most of the changes will happen outside Leicester. The major players include consumers (whose dietary and lifestyle habits influence production), private landowners, businesses, industry bodies, communities, and researchers/innovators in the field of agricultural production.

What areas can LCC influence the most?

- LCC can potentially deliver carbon sequestration projects on council-owned land outside of the city boundaries although this is clearly subject to practical constraints such as existing lease agreements. It needs to be ensured these projects also consider biodiversity requirements, tackling the Ecological Emergency alongside.
- The Council can further provide business support to landowners and farmers to enable them to adopt low carbon practices, and support research initiatives or pilot projects on these topics as appropriate.
- There is scope for LCC to partner with other local authorities or organisations to deliver projects within (or outside of) the City such as woodland creation.
- LCC can promote tree cover and other green infrastructure via the Local Plan and spatial strategy, although in practice this would primarily impact new developments. The requirement for certain developments to achieve Biodiversity Net Gain should lead to woodland and other habitat creation, both on development sites and elsewhere. Note that biodiversity should be given high importance alongside carbon emissions and energy use in planning policy, although that is not the focus of this report.

4.2 Costs

4.2.1 Introduction

This section presents a rough assessment of the resource costs (present value[45]) of the proposed mitigation measures described in Section 3, *where sufficient data was available to support an estimate.*

Market research and case study evidence show that there is considerable variation in the costs of these measures even today. Bearing in mind the limited scope of this project and very high level of uncertainty in predicting the costs of climate mitigation measures years and decades into the future, the costs presented in this report are solely intended to indicate the order of magnitude of investment that may be required. This enables a rough comparison (a) between different measures and (b) across different scenarios. Further work would be needed to validate these findings and to get more detailed and robust estimates.

4.2.2 Approach to estimating costs

Broadly speaking, the assessment considers the typical unit costs of each measure (e.g. price of a typical whole-house energy efficiency retrofit) and the number of units that are required (e.g. number of homes). The latter is based on outputs from the NZP tool and data collected as part of the baseline assessment, so the results align with the other modelling assumptions used in this report.

Where it is considered likely that the cost of a technology could decrease in future, either due to adopting measures at scale or other market factors, this has been modelled implicitly by selecting typical prices that are at the lower end of the range. This applies to the cost of heat pumps, domestic retrofits and electric vehicles. Fuel bill savings are based on the changes in energy demand associated with each measure, as modelled in the NZP tool, and 2021 typical fuel prices.

This information is used to calculate:

- *Capital expenditure*, i.e. the unadjusted level of investment that would be required.
- *Net capital expenditure*, which covers the investment required, minus costs saved on fuel bills (where relevant) or costs that would have been incurred anyway without the transition to net zero (where there is a comparable alternative). This can be thought of as 'extra over' costs, e.g. the difference in price between a heat pump and boiler.

The calculations consider intervention measures taking place within Leicester, but do not include the costs of wider enabling measures that would also be needed. Examples include, but are not limited to:

- Upgrading the wider UK electricity grid network to support grid decarbonisation,
- Changes to the physical road network to facilitate a shift away from the use of private vehicles
- Any initiatives/campaigns that would be needed in order to promote or administer the measures.

Results are presented as totals and as average annualised figures. For the sake of comparison, they are also shown as a percentage of Leicester's current and forecast GDP[46]. However, these figures should be interpreted with great caution given the levels of uncertainty involved, and bearing in mind

[45] Discounted to reflect the fact that costs and benefits in future years are valued less than nearer term costs and benefits.
[46] Nominal GDP (not adjusted for inflation). Figures from ONS, 2021.

that some measures could not be costed due to data and resource limitations. Also note that some of the measures could have beneficial impacts on Leicester's economy overall (see Section 4.3) but those effects have not been quantified as part of this study.

4.2.3 Results and discussion

Overall, the cost of delivering the intervention measures, where data was available to support an assessment within the scope of this study, ranges from £950m to £5.3bn. The most ambitious scenario (#3) is understandably the most expensive. Divided equally over 9 years, the costs of aligning with Scenario 3 would be between £550-600m, which for context is approximately 5% of Leicester's forecast GDP and 6% of current GDP.[47] Results for each scenario are outlined in Table 12 below.

Table 12. Estimated net capital investment costs

Scenario	Present value (£bn)	Annualised (£m/year)	As a proportion of forecast GDP	As a proportion of 2019 GDP
1	£0.95	£100	1%	1%
2	£3.5	£400	3%	4%
3	£5.3	£600	5%	6%
4	£3.8	£200	4%	2%

Those are the estimated 'net costs', i.e. the additional cost over and above what would otherwise have been spent; they also include cost savings, for example from reduced fuel bills. If these are removed, we get an overall gross capital investment cost of £2-9bn across the scenarios modelled. For Scenario 3 the gross capital costs would be around £1bn per year (8-9% of forecast GDP or 10% of current GDP) over the time period to 2030.

Table 13. Estimated capital investment costs

Scenario	Present value (£bn)	Annualised (£m/year)	As a proportion of forecast GDP	As a proportion of 2019 GDP
1	£1.9	£200	2%	2%
2	£5.3	£600	5%	6%
3	£9.1	£1,000	9%	10%
4	£7.1	£350	7%	4%

Table 14 and Table 15 provide a more detailed breakdown of the costs of each measure and key assumptions. **Note that those figures are not discounted, so they do not add up to the totals shown above.**

Overall, they show that refurbishing the existing building stock, and then replacing fossil fuel heating systems, is expected to incur the highest resource costs. Depending on the level of energy performance, the capital investment required to retrofit the entire domestic stock is estimated in the region of £2.5-3bn, while replacing all domestic gas boilers with air source heat pumps as in Scenario 3 is estimated to cost an additional £700-800m (capital costs would increase if some switch to ground source heat pumps, although these would also offer greater energy savings). The Government hopes that the price of heat pumps will decrease in future[48] and has promised[49] to take steps to ensure that

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[47] ONS, 2021
[48] Boiler Upgrade Scheme (BUS) | Ofgem
[49] Plan to drive down the cost of clean heat - GOV.UK (www.gov.uk)

they are comparable with gas boilers, although this is likely to be limited in the timescale between now and 2030.

The cost of implementing energy saving measures in the non-domestic building stock is estimated at roughly £1-1.5bn (although note that this includes other measures such as smart controls, LEDs and heat pumps).

Although improving the energy efficiency of buildings would tend to decrease energy bills, the savings associated with that measure will be partially offset in buildings that switch from fossil fuel to electric heating systems, due to the higher current cost per unit of electricity. This is accounted for in the calculations.[50] Upgrading buildings to a higher energy efficiency standard is important to help keep bills down for building occupants when heating systems are electrified.

The other most significant capital costs are those associated with replacing existing petrol and diesel vehicles with EVs, which is estimated to require capital investment in the region of £3-4bn if the entire fleet was to be replaced. However, the *net* costs are expected to be much lower, considering the replacement of vehicles that would happen anyway, the decreasing difference in the cost of combustion engine vs. electric vehicles, and the very significant savings in fuel bills. If EVs reach cost parity with petrol and diesel cars and vans by the mid-2020s as predicted, then some progress will be made at no net additional cost by those who will buy a new car before 2030.
Another very important consideration when interpreting the costs of the transport measures is that they are based on the investment required to replace the entire existing vehicle fleet, on the assumption that even if there is a reduction in private vehicle journeys, ownership rates might stay the same. If this is *not* the case, and car/van ownership decreases, then the costs of replacing the vehicles would be lower.

The cost of installing EV charging points is also reliant on the assumed mixture of public and private charging points, and how fast they can recharge a vehicle. In terms of the mix of EV charging points, these calculations are based on evidence that has been collected for other UK cities but there is obviously a large amount of uncertainty regarding the future mix of charging technologies at a city scale. There is also the potential for new technologies (such as vehicle-to-grid systems) to emerge that would have a big impact on the preferred mix of technologies and vehicle charging practices.

Note that the calculations assume that, in Scenario 3, there is a roughly three-fold increase in bus journeys which results in more EV buses being purchased. This also means that, while the fuel costs for existing buses would go down, overall fuel costs for buses will go up as there are more vehicles.

Some measures are more likely to pay back the initial investment due to reducing energy bills, namely smart controls, LED lighting and PV. As with fabric efficiency measures, the benefits of smart controls may be partially offset by higher costs when switching from gas to electric heating systems. For PV, the capital costs have decreased radically in the last decade, which has reduced the payback period to as little as a few years even when accounting for the cancellation of the Feed-in Tariff; the benefits are greater when more of the electricity generated can be used on-site.[51]

The cost of switching to hydrogen boilers and HGVs has been estimated based on an assumed price premium, but due to the fact that these technologies are not yet commercialised, should be

[50] Depending on future Government policies, which may aim to shift the tax burden off electricity and onto fossil fuels, it is possible that the cost disparity will begin to decrease, but the timing and scale of that change is uncertain.
[51] Smart Export Guarantee (SEG) | Ofgem

interpreted with additional caution. This is another example of a measure that would incur wider enabling costs (to adapt the gas grid to accommodate hydrogen) that have not been estimated.

Table 14. Estimated Capital Investment Costs (£million) – not discounted

Sector	Description of measure	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Comments
Domestic	Fabric efficiency measures	£459	£2,524	£3,078	£2,524	Domestic energy efficiency retrofits can cost anywhere from £10,000 to £30,000, while very high specification retrofits such as Energiesprong can cost £65,000 or more. The calculations assume that there will be some cost savings due to the large-scale rollout of domestic retrofitting measures.
	Smart controls	£28	£28	£31	£28	Typical installation costs are £200-£300 per household. These calculations assume that there is already some level of uptake.
	Replace gas cooker with electric	£38	£38	£38	£38	Based on typical prices of domestic induction, gas and electric cookers.
	Expand DHN to meet c. 5% of domestic heat demand currently supplied by gas				£12	A benchmark (£/MWh) was developed based on the existing city centre energy network. This aligns with other published research on DHN costs in the UK. Heat demand is based on NZP tool outputs.
	Replace gas or fossil fuel boiler with air source heat pump (ASHP)	£79	£676	£786	£676	Domestic heat pumps can cost anywhere from £7,000-£18,000 depending on the system type.
	Install LED lighting	£31	£31	£31	£31	Replacing all household lights can cost around £250-£350. These calculations assume that there is already a significant level of uptake.
	Install PV	£10	£49	£97	£97	Based on typical costs (£1500/kWp) of small-scale roof-mounted PV (<4 kWp).
Non-Domestic	Energy efficiency retrofitting, smart controls, LED lighting and heat pumps	£336	£672	£1,344	£1,344	Costs of refurbishing non-domestic buildings varies widely but the CCC indicates these are often in the region of £300-400/m2 floorspace. These metrics include fabric efficiency, smart controls, lighting, and HVAC upgrades; individual measures have not been disaggregated.
	Replace gas cooker/catering equipment with electric	£9	£9	£9	£9	Based on typical prices of commercial induction, gas and electric cookers.
	Expand DHN to meet c. 5% of non-domestic heat demand currently supplied by gas				£9	A benchmark (£/MWh) was developed based on the existing city centre energy network. This aligns with other published research from BEIS on DHN costs in the UK. Heat demand is based on NZP tool outputs.
	Replace gas boilers with hydrogen boilers				£76	Based on typical costs of commercial boilers, and assuming there is a 25-50% price premium on hydrogen boilers. However, the technology is not yet commercialised so this is considered highly speculative.

	Install PV	£3	£15	£31	£31	Based on typical costs (£1000/kWp) of small-scale roof-mounted PV (5-10 kWp).
Transport	HGV driver training	£0.2	£0.3	£1	£1	Available training courses vary in price from roughly £400-£700 per HGV driver.
	Replace cars with EV	£931	£1,563	£3,685	£3,685	Based on typical costs of a new car and the number of cars that would switch to EV as per the NZP tool.
	Replace vans with EV	£122	£204	£481	£481	Based on typical costs of a new van and the number of vans that would switch to EV as per the NZP tool.
	Replace motorcycles with EV	£8	£13	£31	£31	Based on typical costs of a new motorcycle and the number of motorcycles that would switch to EV as per the NZP tool.
	Replace buses with EV (and increase bus fleet)	£76	£205	£644	£400	Calculations account for the fact that LCC has funding to convert c. 200 buses to EV plus the need to purchase more buses if expanding the public transport network. Electric single decker buses cost up to £340,000 per bus.
	Replace HGVs with hydrogen	£0.2	£2	£2	£21	Research suggests there will be a 25-50% price premium on hydrogen HGVs. However, the technology is not yet commercialised so this is considered highly speculative.
	EV charging infrastructure to support above	£29	£49	Up to c. £115		The costs shown for Scenarios 3 and 4 represent high estimates based on the number of chargers that would be needed to supply the entire current vehicle stock with no reduction in transport demand or change in car ownership. Costs shown for Scenarios 1 and 2 are pro rated based on the relative scale of EV uptake in those scenarios. These costs could decrease by as much as 50% if demand reduces. The estimates are also highly sensitive to assumptions about the mix of public vs private chargers, and whether they are slow, fast or rapid. Between half to two thirds of the costs shown would be for private residential chargers.

Figure 71. Estimated Capital Investment Costs (£million) – not discounted

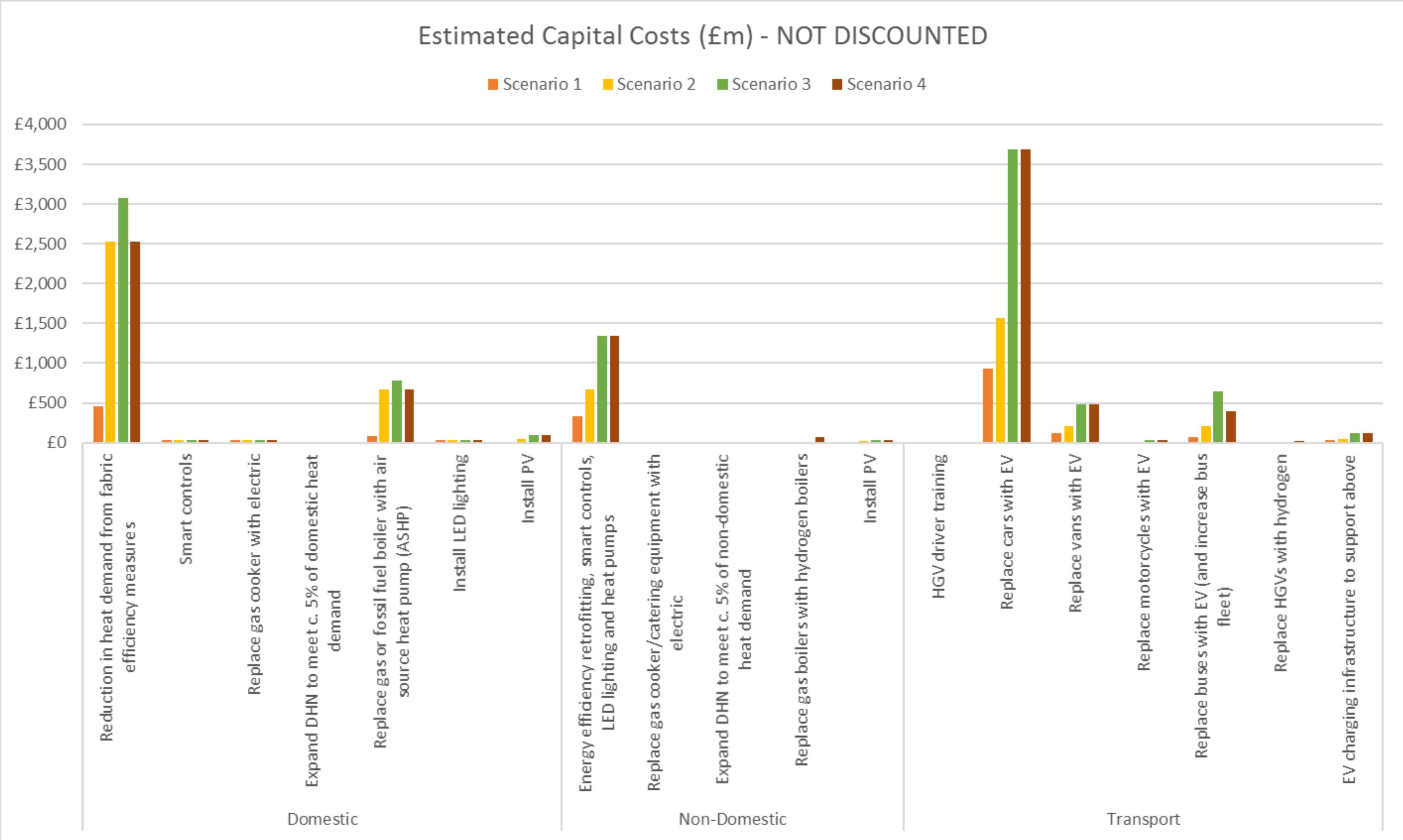
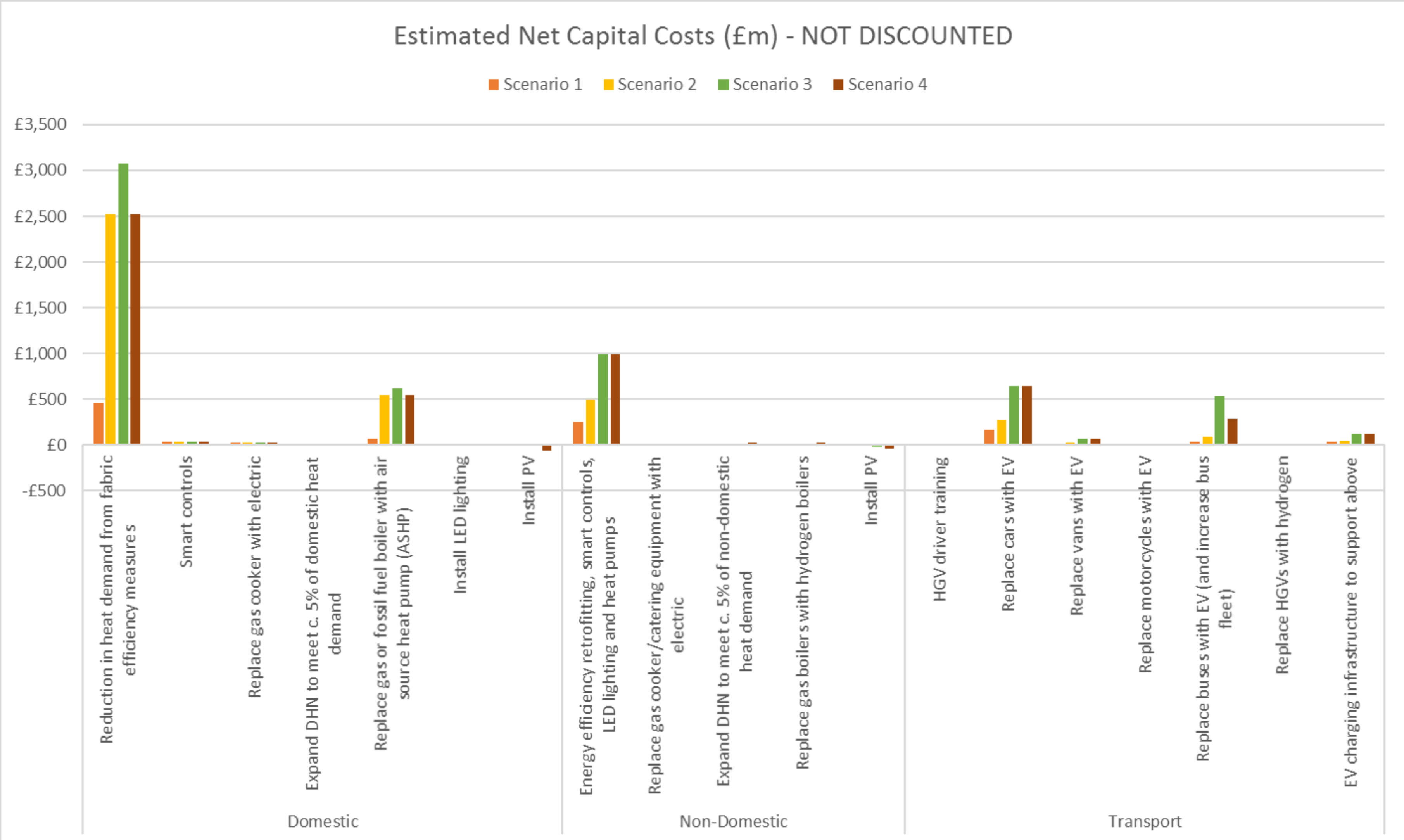


Table 15. Estimated Net Investment Costs (£million) – not discounted

Sector	Description of measure	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Comments
Domestic	Fabric efficiency measures	£459	£2,524	£3,078	£2,524	Same as gross capital costs on the basis that (a) the measures would not happen anyway and (b) fuel bill savings are affected by subsequent heat pump uptake so the overall impact is calculated as part of the ASHP measure (see below)
	Smart controls	£28	£28	£31	£28	As above
	Replace gas cooker with electric	£18	£18	£18	£18	Fuel bills will tend to increase due to the higher cost of electricity, despite the higher efficiency of induction hobs compared with gas
	Expand DHN to meet c. 5% of domestic heat demand currently supplied by gas				£12	Same as capital costs as difference in fuel bills is unknown
	Replace gas or fossil fuel boiler with air source heat pump (ASHP)	£62	£541	£621	£542	The fuel bill savings here account for the fact that domestic heat demands will decrease due to fabric efficiency measures (see above)
	Install LED lighting	-£4	-£4	-£4	-£4	Due to the ban on incandescent bulbs, it is assumed that all new lightbulbs will be LED anyway, so these lead to a net cost saving due to lower bills
	Install PV	-£1	-£5	-£11	-£60	This calculation assumes that approximately 50% of the electricity generated by PV is used onsite and the rest is exported to the grid, resulting in significant energy bill savings. These benefits would increase if more electricity is used onsite.
Non-Domestic	Energy efficiency retrofitting, smart controls, LED lighting and heat pumps	£247	£493	£988	£988	Accounts for measures that reduce energy demand as well as potential increases in bills due to switching from gas to electric heating.
	Replace gas cooker/catering equipment with electric	£9	£9	£9	£9	Fuel bills will tend to increase due to the higher cost of electricity, despite the higher efficiency of induction hobs compared with gas
	Expand DHN to meet c. 5% of non-domestic heat demand currently supplied by gas				£17	Same as capital costs as difference in fuel bills is unknown
	Replace gas boilers with hydrogen boilers				£19	Net costs account for the fact that some boilers would be replaced anyway but do not account for differences in fuel bills as the impact is unknown
	Install PV	-£2	-£9	-£18	-£40	As for domestic PV
Transport	HGV driver training	-£0.1	-£0.5	-£2	-£1	Net costs account for lower fuel costs following training. This results in near zero net costs for Scenarios 1 and 2 and net savings in Scenarios 3 and 4. Changes in fuel use based on the NZP tool.

	Replace cars with EV	£159	£267	£637	£646	Net costs account for the fact that some cars would be replaced anyway, plus significantly lower fuel costs. Changes in fuel use based on the NZP tool.
	Replace vans with EV	£15	£24	£61	£61	As for cars
	Replace motorcycles with EV	£1	£2	£6	£6	As for cars
	Replace buses with EV (and increase bus fleet)	£37	£86	£528	£283	Net costs account for difference in price of technology as well as lower fuel costs, however, note that due to the modelled increase in use of buses, there are still new buses that would not have been purchased otherwise, and these will incur additional fuel costs to run.
	Replace HGVs with hydrogen	£0.1	£0.6	£0.8	£7	Net costs account for higher price of technology but no difference in fuel bills due to lack of data to support an estimate.
	EV charging infrastructure to support above	£29	£49	£115	£115	Same as capital costs. See associated notes.

Figure 72. Estimated Net Investment Costs (£million) – not discounted



Although these numbers are large, there are some important factors to note:

First, these figures are high-level estimates intended to illustrate the order of magnitude of the funding required. There is huge uncertainty around future costs and the speed with which they can come down. As it stands, at present many of the individual measures can vary by up to 50% in cost.

It is possible – perhaps likely – that meeting carbon neutrality after 2030 would lower some of these costs, whether due to market maturity, or additional Government funding. Clearly, it would also reduce the annual investment needed. But such an approach would not be consistent with the city's desire to be a leader on the climate emergency, as evidenced by its ambition to achieve carbon neutrality by 2030 or sooner.

Second, some of the costs will not be truly new or additional – they would require reassignment of investments that would otherwise be spent on 'business as usual' measures such as refurbishing buildings without improving their energy performance, or expanding roads to accommodate traffic growth.

Third, not all of these costs would fall on the Council – many will need to be met by other stakeholders, including businesses, householders, landlords, and other public sector bodies. One of the major challenges will therefore be to ensure that 'conventional' investments by all these stakeholders are reassigned towards measures that help Leicester along the path to carbon neutrality.

Finally, some of the most important benefits of investing in carbon neutrality are 'common goods' – such as 'helping to avert climate catastrophe' – that are critical to achieve, but do not necessarily generate streams of income for any particular investor. Others are classified as co-benefits, which may have a range of positive, but indirect, financial impacts as well as environmental and social ones. These factors are not reflected in the numbers above but are discussed further in Section 4.3.

Priority measures

Because Leicester is aiming to achieve net zero emissions 20 years in advance of the national deadline, there will understandably be less public funding available to support these measures. Realistically, in the immediate term, there is likely to be more of a focus on:

- Investments that are known to be cost-effective, such as LED lighting and smart energy controls
- Opportunities for LCC and other public sector organisations to access low-cost borrowing and public funding
- Engaging with, and showcasing, examples of businesses or households implementing best practice in reducing their own emissions
- Identifying alternative or innovative sources of funding such as green bonds

However, clearly this approach will not be enough to deliver net zero by 2030, which makes it all the more important to avoid actions that could either directly increase emissions (e.g. less efficient new developments or road network expansion), or lock in future emissions (e.g. replacing old gas boilers with new ones).

4.3 Benefits

As well as the costs, there will also be significant benefits to this climate action. Some examples of likely co-benefits for each sector are outlined in Sections 4.3.1 to 4.3.4. Aside from cost savings due to lower energy bills, the investment costs outlined above do not take account of the potential cost savings from these co-benefits. Some of these could be quite significant and would help reduce overall net costs. As an example, the cost savings from the improvement in air quality (see Table 17 and Table 18) could save Leicester City up to £7.2m annually – the current cost of air pollution to Leicester's economy.[52] Nor does it take account of the cost of not taking action on climate change, which will be huge.

Care will need to be taken to ensure that the actions to deliver carbon neutrality do not worsen social inequality by hitting certain groups harder. For example, households experiencing fuel poverty would risk seeing their bills increase if they switch from gas boilers to electric heating without a significant reduction in energy demands. It is also especially important to ensure that any retrofitting measures are undertaken to a high standard to avoid issues such as damp and moisture problems, which would have negative health impacts – disproportionately impacting those who are already vulnerable – and potentially exacerbate issues with poor quality housing.

4.3.1 Buildings

There are also a large number of co-benefits which can be realised from measures in the buildings sector, especially through the implementation of energy efficiency measures. Energy efficiency measures cover a vast range of interventions from fabric improvements and smart heating controls to the installation of heat pumps and hydrogen boilers. As LCC follows the 'fabric first' approach (LCC, 2020), initial measures for most Leicester residents are likely to be fabric improvements – although an upgrade to low emission heat systems will need to either be undertaken at the same time or follow swiftly to achieve carbon neutrality. An overview of co-benefits from local energy efficiency measures including an explanation of what this means in more detail can be found in Table 16.

Table 16. Common co-benefits of energy efficiency measures in buildings.

Co-Benefits	Elaboration
Boost local employment	Retrofitting measures have the potential to facilitate job creation in construction, manufacturing, installation, and design. The UK Government's Green Jobs Taskforce[53] aims to create a total of 2 million "green" jobs by 2030; for Leicester, this could translate to between 5,000-10,000 new jobs.
Socio-economic development	This will especially be realised for deprived areas through factors such as local employment, spending, and increased property values (Gillard et al., 2017).
Reducing fuel poverty	Enhancing energy efficiency in buildings reduces the amount of fuel required to heat homes, thus contributing to the reduction of fuel poverty (Ashden, 2020). Leicester is particularly affected by this issue with 19% of households being classed as fuel poor as of 2019 compared to the national average of 13.4% (England) (BEIS, 2021). The 2018 Leicester Health and Wellbeing survey further showed that the by far most affected group experiencing food or fuel poverty are off work long-term sick or disabled residents – 41% of which were affected by this issue. Additionally, while only 7% of homeowners experienced food or fuel poverty, 17% of private and 18% of social renters did compared to the 12% average determined by the survey (LCC, 2019).

[52] LCC, 2015: Healthier Air for Leicester. Leicester's Air Quality Action Plan (2015-2026)
[53] UK government launches taskforce to support drive for 2 million green jobs by 2030 - GOV.UK (www.gov.uk)

Reduced adverse health impacts	Fuel poverty has various adverse effects on the population, and it is estimated that nearly 1/3rd of excess winter deaths (EWDs) in the UK each year are directly or indirectly linked to fuel poverty.[54] This is primarily due to respiratory and cardiovascular diseases being exacerbated by cold conditions, along with higher incidences of trips and falls, in addition to hypothermia. In Leicester, that would translate to roughly 50-60 deaths per year.[55] Some of these could be avoided by introducing more energy efficient housing. Adequate heating can also reduce the risk of mould in homes and improve thermal comfort. Aside from physical health, mental health was also found to be affected negatively by fuel poverty with the risk for these issues increasing fivefold if an individual experiences fuel poverty. Finally, children are a particular risk group as negative effects on their education, diet, and physical fitness have been observed (Friends of the Earth & the Marmot Review Team, 2011).
Cost savings	People commonly undertake energy efficiency measures in the hope that this will lead to long-term savings. The payback time of various measures differs substantially depending on the current state of the home, the insulation type / efficiency improvement, and the energy prices. (Note that, as of spring 2022, energy prices have risen dramatically in the last year. This would reduce payback times and make more expensive measures such as external wall insulation more attractive. It also illustrates how efficiency measures reduce the vulnerability of households and businesses to energy price rises, which is an important co-benefit and positive in its own right.) Overall, comprehensive insulation projects have a longer payback time due to the high upfront costs but are important measures to undertake when possible, especially given the likely switch to heat pumps in the coming decades. Smaller measures such as smart meters quickly recoup the upfront costs (Prince, 2014; CSE, 2019). Retrofitting also reduces the need for costly demolition and/or new builds.
Resilience	Improved energy efficiency can enhance resilience to climate change by reducing the susceptibility of the housing stock to events such as extreme cold or heatwaves (Ashden, 2020). This, in turn, enhances to resilience of the community, as less energy is needed to heat/cool the home when energy efficiency is enhanced (leaving more energy for other uses).

4.3.2 Transport

Both of the two core interventions in the transport sector – the modal shift and the required uptake of ULEVs – are crucial for reaching net zero in Leicester's transport sector. However, active travel and public transport have benefits that cannot be realised by personal EV travel. For example, EVs still cause air pollution due to the emission of particulate matter through tire abrasion, brake disks, clutches, and secondary dust entrainment (Sendek-Matysiak, 2019). A reduction in vehicles on the road through car sharing, home working, public transport use, and active travel can alleviate this problem. From a local perspective, promoting modal shift is more within the control of the local authority as a majority of the emission savings from EVs relies on the decarbonisation of the national grid which the local council alone cannot influence.

[54] https://committees.parliament.uk/writtenevidence/8749/html/
[55] E06000016 (phe.org.uk)

Co-benefits have been segregated into active travel and public transport – although there is naturally some overlap. Table 17 shows common co-benefits from active travel and Table 18 co-benefits from increased public transport use in place of individual car travel. Both of these interventions, along with EV uptake, have the potential to deliver economic benefits including jobs creation, whether in construction, EV charge point installation/maintenance, and in the supply chain for manufacture and supply of bicycles and zero emission vehicles. Even if the jobs are not based in Leicester directly, they could be within commuting distance of Leicester residents. An example of this is in a Government-supported EV battery research and development facility near Coventry.[56]

Table 17. Common co-benefits associated with active travel.

Co-Benefits	Elaboration
Improved health	A common co-benefit cited in relation to active travel (walking and cycling) is the improvement in physical health. The use of motorised vehicles is commonly associated with increased mortality, most commonly as a result of chronic diseases such as heart disease, stroke, type 2 diabetes, breast cancer, and osteoporosis (Creutzig et al., 2012; CIHT, 2015; DfT, 2021). In fact, physical activity of 150 minutes per week (e.g., 30 minutes of cycling to commute to and from work) has been found to reduce the risks of heart disease by 40%, type 2 diabetes by 40%, dementia by 30%, depression by 30%, breast cancer by 25%, and osteoporosis by 50% (McNally, 2019). A study from New Zealand further showed that interventions geared towards active travel results in 34.4 disability-adjusted life years (DALYs) and two lives saved resulting from reductions in cardiac disease, diabetes, cancer, and respiratory illness (Chapman et al., 2018). Assuming that some of these same benefits would apply to Leicester, active travel would thereby not only improve the general wellbeing of Leicester's population, but also potentially alleviate pressures on the NHS.
Societal benefits	Increasing active travel, and thus reducing motorised transport, presents the opportunity to repurpose spaces previously allocated to roads (Ashden, 2020). This space can be reclaimed for social purposes. An example of this already exists in Leicester, where a car park has been converted into a new public social space, Jubilee Square, as part of the Mayor's Connecting Leicester programme. Furthermore, improving the environment for active travel can facilitate improved access to jobs and services for people without access to a private vehicle.
Resilience	Encouraging active travel over motorised transport may allow road space to be reallocated to green space (Ashden, 2020), which acts to enhance resilience by helping reduce flood risk and urban heat island effects (CCC, 2019).
Reduced traffic congestion	Cycles take up vasty less road space than cars, especially when vehicle occupancy is low (see Figure 73), thereby alleviating congestion (DfT, 2021). Congestion currently costs the average driver over £1000 PA, thereby these measures would also result in significant cost savings (Inrix, 2019).
Air quality improvements	Road traffic is responsible for 70% of the most damaging pollutants: nitrogen dioxide, particulates, and ozone. Decarbonising transport can

[56] UK BATTERY INDUSTRIALISATION CENTRE - UKBIC

	therefore deliver significant air quality co-benefits, alongside GHG emissions reductions (CSE, 2019). To maximise on air quality benefits, especially short trips need to be replaced with active travel (short car trips are especially harmful due to cold starts) (CIHT, 2015; DfT, 2021). This is well-suited for an urban local authority such as Leicester where 80% of NO2 is currently produced by road transport (LCC, 2021b). Additionally, improving air quality helps with addressing health inequalities. Across the UK, communities with higher levels of deprivation are shown to be most affected by air pollution – even though they are generally least responsible for causing it (Ashden, 2020).
Noise pollution reduction	Combustion engine vehicles cause high levels of noise pollution which adversely affects public health and wellbeing (Chapman et al., 2018). A study from Copenhagen also found that noise pollution can negatively impact the local economy with house prices experiencing a drop by 1.2% per dB provided that the base level exceeds 55dB (Gossling and Choi, 2015).
Economic gains	Economic gains can be realised by strengthening the local economy through increased footfall. Additionally, higher quality pedestrian areas have been shown to lead to increased house values (CIHT, 2015).
Cost savings	A switch to active travel (and EVs) can have cost-saving co-benefits, by reducing the amount of money spent on fuel. Active travel also reduces demand for other costly materials/resources (e.g. motor vehicles, infrastructure).

Figure 73. Road space taken up by 69 bus passengers, cyclists, and car passengers. Source: Cycling Promotion Fund

Table 18. Common co-benefits associated with public transport.

Co-Benefits	Elaboration
Improved health	If adequately planned for, increasing use of public transport can have indirect health benefits if people generally walk or cycle to and from the bus stop/train station. Additionally, the availability of public transport options has been shown to result in a more positive image of walking as a mobility option (Soest et al., 2019).

Societal benefits	Lack of reliable and safe public transport can lead to isolation among vulnerable people such as the elderly. Improving services with these groups of the population in mind can thereby aid in reducing social isolation (Hemingway and Jack, 2013). Furthermore, improving public transport infrastructure can facilitate improved access to jobs and services for people without access to a private vehicle.
Reduced social inequalities	Research from Birmingham has shown that deprived communities are especially negatively affected by the lack of affordable and reliable public transport options with sufficient service coverage (Soest et al., 2019). This means that without such options, deprived individuals are unable to adequately participate in society.
Reduced traffic congestion	As buses take up significantly less space to transport the same number of passengers (see Figure 73), increased use of public transport options can reduce traffic volumes and thereby congestion issues (Jacyna et al., 2017).
Noise pollution reduction	Similar to the benefits surrounding decreased traffic congestion, noise pollution also can be reduced through a switch to public transport – albeit to a lesser extent than active travel. This effect is much stronger if the buses are electric.

4.3.3 Energy

While most of the interventions will need to happen at the national level, small-scale renewable energy projects can still play an important role for Leicester. These can realise a number of co-benefits for Leicester city and its residents which are outlined in Table 19.

Table 19. Common co-benefits of small-scale renewable energy installations.

Co-Benefits	Elaboration
Boost local employment	Renewable energy is on the rise globally – this includes small-scale renewable energy installations. To meet the increasing demand, new jobs need to be created (IRENA, 2017). As mentioned previously, the UK Government has established a taskforce that aims to create 2 million "green" jobs by 2030 which would include work in the renewable energy sector. If this is done locally (e.g., through upskilling programmes) it can tackle other issues such as unemployment (Ashden, 2020).
Long-term cost savings	Individual installations, such as rooftop PV usually generates cost savings after the upfront investment has been paid off. Based on 2021 typical electricity prices, an average household could therefore potentially save £100-£300 per year in electricity bills. Savings would increase if the cost of electricity increases or if more electricity can be used onsite rather than exported. There are also payments available via the Smart Export Guarantee which would improve the financial benefits.
Generation of revenue for the council	Local renewable energy projects have the potential to generate revenue for the council as well as their communities. They can provide long-term income as well as increased control over the available finances (Ashden, 2020).
Pollution reduction	Renewable energy sources are often associated with lesser levels of air pollution and noise pollution compared to fossil fuel sources. For example, flue gases from gas boilers can contain particulates, heavy metals and acidic gases alongside CO_2 and water vapour, and also incur a risk of carbon monoxide, which are not present with renewable electricity systems.
Resilience	Diversifying and localising energy sources increases the resilience of the energy sector to external shocks such as disruption to supply (e.g.

	due to extreme weather events) and price fluctuations influenced by overseas imports and weather changes (Ashden, 2020).

4.3.4 Land Use and Carbon Sequestration

When green spaces are well-planned, they can tackle climate mitigation through carbon sequestration, address the ecological emergency through enhancing the local biodiversity, and finally, achieve several other co-benefits. Some of the most common co-benefits of urban green space management with the primary goal of carbon sequestration are listed in Table 20.

Table 20. Common co-benefits associated with carbon sequestration through urban green infrastructure.

Co-Benefits	Elaboration
Resilience	Green urban infrastructure can help alleviate adverse effects of climate change. Green spaces can alleviate flooding by balancing water flows or help counteract the urban heat island effect by providing shade (Demuzere et al., 2014).
Air quality improvements	Trees and other green infrastructure can aid in improving air quality by absorbing pollutants such as particulate matter (Demuzere et al., 2014).
Improved physical health	There are many health benefits from urban green spaces. This ranges from decreased air pollution (see above) to improvements in physical fitness as a result from available sports grounds as well as increased uptake of walking and cycling (Demuzere et al., 2014). Therefore, green urban infrastructure can be seen as an enabling factor of active travel.
Improved mental wellbeing	Green urban infrastructure has been shown to increase the overall wellbeing of residents (Mansor et al., 2009). Several mental health issues such as anxiety and depression have been shown to see improvements as a result of well-managed urban green spaces. However, *poorly* managed green spaces can have the opposite effect (Tzoulas et al., 2007).
Societal benefits	Well-managed green spaces can increase social cohesion, i.e., the connectedness and solidarity amongst community members. This is primarily a result of providing community members from different backgrounds with a space to interact with nature and each other (Jennings and Bamkole, 2019).
Economic gains	Similar to well-planned pedestrian zones and walking/cycling routes, urban green spaces can result in economic gains by increasing property values of the local area. Additionally, improvements in public health alleviate financial pressures on the health care system (McDonald, N.D.).
Noise pollution reduction	Some green spaces can provide screening from noise pollution, e.g., from road traffic (Cohen et al., 2014). Additionally, green spaces can act as a 'psychological buffer' for noise pollution. This means that the presence of green space nearby lessens the perception of noise and thereby the associated adverse health effects (Dzhambov and Dimitrova, 2014).

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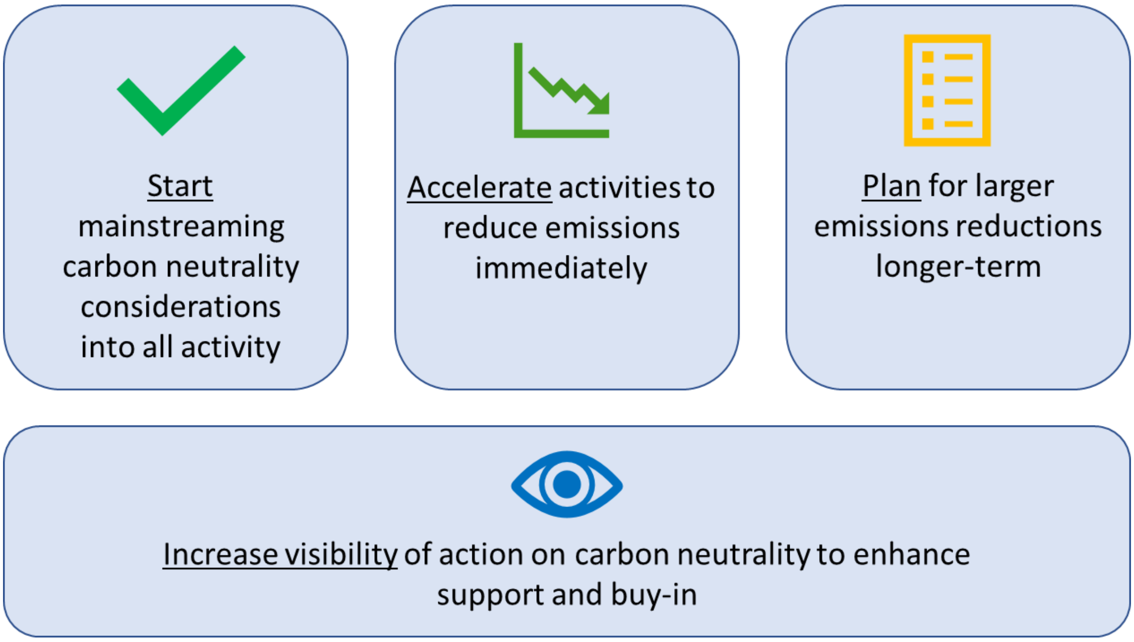
4.4 A framework for delivering carbon neutrality

Building on the evidence provided above, an overall framework for action has been developed in discussion with LCC which considers four main areas for action – stop, accelerate and plan, alongside greater visibility. This is shown in Figure 74 below.

Figure 74. A framework for action on carbon neutrality



The components of this framework are set out below:

- **Start** mainstreaming carbon neutrality considerations into all activity

With so little time before 2030, not only is there an imperative on the Council and other stakeholders to take radical action to reduce emissions, steps need to be taken to ensure that the situation is not being made more difficult by actions that run counter to carbon neutrality. This is particularly the case when it comes to typical replacement rates of certain technologies. For example, the average lifespan of a condensing gas boiler, or a car, is around 15 years. This means that any action in recent years, or over the coming months and years, that add to the stock of fossil fuel boilers and cars, make the possibility of attaining carbon neutrality even slimmer. Examples of the kinds of things that could be happening now in Leicester that run counter to the carbon neutrality goal include

- Building new homes with gas boilers
- Building homes and offices that are not insulated to the highest possible standards
- Any measures that might increase road traffic
- Developing road infrastructure that doesn't actively encourage walking or cycling, and that has assumptions regarding increased road traffic built into it

In some cases, this requires a mindset shift. Some activities might appear to be the right ones because they are low carbon. But they may not be compatible with carbon neutrality (at least not in the timescales that Leicester is aiming for). One example of this is replacing current boilers with more efficient ones. This will undoubtedly help reduce GHG emissions, but the hard fact is that fossil fuel infrastructure is still being installed, and this is simply not compatible with reaching carbon neutrality by 2030.

What this clearly points to is the need to embed carbon neutrality considerations into every activity within the city. Climate emergency actions should be checked against the pathways set out in this report to consider whether they are sufficiently ambitious. And all non-climate emergency actions (e.g. economic development, health policy, social policy etc). This would benefit from having an agreed approach to carbon accounting for projects, so they can be appraised against the carbon neutrality goal. But even in the absence of this, an assessment of any proposed actions, plans or policies against the pathways in this report will help check their compatibility with carbon neutrality. The sooner in the process of development that this can be done, the better.

- **Accelerate** activities to reduce emissions immediately

It goes without saying that urgent action is needed to reduce emissions. As with most local authorities, and the UK as a whole, emissions have been falling steadily since 2005 (as shown in Section 2.2) – by 41% between 2005 and 2019. This masks quite variable year-to-year reductions. The biggest annual reduction was in 2014 – a 12.5% reduction from 2013. But in some years, emissions went up (2010 and 2012). The average annual reduction was 4.2%. And yet we know from the pathways work in Section 3 that reductions of almost 11% a year will be needed. Not only that but to follow a Paris Agreement-aligned emissions pathway, the steepest emissions reductions will be needed in earlier years.

So this means that whilst time will be needed for some actions to be implemented and to take effect on rates of emission reductions, just allowing emissions to fall by around 4-5% a year for the next few years will likely put the carbon neutrality goal out of reach. Much more significant emissions reductions are needed immediately. And to achieve this, the Council should focus on those key stakeholders that have the most influence over the widest number of people. For example, when it comes to buildings, the Council themselves and housing associations are the key landlords in the city and could potentially enact a rapid and ambitious programme of thermal efficiency improvements and heat decarbonisation. Working with major energy users in the city, such as the universities and the NHS, along with other members of the Climate Emergency Partnership will also help drive real energy savings and emissions reductions in the near term.

- **Plan** for larger emissions reductions longer-term

As mentioned above, whilst emissions reductions need to be ramped up in the near term, careful planning will also be needed to ensure that much greater levels of activity and of emissions reductions are seen later in the decade as the city pushes towards carbon neutrality. Coming back to the housing example cited above, whilst the Council and housing associations have an important role to play in rolling out thermal insulation and heat decarbonisation in their building stock, the planning stage looks to address the much wider proportion of homeowners and private tenants that will also need to take action. Therefore, over the next couple of years, urgent action is needed to review options for (and to design) local policy mechanisms that could potentially drive action at a faster pace than at the national level, putting in place appropriate coordination and governance mechanisms and addressing possible skills gaps (e.g. qualified heat pump installers).

A key element of this planning stage will be reviewing options for funding accelerated action. Any local authority that has decided to aim for carbon neutrality faster than the national target should not expect to rely on national government funding – there simply will not be enough of it and it will not likely be commensurate with the pace and scale needed. Leicester will need to consider innovative mechanisms for funding, such as issuing green bonds, using existing instruments such as council tax or business rates, or enabling and supporting enhanced private sector investment into climate action.

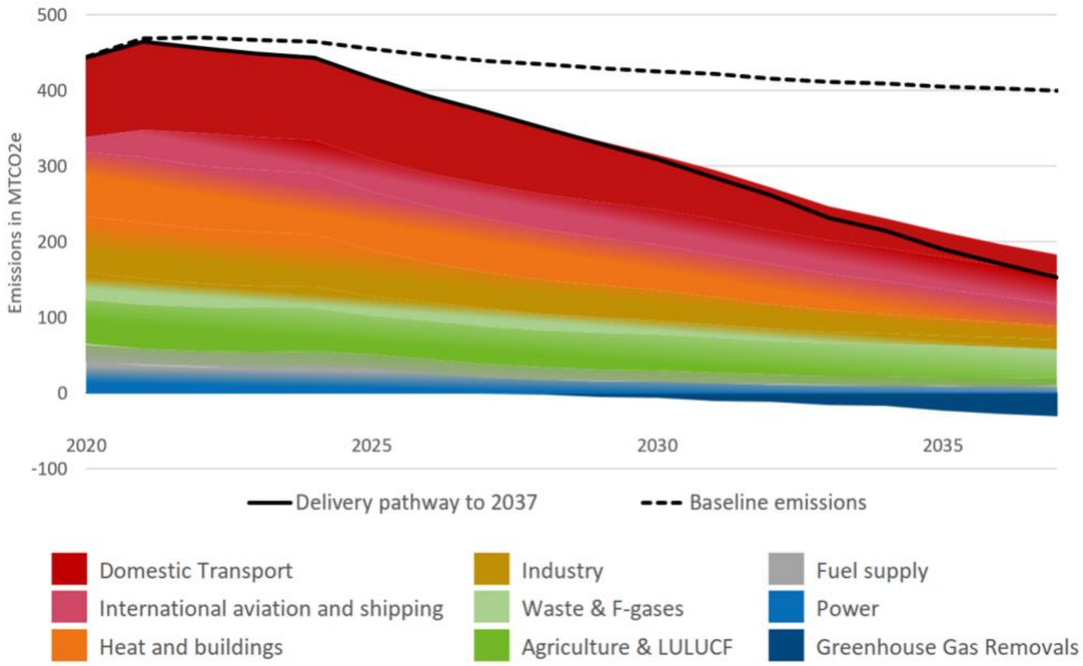
- **<u>Increase visibility</u>** of action on carbon neutrality to enhance support and buy-in

All of the above needs to be done in a way that increases visibility of the carbon neutrality goal and actions being done to meet it. Studies of behavioural psychology show us that people are more likely to act if they see others are taking similar action. Whilst awareness of the climate emergency and the need to take action is arguably greater now than it has even been, until people start coming across evidence of climate action in their day-to-day lives, they may be unwilling to make changes to their own lives, be it changing their behaviours with regards to heating their homes or travelling to the shops, or for purchasing decisions such as when replacing an old vehicle or a gas boiler.

Visibility of the need for urgent action on carbon neutrality can be increased through various media, for example more frequent coverage of climate actions in the city in the local press, or on social media. But a more effective approach is to couple this with greater visibility of the actions themselves. We can look to the response to the Covid-19 pandemic for an example of what this might look like. It is barely possible to spend a day without being reminded of the emergency, be it traffic cones on roads to secure space for cyclists and socially-distanced pedestrians, signs in shops for one-way systems or limits on numbers of people, announcements reminding people of the need to wear face coverings. Something similar for the climate emergency response could include all businesses putting signs in their windows detailing the steps they are taking to reduce their energy consumption, all plumbers and gas engineers being given pamphlets on heat decarbonisation options, to give to clients, or pedestrianisation of areas to encourage walking and cycling.

Appendix A: Implications of the UK Government's Net Zero Strategy for Leicester's Roadmap

The UK Government published its Net Zero Strategy (NZS) in October 2021. The chart below indicates how the Government expects the UK's future GHG emissions trajectory will progress, compared against a baseline prior to the introduction of the NZS, which largely aligns with the EEP 'reference case'.[57] It shows that, compared with a 2020 baseline, emissions would drop by approximately 30% by 2030. This compares favourably against the 'baseline emissions' reported within the NZS. It is a larger reduction than the BAU scenario calculated for Leicester (see Section 3), which would result in a roughly 19% reduction in emissions by 2030 compared with a 2019 baseline.



As of January 2022 BEIS has not yet published an updated version of the EEP figures that accounts for the policies set out in the NZS. An independent assessment conducted by the CCC found that the future trajectories outlined in the NZS are 'broadly similar' to the CCC's Balanced Pathway.[58] However, neither BEIS nor the CCC has published detailed information enough to support a quantitative assessment of how the NZS would impact Leicester.

The one potential exception relates to the Government's stated ambition for the UK electricity grid to be net zero emissions by 2035. Depending on the speed of grid decarbonisation, this would potentially result in emissions (kgCO_2e/kWh) from electricity in 2030 being lower than was assumed in the NZP modelling tool – although this would depend on the timing of any changes. However, the NZP tool uses future emission factors based on the Treasury Green Book, which assume that there will be dramatic levels of electricity grid decarbonisation in the next 10-15 years before tapering off in the late 2030s, so the actual impact on the scenarios modelled is expected to be small. The impact would be more significant if the grid became net zero by 2030. In that case, emissions in Scenario 3 would drop by 83% instead of 71%.

[57] For more details, refer to Net Zero Strategy baseline: covering note - GOV.UK (www.gov.uk)
[58] Independent Assessment: The UK's Net Zero Strategy - Climate Change Committee (theccc.org.uk)

The NZS restates some earlier commitments that are relevant to this study, such as:

- **Ban on petrol and diesel cars**: The NZS reaffirms the Government's intention to phase out the sale of new combustion engine cars and vans; this is already accounted for in the NZP tool.
- **Active travel:** As announced in May 2020, £2 billion will be invested into walking and cycling over five years to support the ambition for half of all journeys in towns and cities to be walked or cycled by 2030. Scenario 3 assumes that the ambition is achieved but does not consider funding sources, so potentially this investment could help introduce additional active travel measures in Leicester.

It also contains a few other new announcements that are particularly relevant to Local Authority decarbonisation planning:

- **Gas boiler ban:** A proposed ban on the sale of new gas boilers from 2035. This would mean that any homes in Leicester still using gas boilers by that time would be required to replace them. In the context of the 2030 ambition, this measure is considered less relevant to Leicester. It remains the case that Local Authorities do now have the power to implement such a ban independently.
- **Boiler Upgrade Scheme**: Grant funding towards the purchase of heat pumps, providing up to £5,000 per home for up to 90,000 homes. The Government's hope and expectation is that this will stimulate demand and help to reduce the costs of installing heat pumps, which in future will then promote uptake. LCC should seek to identify ways of helping local residents access this funding, although clearly it will not be sufficient to achieve the pace of change that is needed for Leicester.
- **Funding for MEES enforcement**: The Government will provide £4.3 million to Councils in an effort to clamp down on landlords not complying with energy efficiency regulations. Since April 2020, landlords have had to upgrade all rented properties to EPC Band E with non-compliance resulting in a fine of up to £5,000, but few Local Authorities enforce this. The new support can potentially start to ensure that action is ramped up over the course of this decade.
- **Hydrogen**: A decision on the role of hydrogen to heat buildings will be announced in 2026. In practical terms, this could result in more gas heating systems being installed between now and then on the assumption that hydrogen will save the day, risking further delays on short-term low-regret actions. This means that, although LCC should not yet write off the possibility of hydrogen as a solution for low carbon heating in Leicester until the announcement is made, the focus should still primarily be on heating technologies that are already available.
- **Sustainable transport**: Within the NZS, uncertainty remains on how the national and local governments will work together to shift away from motorised travel. While local action will play a key role in decarbonising travel, with the NZS pledging to embed this into spatial planning processes, how and if this will be done in co-operation with local authorities remains unanswered. The NZS further states that the Government is in the process of "building [the] evidence base to understand the barriers and potential policies to increase the uptake of shared mobility", such as car sharing, which the central government plans to do in co-operation with local authorities.

The NZS also states that the Government is committed to "set clearer expectations on how central and local government interact in the delivery of net zero". Further details are yet to be announced.

Overall, it is not yet clear whether the policies in place will actually deliver the emissions reductions that are required. For example, there is a heavy reliance on market forces bringing down the costs of technologies such as heat pumps but almost no mention of energy efficiency in buildings, which is a prerequisite. More importantly for Leicester, the targets are designed for a carbon neutrality goal of 2050. It therefore remains the case that national level action will not deliver the major, short-term emissions cuts that are needed.

Appendix B: Modelling assumptions

Provided separately.

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