APPENDIX 1

NET ZERO CARBON EMISSIONS

Feasibility and options

Report for: Mid Sussex District Council

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1 INTRODUCTION

1.1 BACKGROUND

Mid Sussex District Council (MSDC) is looking to understand the implications of the net zero carbon agenda for the district and the delivery of council services. It has commissioned Ricardo Energy & Environment to carry out a feasibility study to provide the evidence needed to understand the scale of the challenges and the key actions required to achieve net zero, both for the council's own emissions and for the district as a whole. The first step in this work is to carry out an assessment of current greenhouse gas (GHG) emissions, both for the Council's own emissions and for emission across the whole District. An influence mapping exercise was carried out that looked at the drivers of GHG emissions and which organisations/teams could influence them. A set of net zero pathways were then developed that showed how the Council's own emissions, and emissions across the whole district, could be reduced to net zero. A plan was then prepared, indicating the actions that need to be taken to deliver this, who needs to take them and by when.

1.2 DEFINITIONS AND SCOPE

Net zero, also known as carbon neutrality, simply means achieving a balance between emissions of GHGs to the atmosphere and removals of GHGs (mainly CO_2) from the atmosphere, for example by nature-based solutions such as tree planting or by technological means such as carbon capture and storage (CCS). 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 GHGs, 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.

1.3 REPORT STRUCTURE

This report considers net zero for both the Council's own GHG emissions and for the GHG emissions across the whole district. Chapters 2.1 and 3.1 look at GHG emissions from the Council's own activities and from across the whole district respectively, setting out what latest emissions are, what the key drivers of emissions are and developing a couple of net zero scenarios for both levels. Chapters 2.3 and 3.3 then sets out a plan and routemap for net zero for both the Council's own emissions and the emissions across the whole district, detailing who should do what, by when to deliver it.

2 A NET ZERO COUNCIL

This section looks at GHG emissions for the Council. It starts with the GHG baseline for the Council's activities, then considers which stakeholders have influence over emissions and finishes by outlining two possible net zero pathways that the Council could take.

2.1 GHG BASELINE

2.1.1 Definitions and scope

A GHG baseline was developed for the Council's own emissions in the financial year 2019/20. This was the latest year for which data was available and has the additional benefit that it provides a recent picture of emissions that is relatively unaffected by the Covid-19 pandemic, and therefore reflects typical activity levels as closely as possible. The inventory has been produced covering scopes 1, 2 and 3 as set out in the World Resources Institute's 'GHG Protocol Corporate Accounting and Reporting Standard'[1]. It therefore includes:

- Scope 1 (direct emissions): Emissions produced from sources linked to a company's assets.
- Scope 2 (indirect emissions): Emissions produced by the generation of electricity purchased from third parties and consumed in the company's assets.
- Scope 3 (indirect emissions): Emissions that arise as a consequence of the activities of the company, but occur from sources not owned or controlled by the company.

The emissions sources that are included in these scopes depend on the specific methodology used. For this study we have used the concept from the GHG Protocol Corporate Accounting and Reporting Standard called 'Operational Control'. This is defined as:

"A company has operational control over an operation if the former or one of its subsidiaries has the full authority to introduce and implement its operating policies at the operation".

Ricardo often summarises this as: "Who has responsibility for making changes to improve the properties energy efficiency or performance?" This definition of "Operational Control" is important for MSDC when it comes to the reporting of emissions from an organisation's properties. Only the sites that MSDC have operational control over were included in the baseline assessment, meaning the following:

- Properties directly occupied/operated by MSDC will have their emissions reported as Scope 1 (for direct emissions) and Scope 2 (for indirect emissions) as MSDC have direct control over the energy/utilities used at these properties. This includes properties that are owned and occupied by MSDC and that are leased by MSDC from someone else.
- Properties that are not directly operated by MSDC (e.g., owned by MSDC but then tenanted or hired out) will have their emissions reported as Scope 3, as MSDC have indirect control over their emissions. In other words, the emissions are being produced by the tenants' activities, but MSDC can make changes to the properties to reduce these emissions.
- Properties that MSDC do not have operational control over (i.e., owned by MSDC but they are not responsible for making changes to the property to reduce emissions) have been excluded from the baseline assessment.

A complete list of MSDC's properties was compiled by MSDC's staff and their assignment to the above categories discussed with Ricardo.

What this means is that the following emissions sources were included in scopes 1, 2 and 3.

[1] https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

Figure 1: scopes and emissions sources included in the GHG baseline assessment for Mid Sussex District Council

Scope 1
"***Direct Emissions***"
- Natural gas used for heating in buildings occupied by MSDC
- Fuels used in MSDC-owned vehicles

Scope 2
"***Indirect Emissions***"
- Electricity used in buildings occupied by MSDC

Scope 3
"***Indirect Emissions***"
- Tenant electricity
- Tenant natural gas
- Electricity Transmission and Distribution losses
- Transport
  - Grey fleet
  - Contractor fleet
  - Business travel
- Solid waste (Landfill & Recycled)
- Purchased goods and services

Mid Sussex District Council owns the head lease of Orchard Shopping Centre and is also the freeholder of the site. It was intended to include the emissions from gas and electricity consumption in common/landlord areas of the shopping centre in the Council's emissions baseline. However, it has not yet been possible to get data to allow this. Should this data become available, the baseline emissions data could be updated accordingly in future.

Ricardo's Net Zero Gap Analysis Tool (NZGAT) tool has been used for the council level assessment and so the approach was consistent with the district level assessment.

2.1.2 Baseline results

Looking at emissions under scopes 1, 2 and 3, scope 3 is by far and away the largest portion of GHG emissions, representing over 97% of total GHG emissions from the Council's own operations, as shown in Table 1.

Table 1: MSDC total emissions summary

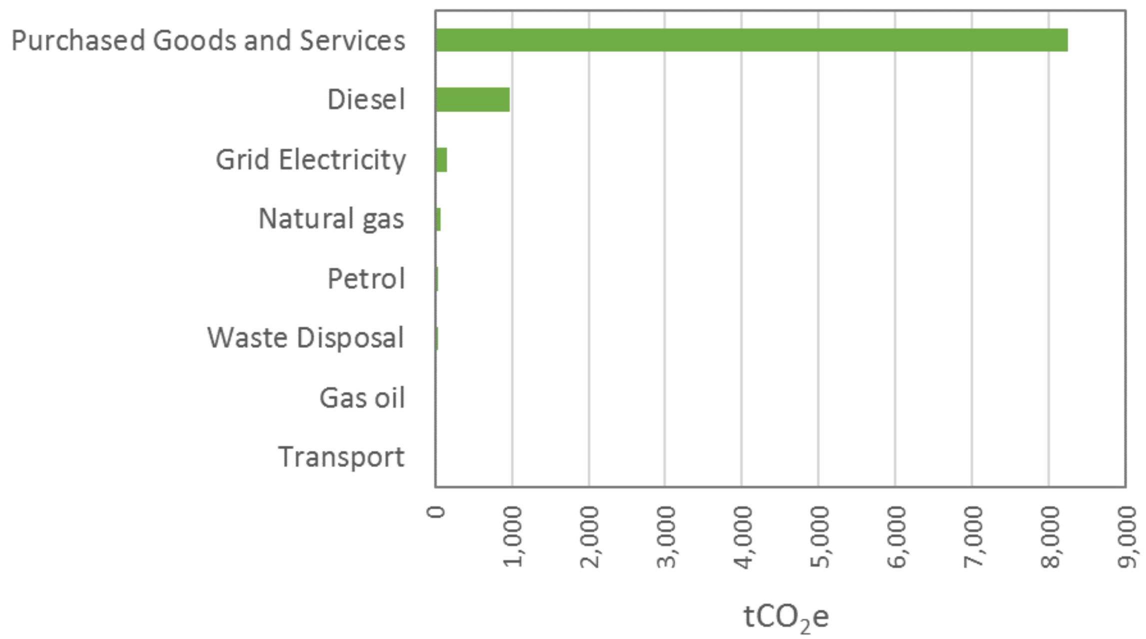
Scope	tCO_2e	% total
Scope 1	138	1.4%
Scope 2	114	1.2%
Scope 3	9,555	97.4%
Total	**9,807**	**100.0%**

As can be seen in Table 2 and Figure 2, the majority of Scope 3 emissions come from "Purchased Goods and Services". This means all upstream (i.e., cradle-to-gate) emissions from the production of products purchased or acquired by the Council. This includes maintenance of properties, purchases of electrical/IT equipment and paper. The emissions from purchased goods and services have been calculated from MSDC accounts records using an external tool. This methodology, although the best that is currently available, has inherent uncertainties in both the categorisation of expenditure into different broad categories, and is based on spend data from 2012 in the USA. As such, the resulting emissions that are calculated need be used with caution and further work outside of the scope of this project is suggested to validate these figures. Therefore, Ricardo has been commissioned to undertake a deep-dive analysis of the Council-only Scope 3 emissions from procured goods and services. This work is ongoing and is not featured in this report.

Table 2: scope 3 emissions from MSDC

Emissions Source	Scope 3 emissions	%
Transport *(Business Travel Public Transport)*	4	0.0%
Gas Oil *(Contractor vehicles)*	25	0.3%
Waste Disposal	33	0.3%
Petrol *(Fleet and contractor vehicles)*	36	0.4%
Natural Gas	69	0.7%
Grid Electricity	160	1.7%
Diesel *(Fleet and contractor vehicles)*	977	10.2%
Purchased Goods and Services*	8,251	86.4%
Total (tCO_2e)	**9,555**	**100%**

Figure 2: scope 3 emissions from MSDC



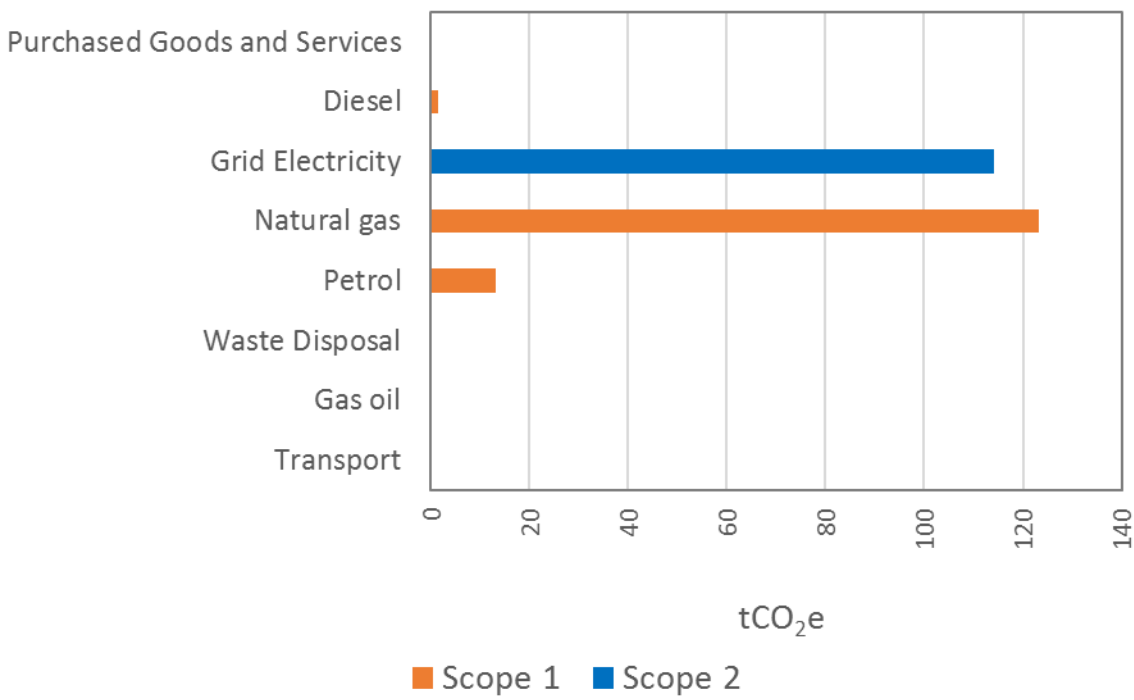
The second most significant emissions source for scope 3 emissions is diesel used in contract fleet vehicles: Waste collection, grounds management and tree surgeons.

Focusing specifically on scope 1 and 2 emissions, Table 3 and Figure 3 show these emissions from the Council. It can be seen that most of the emissions are from use of natural gas in buildings (scope 1) and use of electricity (scope 2), with a much smaller share coming from the Council's fleet of vehicles. This therefore immediately gives a sense of the priorities for achieving net zero on the Council's own estate, with a clear need for the focus to be on energy use in buildings.

Table 3: scope 1 and 2 emissions from MSDC

Emissions Source	Scope 1	Scope 2	Total	%
Transport ***(Business Travel Public Transport)***	0	0	**0**	**0.0%**
Gas Oil ***(Contractor vehicles)***	0	0	**0**	**0.0%**
Waste Disposal	0	0	**0**	**0.0%**
Petrol ***(Fleet and contractor vehicles)***	13	0	**13**	**5.2%**
Natural Gas	123	0	**123**	**49.2%**
Grid Electricity	0	114	**114**	**45.6%**
Diesel ***(Fleet and contractor vehicles)***	1	0	**1**	**0.0%**
Purchased Goods and Services*	0	0	**0**	**0.0%**
Total (tCO_2e)	**136**	**114**	**250**	**100%**

Figure 3: scope 1 and 2 emissions from MSDC



2.1.3 Conclusions and observations

Scope 1 & 2 emissions sources (under MSDC's direct control) make up ~3% of the total carbon footprint. Of these, the largest emissions sources are natural gas used in heating systems (49%) and grid electricity (46%) used in properties for which MSDC have "operational control". Therefore, these two emissions sources should be a focus for decarbonisation efforts as follows:

- To reduce emissions from natural gas, strategies involve encouraging the sustainable use of heating or implementing alternative renewable heat sources such as: Renewable biofuels, solar heating, geothermal heating, and heat pumps.
- There are multiple routes for reducing emissions from grid electricity, such as: Efficient HVAC (heating, ventilation, and air conditioning), using energy efficient appliances (e.g., LED lighting), or sourcing electricity from on-site renewables such as rooftop solar or purchasing green tariff electricity.

Scope 3 emissions sources (not under MSDC's direct control) are the largest source of reported emissions (97%), with the main contributors being purchased goods & services (86%) and diesel used in contractor fleets (10%).

- An effective net zero strategy should implement sustainable procurement mechanisms as an effective route to reduce emissions from purchased goods and services.
- Incentivising contractors to reduce diesel consumption can reduce emissions by promoting the use of ZEVs (Zero Emission Vehicles) or ULEV (Ultra Low Emission Vehicles) and alternative low carbon fuels.

2.1.4 Comparison with other Councils

It is helpful to compare these results with the GHG emissions from other Council's own operations, in particular second tier local authorities in the region.

Adur and Worthing Councils don't report their scope 3 emissions, but in their most recent report for 2019/20[2] their scope 1 and 2 emissions were split between vehicles (39%), gas use in buildings (32%) and electricity use (28%). It can therefore be seen that the emissions from their fleet is much greater than in Mid Sussex.

Arun Council's carbon footprint is similar to that of Mid Sussex, with 98.1% of total emissions being scope 3 in 2019-20 and 2020-21[3] (the data therefore covers the period of the Covid-19 pandemic). The split of scope 1 and 2 emissions is also similar to Mid Sussex, with only 11% coming from petrol and diesel use, and much larger shares coming from gas and electricity use. And nearly all of the scope 3 emissions come from purchased goods and services, even more so than in Mid Sussex (86%).

Chichester Council reports on scopes 1, 2 and some scope 3 emissions. As can be seen in Appendix 2 of their Climate Emergency Action Plan[4], 2019-20 scope 1 emissions were 47% of the total, scope 2 10% and scope 3 43%. However, it should be noted that only very few scope 3 sources were included - fuel- and energy-related activities not included in Scopes 1 & 2, business travel and downstream leased assets. They have excluded purchased goods and services, capital goods, upstream transportation and distribution, waste generated in operations and end-of-life treatment of sold products (would include emissions from trade waste collected by the Council). It might be expected that with all scope 3 sources included, the estimate for scope 3 might be similar to that of Mid Sussex in percentage terms.

Horsham District Council estimated their GHG emissions in 2018/19 to be 11% from scope 1, 8% from scope 2 and 81% from scope 3[5].

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[2] https://www.adur-worthing.gov.uk/media/Media,158900,smxx.pdf
[3] https://www.arun.gov.uk/download.cfm?doc=docm93jijm4n18057.pdf&ver=18990
[4] https://www.chichester.gov.uk/climatechange
[5] https://www.horsham.gov.uk/__data/assets/pdf_file/0006/77685/Carbon-Footprint-Report.pdf

2.2 INFLUENCE MAPPING

This section looks at what the key drivers are that affect the Council's own GHG emissions and which parties have most influence and control over them. This will then inform the development of the net zero plan.

2.2.1 Drivers of change

As a first step in influence mapping, it is helpful to consider what the drivers of changes in emissions are.

2.2.1.1 Policies, plans and strategies

Many of the national, regional and local-level drivers of change set out in the influence mapping for the district will also apply to the Council's own emissions. Please refer to Section 3.2 for more details on these. As an example:

- The national phase out on the sale of petrol and diesel vehicles by 2030/35 will lead to a decarbonising of the Council's vehicle fleet.
- National-level grid decarbonisation will continue to drive down the Council's emissions from its own electricity use.
- The Future Homes Standard will ensure that any new build Council buildings will not have gas connections from 2025.

But there are also certain other more specific drivers for Councils in terms of reporting on and managing their carbon footprint, which are outlined below.

2.2.1.2 Emissions reporting

Reporting of emissions will always be a key driver for climate action. By transparently reporting on their emissions, Councils provide the tools needed for interested parties to hold them to account over their emissions levels and to challenge their plans for emissions reductions. Previously, National Indicator 185, the percentage CO_2 reduction from local authority operations, required local authorities to calculate the carbon emissions of their buildings and services on a yearly basis and report the results to Government. However, these indicators were abolished in 2011 and there is now no requirement for local authorities to set or negotiate targets to reduce their own or area-wide emissions. This gap has led to patchy and inconsistent reporting of emissions, although some support is now being provided, for example the Local Government Association, with Local Partnerships and CDP, have recently launched a free GHG Accounting Tool for Scope 1 and 2 emissions and basic Scope 3 emissions. A small number of local authorities report emissions through the CDP.

GHG emissions reporting by local authorities still takes place but on a less mandatory basis, with a memorandum of understanding in place with various key milestones, including "to develop and agree an approach for sharing information on greenhouse gas emissions from councils' own estate and operations"[6].

2.2.1.3 Public expectation/pressure

One of the key factors behind the recent drive of local authorities to declare climate emergencies has been public pressure and campaigning. It is hard to predict how this will change over time. On the one hand, we can expect that pressure to act on climate change will not go away and will likely only intensify, especially if local climate events (e.g., flooding) raise awareness of the issue. On the other hand, as local authorities develop more detailed plans for climate action, and publish the evidence base behind it, this could provide ammunition to those concerned about the transition to net zero, for example because of possible impact on lifestyles, cost of living, jobs etc.

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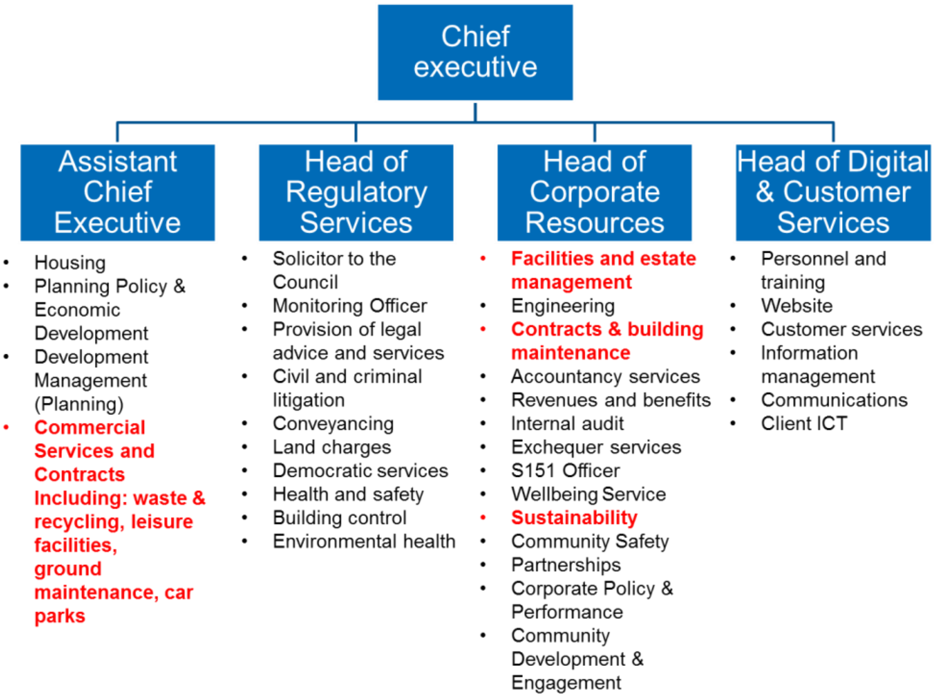
[6] https://www.gov.uk/guidance/sharing-information-on-greenhouse-gas-emissions-from-local-authority-own-estate-and-operations-previously-ni-185

2.2.2 Key stakeholders

We can see from the data in Section 2.1 that of the emissions that the Council can more easily control (scopes 1 and 2), nearly all (around 95%) comes from gas use in buildings and electricity use (most of which will be from buildings). Clearly then the Council teams responsible for the management and operation of the buildings will be key to achieving net zero for scope 1 and 2 emissions, specifically the Facilities and Estate management team and the Contracts and Building Maintenance team (see below for an organogram of the Council structure, although it should be noted that this will shortly change).

Figure 4: Mid Sussex District Council organogram



These teams should look for opportunities and funding to upgrade the Council's building stock, improving energy efficiency and switching away from gas boilers towards decarbonised heating systems (e.g., heat pumps). They may also be able to maximise opportunities for rooftop solar PV to be installed on Council-owned buildings, in particular large roof spaces such as car parks.

2.2.2.1 Level of influence

Of the different emissions sources set out in Section 2.1, the Council and other key stakeholders (e.g. contractors) will have varying degrees of influence.

Emissions source	Degree of Council influence (high, medium, low)	Actions	Other key stakeholders
Scope 1 natural gas (buildings occupied by MSDC)	High	Should look to replace boilers with low carbon heating systems, e.g. heat pumps	
Scope 3 natural gas (tenant gas use – natural gas used by tenants in temporary housing, halls and	Low	Could make replacement of heating systems with low carbon a precondition of the lease? Could try to engage directly with tenants – however it is very difficult to work around tenants to	The organisations/individuals to which the buildings are being leased

community centres, and residential)		introduce alternative low carbon heating systems into properties e.g. tenant convenience, health and safety, etc.	
Scope 1 transport (fuels used in Council-owned vehicles)	High	Should look to replace vehicles with electric ones Introduce appropriate infrastructure e.g. electric charging points	
Scope 2 electricity	Medium	Switch suppliers to procure more renewable energy	Laser
Scope 3 electricity (tenant electricity yes)	Low	Could engage with tenants on the benefits of on-site renewables e.g. solar PV	Tenants
Scope 3 transport (business travel on public transport)	Medium	Could introduce policies to favour use of public transport. But convenience may often be a limiting factor e.g. cycle to work scheme, car share, reduced bus fare, etc.	Staff
Scope 3 transport (contractor vehicles)	Medium	Could ensure that requirement to move to a low carbon fleet is set out in contracts – will be a legal requirement for all cars from 2030 anyway	Contractors
Waste disposal (scope 3)	Low		Waste contractors
Purchased goods and services	Medium	Can use procurement policy to favour low carbon goods and services, but ultimately reliant on what the market can offer	Other councils (could joint procurement help increase influence?)

Not surprisingly, the Council tends to have more control over scope 1 emissions and less over scope 2 and then 3 emissions. But we can see that even within scope 3 emissions, the level of influence can vary. It is possible for a local authority to set a target that does not include all scope 3 emissions (although there is a risk that some stakeholders would view this as insufficient). But in Scotland, local authorities are given guidance to set a zero direct emissions target (for scope 1) and to aim to reduce scope 2 and 3 emissions but to mainly focus on those emissions sources over which it has most control. The Scottish Government points out that it "may be more appropriate to have a range of targets covering specific categories of indirect emissions, instead of one overarching target".

2.3 NET ZERO PATHWAYS

2.3.1 The BAU scenario

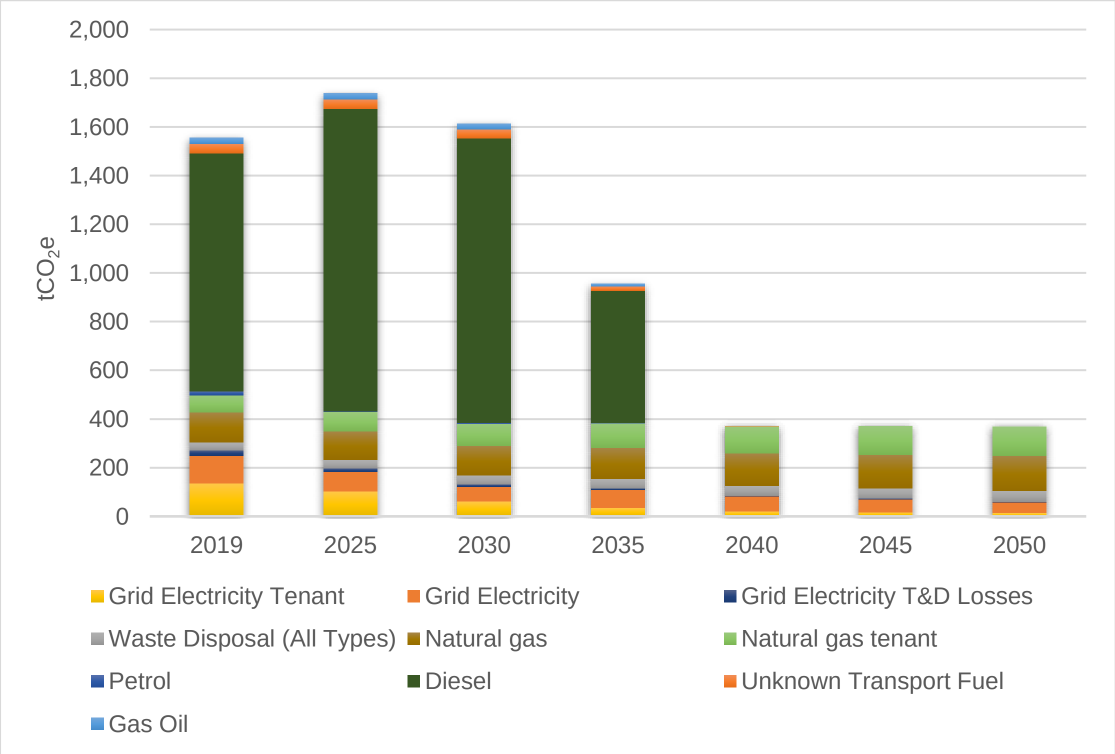
Projecting the baseline emissions to 2050 in line with the predicted business as usual (BAU) scenario provides an assessment of the gap compared to a net-zero scenario. This gap shows the scale of the intervention(s) required to achieve net-zero. It should be noted that this scenario only accounts for activities and events that are planned and are highly probable to occur.

As part of the BAU modelling, we looked to capture any information that will affect MSDC's carbon emissions under business-as-usual conditions. This includes known plans for building stock, projects confirmed and in the pipeline that will affect the emissions sources included within the baseline as well as growth in emissions sources due to external factors and efficiency trends. These are summarised below:

- **Known internal factors**: Known internal factors/changes that will impact on the baseline emissions, e.g., increasing temporary housing by 100% by 2040.
- **Known external factors**: Known external factors/changes that will impact on the baseline emissions, e.g., ongoing decarbonisation of the national grid, UK Government ban on sales of fossil fuel cars after 2030.
- **Confirmed pipeline projects**: Projects that impact emissions that have been signed off on or are very close to being given the go-ahead, e.g., plans to install a building management system (BMS) at Oaklands Bolstro Road to provide more control of heating.
- **Growth rate**: This growth rate will be used by the model to indicate how emissions will grow year-on-year due to multiple affects. E.g., MSDC have suggested a conservative estimate of 1% annual growth within the council's operations.
- **Efficiency rate**: This rate counteracts the growth rate and is due to ongoing improvements in efficiency (energy/utility use) in the way the council is run. E.g. vehicle fleet will become more fuel efficient with time as vehicles are replaced with modern variants.

2.3.2.1 BAU modelling results

The outputs of the BAU modelling are shown below in Figure 5, Figure 6, Figure 7, Figure 8, Figure 10 – BAU emissions by source (excluding purchased goods and services), 2019-2050



, and Figure 10.

The main factors already committed by MSDC that will contribute to the projected emissions under BAU are:

1. The removal of all old light fittings and replacement with LED lightings at Orchards. It has been assumed that lighting accounts for approximately 20% of the overall electricity consumption at Orchards. We have modelled a 75% reduction in energy consumption from LED lighting within that proportion of electricity consumption.
2. MSDC have introduced a building management system (BMS) at Oaklands Bolstro Road to provide more control of heating. Estimated 10% savings in natural gas consumption.

3. MSDC have replaced an inefficient single pipe system with a twin pipe system, which combined with a BMS, has the potential to accumulate an additional 1% saving in heating demand.
4. MSDC are currently in the process of transitioning away from conventional fossil fuel vehicles to electric vehicles (EVs). The council has currently replaced three out of five petrol vehicles with EVs and plans to replace one more in 2022.
5. Increased delivery in contracted services as a result of food collection in 2024. We have assumed a 26% proportional increase above the current quantity of fuel used for contracted services.
6. All grey fleet, public transport and taxis will be replaced with EVs by end of 2040 due to UK Government policy of halting sales of new fossil fuel vehicles from 2030. Modelled as gradual change over next 25 years.
7. Decarbonisation of the national grid. BEIS projected emission factors for UK electricity generation have been used to model a gradual decrease in emissions intensity.

Modelling shows that under a BAU scenario, total emissions (scopes 1, 2 and 3) will increase by around 14% by 2050 without any further intervention from MSDC. The remaining emissions gap that will need to be addressed to achieve net-zero in 2050 is 11,177 **tCO2e**. The increase is driven by an expected increase in scope 3 emissions. When looking at scopes 1 and 2 only, emissions are expected to fall by 25% by 2050.

Figure 5 – BAU emissions by scope 1, 2 and 3, 2019-2050

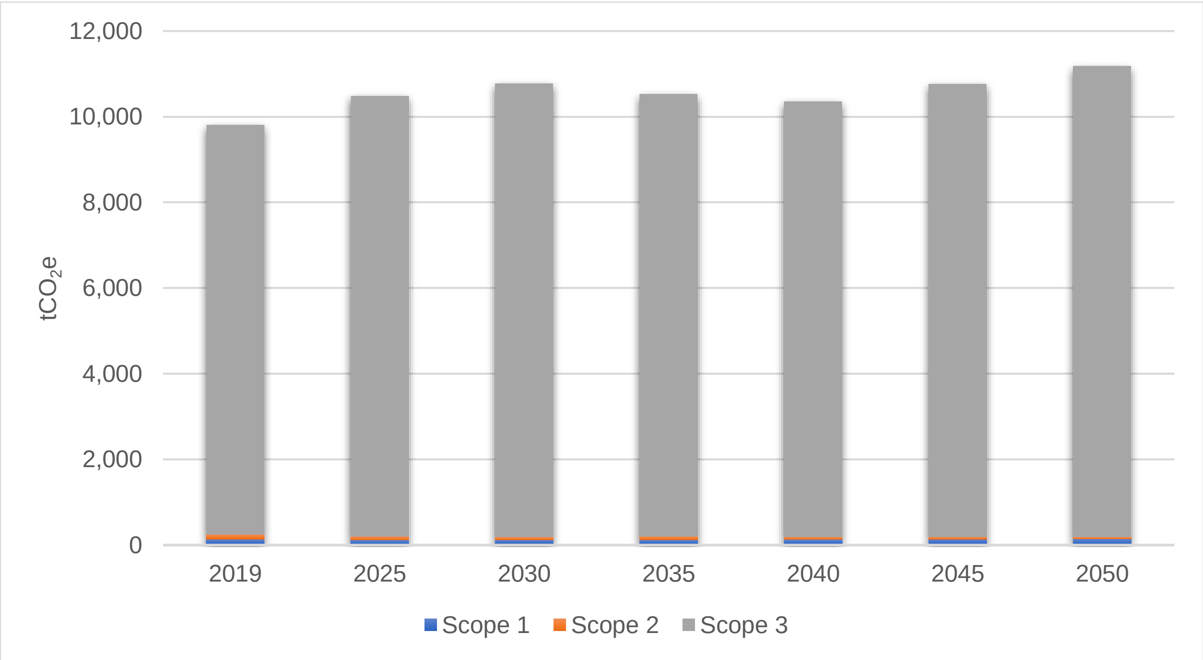


Figure 6 – BAU emissions by scope 1 and 2, 2019-2050

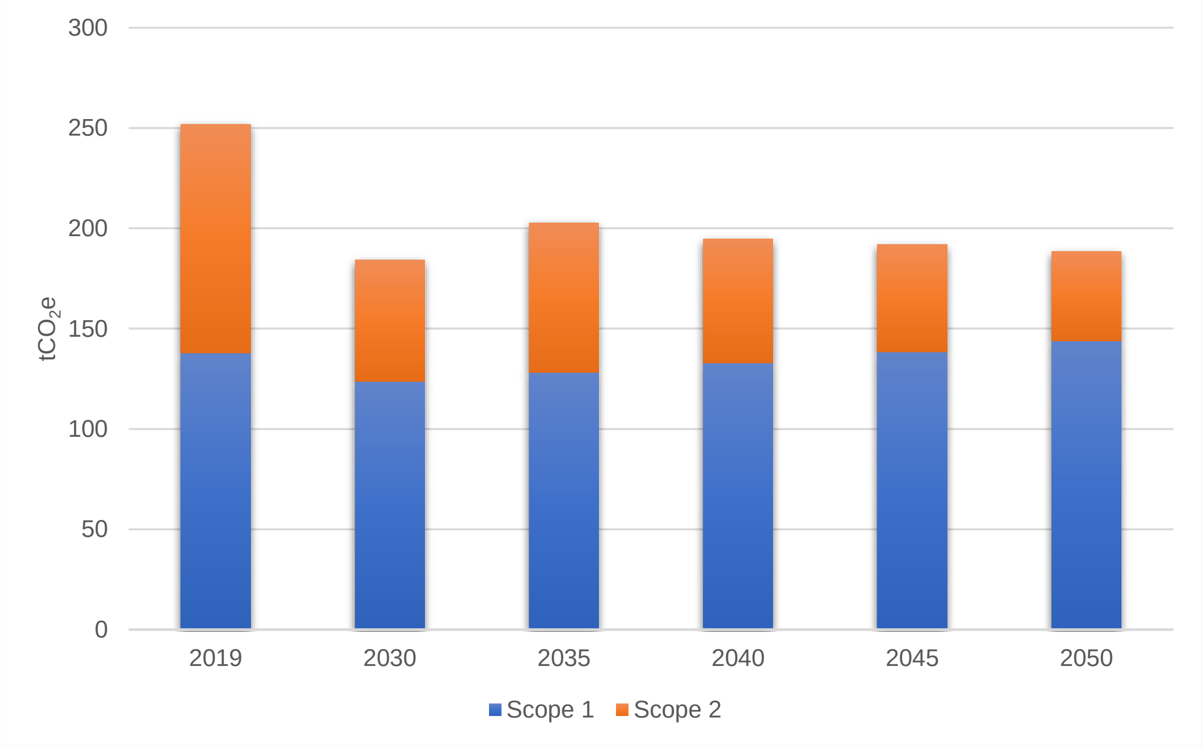


Figure 7 – BAU emissions by area, 2019-2050

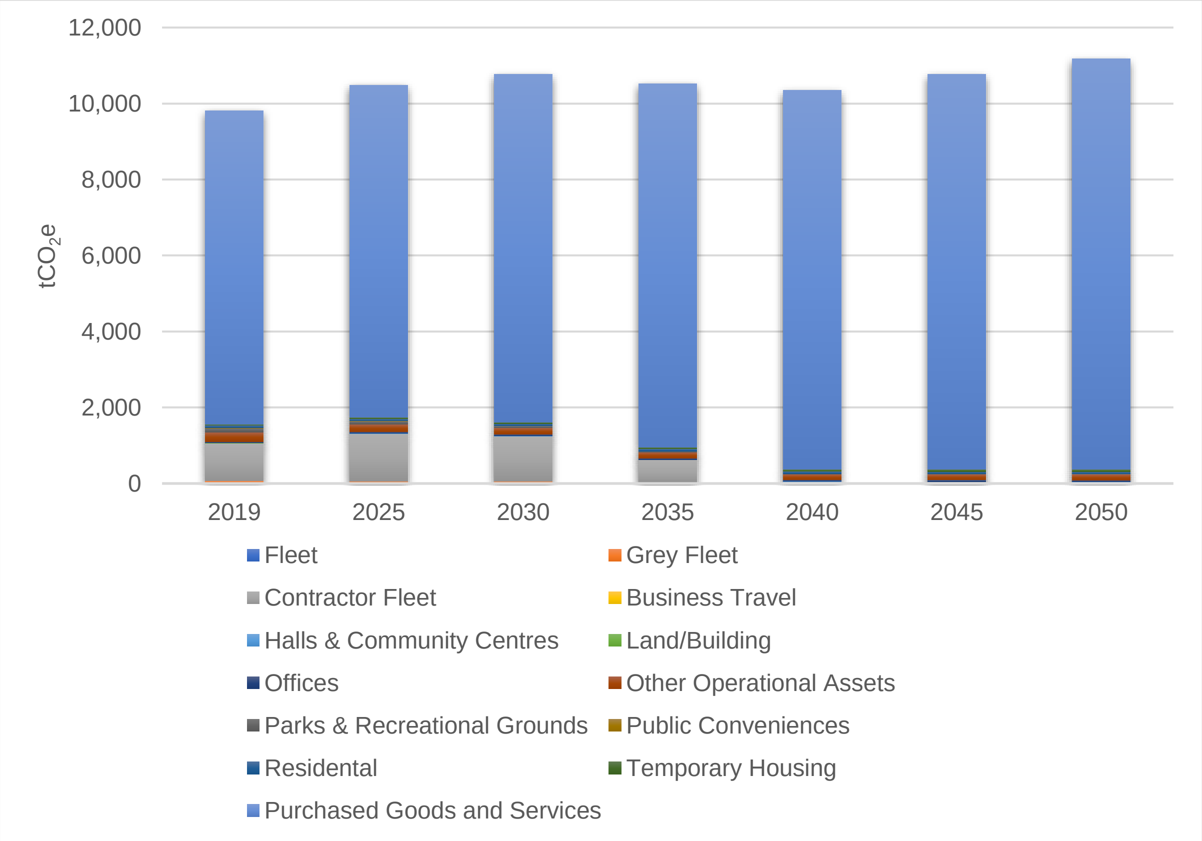


Figure 8 – BAU emissions by area (excluding purchased goods and services), 2019-2050

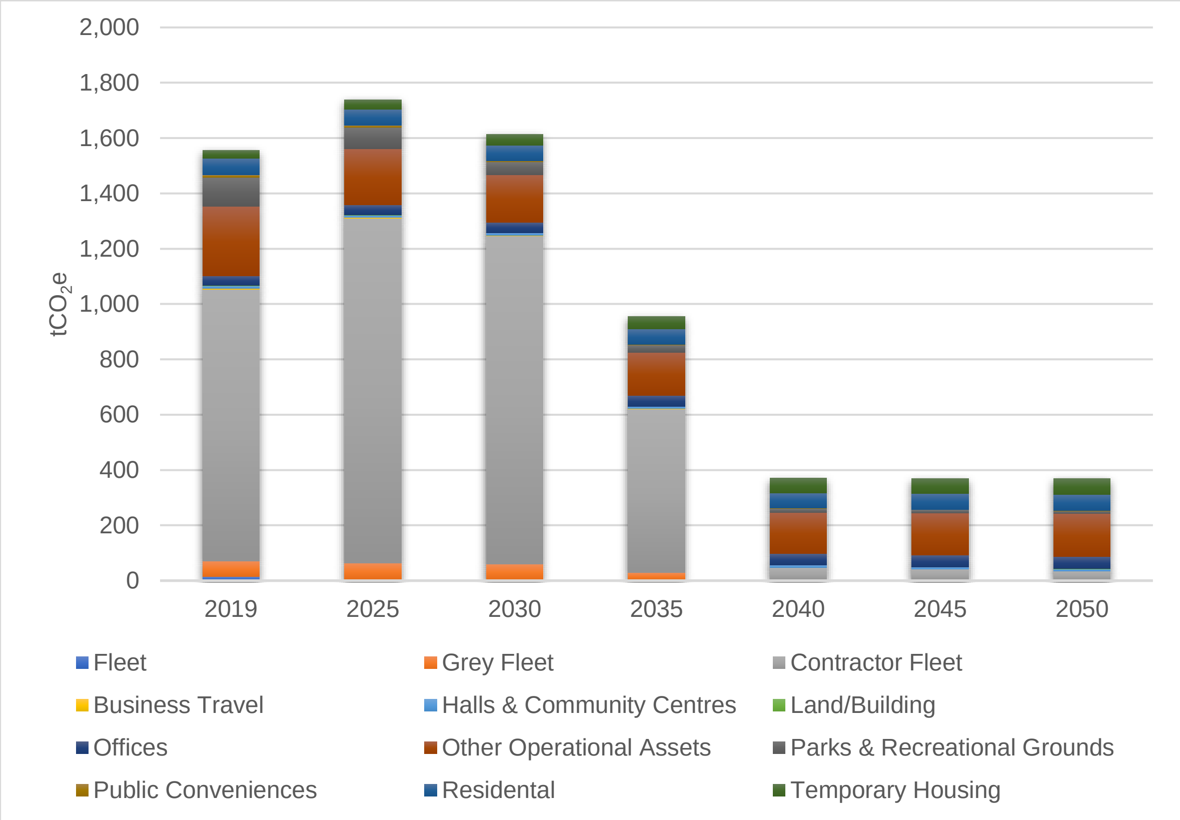


Figure 9 – BAU emissions by source, 2019-2050

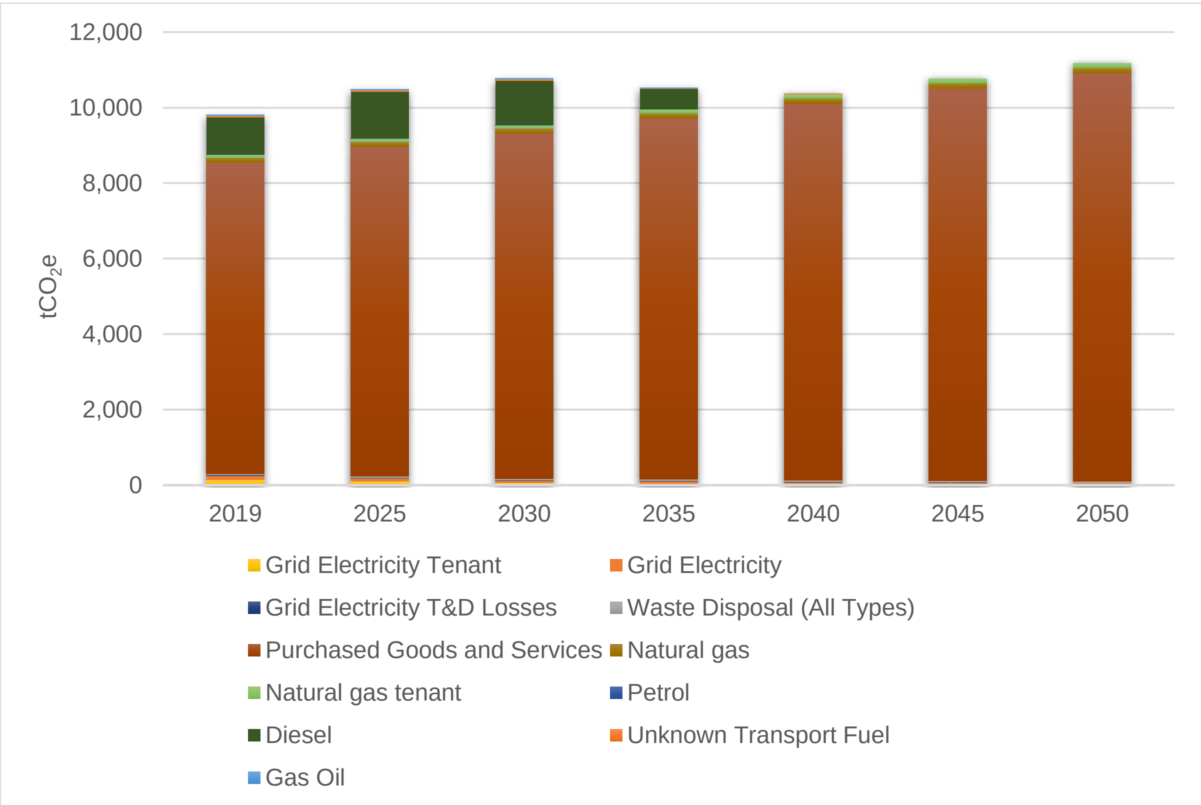


Figure 10 – BAU emissions by source (excluding purchased goods and services), 2019-2050

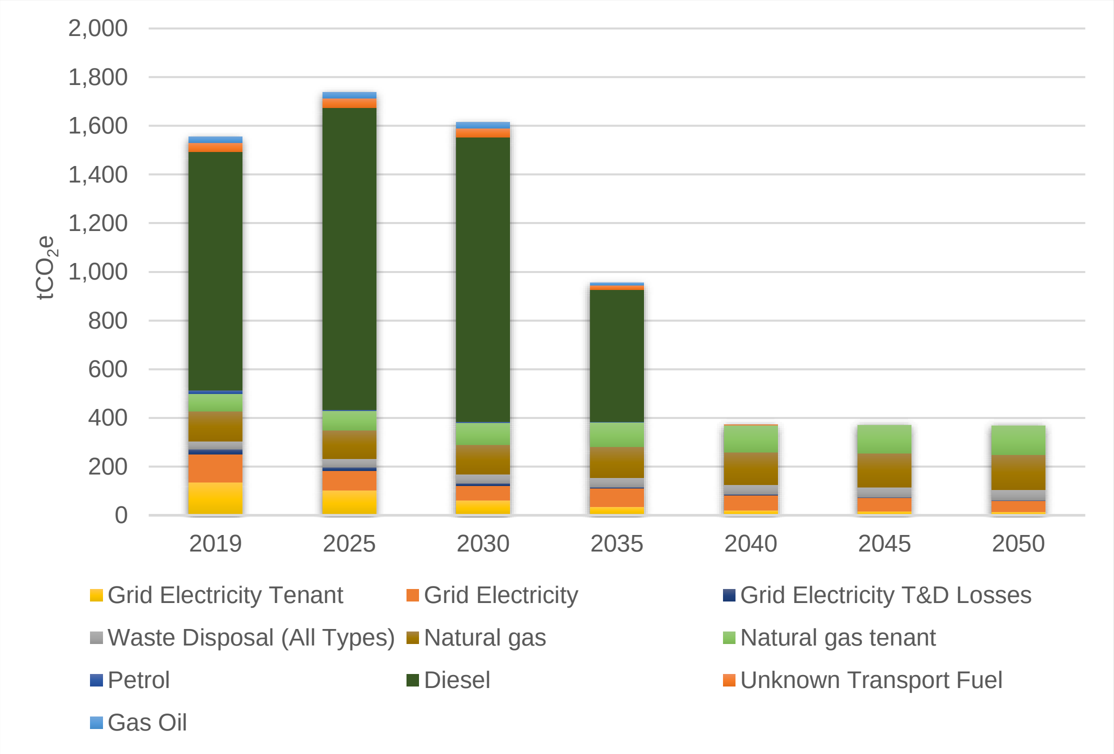


Figure 7 demonstrates that the purchase of goods and services are projected to be the largest proportion of emissions remaining in 2050, accounting for 96.7% of the overall total. The second largest is natural gas at 1.2%. The expected decarbonisation of the UK national grid means that electricity emissions are expected to fall year-on-year at a faster rate than the growth rate and efficiency rate account for. All other emission factors remain static across the modelled period, and, as such, any changes reflect growth and efficiency rates as well as any modelled BAU changes.

By 2050, the remaining emissions for MSDC are from a range of emissions sources, including grid electricity, electricity transmission and distribution losses, waste, water, natural gas, and emissions from purchased goods and services.

After accounting for planned business-as-usual activities and changes, the largest challenges for MSDC to address by 2050 if it is to achieve net-zero are:

1. Reducing emissions associated with the purchase of goods and services as much as feasibly possible.
2. Divesting from all fossil fuel use across all sites e.g., identifying alternative options for heating sites that currently use conventional gas boilers.
3. Establishing off-grid sources of renewable electricity and/or purchasing green electricity.

2.3.2 2050 net zero scenario

2.3.2.1 Overview of implementation pathway

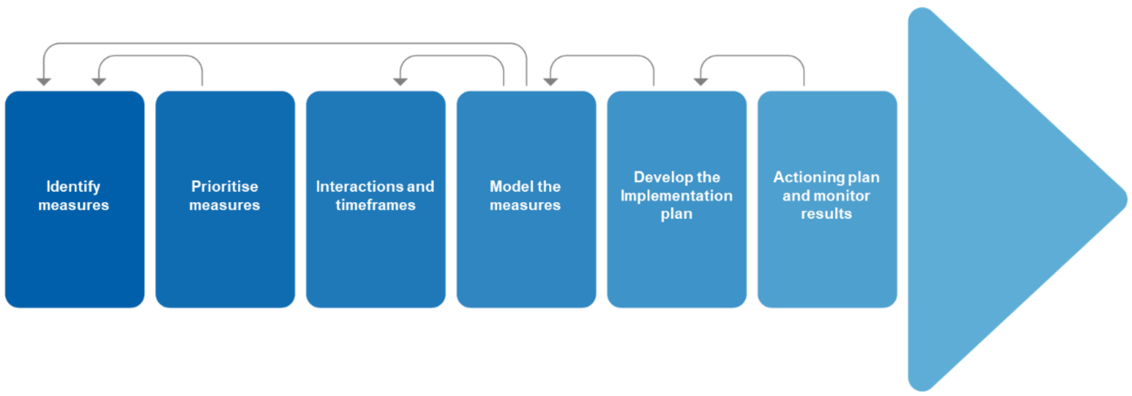
When analysing the timeline and aspiration for implementation of decarbonisation measures, the following 2050 net zero pathway assumes that sufficient resources and budget are made available to allow the rapid implementation of decarbonisation measures while taking account of current contractual constraints. Importantly, this approach collectively applied by the public sector can support the required market transformation of buildings and energy use across the UK. This approach would also minimise cumulative carbon emissions which, in turn, will reduce the impact of climate change and the associated health implications on the global population.

However, there may be negative cost implications as it is possible that a premium will be paid because of early adoption of these solutions before market forces drive down costs. There is also a risk that MSDC could invest in solutions which are made redundant by later technological developments. On the other hand, this proactive approach could avoid a situation where MSDC finds itself approaching the 2050 target and having to pay a premium for low-carbon solutions because demand exceeds availability. This situation could be exacerbated by a late rush to adapt to net zero by the private sector, which ultimately could lead to MSDC missing the 2050 target.

2.3.2.2 Introduction to decarbonisation measures

Identifying decarbonisation interventions and developing emissions reduction plans is an iterative process that has generated a live document for MSDC that will evolve over time. The feedback loops are shown in Figure 11 below, and the following sections of this report reflect some of the identification, prioritisation, interactions and modelling loops that took place during the project.

Figure 11 - Workflow to develop decarbonisation interventions



A long list of decarbonisation measures to reduce MSDC's emissions were identified by the Ricardo technical leads across the following categories:

- Heating systems.
- Waste management.
- Energy efficiency.
- Renewable energy generation.

The measures were entered into Ricardo's modelling tool, taking account of factors such as:

- Fuel type and kWh (before and after each measure is implemented).
- Which year the measure is undertaken, and the number of years needed to implement.
- Fuel and cost savings associated with the net zero audit undertaken by Ricardo[7].

Note: Costs indicated are based on a high-level desk-based assessment of potential measures, with all information on current systems and practices provided by MSDC. As such, full financial and technical feasibility studies will need to be carried out before measures are implemented.

[7] Note: Projected cost savings do not take into account any future government policies (such as a levy on natural gas) that may impact fuel costs to drive people towards low carbon fuels, or other incentive schemes such as RHI payments that will impact the financial feasibility of a move to low carbon heating systems.

Factors around site suitability, technical feasibility and financial feasibility were considered to inform the modelling. It is noted that all measures will need to be installed in compliance with standard MSDC operating procedures and health standards.

A description of each short-listed measure has been provided in **Appendix C** of this report, a summary which is provided in Table 4.

Table 4: Modelled MSDC decarbonisation measures

Mitigation Measure
Installing air source heat pumps (ASHP)
Improving energy management and controls
Energy sub metering / reporting systems
Installing LED Lighting
Optimising the operation of existing plant
Installing new roof-mounted solar photovoltaics
External / internal wall insulation, and loft / roof insulation
Improved waste segregation and recycling rate
Reduction in waste arisings due to prevention management

This 2050 net zero pathway model assumes that MSDC is supported in funding to prioritise the reduction of carbon emissions ahead of cost implications. It assumes that budget could be secured to allow rapid investment in measures that reduce carbon emissions.

2.3.2.3 Net zero audit

As part of this study, a net zero audit was undertaken by Ricardo to inform the measures that were entered into the modelling tool and discussed in this section. The sites that were selected for the audit were chosen as a representative sample of MSDC's broader site portfolio. These include:

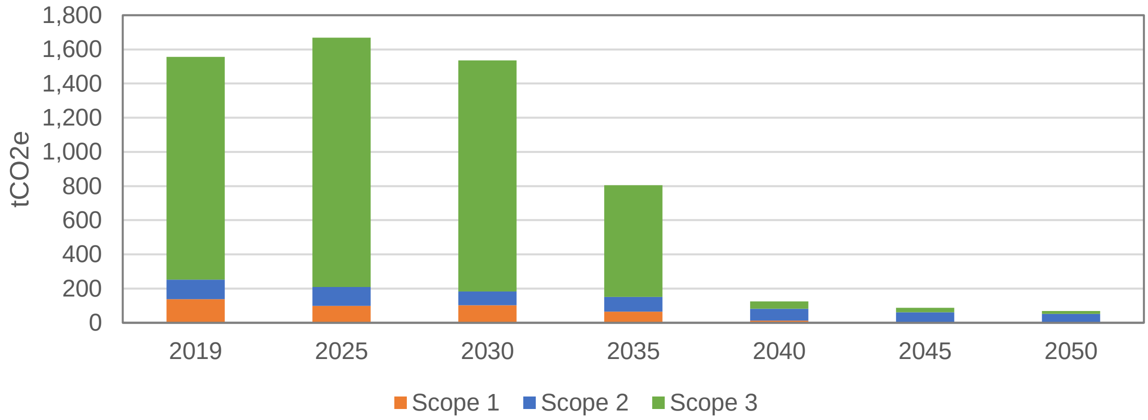
- Oaklands Main Office
- St Johns Pavilion
- Sheddingdean Community Centre

The scope of this audit was to investigate potential decarbonisation measures that could be applied to each site and scaled in order to support a reduction in emissions. The audit has been carried out in line with the requirements of BS EN 16247-2:2014 Buildings and included a site visit with inspection of the premises and discussions with staff, plus off-site analysis examining energy data. The energy and cost savings identified during this audit can be found in **Appendix B**.

2.3.2.4 Pathway mitigation potential

The following charts illustrate the mitigation potential for a net zero pathway to 2050. Please note that this net zero pathway excludes the purchase of goods and services due to its significant proportion of emissions within the baseline, accounting for 86% of the overall emissions.

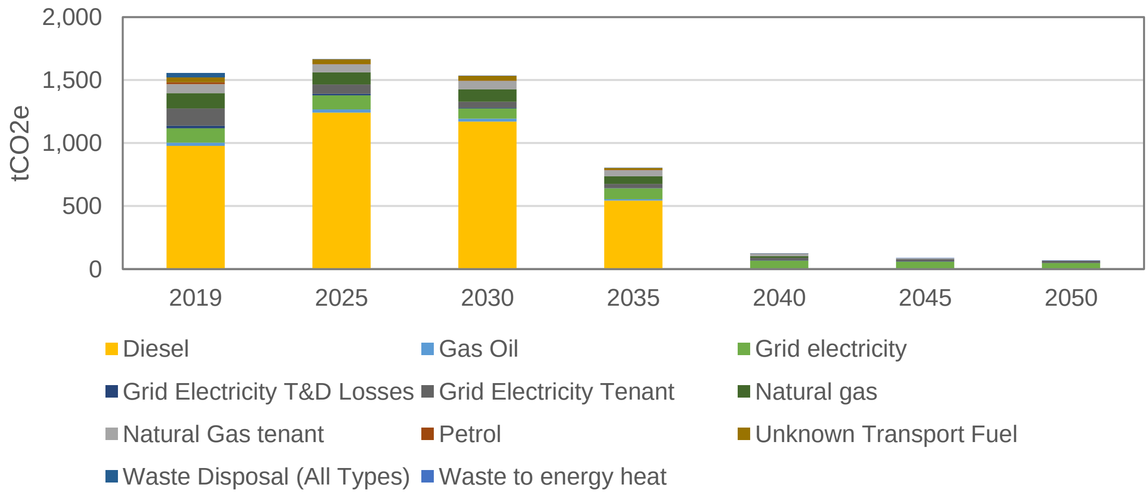
Figure 12 - Impact of net zero pathway split by emissions scope



Scope	2019	2025	2030	2035	2040	2045	2050
Scope 1 (tCO_2e)	138	98	103	65	13	2	2
Scope 2 (tCO_2e)	114	112	80	85	68	59	49
Scope 3 (tCO_2e)	1,304	1,459	1,352	655	44	27	17
Total (tCO_2e)	**1,556**	**1,669**	**1,535**	**806**	**125**	**89**	**69**
% change	**0%**	**7%**	**-1%**	**-48%**	**-92%**	**-94%**	**-96%**

Figure 12 shows the impact of the net zero pathway on total baseline emissions, as well as each individual emissions scope. The overall reduction in emissions seen between 2019 and 2050 is 96%. The residual emissions in 2050 are 25% attributed to scope 3, 71% to Scope 2, with the remaining 4% in Scope 1.

Figure 13 - Impact of net zero pathway split by emissions source

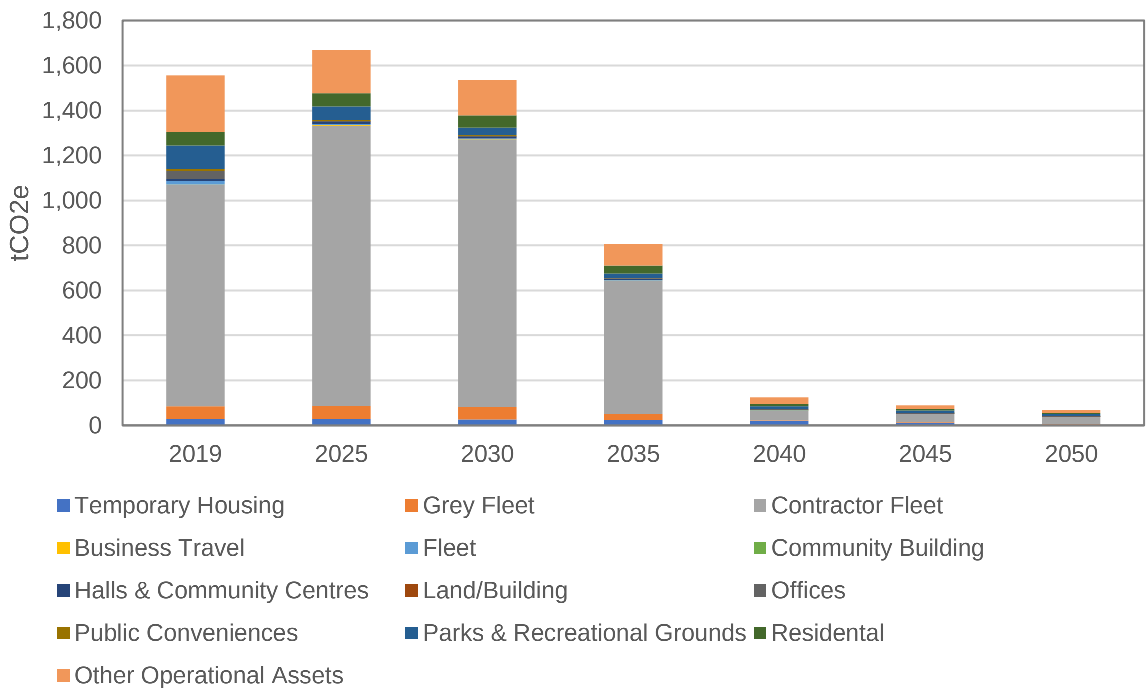


Emissions source	2019	2025	2030	2035	2040	2045	2050
Diesel	978.9	1,242.2	1,170.7	543.8	0.0	0.0	0.0
Gas Oil	24.8	25.9	24.4	11.3	0.0	0.0	0.0

Grid Electricity	114.1	111.7	79.6	85.5	68.1	58.9	49.0
Grid Electricity T&D Losses	21.2	11.1	6.7	3.8	2.2	1.9	1.5
Grid Electricity Tenant	135.9	75.7	47.4	31.3	20.7	18.6	15.6
Natural Gas	123.1	94.6	99.0	62.1	10.8	0.0	0.0
Natural Gas tenant	70.7	64.5	66.5	47.7	20.1	6.8	0.0
Petrol	15.5	2.8	2.6	1.2	0.0	0.0	0.0
Unknown Transport Fuel	37.9	38.6	35.8	17.1	0.8	0.0	0.0
Waste Disposal (All Types)	33.4	0.0	0.0	0.0	0.0	0.0	0.0
Waste to energy heat	0.0	2.0	2.1	2.2	2.3	2.3	2.4
Total (tCO_2e)	**1,555.6**	**1,668.9**	**1,534.8**	**806.0**	**125.0**	**88.6**	**68.6**
% change	**0%**	**7%**	**-1%**	**-48%**	**-92%**	**-94%**	**-96%**

Figure 14 shows how the net zero pathway impacts each of the emissions sources that contribute to the total footprint. Notably, the impact of switching from fossil fuels such as natural gas used in conventional boilers can have a significant impact on the reduction on emissions. For example, when switching natural gas used for space heating with heat pumps, this will initially result in an uplift in emissions associated with electricity. However, this is more than compensated by the reduction in emissions associated with gas use. In addition, as the UK grid decarbonises its electricity generation, the emissions per kWh of electricity usage decreases. For instance, in 2019/20 the emissions per kWh of electricity was 0.2556 kg of CO_2e. This decreased by 17% to 0.21233 kg of CO_2e in 2020/21. As a result, emissions from electricity will level off and start to fall overall.

Figure 14 – Impact of net zero pathway split by emissions area

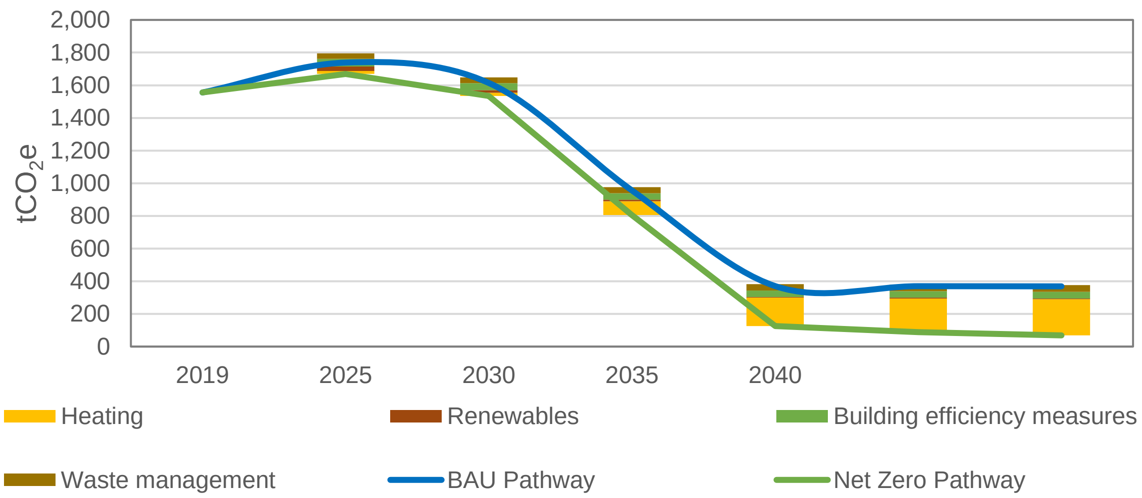


Emissions area	2019	2025	2030	2035	2040	2045	2050
Temporary Housing	28.9	28.0	26.0	23.4	19.5	11.5	4.2
Grey Fleet	56.3	58.6	55.9	27.8	2.1	1.9	1.6
Contractor Fleet	982.2	1,245.7	1,186.8	590.6	44.2	38.6	32.3
Business Travel	3.9	3.4	2.7	1.9	0.9	0.2	0.1
Fleet	14.6	4.9	3.7	2.0	0.7	0.6	0.5

Community Building	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Halls & Community Centres	9.0	8.6	7.7	5.0	1.6	0.8	0.7
Land/Building	1.4	0.9	0.6	0.3	0.2	0.2	0.1
Offices	34.5	2.8	2.8	2.6	2.4	2.4	2.5
Public Conveniences	8.1	5.3	3.1	1.8	1.0	0.9	0.7
Parks & Recreational Grounds	105.4	59.7	35.3	20.2	11.5	9.7	7.9
Residential	60.3	57.8	53.2	35.3	11.0	5.7	4.7
Purchased Goods and Services	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Operational Assets	250.7	193.1	157.0	95.2	29.8	16.1	13.1
Total (tCO_2e)	**1,555.6**	**1,668.9**	**1,534.8**	**806.0**	**125.0**	**88.6**	**68.6**
% change	**0%**	**7%**	**-1%**	**-48%**	**-92%**	**-94%**	**-96%**

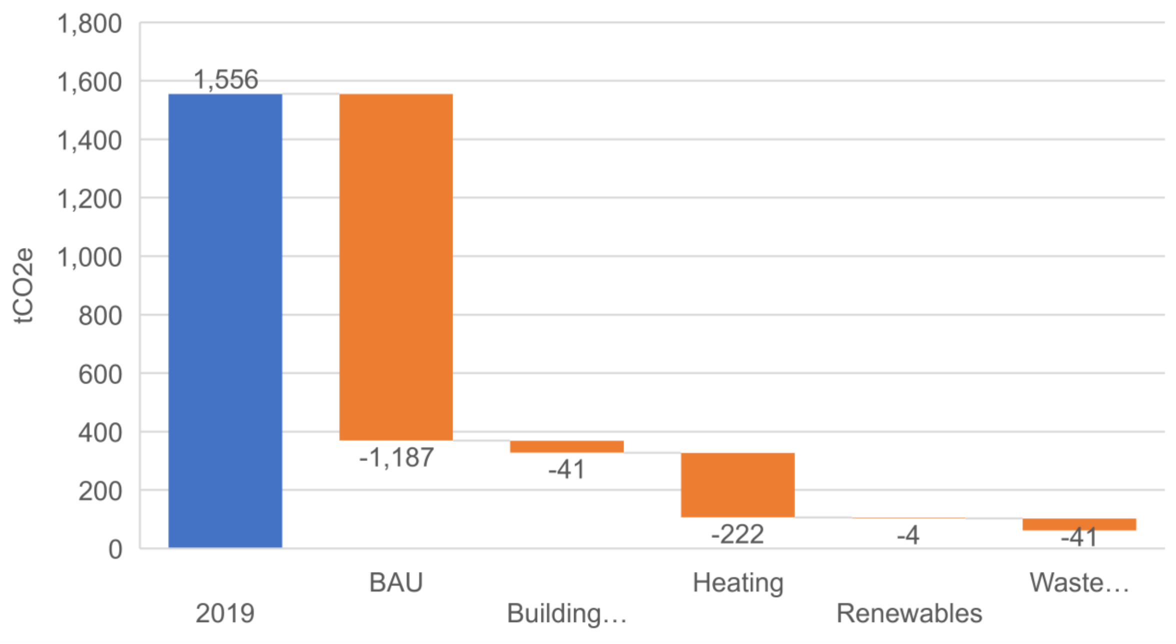
Figure 14 shows that under a 2050 net zero scenario, mitigation measures implemented across temporary housing, residential areas, parks and recreational grounds, and other operational assets (e.g., Oaklands Main Office) can be seen to have the largest cumulative reduction in emissions. The breakdown of these emissions is shown in the table above.

Figure 15 - Comparing the net zero pathway to business as usual



Under the 2050 net zero pathway, baseline emissions are reduced by 96% compared to 76% under a business-as-usual scenario. Figure 15 shows the contribution of groups of measures compared to the significantly reduced emissions profile of the net zero pathway. Emissions can be seen to initially increase as a result of the council's plans to 1) double temporary housing by 2040, and 2) increase delivery in contracted services as a result of food collection planned in 2024. The reduced emissions profile is also shown as a waterfall diagram in Figure 16 below. This highlights the substantial opportunity available through low or zero emissions properties to significantly address MSDC's primary source of emissions.

Figure 16 - Carbon savings by measure for the 2050 net zero pathway, cumulative from 2019/20 baseline to 2049/50



2.3.2.5 *Residual emissions*

Regardless of the implementation plan MSDC chooses to adopt, there will be residual emissions remaining in 2050. A breakdown of scope and categories of residual emissions is provided below in Figure 17 and the supporting table.

Figure 17: Residual emissions in 2050, split by scope

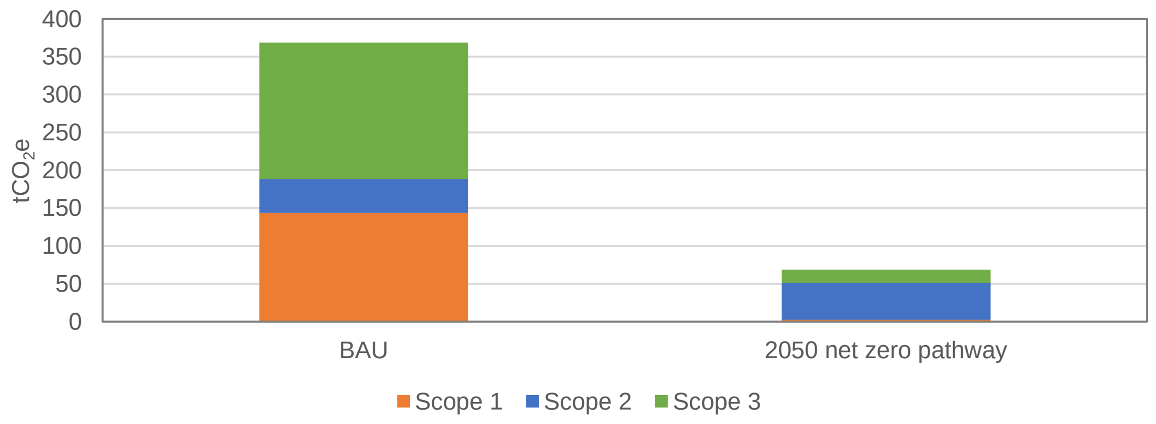
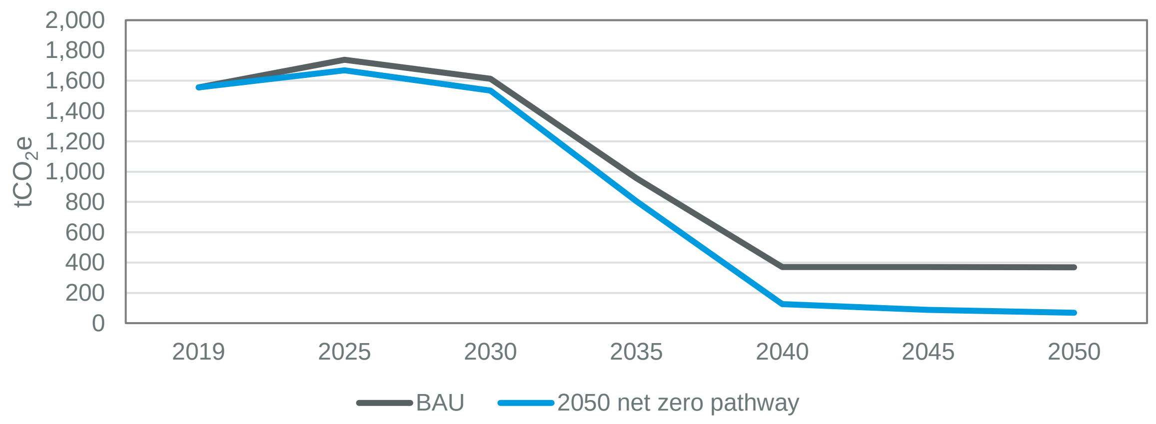


Figure 18: Residual emissions in 2050, split by pathway



tCO_2e	2019	2025	2030	2035	2040	2045	2050
BAU	1,556	1,739	1,614	956	371	370	369
2050 net zero pathway	1,556	1,669	1,535	806	125	89	69

Emissions area	BAU (tCO_2e)	2050 pathway (tCO_2e)
Diesel	0.0	0.0
Gas Oil	0.0	0.0
Grid electricity	44.6	49.0
Grid Electricity T&D Losses	2.1	1.5
Grid Electricity Tenant	14.2	15.6
Natural gas	143.8	0.0
Natural Gas tenant	120.1	0.0
Petrol	0.0	0.0
Unknown Transport Fuel	0.0	0.0
Waste Disposal (All Types)	43.8	0.0
Waste to energy heat	0.0	2.4
Total	**368.7**	**68.6**
% of 2019/20 baseline	23.7%	4.4%

2.3.2.6 Offsetting

While outside of the project scope, it is useful to understand the scale and potential cost of offsetting residual emissions to achieve net-zero emissions in 2050. We have estimated the cost of offsetting residual emissions in mid-century at £160/tCO_2 based on a recent assessment by the Grantham Institute[8]. This sets the carbon price at a level equivalent to the projected marginal abatement cost, the price signal considered necessary to deliver net-zero in UK industry.

Based on the modelled pathways, the cost of off-setting residual emissions for the year 2050 would be:

- BAU: £58,985
- 2050 net zero pathway: £10,969

[8] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2019/05/GRI_POLICY-REPORT_How-to-price-carbon-to-reach-net-zero-emissions-in-the-UK.pdf

It is important to note that there are more options than offsetting to tackle residual emissions such as insetting emissions reduction projects within the supply chain and downstream activities. **Of particular relevance to MSDC is the option to offset grid electricity emissions by purchasing renewables tariff electricity, which accounts for approximately 17% of all residual emissions in the BAU, and 96% in the 2050 net zero pathway.** This enables climate-related expenditure to remain within value creation cycle and reduces heavy spend on transactional costs for offsets.

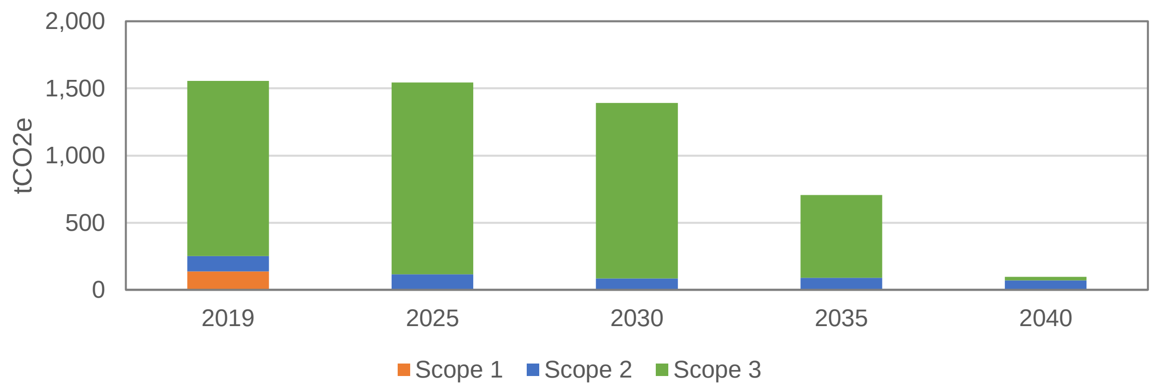
2.3.3 Accelerated net zero scenario (2040)

When analysing the timeline and aspiration for implementation of decarbonisation measures, the notable difference between a 2040 and 2050 pathway is the budget made available to allow the rapid implementation of decarbonisation measures and rate at which measures can be implemented. This scenario assumes that significant resources and budget will be made available to MSDC, meaning that the implementation plan can be brought forward to 2040 for achieving net zero emissions.

2.3.3.1 Pathway mitigation potential

The following charts illustrate the mitigation potential for a net zero pathway to 2040. As with the 2050 net zero pathway, this projection excludes the purchase of goods and services due to its significant proportion of emissions within the council's estate.

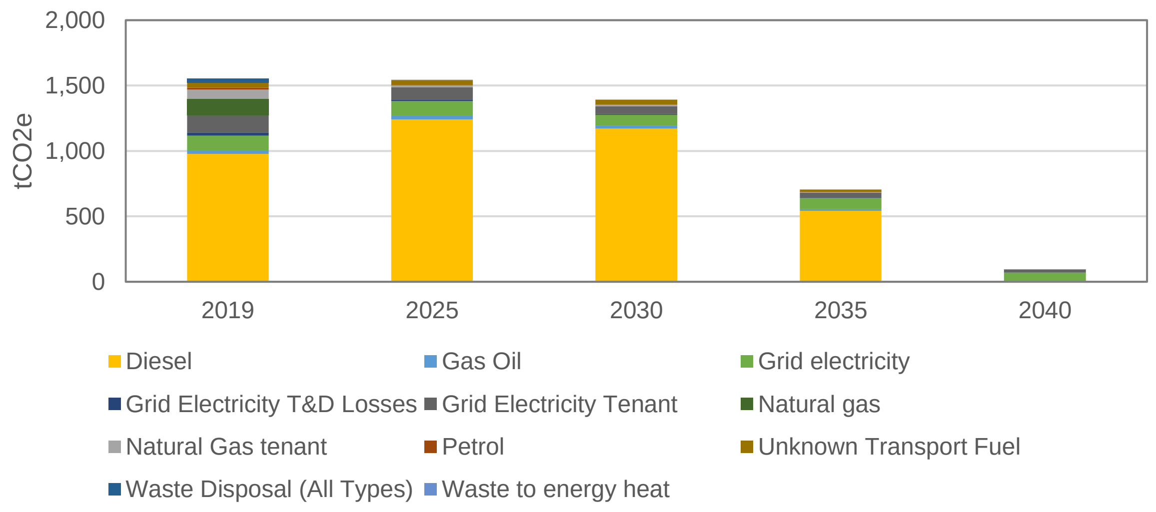
Figure 19 - Impact of net zero pathway split by emissions scope



	2019	2025	2030	2035	2040
Scope 1 (tCO_2e)	138	4	4	3	2
Scope 2 (tCO_2e)	114	112	80	86	68
Scope 3 (tCO_2e)	1,304	1,428	1,308	618	25
Total (tCO_2e)	**1,556**	**1,544**	**1,392**	**706**	**96**
% change	**0%**	**-1%**	**-11%**	**-55%**	**-94%**

Figure 19 shows the impact of the net zero pathway on total baseline emissions, as well as each individual emissions scope. The overall reduction in emissions seen between 2019 and 2040 is 94%. The residual emissions in 2040 are 26% attributed to scope 3, 71% to Scope 2, with the remaining 2% to Scope 1.

Figure 20 - Impact of net zero pathway split by emissions source

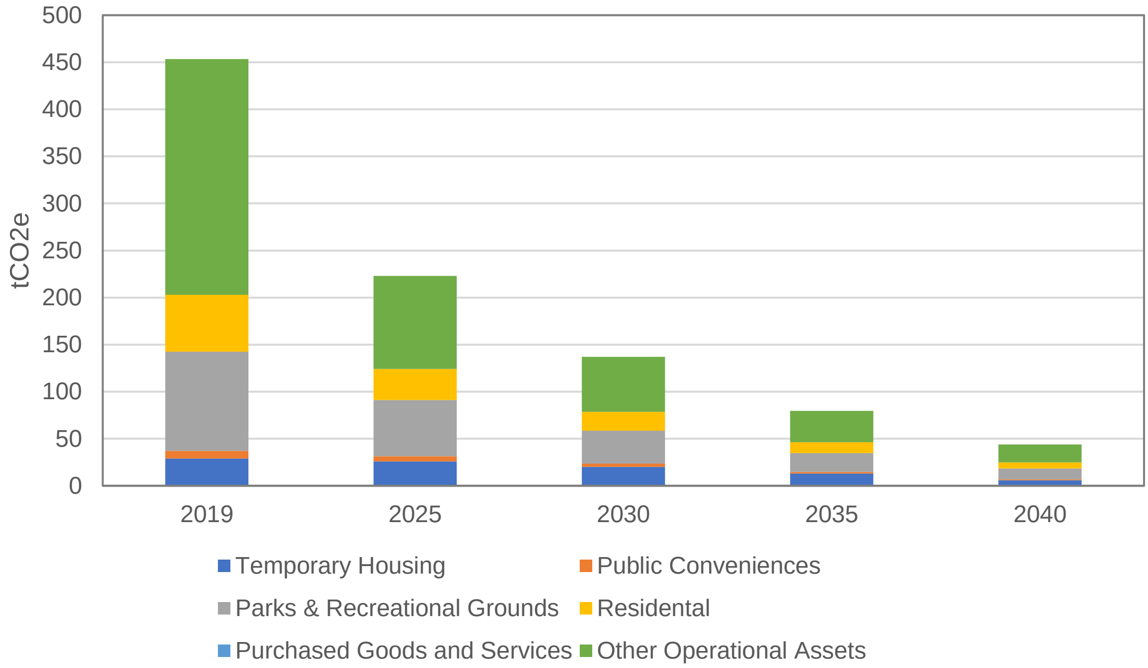


Emissions source	2019	2025	2030	2035	2040
Diesel	978.9	1,242.2	1,170.7	543.8	0.0
Gas Oil	24.8	25.9	24.4	11.3	0.0
Grid Electricity	114.1	111.9	79.7	85.5	68.1
Grid Electricity T&D Losses	21.2	11.1	6.7	3.8	2.2
Grid Electricity Tenant	135.9	95.8	60.5	37.0	22.2
Natural Gas	123.1	0.0	0.0	0.0	0.0
Natural Gas tenant	70.7	13.8	9.3	4.3	0.0
Petrol	15.5	2.8	2.6	1.2	0.0
Unknown Transport Fuel	37.9	38.6	35.8	17.1	0.8
Waste Disposal (All Types)	33.4	0.0	0.0	0.0	0.0
Waste to energy heat	0.0	2.0	2.1	2.2	2.3
Total (tCO_2e)	**1,555.6**	**1,544.0**	**1,391.8**	**706.3**	**95.6**
% change	**0%**	**-1%**	**-11%**	**-55%**	**-94%**

Figure 20 shows how the net zero pathway impacts each of the emissions sources that contribute to the total footprint.

As with the 2050 net zero scenario, the impact of switching from natural gas used for space heating to heat pumps is crucial for reducing emissions. However, this pathway assumes that new technologies such as heat pumps will be installed across the site portfolio at a much quicker rate. For example, the model assumes that natural gas will be completely phased out from temporary housing by 2040 (compared to 2050 in the 2050 net zero scenario). Funding is therefore essential for this technology to be rolled out. Moreover, residents will therefore need some form of engagement to understand the socio-economic implications of installing a heat pump for this to be viable.

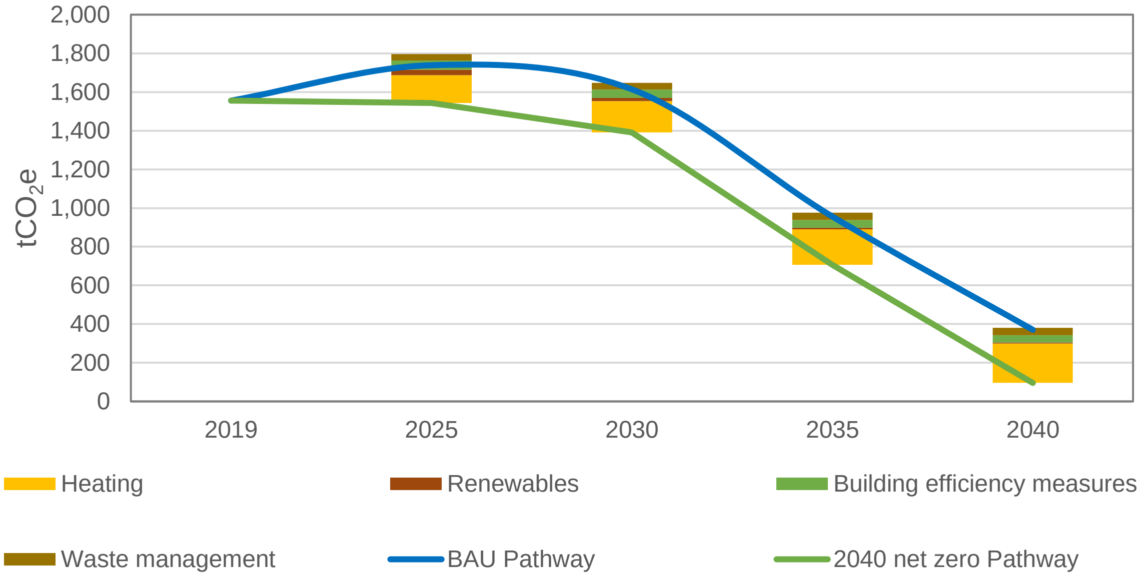
Figure 21 – Impact of net zero pathway split by emissions area



Emissions area	2019	2025	2030	2035	2040
Temporary Housing	28.9	26.1	20.3	12.8	5.9
Grey Fleet	56.3	58.6	55.9	27.8	2.1
Contractor Fleet	982.2	1,245.7	1,186.8	590.6	44.2
Business Travel	3.9	3.4	2.7	1.9	0.9
Fleet	14.6	4.9	3.7	2.0	0.7
Community Building	0.0	0.0	0.0	0.0	0.0
Halls & Community Centres	9.0	4.8	2.9	1.7	1.0
Land/Building	1.4	0.9	0.6	0.3	0.2
Offices	34.5	2.5	2.4	2.4	2.4
Public Conveniences	8.1	5.3	3.1	1.8	1.0
Parks & Recreational Grounds	105.4	59.7	35.3	20.2	11.5
Residential	60.3	33.0	19.7	11.4	6.6
Purchased Goods and Services	0.0	0.0	0.0	0.0	0.0
Other Operational Assets	250.7	99.0	58.5	33.4	19.0
Total (tCO_2e)	**1,555.6**	**1,544.0**	**1,391.8**	**706.3**	**1,555.6**
% change	**0%**	**-1%**	**-11%**	**-55%**	**-94%**

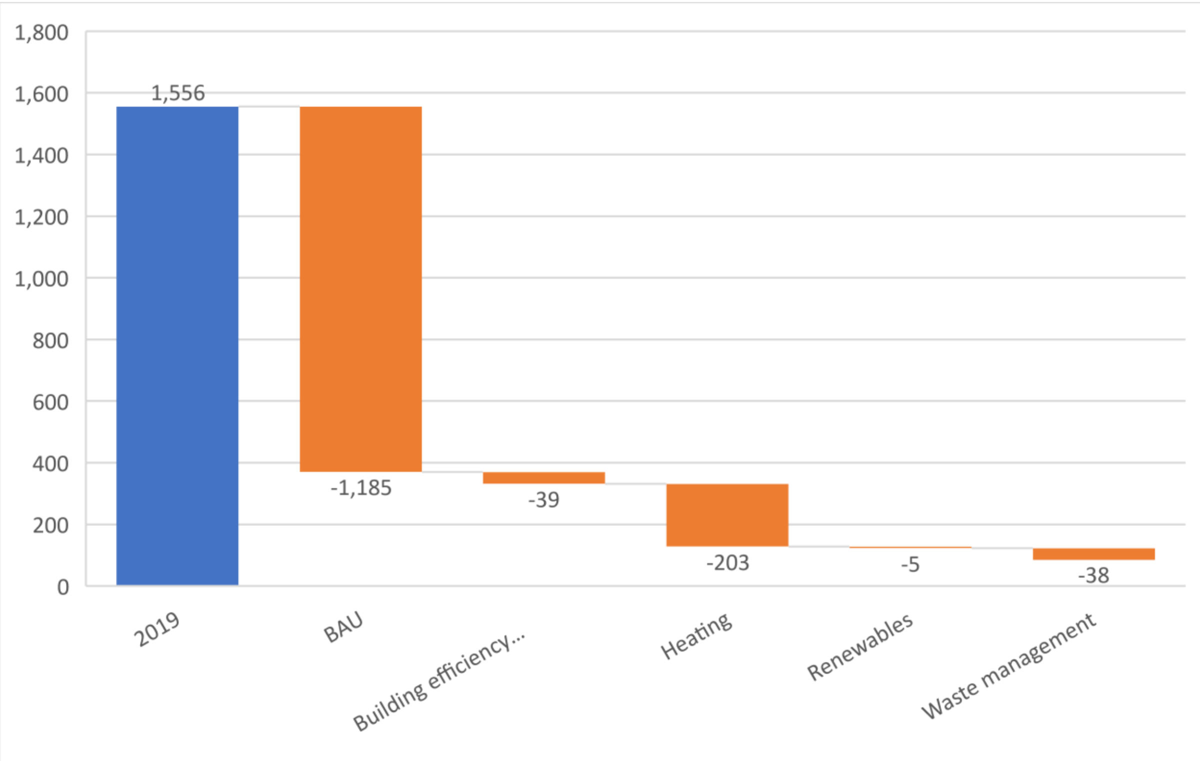
Figure 21 shows that under a 2040 net zero scenario, mitigation measures associated with other operational assets (e.g. Oaklands Main Office), and parks and recreational grounds can be seen to have the largest cumulative reduction in emissions.

Figure 22 - Comparing the net zero pathway to business as usual



Under the accelerated net zero pathway, baseline emissions are reduced by 94% compared to 76% under a business-as-usual scenario. Figure 22 shows the groups of measures which present a significantly reduced emissions profile within the 2040 net zero pathway. This is also shown as a waterfall diagram in Figure 23 below. This highlights the substantial opportunity available through low or zero emissions properties to significantly address MSDC's primary source of emissions.

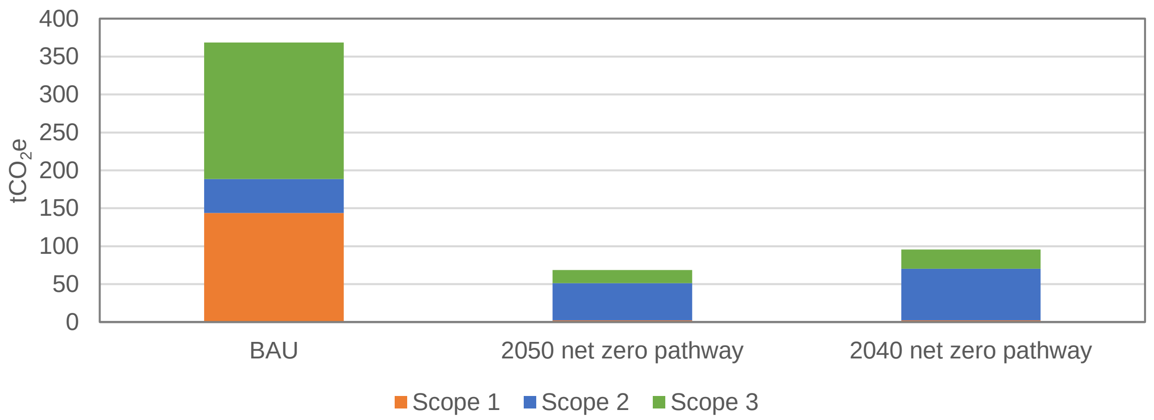
Figure 23 - Carbon savings by measure for the net zero pathway, cumulative from 2019/20 baseline to 2039/40



2.3.3.2 Residual emissions

Similar to the 2050 net zero pathway, regardless of the implementation plan MSDC chooses to adopt, there will be residual emissions remaining in 2040. A comparison breakdown of scope and categories of emissions is provided below in Figure 24 and the following table.

Figure 24: Residual emissions in 2040 and 2050, split by scope



tCO_2e	2019	2025	2030	2035	2040
BAU	1,556	1,739	1,614	956	371
2040 net zero pathway	1,556	1,544	1,392	706	96

Emissions area	BAU (tCO_2e)	2040 pathway (tCO_2e)
Diesel	0.0	0.0
Gas Oil	0.0	0.0
Grid electricity	44.6	68.1
Grid Electricity T&D Losses	2.1	2.2
Grid Electricity Tenant	14.2	22.2
Natural gas	143.8	0.0
Natural Gas tenant	120.1	0.0
Petrol	0.0	0.0
Unknown Transport Fuel	0.0	0.8
Waste Disposal (All Types)	43.8	0.0
Waste to energy heat	0.0	2.3
Total	**368.7**	**95.6**
% of 2019/20 baseline	23.7%	6.1%

2.3.3.3 Offsetting

As outlined in the previous section, we have estimated the cost of offsetting residual emissions in mid-century at £160/tCO_2 based on a recent assessment by the Grantham Institute[9].

Based on the modelled pathways, the cost of off-setting residual emissions for the year 2050 would be:

- BAU: £58,985
- 2040 net zero pathway: £15,296

Of particular relevance to MSDC is the option to offset grid electricity emissions by purchasing renewables tariff electricity, which accounts for approximately 17% of all residual emissions in the BAU, and 97% in the 2040 net zero pathway. This enables climate-related expenditure to remain within value creation cycle and reduces heavy spend on transactional costs for offsets.

[9] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2019/05/GRI_POLICY-REPORT_How-to-price-carbon-to-reach-net-zero-emissions-in-the-UK.pdf

3 A NET ZERO DISTRICT

Chapter 3 looks at GHG emissions across the whole of the Mid Sussex district. It starts with the GHG baseline for the whole district, then considers which stakeholders have influence over emissions and what the role of the Council can be and finishes by outlining two possible net zero pathways that the district could take.

3.1 GHG BASELINE

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

Key messages

- Buildings and transport – specifically, homes and cars – account for the vast majority of both fuel use and GHG emissions in Mid Sussex.
- Fuel consumption has decreased by around 10% since 2005, while CO_2 emissions have decreased by 32%. This is primarily due to the decarbonisation of grid electricity, which is the result of using less coal and more renewable technologies to generate power in the UK.
- Total GHG emissions for Mid Sussex in 2019 were approximately 736 ktCO_2e. This figure includes carbon dioxide (mostly associated with energy use), methane (mostly associated with waste and agriculture), nitrous oxide (mostly associated with fertiliser), and f-gases (used in refrigeration technologies). Around 80% of emissions are from CO_2 alone. This is consistent with the national average.
- The energy efficiency of the building stock in Mid Sussex is broadly in line with the national average. New buildings are significantly more efficient than older buildings. The Government aims to increase the minimum EPC rating that buildings must achieve in order to be rented, which should help to promote energy efficiency measures – but this will present a considerable challenge given the current performance of the building stock.
- There are a range of renewable technologies in Mid Sussex producing both electricity and heat. The majority are roof- or ground-mounted solar photovoltaic (PV) installations. There is also a significant amount of electricity produced by a single sewage gas facility. The amount of renewable electricity generated is equivalent to around 23 GWh per year. For context, electricity use in 2018 was around 509 GWh.
- Uptake of ultra-low emissions vehicles (ULEVs) has increased exponentially since 2011, and as of 2020 there were nearly 1,000 licensed ULEVs within the District, along with 35 public charging points. While this is an encouraging trend, uptake will need to increase nearly 100-fold by 2050 for Mid Sussex to reach net zero emissions.

3.1.1 Overview of the methodology

The baseline information presented in this section 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). This core data has been supplemented, where relevant, with additional local data and further analysis in order 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.

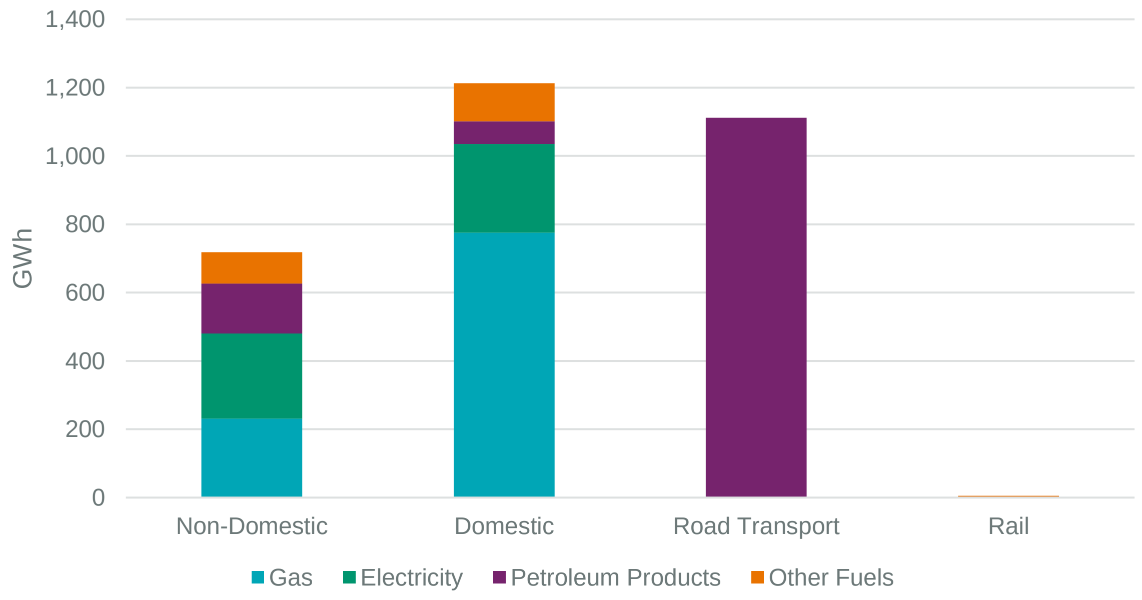
3.1.2 Fuel consumption

The most recent fuel consumption data published by BEIS is for 2018.[10] Results are shown in the table below and illustrated in Figure 25. (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 5. Fuel Consumption by Sector, 2018

	Gas (GWh)	Electricity (GWh)	Petroleum Products (GWh)	Other Fuels (GWh)	Total (GWh)	% of total
Non-Domestic	231	250	145	92	**718**	24%
Domestic	776	260	66	111	**1,213**	40%
Road Transport	0	0	1,112	0	**1,112**	36%
Rail	0	0	2	3	**5**	<1%
Total	**1,007**	**509**	**1,326**	**207**	**3,048**	**100%**
% of total	33%	17%	43%	7%	**100%**	

Figure 25. Fuel Consumption by Sector, 2018



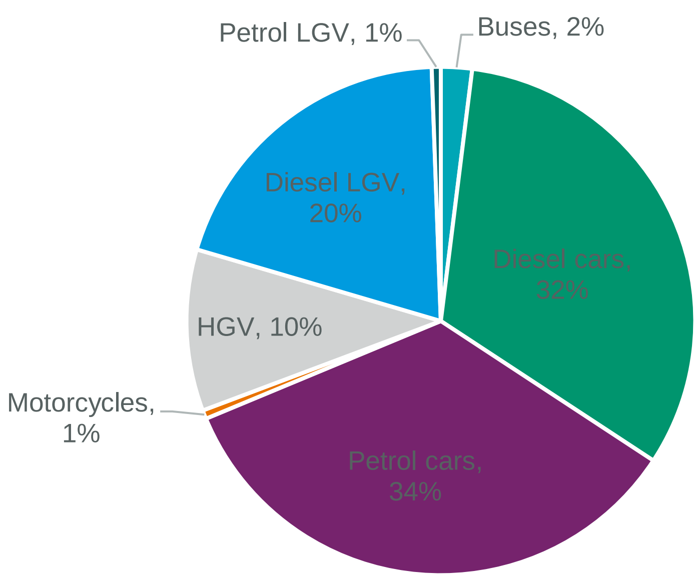
These statistics show that 40% of the fuel used in Mid Sussex in 2018 was associated with domestic buildings. Within the domestic sector, the majority of fuel used was natural gas, which typically supplies space heating and hot water, followed by electricity. Non-domestic buildings and processes/activities accounted for around 24%. This sector exhibits a more diverse mix of fuels compared to the domestic sector. The road transportation sector accounted for around 36% of total fuel consumption. There was also a very small amount of coal and petroleum use associated with rail transportation.

[10] BEIS, 'Sub-national total final energy consumption data 2005-2018' (published 2020). Available at: Sub-national total final energy consumption data - data.gov.uk

When considering fuel consumption by fuel type, petroleum products were the largest contributor, accounting for 43% of all fuel used in 2018. The majority of petroleum use was attributed to road transportation (petrol and diesel), although some petroleum products are also used in industrial, commercial, and domestic buildings. Considering that Mid Sussex is a rural district, this could reflect a greater reliance on private transport and a higher proportion of homes that are off the gas grid compared with more urban areas. Natural gas accounted for around 33% of total fuel consumption while electricity accounted for 17%.

Examining road transport in more detail, around 67% of fuel is used in petrol or diesel cars, as shown in Figure 26. Around 20% is used for diesel light goods vehicles (LGVs) and 10% is used for heavy goods vehicles (HGVs). The remainder is associated with buses, petrol LGVs, and motorcycles. Overall, around a third of road transport fuel is currently used for freight, with the remainder used for personal travel.[11]

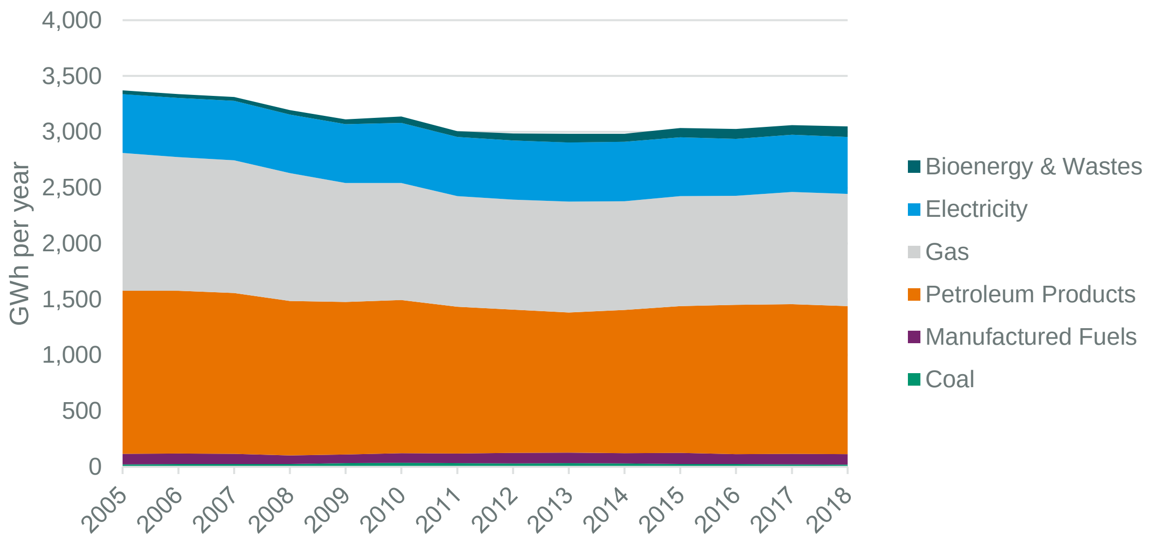
Figure 26. Split of road transport fuel use by vehicle type, 2019



As shown in Figure 27 below, total fuel consumption in Mid Sussex decreased by around 10% between 2005 and 2018 for all sectors and all fuel types, with the exception of fuels derived from bioenergy and waste. In particular, the use of natural gas decreased by around 18% in that time period. This trend is likely due to a wide range of factors but could indicate an increasing prevalence of energy efficiency measures in buildings and industry. When looking at total fuel consumption over this period, it is interesting to note that the reductions mostly occurred in the time period up to around 2011 – from that point fuel consumption has remained largely stable or has even slightly increased.

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

Figure 27. Trends in fuel consumption, 2005-2018



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.[12,13]

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

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

Figure 28. Domestic electricity consumption by LSOA, 2019. Source: BEIS

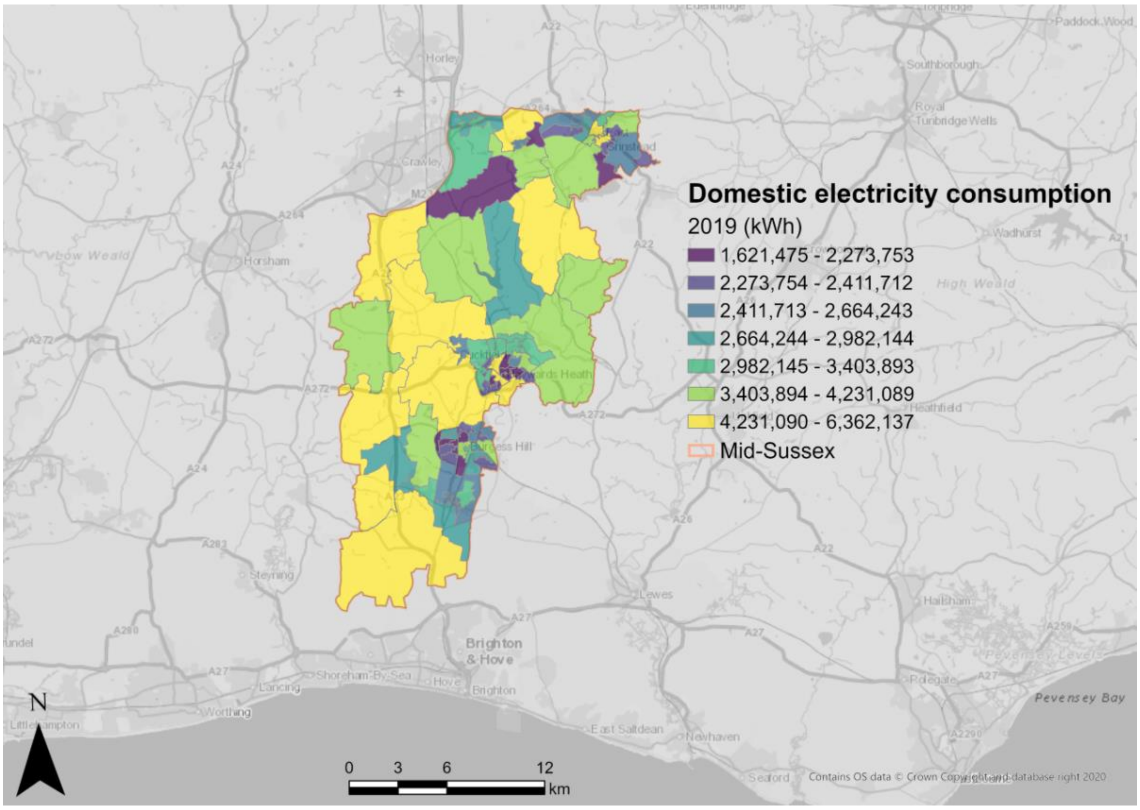


Figure 29. Domestic gas consumption by LSOA, 2019. Source: BEIS

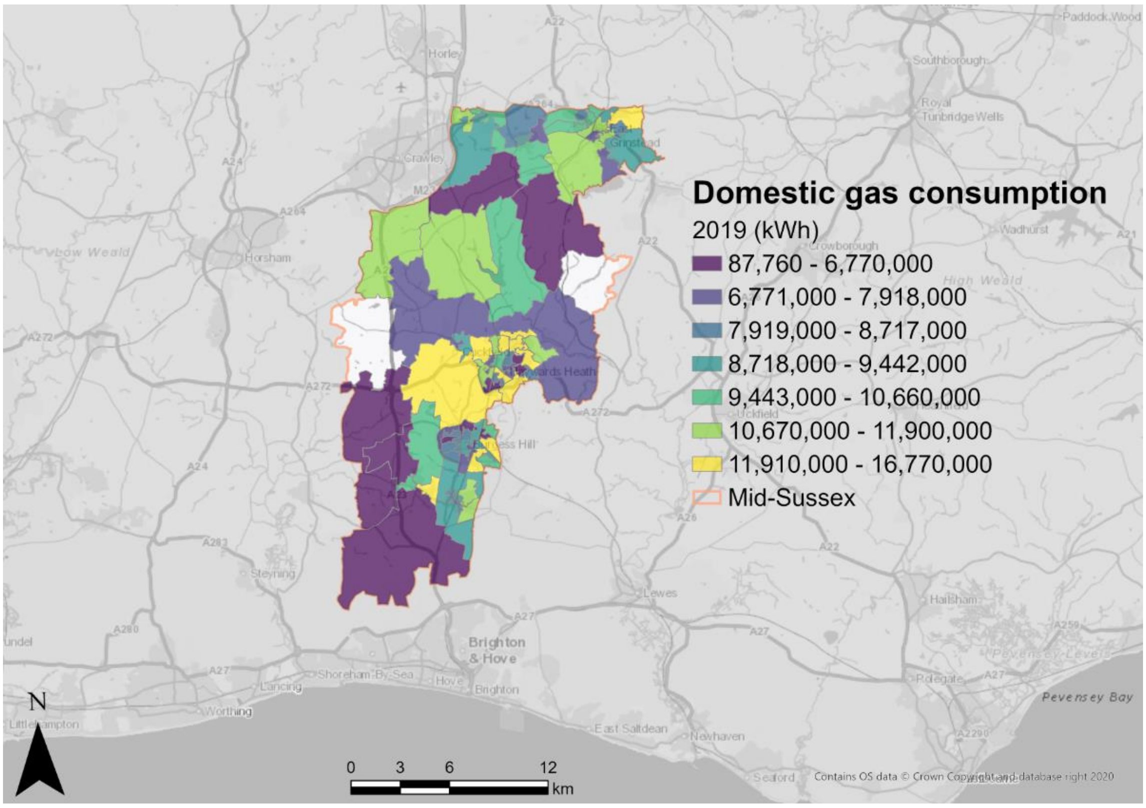


Figure 30. Non-domestic electricity consumption by MSOA, 2018. Source: BEIS

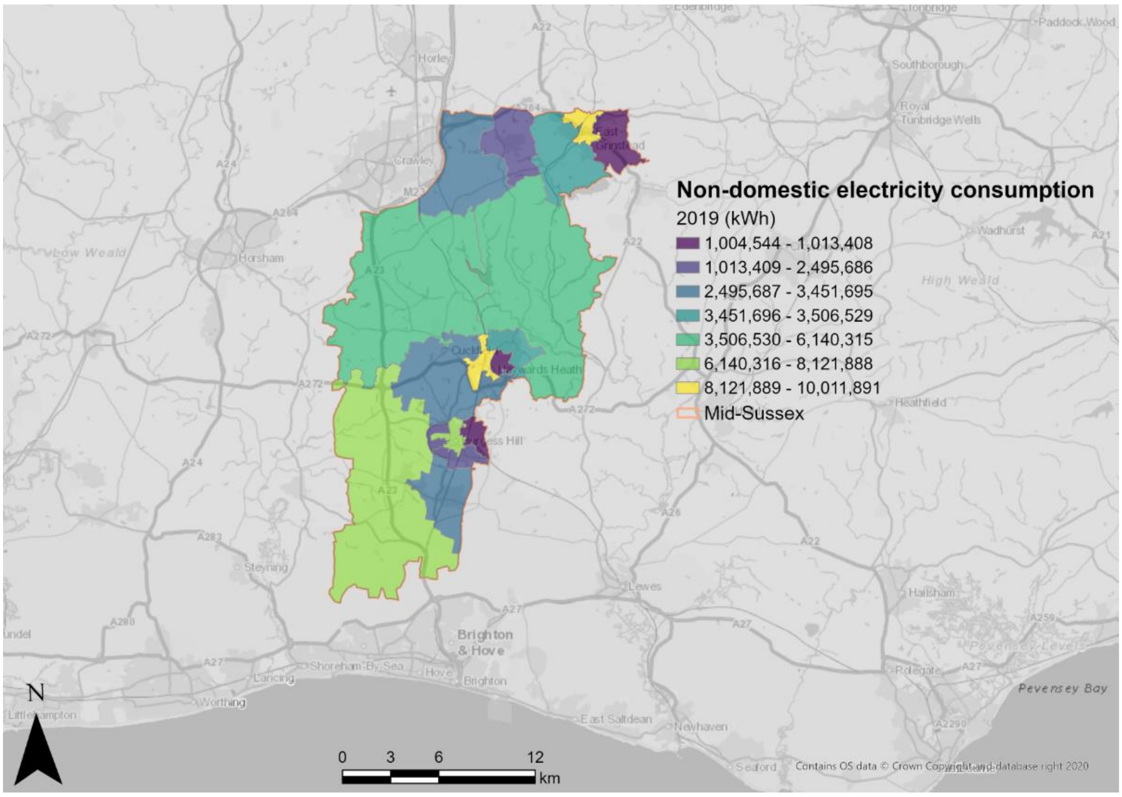
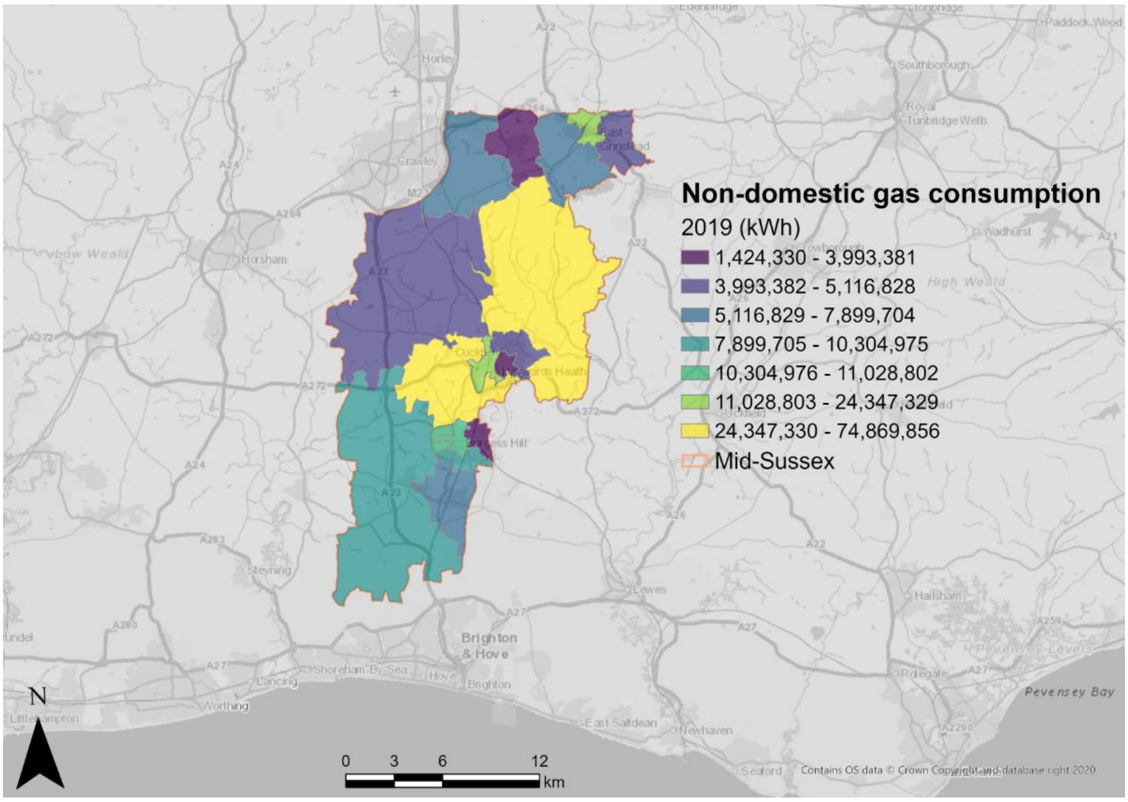


Figure 31. Non-domestic gas consumption by MSOA, 2018. Source: BEIS



3.1.3 Greenhouse gas (GHG) emissions

Information on CO_2 emissions at a local authority level is published annually by BEIS, two years in arrears.[14] 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.[15] 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; and
- Fluorinated gases (f-gases), which are used in refrigerants and air conditioning systems but can leak out during the manufacturing, operation or disposal process.

Therefore, in order to provide a more comprehensive GHG emissions inventory for Mid Sussex, 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 district with our proprietary Net Zero Projections (NZP) tool. Results are presented in Table 6 below. These have been split according to sector to facilitate a like-for-like comparison with the BEIS CO_2 dataset (illustrated in Figure 32).

Table 6. GHG emissions in Mid Sussex 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 ($ktCO_2e$)
Sectors in the BEIS CO_2 dataset					
Light industry	13.55	18.14		32.09	63.78
Large industrial installations	5.86	3.92		9.62	19.40
Agriculture (CO_2 from energy use) [2]				8.20	8.20
Commercial	17.96	27.29		1.27	46.52
Public sector	11.00	6.77		0.47	18.25
Domestic	147.48	56.05		22.93	226.46
Road transport			291.40		291.40
Railways			0.66		0.66
LULUCF net emissions [3]				-70.06	-70.06
Total	**195.86**	**112.16**	**292.05**	**4.53**	**604.61**
Additional sectors					
Agriculture (non-CO_2 gases) [2]				40.50	40.50
F-gases [4]				30.37	30.37
Waste [4][5]				42.95	42.95
Domestic Aviation [4][5]				3.21	3.21
Total				**117.04**	**117.04**

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

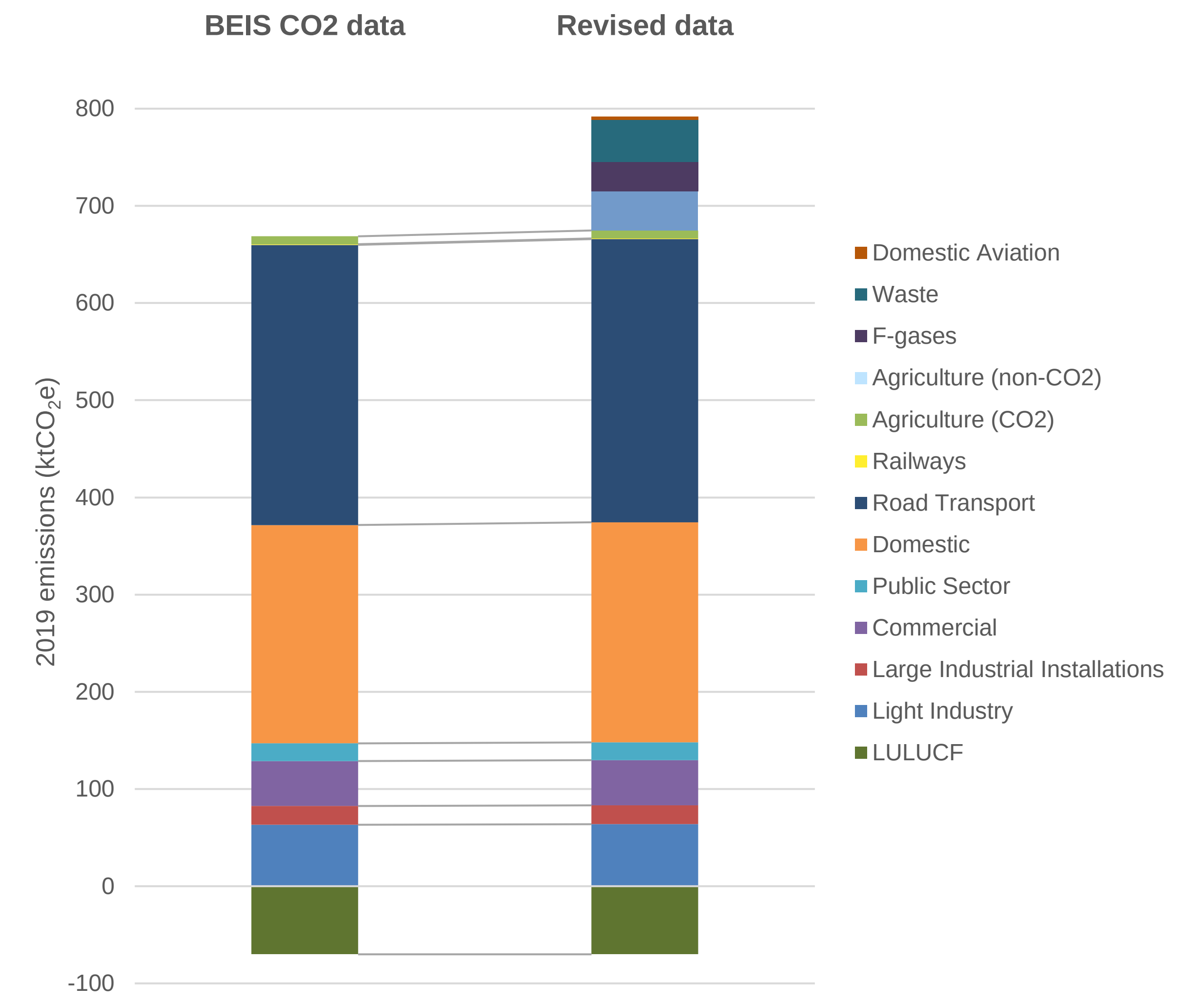
[14] BEIS, 'Emissions of carbon dioxide for Local Authority Areas; (published 2021). Available at: Emissions of carbon dioxide for Local Authority areas - data.gov.uk

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

in landfill. Similarly, LULUCF (land use, land use change, and forestry) emissions are affected by soil and plants absorbing CO_2 during respiration.

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. These were estimated by referencing the NAEI emissions map and converting units of methane and nitrous oxide to tCO_2e.
3. 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. Estimate based on national datasets and apportioned to Mid Sussex based on population.
5. Some or all of the emissions from these categories may be classified as 'indirect' emissions, and therefore outside the scope of this inventory, if they occur outside of the Local Authority boundary. This would be the case, for instance, if waste generated in Mid Sussex is sent to landfill elsewhere. However, it is not possible to confirm based on available information.

Figure 32. Gross GHG emissions in 2019, comparing the BEIS CO_2 data and the revised GHG inventory



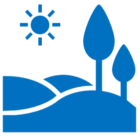
There are a few key differences between the BEIS CO_2 data and the revised inventory:

- 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.
- F-gases, waste, and domestic aviation are additional sources of emissions that were not included in the BEIS data.

The revised results highlight that road transport and domestic buildings contribute the most to total GHG emissions. Although the domestic sector is more energy-intensive (measured by annual fuel consumption), the rapid decarbonisation of the electricity grid in recent years means that road transport is now the highest emitting sector (see Figure 33).

The next most significant contributions come from light industry, agriculture, and the commercial sector. Energy use in public sector buildings and large industrial installations each comprise a relatively small portion of the overall total – less than the estimated emissions from f-gases, although it should be noted that the latter are based on prorated national datasets rather than locally specific information.

Emissions from waste management and domestic aviation have also been reported, although again, these are based on national datasets. Although they may fall outside the Local Authority boundary, it is possible that MSDC could exert some influence over these emissions e.g., by collaborating with waste collection contractors, or via awareness raising campaigns.

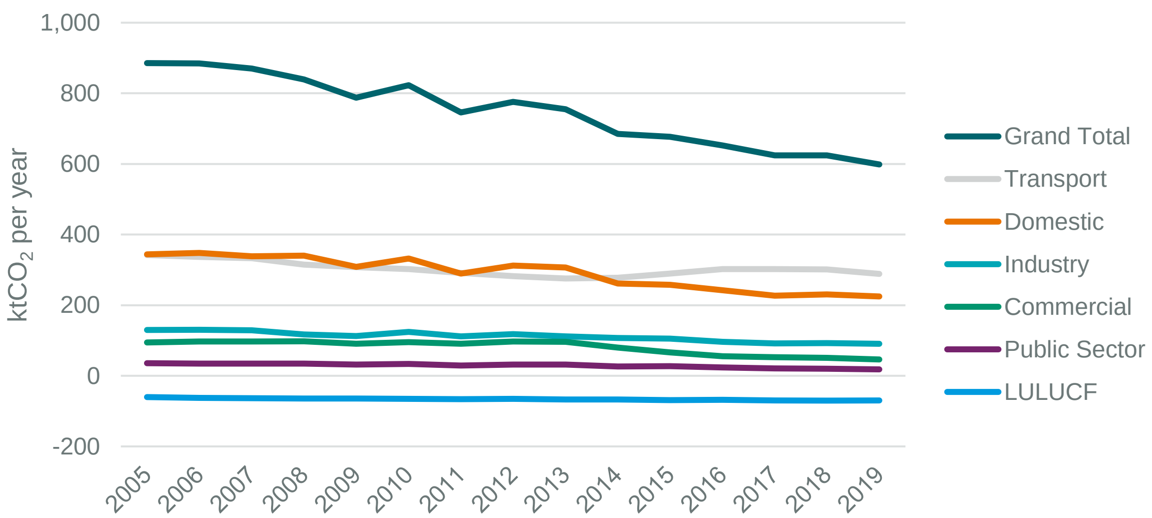


GHG reductions from the LULUCF sector reduce the total net emissions by around 10%. Although this is environmentally beneficial, it also serves as a reminder of the sheer scale of GHG emissions reductions that would need to occur in order to reach net zero emissions overall. Given that Mid Sussex is comparatively rural, and already includes important natural landscapes and national parks, there may be less scope for additional CO_2 sequestration to be achieved via 'natural' methods.

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 33 below, total CO_2 emissions in Mid Sussex decreased by around 32% from 2005-2019. This is slightly below the national and county-wide averages, both of which saw around a 36% decrease in the same time period. By far the most significant change in emissions was due to decarbonisation of the national electricity grid, associated with the phasing out of coal and increase in renewable power generation. While electricity use in Mid Sussex decreased by around 4% in that time, CO_2 emissions per unit of grid electricity dropped by 55%. 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. Other changes in emissions are primarily associated with trends in fuel consumption, as the carbon intensity ($kgCO_2/kWh$) of most fuels other than electricity remains comparatively stable.

Figure 33. Trends in CO_2 emissions in Mid Sussex, 2005-2019



The maps on the following pages show the spatial distribution of CO_2, CH_4 and N_2O emissions at a 1x1km grid level, as published within the National Atmospheric Emissions Inventory (NAEI) mapping database.[16]

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

Figure 34. Total CO_2 emissions in Mid Sussex, 2019. Source: NAEI

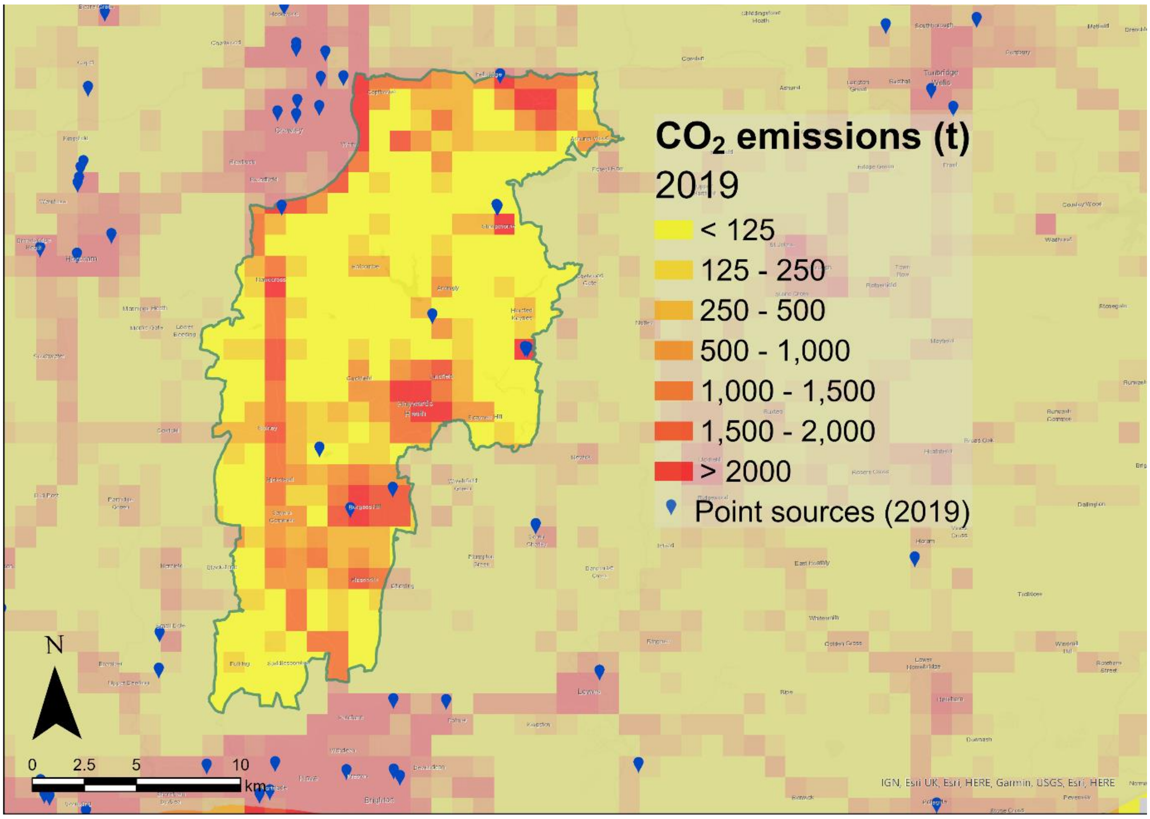


Figure 35. Domestic CO_2 emissions in Mid Sussex, 2019. Source: NAEI

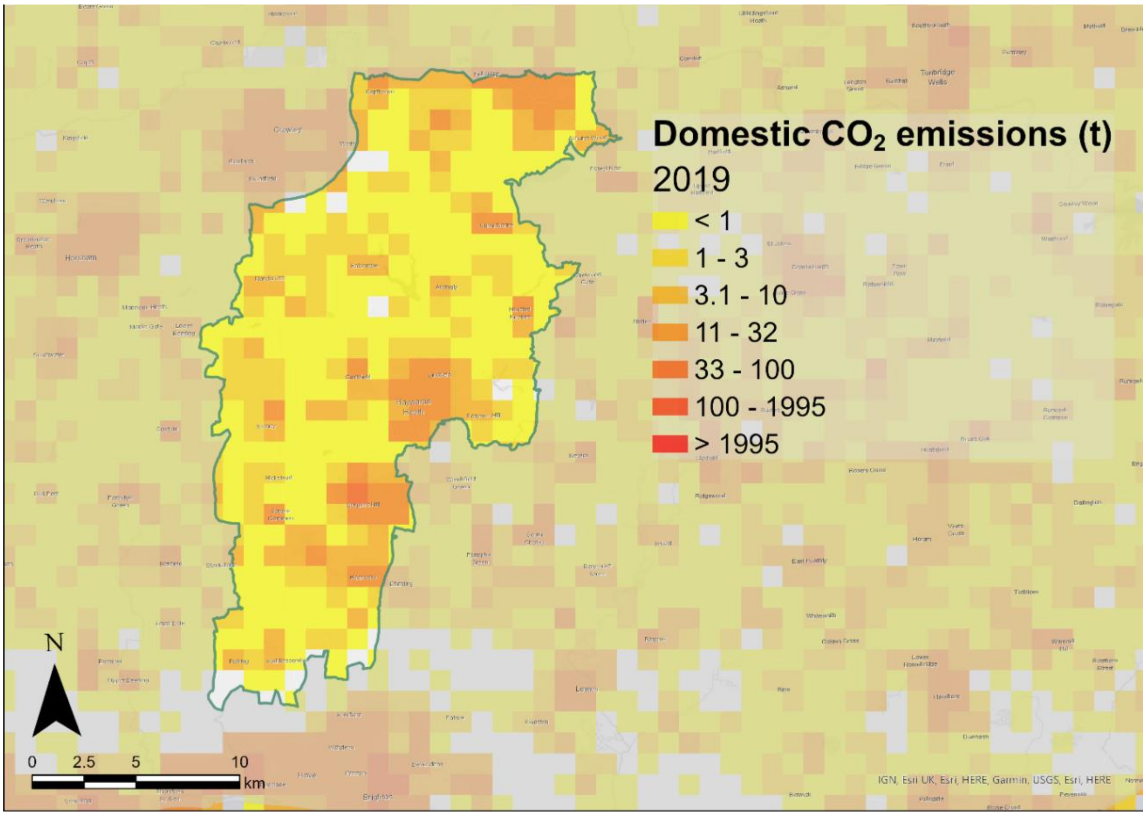


Figure 36. CO_2 emissions from road transport in Mid Sussex, 2019. Source: NAEI

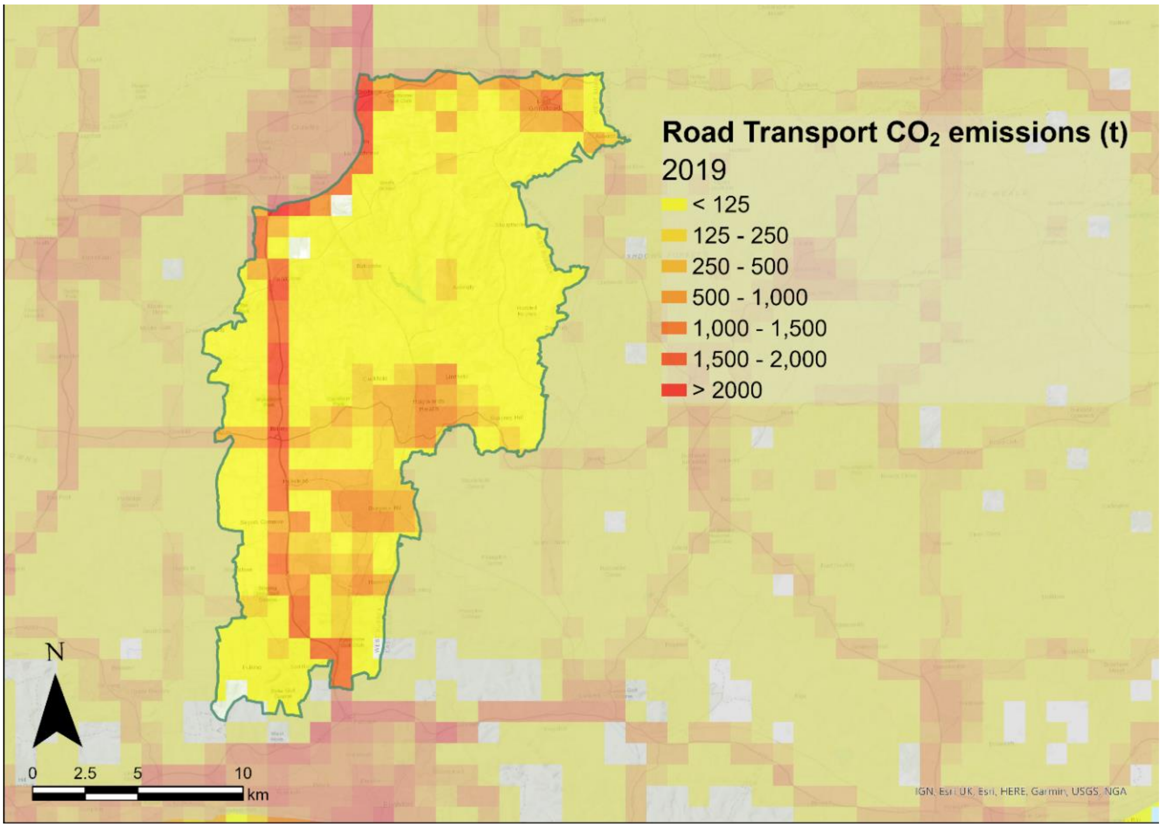


Figure 37. CO_2 emissions from manufacturing in Mid Sussex, 2019. Source: NAEI

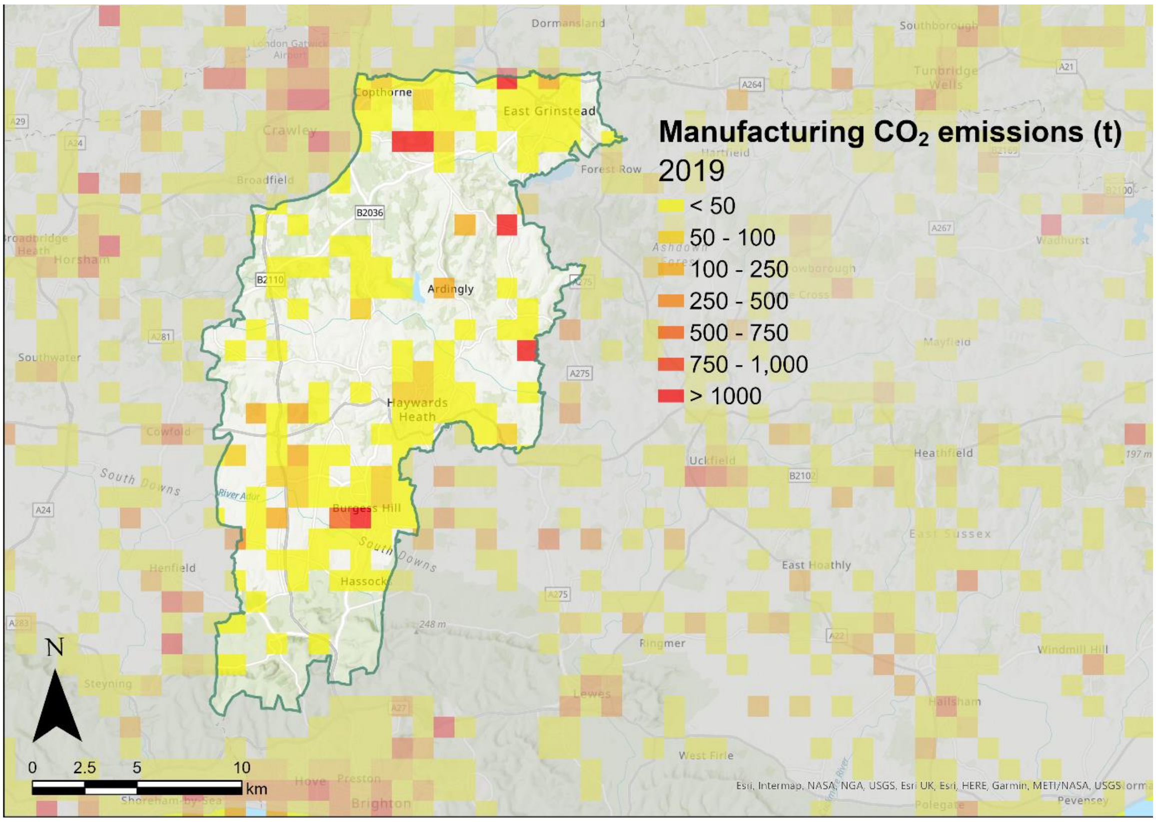


Figure 38. Methane (CH_4) emissions in Mid Sussex, 2019. Source: NAEI

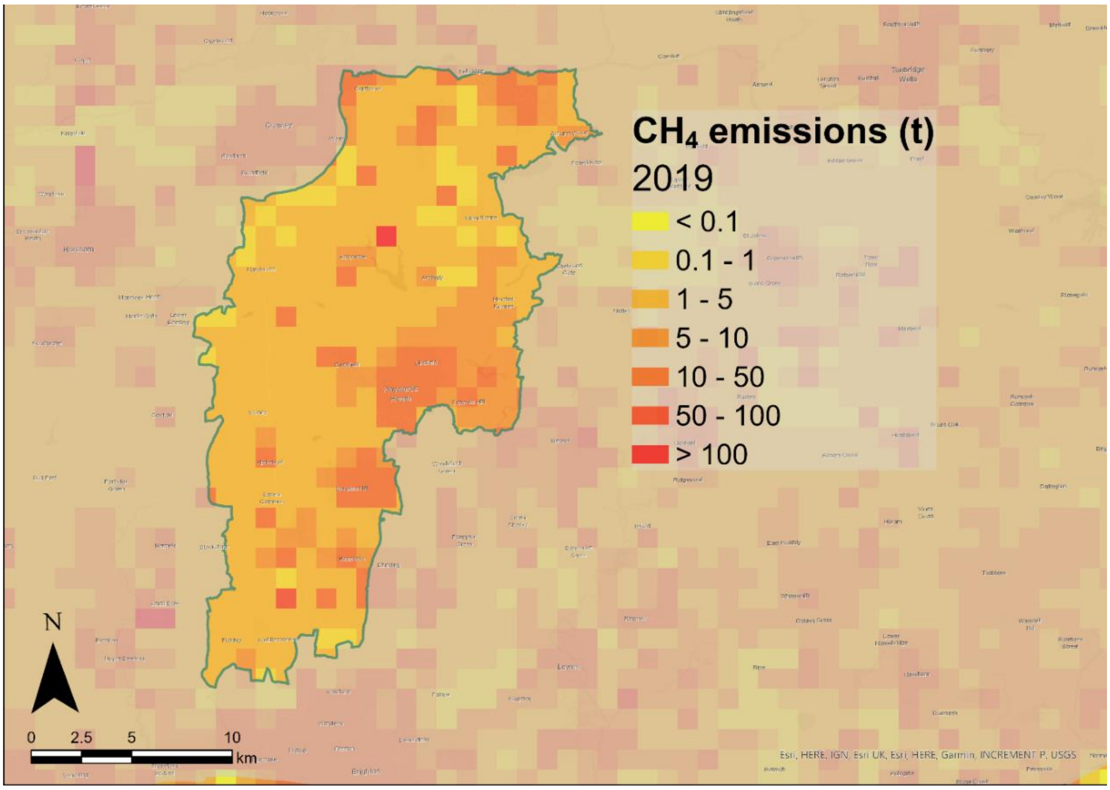
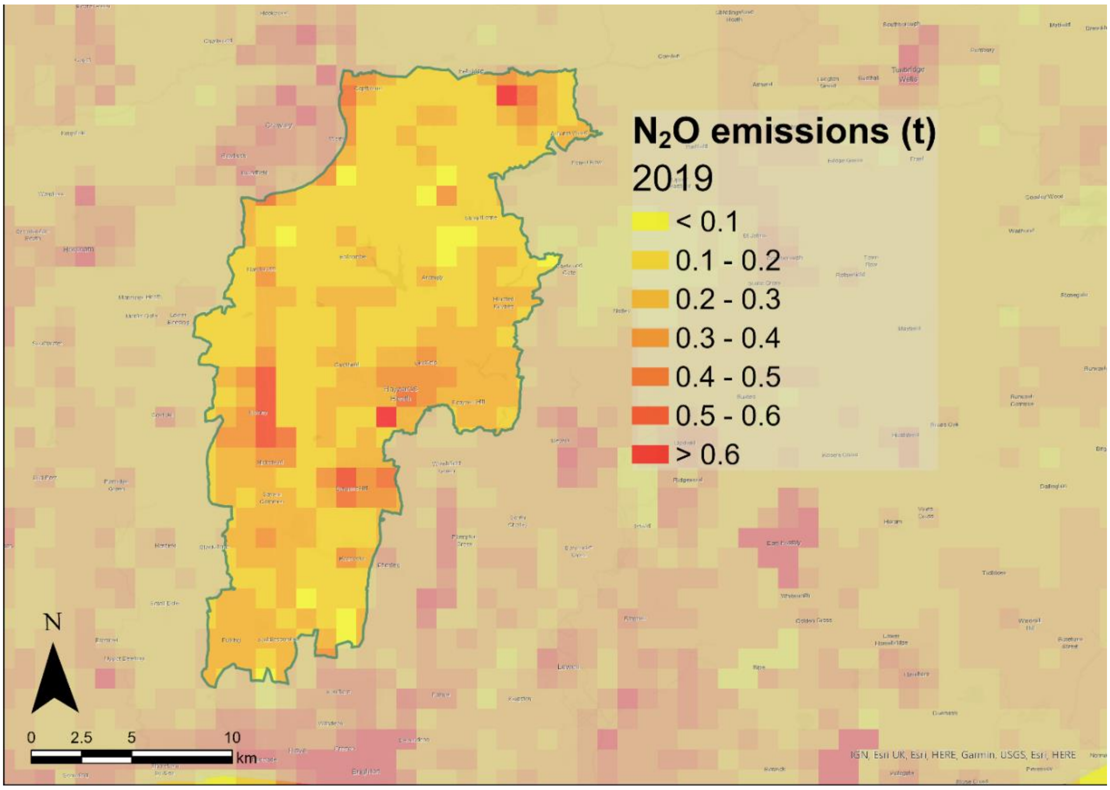


Figure 39. Nitrous oxide (N_2O) emissions in Mid Sussex, 2019. Source: NAEI



The maps indicate that CO_2 emissions are highest around the main town centres in Haywards Heath, Burgess Hill, and East Grinstead, which is not surprising given the rural nature of the district. Road transport emissions are dominated by the A23 and M23 where it encircles Crawley. The map of total CO_2 emissions shows that there are relatively few large point sources of CO_2, which typically include high energy users such as power stations, large industrial facilities, etc. The map of emissions from combustion in manufacturing also shows a small number of hotspots which correlate to these point sources' further details are available on the NAEI website. There is comparatively less spatial variation in CH_4 and N_2O emissions; these gases are predominantly associated with agricultural activities which are distributed across the district.

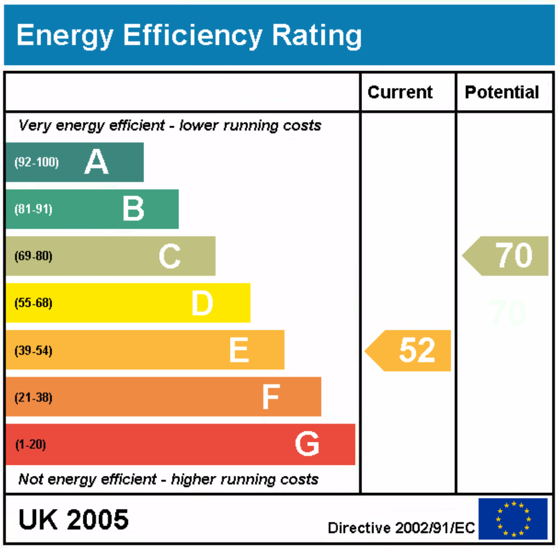
Note: Separate maps have been provided for CO_2, CH_4 and N_2O because the NAEI does not include f-gases which form part of Mid Sussex's total GHG footprint. Emissions of f-gases are assumed to correlate spatially with buildings, particularly non-domestic buildings which are more likely to use refrigerants and air conditioning systems.

3.1.4 Energy efficiency in buildings

In order to understand the relative level of energy efficiency of the existing building stock, energy performance certificate (EPC) data was retrieved from the Ministry of Housing, Communities and Local Government website.[17]

What are EPCs?

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'.[18] (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

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

[18] Minimum Energy Efficiency Standards (MEES) for Landlords (elmhurstenergy.co.uk)

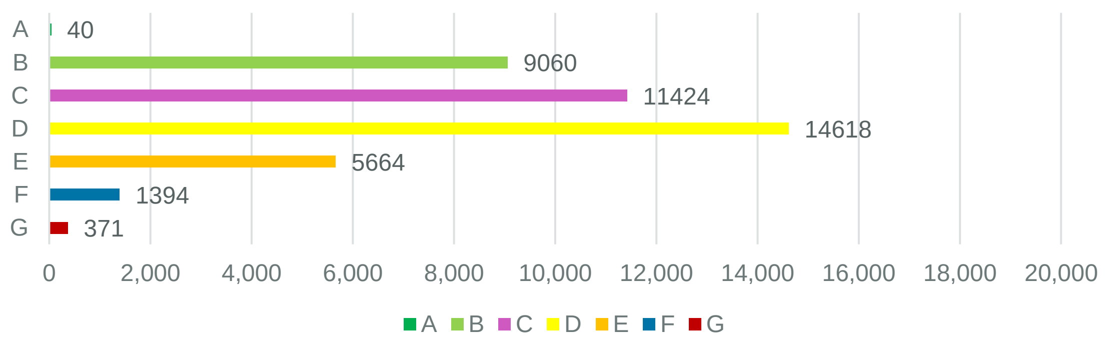
apply for commercial tenancies from April 2023. Over time, the minimum EPC rating will progressively increase. The Government has set out an ambition that, by 2030, most rented non-domestic properties will be required to achieve a 'B' rating and homes will achieve a 'C' rating.[19,20] Local Authorities 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 3.1.3, 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.

3.1.4.1 Domestic buildings

As shown in Figure 40, the median 'current' EPC rating for buildings in Mid Sussex 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.[21] 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.[22]

Figure 40. Current domestic EPC ratings



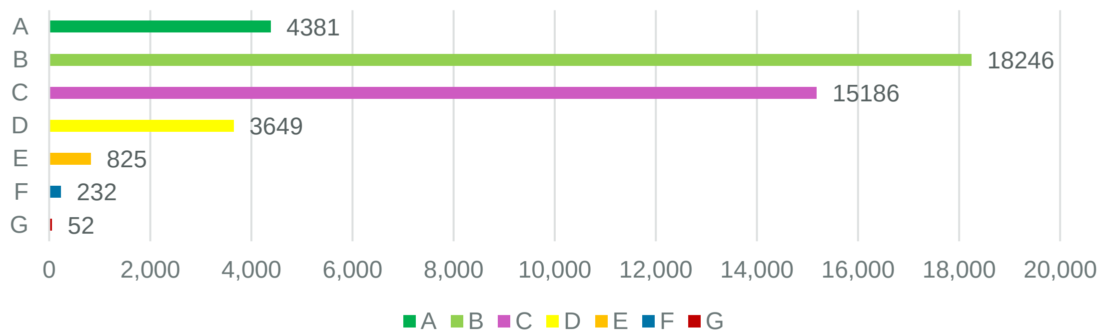
[19] Improving the energy performance of privately rented homes - GOV.UK (www.gov.uk)

[20] Non-domestic Private Rented Sector minimum energy efficiency standards: EPC B implementation - GOV.UK (www.gov.uk)

[21] 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.

[22] 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.

Figure 41. Potential domestic EPC ratings

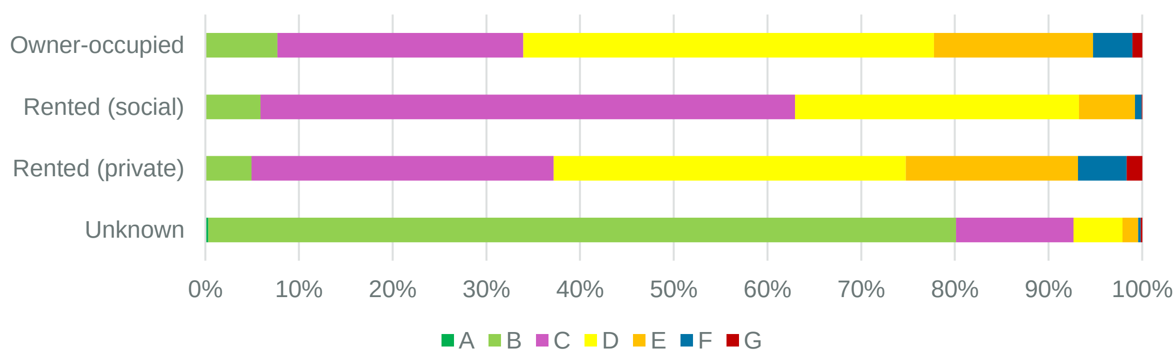


EPC data for England and Wales indicates that there is considerable variation between EPC ratings for buildings of different types and age of construction, and this is also the case for Mid Sussex. Larger properties, and those that are detached or semi-detached, tend to use more energy than smaller ones. 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.[23] This indicates that significant effort would be required to achieve the Government's aim of bringing as many buildings as possible up to a 'C' rating by 2035.

Considering energy efficiency by tenure, the domestic EPC data for Mid Sussex suggests that social rented housing tends to be more efficient than owner-occupied or private rentals. 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.

(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.)

Figure 42. Current domestic EPC ratings by tenure

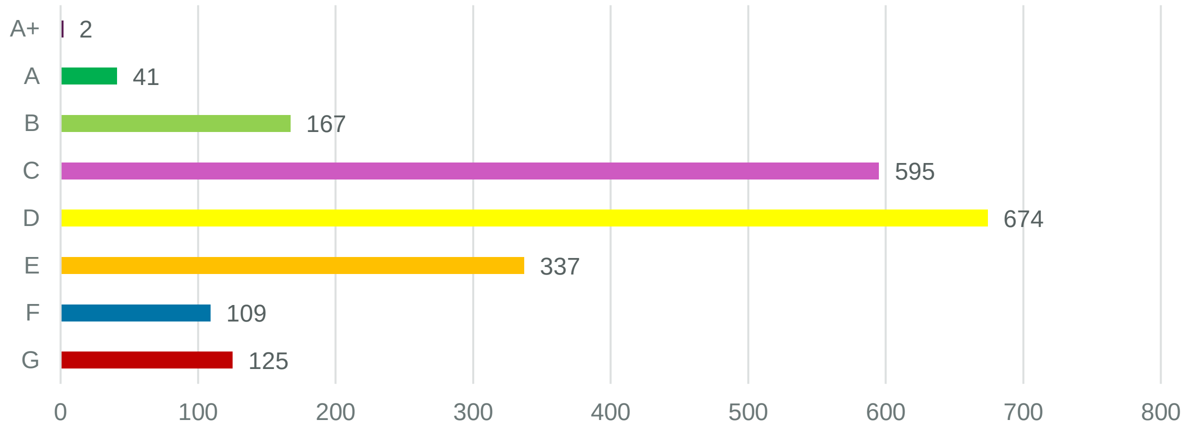


3.1.4.2 *Non-domestic buildings*

The median non-domestic EPC rating in Mid Sussex is D, and the majority (over 60%) have either a C or a D rating. 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.

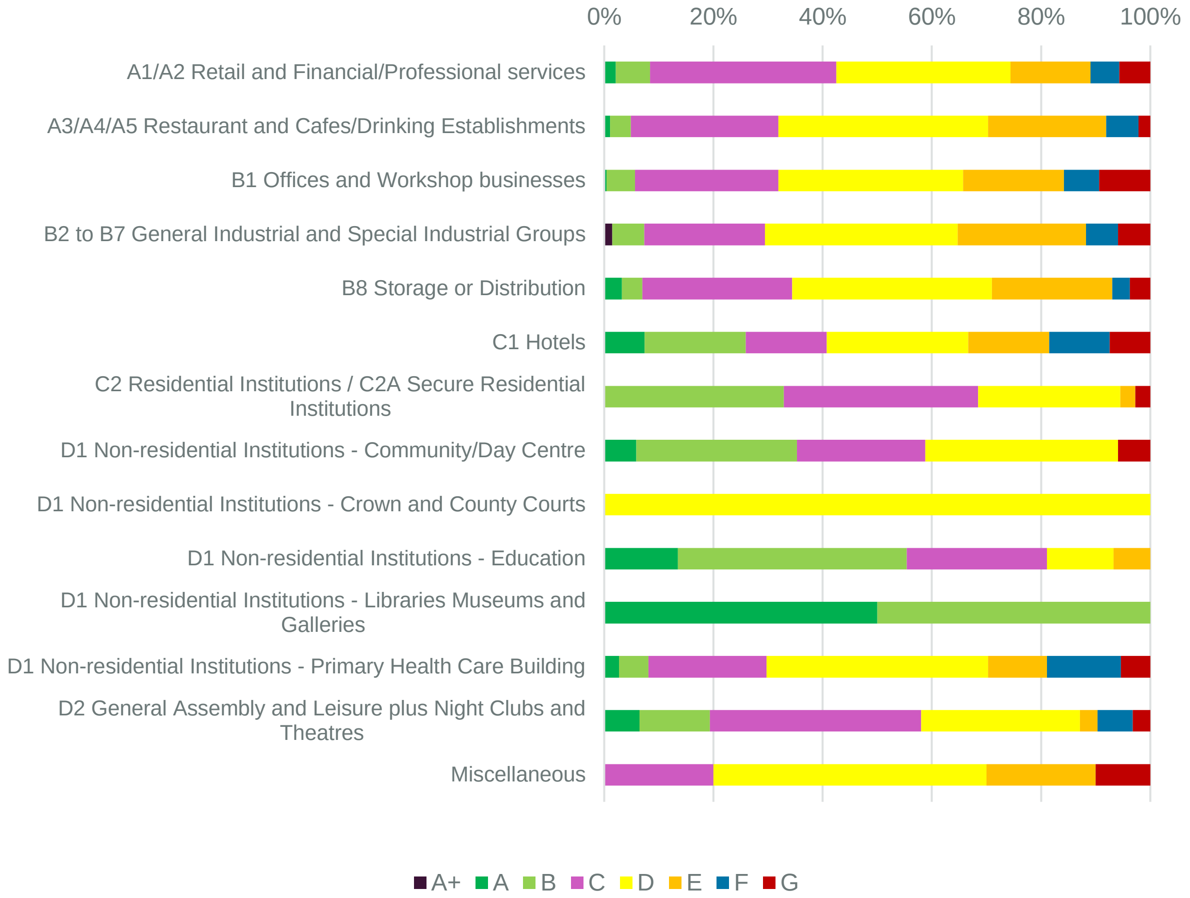
[23] Office for National Statistics, 'Energy efficiency of housing in England and Wales' (2021). Available at: [Energy efficiency of housing in England and Wales - Office for National Statistics (ons.gov.uk)](#)

Figure 43. Non-domestic EPC ratings



Non-domestic EPCs report the planning use category of a property, rather than tenure. Figure 44 shows a breakdown of results by use, 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 – Crown and County Courts' is based on the EPC record for just one building.) 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 44. Non-domestic EPC ratings by use category



3.1.5 Renewable energy

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

- 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.

Results are shown in Table 7 below.

As at the end of 2019, there were 2,138 electricity-producing renewable energy installations in Mid Sussex. The vast majority of these, in terms of number of installations, were solar photovoltaics (PV). It is likely that most PV installations are small, roof-mounted systems, although the REPD indicates that there are four operational ground-mounted PV farms in the district as well.

In addition to PV, there are five onshore wind turbines with a total capacity of around 0.02 MW. The small capacity suggests that these are small- or micro-scale turbines, which may reflect the fact that much of the district is located within the sensitive landscapes of the High Weald AONB and South Downs National Park.

There is also one sewage gas plant within Mid Sussex. Because this technology has a comparatively high output (MWh per unit of installed capacity), the single sewage gas plant generates around a third of the renewable electricity in the district.

Table 7. Renewable electricity technologies in Mid Sussex, as at end of 2019

	Number of Installations (#)	Installed Capacity (MW)	Generation (MWh per year)
Photovoltaics	2,132	19.61	17,753
Onshore Wind	5	0.02	44
Sewage Gas	1	0.8	5,388
Total	2,138	20.44	23,186

Source: BEIS, RRS

The RRS indicates that there are no hydropower, anaerobic digestion, wave, tidal, landfill gas, municipal solid waste, animal biomass or plant biomass installations in Mid Sussex. However, because the RRS only records technologies that produce electricity, we have referred to other sources for information on renewable heat technologies:

- The REPD indicates that there has been one planning application submitted for an air source heat pump (ASHP) based communal heating system that would supply care home residences in the Downlands Park Care Home in Hayward Heath.
- RHI statistics suggest that there are 45 non-domestic RHI installations in Mid Sussex, with a total installed capacity of around 8MW, and 206 domestic RHI installations, for which the capacity is not reported.

While it is impossible to confirm the types and sizes of individual RHI installations in Mid Sussex based on public data, for context, Table 8 and Table 9 present information based on 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.

Table 8. Split of technology types among non-domestic RHI applications

Technology Type	% of nationwide total
Small Solid Biomass Boiler (< 200 kW)	62%
Medium Solid Biomass Boiler (200-1000 kW)	19%
Large Solid Biomass Boiler (> 1000 kW)	1%
Solar Thermal (< 200 kW)	2%
Small Water or Ground Source Heat Pumps (< 100 kW)	7%
Large Water or Ground Source Heat Pumps (>100 kW)	2%
Biomethane	<1%
Biogas	4%
Air Source Heat Pumps	3%
CHP	<1%
Deep Geothermal	<1%

Source: BEIS, RHI Deployment Data April 2021, Table 1.1

Table 9. Split of technology types among domestic RHI applications

Technology Type	% of nationwide total
Air source heat pump	62%
Ground source heat pump	14%
Biomass systems	14%
Solar thermal	10%

Source: BEIS, RHI Deployment Data April 2021, Table 2.1

The table below summarises the large-scale renewable energy installations in Mid Sussex, both electricity and heat, that are listed within the REPD. A map of these renewable energy installations, based on data collected by the UK Renewables Map website, is provided in Figure 45.

Table 10. Large-scale renewable energy installations, as listed in the REPD

Operator (or Applicant)	Site Name	Type	Capacity (MWelec)	Development Status
INRG Solar	Land Parcel North of Goddards	PV	5	Operational
REPOWER	Balcombe & Chiddinglye Solar Park	PV	5	Operational
Haymaker Energy	Majors Hill/Turners Hill Solar Farm	PV	1.1	Operational
S4N Worsted	Worsted Farm	PV	5	Operational
British Solar Renewables	Coombe Solar Farm	PV	15.3	Planning Permission Granted
Dacorar Southern	Goddard's Green	PV	4.4	Planning Permission Granted
Kingscote Valley Ltd.	Moatlands	GSHP	0.12	Planning Application Submitted
Eden (Downlands) Limited	Downlands Park	Heat Network (ASHP)	N/a	Planning Application Submitted

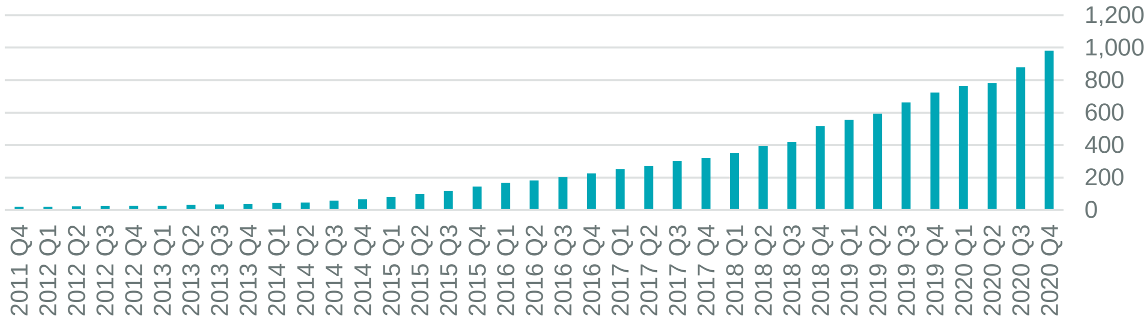
Figure 45. Locations of renewable energy technologies in Mid Sussex. Source: UK Renewables Map

To put these figures into context, it is helpful to consider the annual electricity demand of Mid Sussex, which was roughly 509 GWh as of 2018. Renewables therefore provide the equivalent of 4-5% of the district's annual electricity demands. 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 Mid Sussex to achieve net zero emissions.

3.1.6 Ultra-low emission vehicles (ULEVs)

ULEV uptake has increased exponentially in recent years across the UK, albeit from a low base, and Mid Sussex is no exception. As shown in Figure 46, by the end of 2020 there were 982 licensed ULEVs in the district, compared with just 20 in 2011. Around half of these (486) were battery electric vehicles (BEVs).

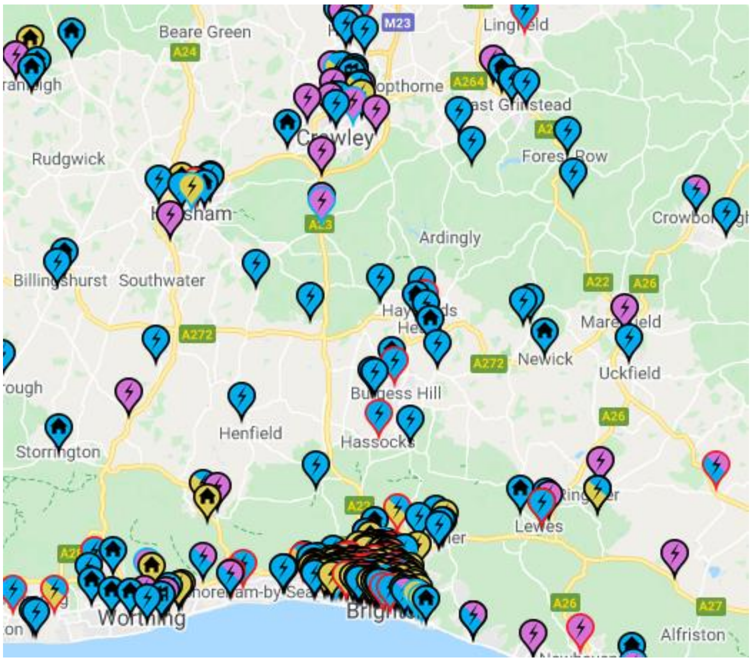
Figure 46. Licensed ULEVs in Mid Sussex, 2011-2020



Although this is an encouraging trend, ULEVs still represent a tiny proportion (<1%) of licensed vehicles in Mid Sussex. The UKPN Future Energy Scenarios envision that there could be nearly 100,000 EVs in Mid Sussex by 2050 – 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.

As of April 2021, there were 35 public charging points in Mid Sussex, including 5 rapid charging points. These are shown in Figure 47 below.

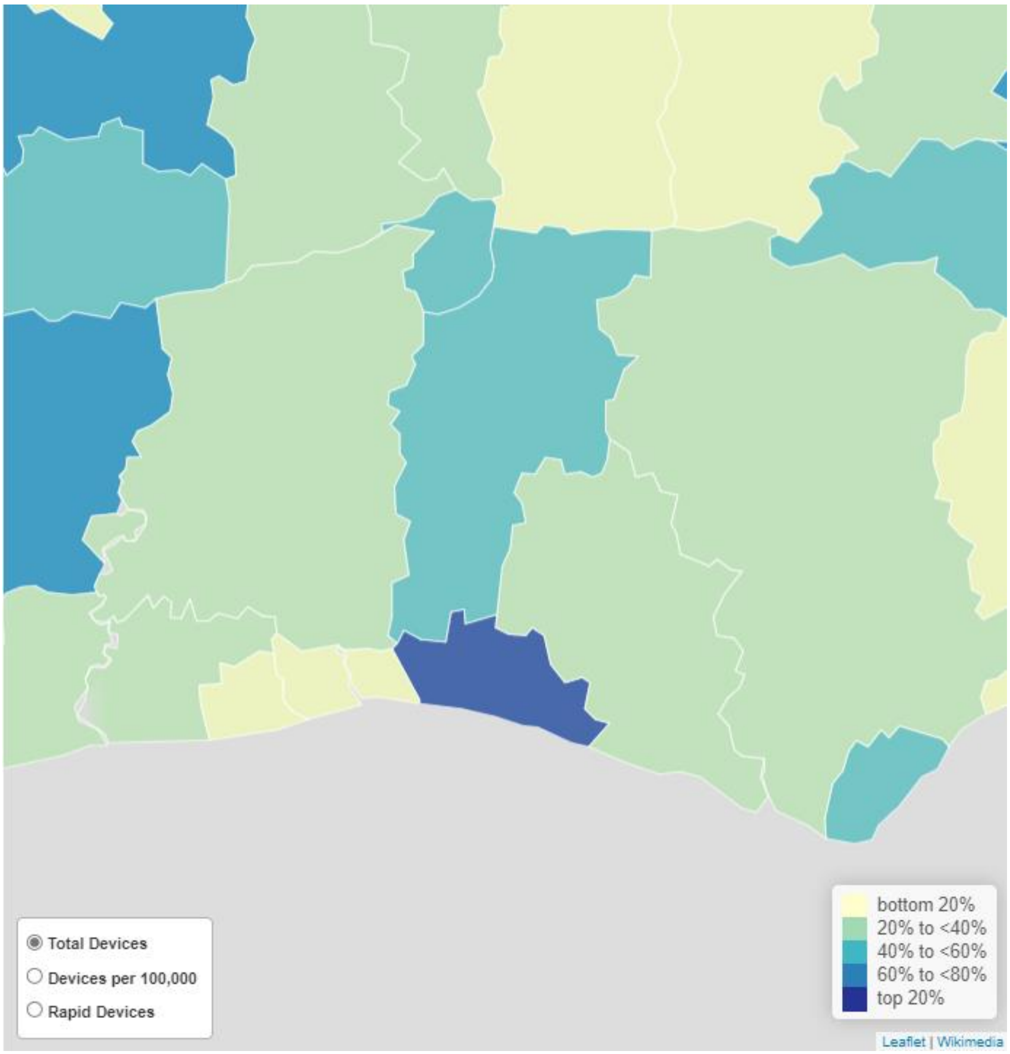
Figure 47. Locations of public charging points in Mid Sussex and surrounding area. Source: Zap-Map



Considering the district's population, this equates to around 23 public charging points per 100,000 head of population.[24] As illustrated in Figure 48, this is roughly equivalent to other local authorities in the UK, and higher than several of the more rural surrounding local authorities.

[24] maps.dft.gov.uk/ev-charging-map/

Figure 48. Density 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. West Sussex County Council has published an EV Strategy that envisions 70% of cars to be electric by 2030 and identifies ways that the Council can support the transition.[25] One of the key factors of the Integrated Action Plan for Mid Sussex will be to identify ways that MSDC can similarly play its part.

3.2 INFLUENCE MAPPING

This section looks at what the key drivers are that affect GHG emissions across the whole district and which stakeholders have most influence and control over them. This will then inform the development of the net zero plan.

3.2.1 Drivers of change

The UK is committed to achieving a 100% reduction in net GHG emissions by 2050. This is a legal requirement as per the Climate Change Act 2008. The previous 80% reduction target was revised

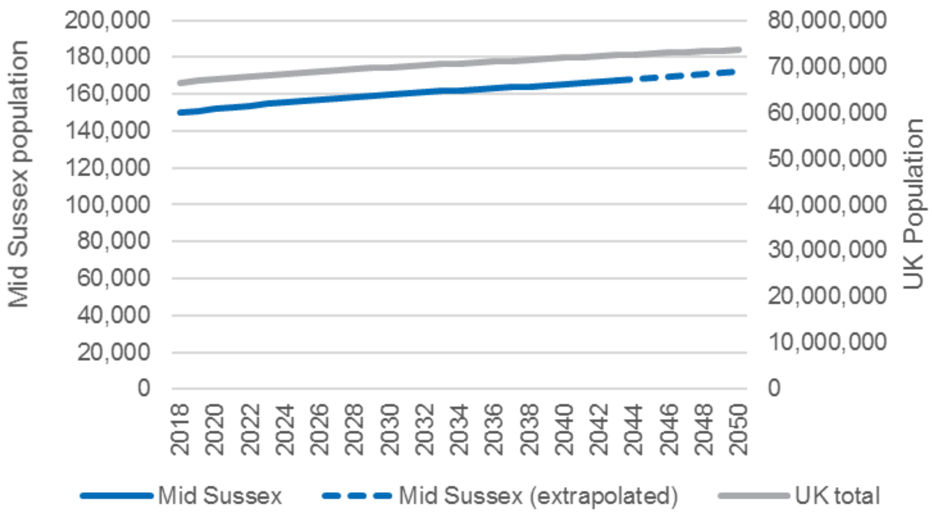
[25] Electric vehicles - West Sussex County Council

upwards in 2019. The Climate Change Committee (CCC) provides evidence and advice on how this can be achieved.

In 2019, MSDC pledged to take local action on climate change in order to support the national net zero target. Building on the Sustainability Strategy produced in 2018, the Council voted to establish a sustainability and climate change panel to provide advice on these topics. Section 3.1 identifies all sources of GHGs in the district, which is a first step towards being able to mitigate, or reduce, those emissions.

Achieving GHG emissions reductions, while also responding to the needs of a growing population, and maintaining economic development, is a significant challenge. The ONS predicts that the population of Mid Sussex, similar to the rest of the UK, could increase by c. 14-15% in the next three decades (see Figure 49). Higher incomes, new buildings 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 likely to be offset without further policy interventions.

Figure 49. Population projections for 2018-2050 (source: ONS)



Of course, there are many unknowns – factors such as energy prices and weather changes, for example, are hard to predict and can influence energy demand in either direction. However, the general picture includes significant headwinds.

Figure 50. common drivers of change for GHG emissions

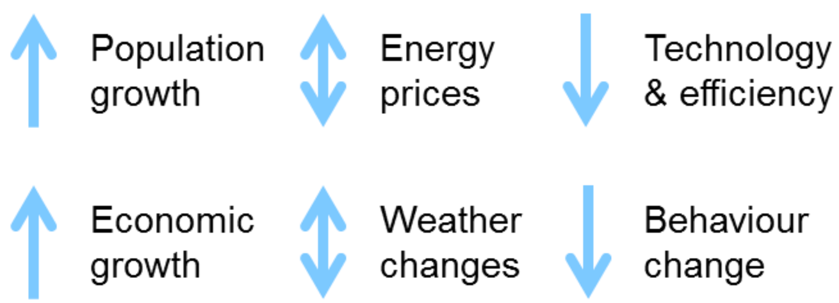
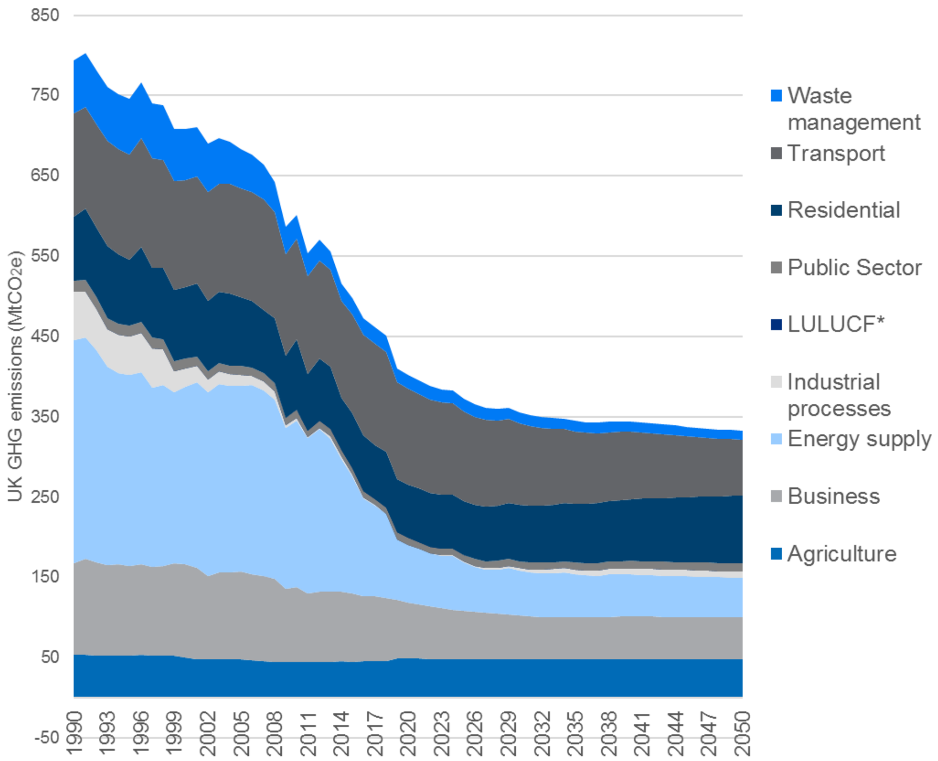


Figure 51 shows projections of UK-wide GHG emissions based on a ‘Reference Scenario’ produced by BEIS, which accounts for population and economic growth, fuel prices, and other national trends.

Figure 51. Projections of UK-wide GHG emissions (Source: BEIS Energy and Emissions Projections - Reference Scenario)



It shows that, in a Business-as-Usual (BAU) scenario, emissions at a national scale would fall fairly rapidly in the coming years despite rising energy demands, largely due to the electrification of heating and vehicles, and a switch towards renewable electricity, but the reductions will then tend to level off. By 2050, there would be marginal improvements, with a significant 'gap' to net zero emissions. Bridging the gap to net zero by 2050 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.

Many of the changes that will take place are outside of MSDC's direct control, but this report is intended to highlight the main drivers of emissions in Mid Sussex, and who has influence/powers to tackle GHG emissions in different sectors. These are broken down by topic area as follows:

- Buildings
- Transport
- Energy & Utilities
- Waste
- Land Use & Environment

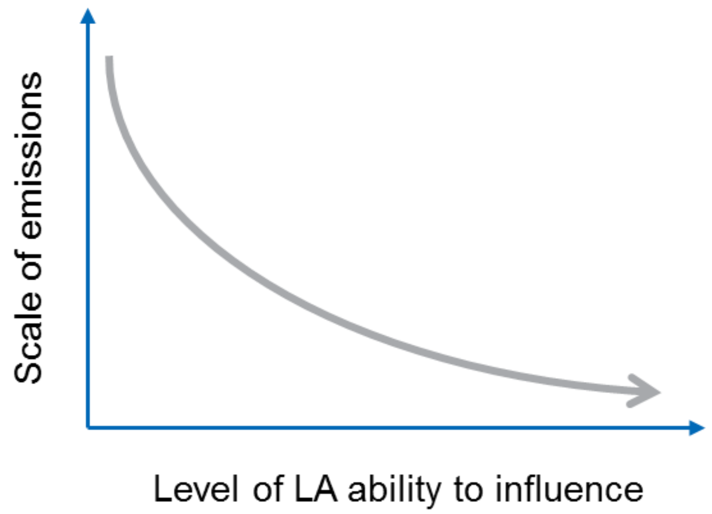
Future emissions will also be dictated by the policy landscape. This includes policies at the national, regional (e.g., county-level, the Southeast region) and local (i.e., district) level. A number of national-level policies have been announced in the last year, including the Government's Net Zero Strategy, Industrial Decarbonisation Strategy, Transport Decarbonisation Strategy and Heat and Buildings Strategy. Key plans and policies at the regional level include the West Sussex Energy Strategy, Bus Strategy and Transport Plan. At the local level, key documents include the Mid Sussex District Plan, Sustainability Strategy and the Sustainable Economic Strategy currently being developed. More information on these can be found at **Appendix A**.

3.2.2 Opportunities for local authorities to influence GHG emissions

Typically, UK local authorities are only directly responsible for a small proportion of GHG emissions. In Mid Sussex, as explained in the Section 3.1, public sector emissions account for roughly 2-3% of the total, and this proportion is fairly typical (note: these are Scope 1 and 2 emissions which are predominantly associated with buildings (council offices, public buildings, and housing) and don't include scope 3 emissions, which may take place outside the area boundary).

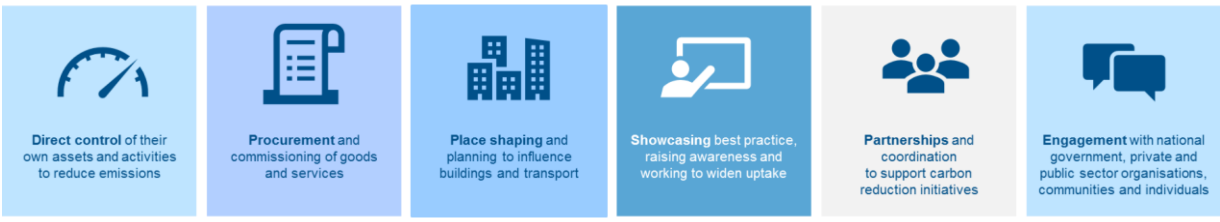
As a result, there is often an inverse relationship between the level of control they exert, and the scale of emissions reduction that they can achieve (see Figure 52).

Figure 52. Diagram illustrating the inverse relationship between level of control and scale of emissions



However, Local Authorities have a wide range of options for exerting indirect influence over emissions that they do not directly control, as set out in Figure 53.

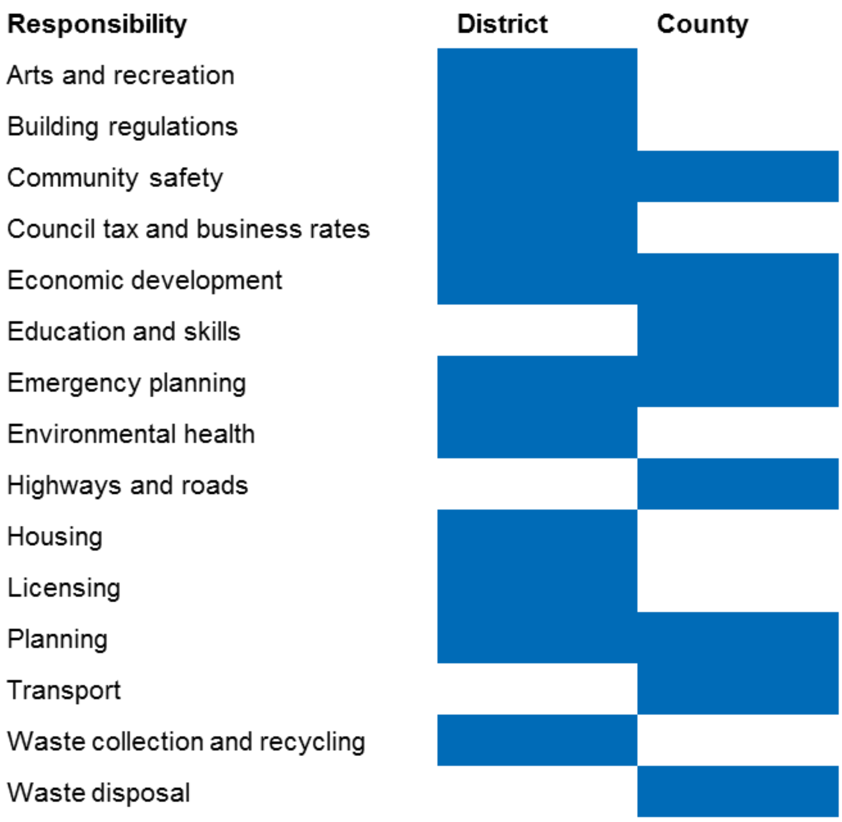
Figure 53. typical options for councils to influence area wide GHG emissions (source: Adapted from Local Authorities and the Sixth Carbon Budget, 2020[26])



The division of responsibility between district and county council affects where district-led decarbonisation is feasible and effective. Figure 54 below illustrates how responsibility is generally shared between English district and county councils, in policy areas which are most relevant to decarbonisation.

[26] https://www.theccc.org.uk/publication/local-authorities-and-the-sixth-carbon-budget

Figure 54. Responsibilities of a district council in relation to a county council (responsibilities with potential environmental impact). Adapted from: Institute for Government, 2021[27].



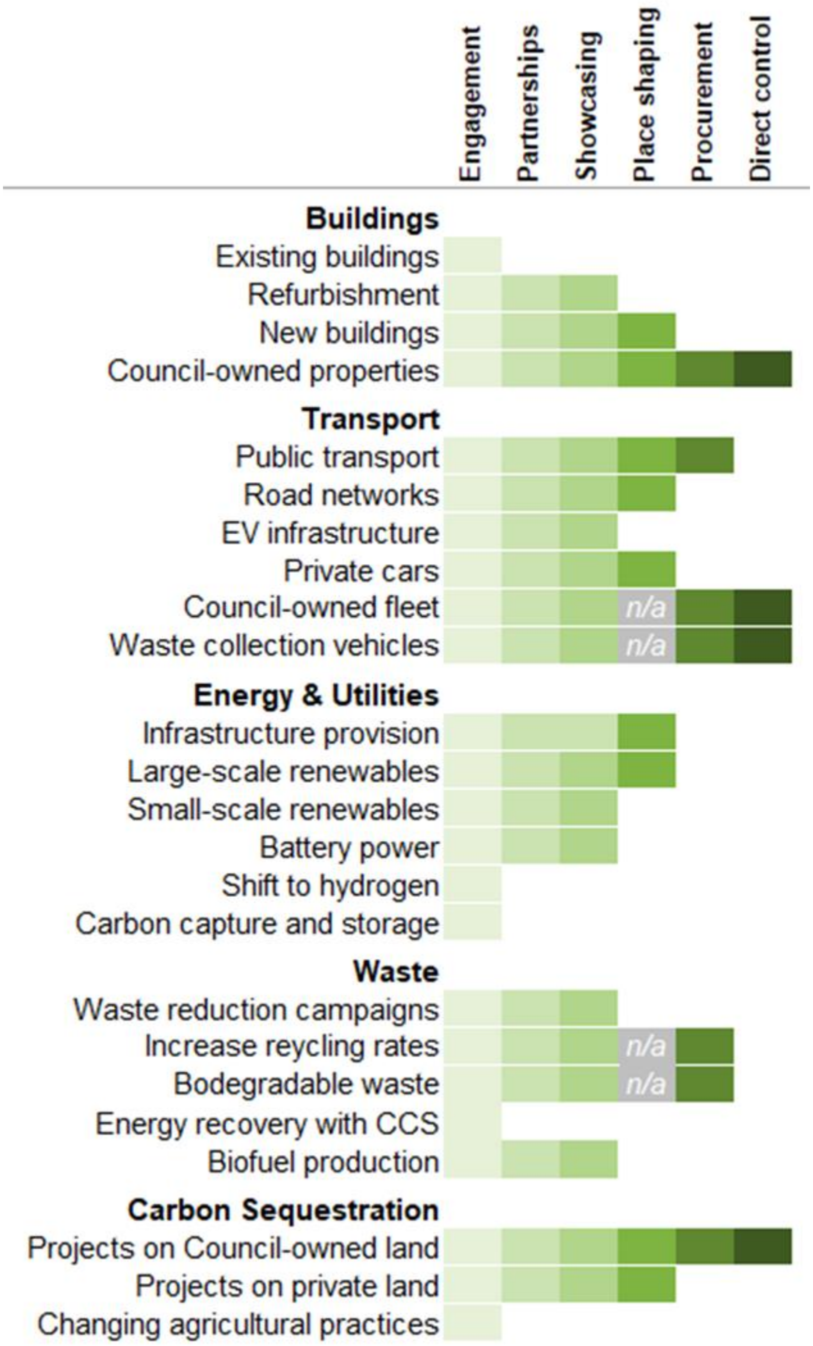
To summarise:

- District Councils are responsible for building regulations and planning, which would impact carbon emissions from the built environment (and, to a lesser extent, transport). They also have influence over carbon emissions from council housing that they own and/or operate. They can indirectly support carbon reduction through business support activities and licensing. Although responsibility for highways and roads is more within the remit of the Highways Agency, Local Authorities do have the power to establish Clean Air Zones and Low Emission Zones.
- County Councils are responsible for more strategic road and infrastructure planning, so have more influence over transport emissions. They are responsible for waste disposal whereas District Councils are in charge of waste collection and recycling; this means that District and County Councils can collaborate on waste reduction initiatives, awareness campaigns, and so on. Both can influence emissions from waste via waste contracts and procurement and would play a role in approving energy from waste or anaerobic digestion projects that can produce low carbon energy.

Figure 55 below summarises more specifically how MSDC can influence decarbonisation across key policy areas. The colour coding is used to indicate the ways that the Council 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.

[27] https://www.instituteforgovernment.org.uk/explainers/local-government

Figure 55. MSDC influence over district-wide emissions



The figure highlights that 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 MSDC (for more information, see Section 2.2 on influence mapping within MSDC).

MSDC also has an influential role in its capacity as a Local Planning Authority (LPA), setting planning policy and determining the spatial strategy for the district. This is primarily relevant to energy and sustainability standards for new developments but can also affect longer-term development in existing towns and villages. It is also one of the key ways that the Council can contribute towards electricity grid decarbonisation and increasing carbon sequestration – by identifying suitable areas for large-scale renewable energy installations and afforestation.

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.

The following sections of this chapter 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 MSDC and a feasibility assessment of reaching net zero.

3.2.3 Other key stakeholders

The sections above clearly show that the Council cannot deliver net zero across the district by itself but will need to work closely with a range of other stakeholders to make net zero a reality. These stakeholders are listed in Figure 56, and expanded on in subsequent sections focusing on different sectors.

Figure 56. Key net zero stakeholders at the national, regional and local level

	Domestic	Commercial	Industrial	Public Sector	Agriculture	Waste & Wastewater	Road transport	Other transport	Land use / Environment	Power & Utilities
National	MHCLG (Building Regs)	MHCLG (Building Regs)	MHCLG (Building Regs) BEIS	MHCLG (Building Regs)	DEFRA Environment Agency	DEFRA Environment Agency	Department for Transport National Highways (Highways England) Office of Rail and Road Traffic Commissioner, DVLA (regulator for commercial bus services)	Department for Transport Office of Rail and Road Network Rail	DEFRA Environment Agency National Park Authorities	National Grid Ofgem Ofwat HNDU
Regional/ County-wide	-	C2C LEP	C2C LEP	C2C LEP	C2C LEP	West Sussex County Council (waste disposal) Serco (contractor)	West Sussex County Council Bus operators: Compass Bus, Metrobus, National Express, etc.	Govia Thameslink Railway	South Downs National Park Authority High Weald AONB	UKPN Southern Water Southern Gas Scotie Gas Networks
Local (public sector)	MSDC Building Control MSDC Planning Dep't MSDC Housing	MSDC Building Control MSDC Planning Dep't MSDC (Licensing & Business)	MSDC Building Control MSDC Planning Dep't MSDC (Licensing & Business)	MSDC Building Control MSDC Planning Dep't NHS, schools, etc. Neighbouring LAs	MSDC Planning Dep't MSDC Environmental Health	MSDC (waste collection) MSDC Environmental Health	MSDC (parking and licensing)	-	MSDC Environmental Health Parish Councils	-
Local (other)	Private individuals Tenants' associations Landlords/ Landowners	Local businesses Business associations	Local businesses Business associations Industry groups/bodies	Private individuals Community groups	Local businesses Business associations	Private individuals Local businesses Landlords/ Landowners	Private individuals Local businesses Landlords/ Landowners	Private individuals Local businesses Landlords/ Landowners	Private individuals Local businesses Landlords/ Landowners People and Nature Network (PANN)	Private individuals Local businesses Landlords/ Landowners Community energy groups Solar Together
Cross-cutting	NGOs, charitable organisations, academic and research organisations, community groups, etc.									

3.2.3.1 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.

Key policy drivers of emissions in the sector are set out in Table 11.

Table 11. Key policies and strategies for emissions reduction in the buildings sector

National	Regional	Local
The Future Homes Standard: • 2021: c. 31% reduction in regulated CO_2 compared to current standards • 2025: Zero-carbon ready homes Future Buildings Standard: c.27% reduction in regulated CO_2 compared to current standards (tbc) 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	'Mid Sussex District Plan 2014 – 2031' • Minimum provision of 16,390 homes in the 17-year period 2014 – 2031 • Policy DP39: "minimise energy use" and "use renewable sources of energy" 'Mid Sussex Economic Recovery Plan 2020 – 2021 • Promote the Green Homes Grants (local authority delivery) 'Mid Sussex Sustainability Strategy 2018 – 2023' • Install energy efficiency measures for the Oaklands modernisation project

The key challenges and major players are as follows:

Key challenge	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. National, regional, and local governments can have an impact via energy efficiency advice, loans, and grant funding (where available).
Decarbonising heat and switching away from natural gas and other fossil fuels	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.
Ensuring that new buildings are compatible with a net zero future	The Department for Levelling Up, Housing & Communities (DLUHC) is responsible for UK Building Regulations on energy and carbon emissions, and Local Authorities are responsible for enforcement. LPAs can currently set higher performance standards, but this may change in the future.
Adopt Circular Economy principles across the entire construction industry	County Councils 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.

The areas that MSDC can most influence are as follows:

- The Council will need to rely primarily on engagement and partnerships to reduce emissions in existing housing 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.
- It 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.
- MSDC can also play a coordinating role in helping to deliver heat networks (e.g., feasibility studies and engaging with stakeholders), and developing a spatial strategy that facilitates the use of waste heat, where available.

3.2.3.2 Transport

What needs to happen 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, except for 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. The only way this will be achievable is by radically reducing demand for travel, which includes changes in consumer habits and also switching towards walking, cycling, car clubs/ridesharing, e-scooters (where appropriate) and public transport.

Key policy drivers of emissions in the sector are set out in Table 12.

Table 12. Key policies and strategies for emissions reduction 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	'Electric Vehicle Strategy', West Sussex County Council • Increase charging points from 89 to 3,305 by 2025, and 7,346 by 2030 'West Sussex Transport Plan', West Sussex County Council • Maintain roads and public rights of way • Encourage sustainable travel • Complete the A272 Haywards Health Relief Road to support delivery of new development	'Mid Sussex District Plan 2014 – 2031' • Create a sustainable transport network 'Mid Sussex Sustainability Strategy 2018 – 2023' • Burgess Hill Business Parks Promoting good sustainable transport practice 'Mid Sussex Economic Recovery Plan 2020 – 2021' • Deliver Burgess Hill Place and Connectivity Programme (including upgrades to sustainable transport) • Install 26 new Electric Vehicle Charing Point Operators • Develop a local walking and cycling infrastructure plan

The key challenges and major players are as follows:

Key challenge	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. Uptake could be accelerated through local business owners which incorporate ULEVs into their own fleet.
Behaviour change and travel habits	As above, the role of local government may involve awareness campaigns, 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 MSDC's remit as an LPA, while responsibility for the road network lies primarily with National Highways. The DfT plays a strategic role in setting transport policy nationally while Local Transport Plans are produced by West Sussex County Council.
Providing renewable electricity and other supporting infrastructure	West Sussex County Council is responsible for the roll-out of EV infrastructure locally.

The areas that MSDC can most influence are as follows:

- MSDC 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 incentivise uptake through parking charges.
- Ensure that all new developments are located and designed to reduce demand for travel and encourage active/sustainable transport options. 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 MSDC, introduce EV charging (co-located with renewable power generation and battery storage) and make sure the vehicle fleet is 100% low emission.

3.2.3.3 Energy and 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 by then, 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.

Key policy drivers of emissions in the sector are set out in Table 13.

Table 13. Key policies and strategies for emissions reduction from energy and utilities

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	'West Sussex Energy Strategy Action Plan', West Sussex County Council • Reduce energy consumption • Develop the commercial provision of low carbon energy • Develop new financial provision of low carbon energy UKPM Green Action Plan South2East Local Energy Strategy	'Mid Sussex District Plan 2014 – 2031' • Policy DP40: "Proposals for new renewable and low caron energy projects […] will be permitted provided that any adverse local impacts can be made acceptable" • Wind energy developments not permitted unless they are on allocated sites

The key challenges and major players are as follows:

Key challenge	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 Mid Sussex and surrounding areas is UKPN, while the DNO for gas is Scotia.
Identifying and allocating areas for large-scale renewable energy projects	MSDC plays a role by identifying suitable areas for renewable energy projects within the district and setting planning requirements. Other key players include community energy groups, along with organisations and businesses that deliver renewable energy projects. Historically there has been community opposition to some technologies (particularly wind) so the general public is also a key stakeholder in this regard.

The areas that MSDC can most influence are as follows:

- MSDC 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 Solar Together Sussex or community energy projects)
- In terms of infrastructure provision and large-scale renewables, the Council will need to work with UKPN, energy companies and landowners to identify suitable locations and support infrastructure improvements. It can facilitate this via permissive Local Plan policies.
- Providing funding where possible and lobbying the Government for additional support.

- There are limited opportunities for MSDC 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.

3.2.3.4 Waste

What needs to happen to reach net zero?

- At present there are no technologies that entirely mitigate the GHG effects of methane, a gas that is emitted by landfill and sewage treatment. Waste is therefore a sector that may need to rely on negative emissions technologies to reach net zero by 2050 – technologies that are not yet commercialised. Therefore, to avoid these emissions, it will be necessary to radically reduce food waste, stop sending biodegradable waste to landfill in the 2025-2030 timescale, and separate all remaining waste to enable much higher recycling rates of c. 70%, according to the CCC.
- Some waste products can be used to provide bioenergy, thus displacing fossil fuels. Energy recovery with carbon capture and storage will need to be deployed to any waste incineration facilities (EfW) to make sure that all available resources are used.

Key policy drivers of emissions in the sector are set out in Table 14.

Table 14. Key policies and strategies for emissions reduction from waste

National	Regional	Local
'Resources and Waste Strategy for England' • Ambition for 55% recycling rate by 2025, rising to 65% by 2035, from the 2018/2019 level of 47%. • Aim for "eliminating avoidable waste of all kinds by 2050." • Strategy hopes to achieve this by measures such as: requiring LAs to collect a consistent set of recyclables and food waste, introducing mechanisms to ensure that the 'polluter pays' for the cost of collecting and processing waste that they place on the market, introduction of deposit return schemes, etc.	'West Sussex Local Waste Plan', West Sussex County Council • "The strategy is to plan for a declining amount of capacity over the plan period so that there is so that there is 'zero waste to landfill' by 2031"	'Mid Sussex District Plan 2014 – 2031' • Policy DP39: "Maximise efficient use of resources, including minimising waste and maximising recycling/re-use of materials through both construction and occupation"

The key challenges and major players are as follows:

Key challenge	Major players
Changing behaviour to reduce the amount of waste generated	DEFRA is responsible for policy and regulations on waste, while the EA plays a role in issuing permits for waste disposal and treatment and dealing with waste crime and pollution. District Councils are responsible for household waste collection and some commercial waste collection while County Councils are responsible for waste disposal; MSDC has contracted Serco to deliver waste management services. Collectively they can influence recycling rates and biodegradable waste at different stages of the
Increasing recycling rates and diverting	

biodegradable waste from landfill	supply chain, and deliver awareness campaigns to change people's behaviour, although ultimately this relies on cooperation from consumers and businesses.
Deployment of energy recovery with carbon capture and storage (CCS)	The Government is leading on CCS technologies nationally, but District and County Councils may have a role linked to their responsibilities for waste management, environmental services, planning powers and community consultation. However, this will also rely on technological improvements and industrial R&D.

The areas that MSDC can most influence are as follows:

- The main options are:
  - Engagement with residents, businesses, the County Council, waste contractors and Government to promote waste reduction measures
  - Considering options for future carbon emissions reduction when renewing waste contracts
  - Continuing to provide separate collections for different waste streams, including food and green waste
  - Showcasing best practice by setting targets for reducing waste within operations that MSDC directly controls. The CCC suggests that Local Authorities 'introduce a zero-waste procurement policy that bans single-use plastics, excess packaging, specifies recycled content, favours appliances and goods that can are repairable and recyclable.'
- Where appropriate, supporting organisations applying to generate energy from waste e.g., anaerobic digestion facilities – provided that waste minimisation plans are in place – and keeping abreast of developments in EfW CCS.

3.2.3.5 Land use and environment

What needs to happen to reach net zero?

- According to the CCC some reduction in GHG emissions can be achieved through diet change and 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.

Key policy drivers of emissions in the sector are set out in Table 15.

Table 15. Key policies and strategies for emissions reduction 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	'Climate Change Adaptation Plan and Strategy', South Downs Park Authority • "We need to balance the push for increase tree planting with the need to	'Mid Sussex District Plan 2014 – 2031' • Policy DP37: "The District Council will support the protection and enhancement of trees,

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)	protect other priority habitats and avoid unintended consequences" • The South Downs Local Plan requires a 10% gain in biodiversity as a planning condition, which "could support actions such as tree planting, carbon sequestration and work on climate change resilience"	woodland and hedgerows, and encourage new planting." 'Tree Management Policy', Mid Sussex District Council • "The Council wishes to maintain and increase high level of tree cover across the District."

The key challenges and major players are as follows:

Key challenge	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. Other stakeholders are the South Downs National Park Authority and the High Weald Joint Advisory Committee.
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 MSDC can contribute indirectly via its role as an LPA.
Releasing agricultural land for alternative uses e.g., woodland or rewilding projects	As above, the spatial strategy for the district can have an impact; however, 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.

The areas that MSDC can most influence are as follows:

- Engage with local businesses, industry groups, conservation groups, the High Weald AONB and South Downs Park Authorities to raise awareness of sustainable land use and showcase best practice on land that it owns.
- 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 MSDC to partner with other local governments or organisations to deliver projects within (or outside of) the district such as woodland creation.
- Promote tree cover and other green infrastructure via the Local Plan and spatial strategy, although in practice this would primarily impact new developments. Note that biodiversity should be given equal importance to carbon emissions and energy use in planning policy, although that is not the focus of this report.

3.3 NET ZERO PATHWAYS

This section of the report describes potential future GHG emissions trajectories for Mid Sussex, based on three different 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 GHG mitigation actions.

Key messages

- A **'Business as Usual' (BAU) scenario has been modelled** to show the potential scale of emissions reduction that would be achieved if no additional mitigation measures are adopted beyond those that are already likely to occur. 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 and funded Government policies and initiatives. Relative to the 2019 baseline, **the BAU scenario would result in a roughly 17% decrease in emissions by 2030 and 33% decrease by 2050**. This leaves a significant shortfall against the target that would need to be addressed through other means.
- **Two additional pathways have been modelled** using Ricardo's Net Zero Projections (NZP) tool. These scenarios **explore the impact of additional behavioural and technological measures aimed at mitigating energy use and GHG emissions**. They represent different levels of ambition, and contribute towards an understanding of key risks, sensitivities, and opportunities for Mid Sussex.
- **Around 90% of emissions can be addressed using known technologies if supplied with 100% renewable electricity (which can come from the grid in theory).** However, there are no silver bullets. It is important to deliver demand reduction measures as well for a wide variety of reasons, including minimising pressure on grid infrastructure, reducing impacts of energy price rises, and avoiding unsustainable pressure on other resources such as land, materials, and water.
- **Of the remaining emissions, around half are from the industrial sector.** These would likely rely on technological changes such as availability of green hydrogen or bioenergy with carbon capture and storage (BECCS), which is a risk – although in theory could be feasible by 2040. MSDC can take local actions to support the development of those technologies by providing renewables and bioenergy crops where appropriate.
- **The remaining emissions are mostly from the waste and agricultural sectors.** These are, in some ways, the most challenging to address as they rely not only on technological advancement, but also wider changes in consumer behaviour, waste and land management, and so on.
- The path to net zero is challenging, and all of the potential solutions involve risks and trade-offs to consider. **However, compared with some UK Local Authorities, there are more opportunities in Mid Sussex to achieve carbon reduction measures.** This is a positive message, and a useful starting point for developing a net zero roadmap.

3.3.1 Overview of the methodology

3.3.1.1 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 GHGs 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.

3.3.1.2 What pathways were explored and how were they developed?

This work has explored three future pathways for GHG emissions in Mid Sussex: A 'Business as Usual' (BAU) scenario, and two 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 Mid Sussex, 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'*.[28] Taking Mid Sussex' baseline emissions as a starting point, growth curves based on the EEP data were then applied to each sub-sector and fuel type in Mid Sussex. This means that the overall change in emissions reflects the baseline situation in the d.

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 Mid Sussex (see Figure 57). Adjustments were then made to reflect local factors. The main exception is for the domestic sector, where we have applied a 2031 cut-off rate for growth on the understanding that there is not an annual housing target beyond that point, and it is unclear what the patterns of development would be.

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

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

The first net zero pathway considers changes that would need to occur in order to meet the nationwide 2050 target date. The mitigation measures in the 2050 scenario are broadly in line with the CCC's 'Balanced' net zero pathway, which the CCC describes as follows: "The Balanced Pathway makes moderate assumptions on behavioural change and innovation and takes actions in the coming decade to develop multiple options for later roll-out (e.g., use of hydrogen and/or electrification for heavy goods vehicles and buildings)."[29]

The second net zero pathway sets out an alternative, accelerated scenario which reaches net zero by 2040. The key driver for this scenario is the assumption that the Government meets its stated ambition of achieving a net zero electricity grid by 2035. If that were to occur, faster decarbonisation could potentially be achieved by prioritising electrification, particularly for buildings and transport.

The net zero pathways both 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 C.

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 hydrogen gas to provide space heating and hot water.
Industrial energy use	• Switching any remaining fossil fuel demands to electricity, hydrogen, or another zero-carbon fuel source such as bioenergy with carbon capture and storage (BECCS).
Road transport	• Avoiding car journeys via behavioural and technological changes, 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)
Other transport	• Electrification of rail network
Energy system	• Electricity grid decarbonisation taking place in line with national projections (in the 2050 scenario) or reaching net zero by 2035 (in the 2040 scenario)

[29] The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf (theccc.org.uk)

	• Massive increase in deployment of roof-mounted solar technologies on suitable buildings
Agriculture	• Reducing the consumption of meat and dairy and thereby reducing the number of livestock • Halving food waste across the supply chain by 2030 • Implementing measures to release land, such as productivity improvements • Employing low carbon farming practices in soil, livestock, and manure management • Replacing fossil fuels in agricultural machinery with biofuels and electricity
Waste	• Preventing waste, increasing recycling rates, and implementing landfill bans • Employing landfill methane capture technologies and utilising CCS at energy-from-waste (EfW) plants
Miscellaneous	• Increase in carbon sequestration via tree planting within the district and potential land use change to woodland has been discussed with MSDC but at present there is insufficient information to model interventions.

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 MSDC's level of influence when it comes to achieving net zero emissions.

3.3.2 The Business-as-Usual scenario

3.3.2.1 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)
- Retain 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 Mid Sussex, which was 149,716 in 2018, could reach around 159,823 by 2030 (a 6.8% increase) and 165,394 by 2040 (a 10.5% increase). These growth rates are somewhat larger than the ONS forecasts for England as a whole (which would see population increases of 5.7% and 9.3% by 2030 and 2040, respectively), but still align closely as shown in the chart below.

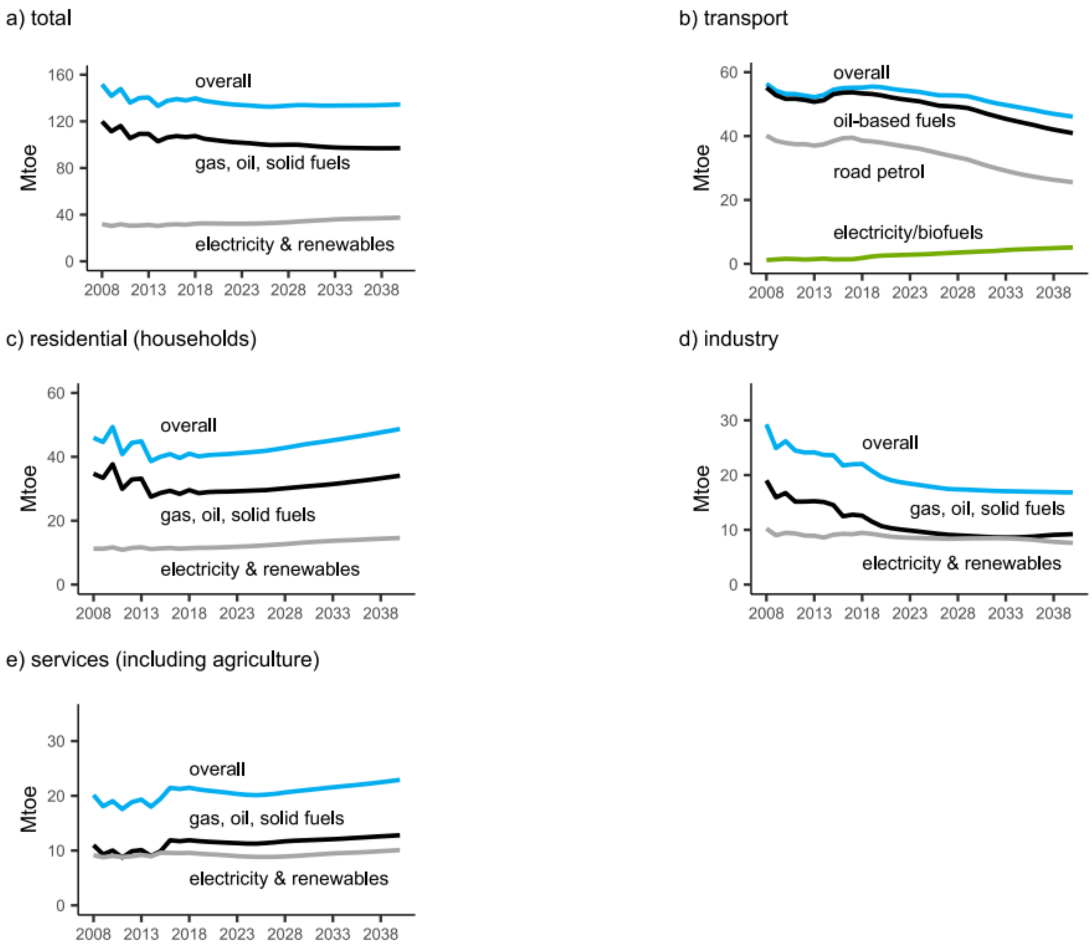
Figure 57. Population growth projections for Mid Sussex and England, 2018-2043. Source: ONS

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 several policy proposals that were announced previously where there was insufficient detail available at the time to support an assessment, 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

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 58. 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.

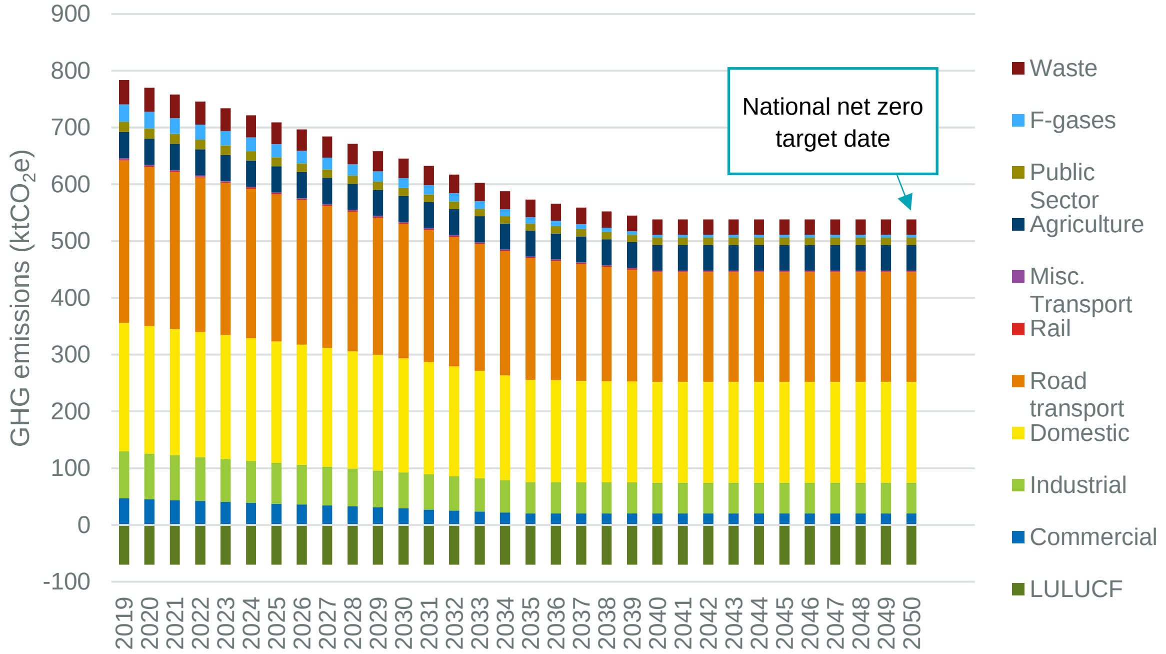
In the industrial sector, demand for electricity and renewables would rise slightly, while demand for gas, oil and solid fuels would remain roughly the same. In other non-industrial sectors (referred to as 'Services' in the chart above), demand for all fuels would increase slightly. For these sectors, economic growth, weather, energy prices and changes in industrial production are key drivers.[30]

3.3.2.2 Impact on GHG emissions

In the BAU scenario, GHG emissions in Mid Sussex would fall by 17% by 2030, 33% by 2040, and 34% by 2050. As illustrated in Figure 59, most of the emissions reduction is projected to occur by 2040 after which it mostly stagnates without the implementation of additional measures.

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

Figure 59. 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 0.2107 kgCO_2e/kWh in 2019 to approximately 0.0888 kgCO_2e/kWh in 2030 and 0.0048 kgCO_2e/kWh in 2050. This can clearly be seen when comparing Figure 60 and Figure 61, 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.

Figure 60. Energy use by fuel type in the BAU scenario

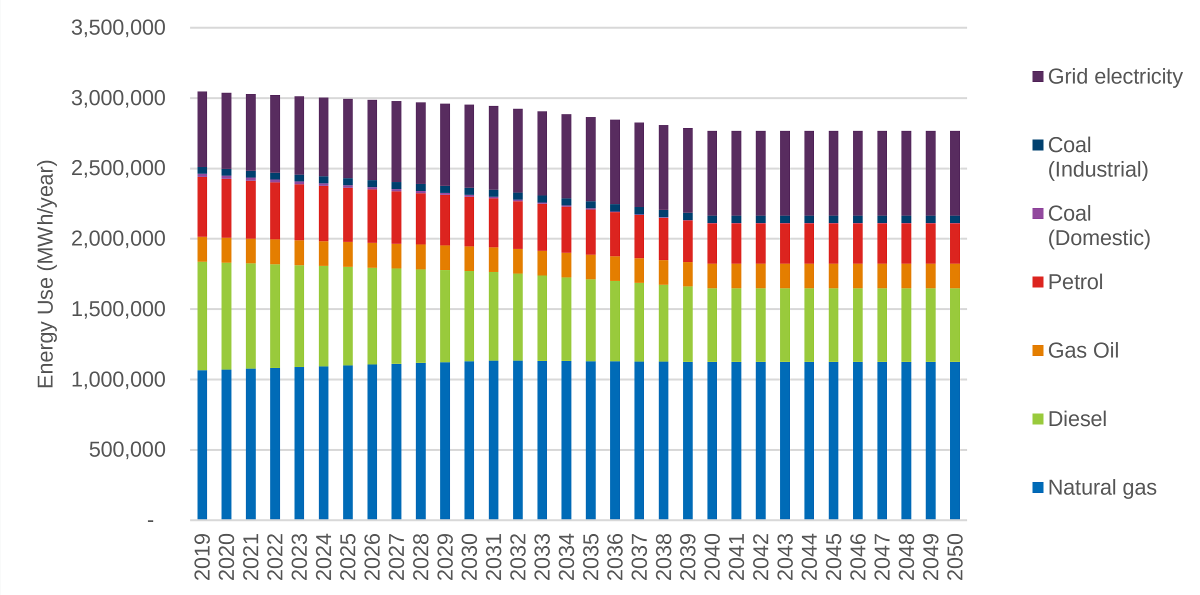
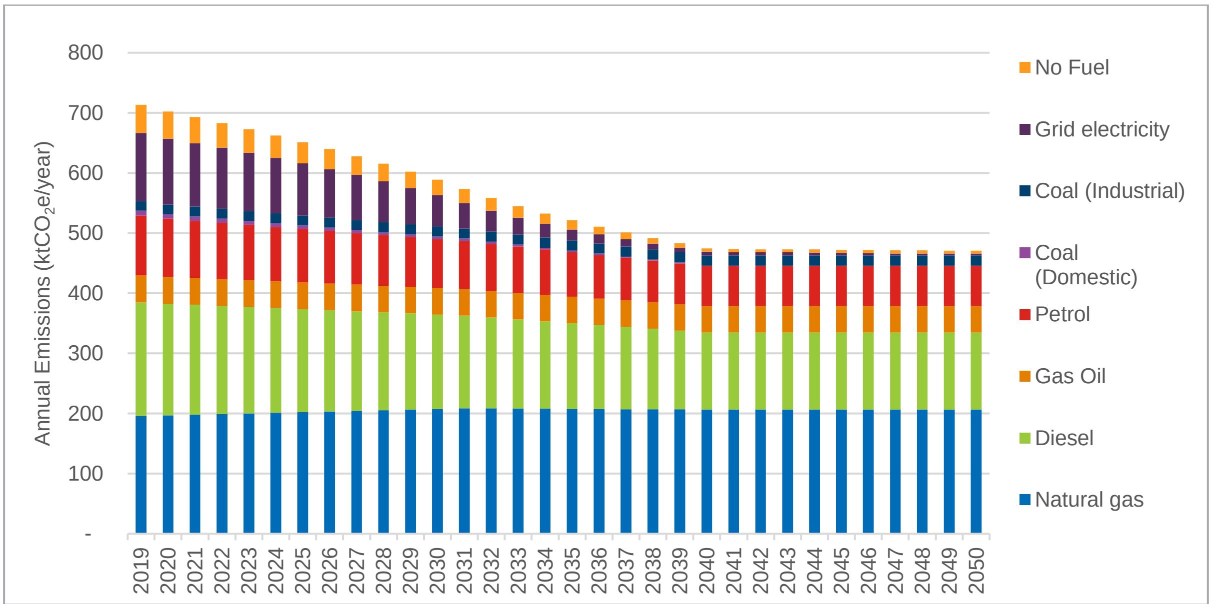


Figure 61. Emissions by fuel type in the BAU scenario



The cumulative energy-related emissions between 2020 and 2050 would be approximately 16,474 $ktCO_2e$. This means that the Paris-aligned carbon budget for the period through the year 2100 would be used up by 2028 if no additional mitigation action is taken.

Mid Sussex currently does not have a carbon neutrality target but aims to align their emissions reduction pathway with the Government's overarching commitment of reaching net zero by 2050. As the BAU scenario shows (see Figure 59), the vast majority of emission reductions on the current trajectory will likely occur before 2040 – especially if the power decarbonisation target of 2035 is achieved. This means that with a target between 2035 and 2050, MSDC could maximise on the national grid decarbonisation which drives the majority of the emissions reduction in the BAU scenario and which many mitigation actions will depend on.

With this as a starting point, reaching net zero in Mid Sussex in line with or ahead of the national 2050 target date will broadly 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 Mid Sussex – *as a last resort*

3.3.2.3 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 summarises 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 specific types of industries and activities taking place in Mid Sussex. As discussed in the Baseline chapter, there is less information available on this topic than, for example, on domestic and road transport energy use.	The lack of information makes it harder to comment on the likelihood that local trends 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	At the time of writing (November 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

change in light of recent announcements on achieving a net zero electricity grid by 2035.	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.	MSDC 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 MSDC or local stakeholders can have an influence. MSDC 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.	MSDC should consider developing strategies for considering climate mitigation and adaptation needs alongside. These will differ between the more rural and urban settings of the district. While this is a crucial consideration for Mid Sussex, 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 district and the energy and CO_2 performance standards that those buildings are required to meet.	MSDC can influence the design of new developments and major refurbishment projects in its role as a Local Planning Authority. This could mean limiting emissions from new developments while promoting uptake of local renewable energy technologies and enshrining this into local policies.
MSDC has full influence over its own assets and can therefore set an earlier net zero target for the Council compared to the entire district. Additionally, the overall net zero pathway can be supported by ambitions in the private sector and other public sector entities such as the County Council and the NHS which has a net zero target of 2045 as well as incremental reduction targets for 2036 and 2039.	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 if 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 as well as the recent proposition (21st of November 2021) of making EV charging points mandatory in new homes and buildings. 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, MSDC 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.

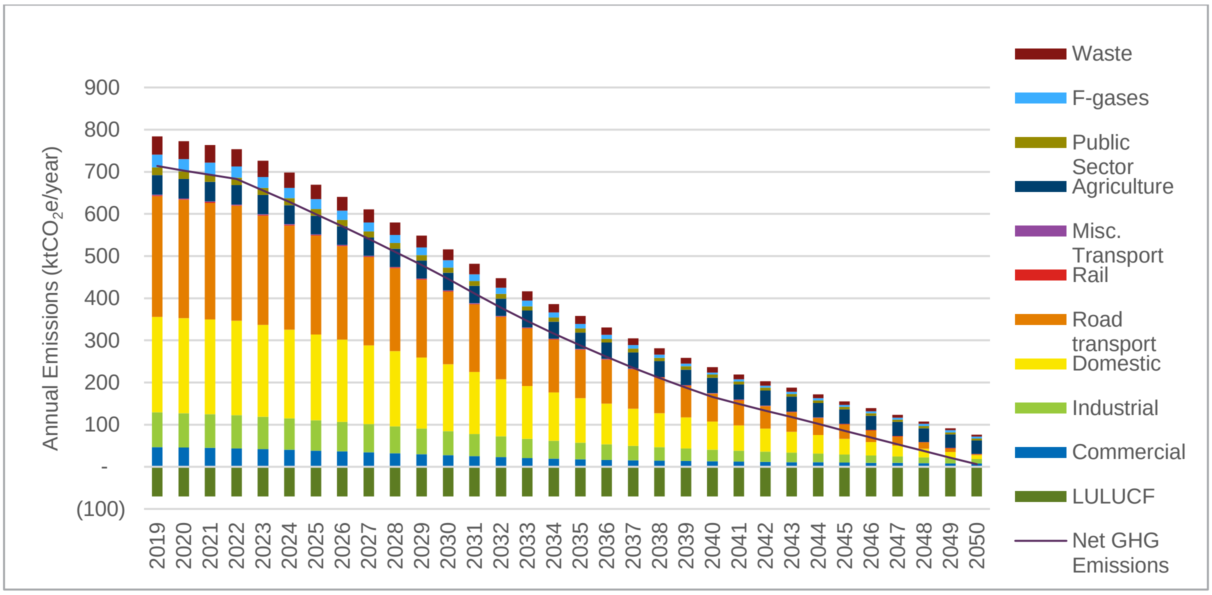
The rural nature of Mid Sussex offers considerable opportunities for carbon sequestration. This should be done with consideration of the ecological emergency and climate adaptation needs such as natural flood protections.	MSDC can reduce their emissions through carbon sequestration projects in existing woodlands or through afforestation projects. This will need to be done in cooperation with stakeholders who manage crucial biodiversity habitats in Mid Sussex such as the High Weald AONB or the South Downs National Park.

3.3.3 2050 net zero pathway

The BAU results clearly show that further actions will be required. This section considers the results from an ambitious pathway that aims to reach net zero by 2050. As stated previously, a key reference point for determining the type and scale of intervention measures for this scenario is the CCC's 'Balanced Pathway' for UK-wide emissions. As with the BAU scenario, information specific to Mid Sussex has also been used wherever possible, with an example being the Sustainable Energy Study from 2014 which has been used to inform estimates of future renewable energy capacity.[31]

Taken together, the mitigation measures modelled in this scenario result in an emissions reduction of 38% by 2030, 77% by 2040, and 99% by 2050 compared to the 2019 baseline with residual annual emissions of 6 ktCO_2e in 2050. As illustrated in Figure 62 below, varying levels of reduction are seen across different sectors. The most dramatic changes occur in sectors where there is a complete (or near-complete) shift to the use of electricity instead of fossil fuels.

Figure 62. Emissions by sector in 2050 scenario



Considering future emissions in Mid Sussex now by sector, the largest reductions are seen in the transport and domestic sectors, which decrease by 99% and 96% respectively by 2050. The smallest reductions can be seen for agriculture and rail with 33% and 37% respectively. The agriculture sector is particularly difficult to decarbonise as it is dominated by non-CO_2 emissions from livestock and crop production (e.g., use of fertiliser), which are hard to eliminate given the inherent biological and chemical processes involved.[32] The LULUCF sector currently shows no change as increases to carbon sequestration were not modelled.

[31] Mid Sussex Sustainable Energy Study Report
[32] The-Sixth-Carbon-Budget-Methodology-Report.pdf (theccc.org.uk)

The effect of switching to a zero-carbon energy source will, to some extent, mask the impacts of any further energy demand reduction measures such as retrofitting buildings. To understand the scale of change in energy use, Figure 63 shows the change in fuel use between 2019 and 2050, whereas Figure 64 shows the associated changes in emissions associated with those fuels. These graphs highlight the fact that neither demand reduction nor fuel switching/technological change can provide a solution on its own – both will need to play an important role.

Figure 63. Energy use by fuel in 2050 scenario

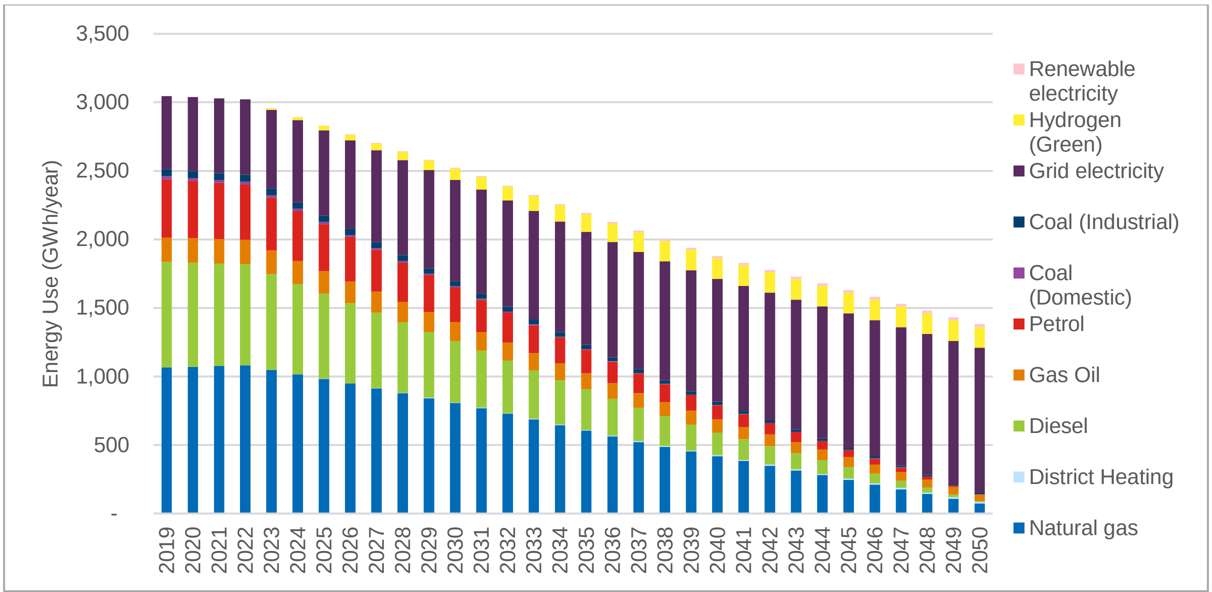
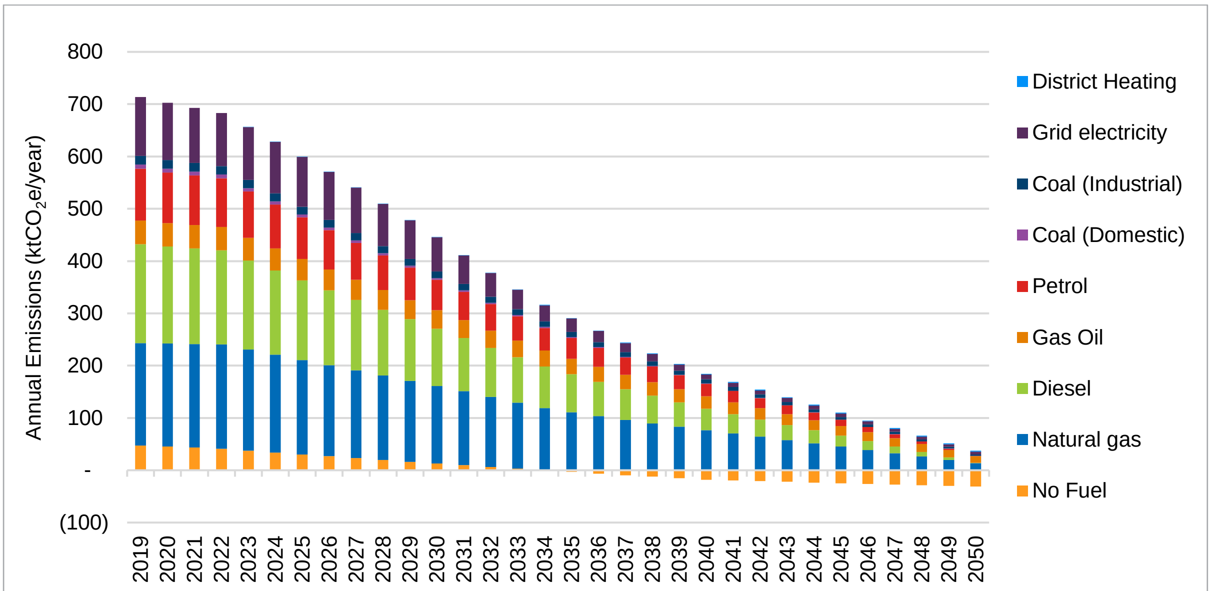


Figure 64. Emissions by fuel in 2050 scenario



Moreover, energy demand reduction should be seen as a *prerequisite* to fuel switching, for various reasons, some examples of which are given below.

- In some cases, it is a technological prerequisite. For example, although heat pumps work in poorly insulated buildings, they operate at lower efficiencies, use more energy to keep the building at a comfortable temperature, and it will take the building longer to heat up. So, it is critical for heat pumps to be installed after or alongside energy efficiency measures. This is not only an issue of comfort, but also finances, as people will be less likely to switch to heat pumps before the gas boiler ban if this results in a substantial increase in their energy bills.

- Because it is likely that both cars and buildings will mostly utilise electricity, it is estimated that electricity demand could more than double nationally. It is therefore necessary to reduce the strain on existing grid infrastructure, which would require considerable reinforcement to expand capacity, likely resulting in higher energy costs. The electricity would also need to be supplied with renewables, such as large-scale wind and solar farms, which have implications for land use and landscape character, among other things.
- For activities where fossil fuels are not being replaced by electricity but some other alternative, in some cases it will be challenging or impossible to scale up unless demand reduces because of the limited supply of other zero carbon fuels. Examples include ‘green’ hydrogen (i.e., produced by electrolysis using renewable electricity) or ‘sustainable’ biomass (which in addition to issues of where it is sourced, would need to be accompanied by advances in carbon capture and storage technologies).
- Demand reduction is also important because it helps to mitigate the other resource requirements (materials, minerals, land, water, labour, etc.) that are required to supply the energy. It also delivers various wider co-benefits, such as improving energy security, reducing fuel bills, helping to alleviate fuel poverty, and mitigating other environmental impacts.

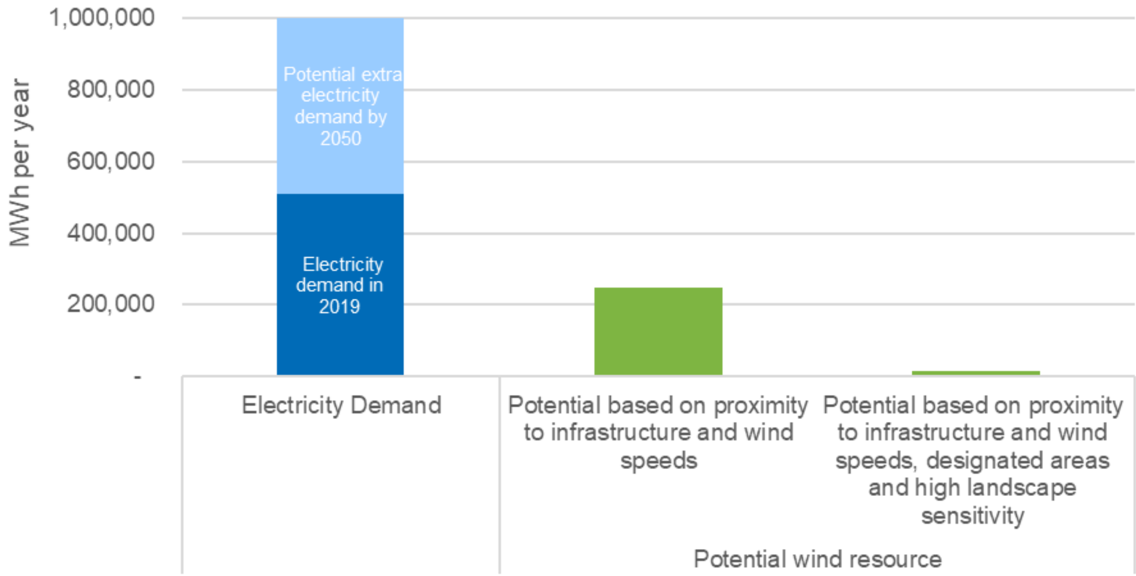
For context

If the entire electricity demand in 2050 was to be met with 100% renewable electricity, this would roughly double the annual electricity use of Mid Sussex. This could be met with *approximately*:

- 1,060 MW of PV (occupying c. 13 square kilometres, around 4% the area of Mid Sussex); or
- 505 MW of onshore wind power (c. 252 large-scale turbines).

In theory, a significant amount of this demand could be met with renewable energy developments within Mid Sussex[33] but this resource is significantly constrained by the current policy landscape, as shown in the chart below. This is just one example of why it will be so challenging to achieve net zero, and how the policy landscape – not just in Mid Sussex but across the whole country – will need to comprehensively change if the target is to be met.

Electricity demand vs. potential wind resource in Mid Sussex

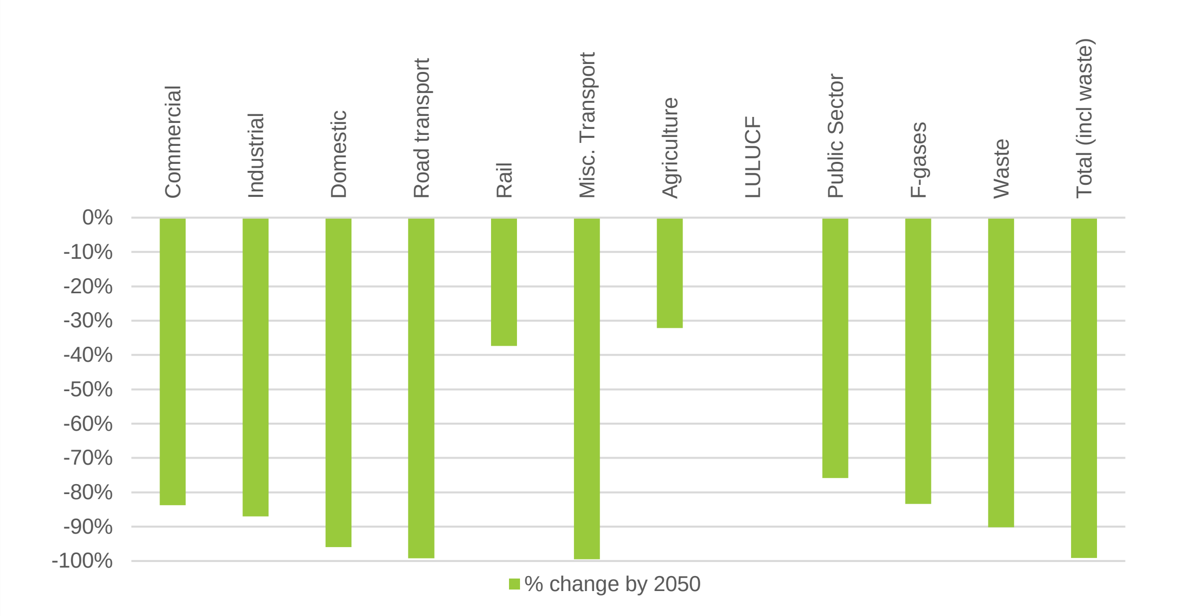


Source: Baseline Assessment (see Section 3.1) and West Sussex Renewable Energy Study (2009)

Considering future emissions in Mid Sussex now by sector, Figure 65 shows that the largest reductions are seen in the transport and domestic sectors, which decrease by 99% and 96% respectively by 2050. The smallest reductions can be seen for agriculture and rail with 33% and 37% respectively. The agriculture sector is particularly difficult to decarbonise as it is dominated by non-CO_2 emissions from livestock and crop production (e.g., use of fertiliser), which are hard to eliminate given the inherent biological and chemical processes involved.[34] The LULUCF sector currently shows no change as increases to carbon sequestration were not modelled.

[33] https://www.midsussex.gov.uk/media/2600/west-sussex-renewable-energy-study.pdf

Figure 65. Change in emissions by sector between 2019 and 2050



By 2050, the residual annual emissions would be roughly 6 ktCO_2e. To meet net zero, this would have to be compensated for either using carbon removal technologies (which are highly speculative and not yet commercialised) or via nature-based solutions such as woodland creation.

For context

According to the Woodland Carbon Code: "A new native woodland can capture 300-400 tonnes of CO_2 equivalent per hectare (tCO_2e/ha) by year 50, and 400-500 tCO_2e/ha by year 100."[35] On that basis, offsetting the 6 ktCO_2e of annual emissions in 2050 would require roughly 15-20 hectares (0.15-0.20 km^2) of new woodland to be created – *and then maintained for at least 100 years.*

To be clear, that would only make up for one single years' worth of residual emissions, and there would be a time lag of roughly a century before the required amount of carbon was actually removed from the atmosphere, as it takes time for woodland to mature.

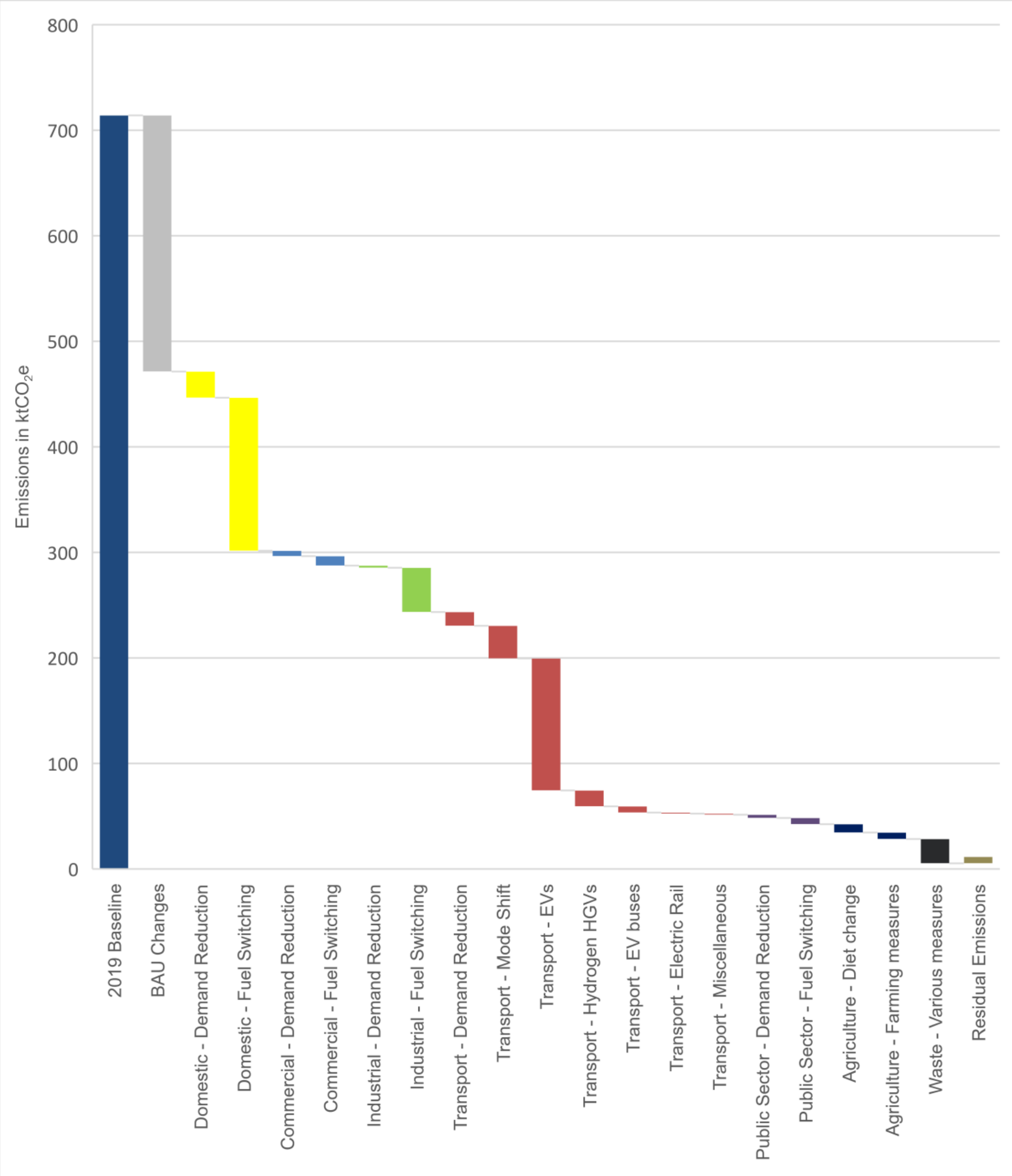
This degree of offsetting is potentially feasible but can only be done if all of the other (ambitious!) mitigation actions modelled in this scenario are implemented. A lack of action in other areas would quickly increase the carbon sequestration need to an unachievable level.

Despite those caveats, this analysis has assumed that one or both of those options (technological or nature-based solutions) would be feasible in future and therefore that net zero could be achieved in Mid Sussex by 2050.

A more detailed breakdown of the mitigation actions is provided in Figure 66 below. When interpreting this chart, note that the impact of each measure depends not only on its ambition, but also on what proportion of baseline emissions it targets. Hence, reductions in the transport sector are the largest because that is the single largest-emitting sector.

[35] https://woodlandcarboncode.org.uk/

Figure 66. Emissions reduction by type of intervention measure



Note: Due to their small impact and to keep the figure readable, PV measures were removed from the domestic, commercial, and industrial sectors, therefore showing a small gap to net zero.

The largest emissions reduction (in absolute terms) is required in the buildings and transport sectors (see Figure 62). The following sections provide more detail about the mitigation measures modelled and what they would mean in practice.

3.3.3.1 Reducing emissions from buildings

- The net zero scenario assumes a 12% reduction in demand for space heating and hot water across the domestic building stock, and a 25% reduction in the public and non-domestic sectors in line with the 'Balanced Pathway' of the CCC's Sixth Carbon Budget. In practical terms, given that different properties will be easier or harder to upgrade, this would require deep energy retrofits in at least 50% of all homes.

- Further, in line with the CCC's 'Balanced Pathway', the scenario assumes an uptake in heat pumps of 86% by 2050. A further 11% of properties switch to hydrogen boilers, leaving 3% that do not switch. It is worth highlighting that there is considerable uncertainty as to the preferred role of hydrogen in heating buildings, and it may not be a viable option. This uncertainty is highlighted by the CCC's assessment which assumed the 11% to be the most likely outcome but with a range of 0% to 71%. The government will only make a decision on the role of hydrogen in the UK's net zero journey in 2026, emphasising the need for a focus on existing technologies in the meantime, namely heat pumps.[36]
- Finally, the scenario assumes that around 20% of heat demand within public sector buildings is met via district heat networks (DHNs), opportunities for which have been previously identified in East Grinstead, Burgess Hill, Haywards Heath, and Lindfield. This is based on a very rough estimate of the potential heat loads but in the absence of more detailed studies is intended only to reflect the potential order of magnitude.[37]

3.3.3.2 Reducing emissions from transport

- The scenario assumes that 4% of car trips can be avoided through behaviour change, such as working from home, online shopping, and the introduction of workplace parking levies. This is consistent with the lower bound of the CCC's Balanced Pathway figure. While the Government has the ambition to switch 50% of *urban* trips to active travel by 2030 – i.e., walking and cycling –[38] no such target has been provided for the rural part of the country. As such, a comparatively conservative estimate of 9% (CCC) was used instead (also the lower bound of the Balanced Pathway assumption). This will mainly be realised in the district's towns where active travel can replace shorter journeys due to the relative density of amenities. The more rural areas will need to focus on an expansion and decarbonisation of the public transport network.
- The majority of emissions are avoided through a switch to fully electric vehicles, assuming that by 2050, close to 100% of cars, vans, and motorcycles are fully electric in line with Government targets.[39] Additionally, both bus and rail are assumed to be fully electrified by the target year while 99% of HGVs are assumed to run on hydrogen by 2050. As vehicles – other than the council-owned fleet – come from private purchases, this will mainly be realised through the free market, guided by the national sales ban of petrol and diesel vehicles by 2030. Nonetheless, the Council will play a role in ensuring that the required charging infrastructure is in place as this is currently insufficient. It should be noted that while EVs play a substantial role in reducing emissions from road transport, the behaviour change measures should not be neglected by any means as they have the potential to realise various co-benefits which cannot be achieved through a switch to EVs.

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[36] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf

[37] This assumption is based on the information provided in the MSDC Sustainable Energy Study. A rough estimate was calculated by using the information provided in Table 4.6 of that study, along with CIBSE benchmarks of typical heating fuel consumption and assumptions about typical floor areas based on analysis of DEC data for Mid Sussex. This is intended merely as a high-level estimate to compare the potential for public sector DHN connections in the district as compared with the CCC estimates of the potential across the whole UK. Note that the previous energy study is now likely to be out of date and any DHN schemes would clearly need to undergo additional feasibility assessments. https://www.midsussex.gov.uk/media/2591/mid-sussex-sustainable-energy-study-report.pdf

[38] net-zero-strategy-beis.pdf (publishing.service.gov.uk)

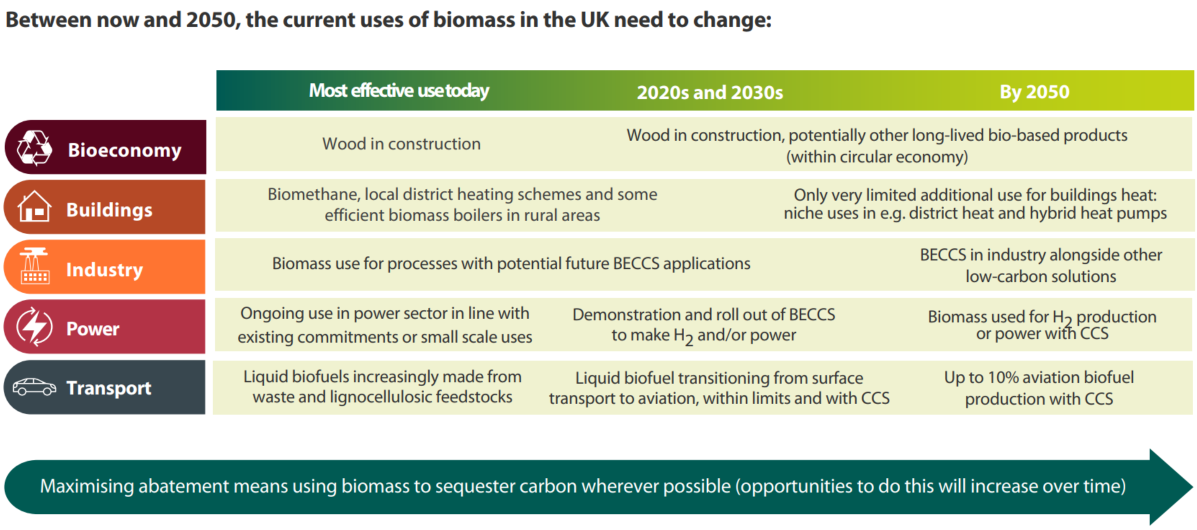
[39] net-zero-strategy-beis.pdf (publishing.service.gov.uk)

3.3.3.3 *Reducing other sources of emissions*

While buildings and transport make up the vast majority of baseline emissions and can, to a large extent, be mitigated by reducing energy demand and switching to renewable electricity using available technologies, there will be some remaining sources of emissions that are more challenging to eliminate. For Mid Sussex, the main examples are industry (particularly processes that use fossil fuels to provide heat), waste and agriculture (particularly non-CO_2 emissions whether from waste, livestock, or fertiliser applications).

Industry: At present, a significant portion of fossil fuel use in industry is used to supply heat, which is used for a variety of industrial processes. In addition to having very limited data available to support recommending specific interventions, in some cases there is no electrically powered alternative to the technologies currently in use. So, the solution will likely be a combination of some renewable electricity along with green hydrogen, bioenergy with carbon capture and storage (BECCS). This scenario assumes that 100% of fossil fuels in the industrial sector will be switched to one of these zero emission alternatives by 2050. However, it is important to acknowledge that the solutions in this regard are uncertain – and may change over time, as illustrated in Figure 67 which shows the CCC's recommendations for the most appropriate use of biomass in a low carbon economy.

Figure 67. Role of biomass in achieving emissions reductions over time. Source: CCC[40]



Waste: The CCC assumes that 75% of emissions from waste can be cut through a variety of measures including waste prevention, increased recycling rates, landfill bans, landfill methane capture, and CCS at EfW plants.

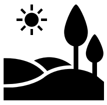
Agriculture: In the agriculture sector, the main actions are diet change (the CCC recommends a 35% reduction in meat consumption compared to today's level for the Balanced Pathway), land release measures (such as productivity improvements and moving horticulture indoors), low-carbon farming practices (reducing emissions from soils, livestock, and waste and manure management), as well as fossil fuel use in agricultural machinery. All measures combined reduce agricultural emissions by 33% in addition to the BAU reduction of 4%. It is acknowledged that these are rough estimates, given that many of these changes would vary and have uneven impacts geographically.

[40] Biomass-in-a-low-carbon-economy-CCC-2018.pdf (theccc.org.uk)

3.3.4 Accelerated net zero pathway (2040)

Realistically, the UK's 2050 target will mean that some Local Authorities need to make faster progress than others, and this will depend on both the scale of emissions in each area as well as the sources of those emissions, i.e., whether they are from sectors that are hard to abate. With that in mind, in addition to the 2050 scenario, consideration has been given to whether it would be possible for Mid Sussex to reach net zero in advance of the national target.

The evidence collected as part of the baseline analysis shows that there are some important reasons why it may be *easier* to reach net zero in Mid Sussex compared with some other UK Local Authorities.

	Opportunity	Further details
	**A high proportion of the district's emissions can be mitigated with existing technologies.**	**Emissions in Mid Sussex are dominated by the domestic sector and road transport – and there are technologies already available that can displace nearly all of the fossil fuel use in those sectors.** So, once the electricity grid reaches zero emissions there would be very large emissions reductions in those sectors. The Government has stated an ambition for the grid to reach net zero by 2035. This means that a large-scale push towards electrification of heating and transport would deliver major benefits for Mid Sussex. There would be considerable practical challenges in achieving this (summarised below), but at least there is a known solution that uses proven technologies.
	**Because the district is predominantly rural, there is land available for projects that can help mitigate emissions. These can provide benefits not only for Mid Sussex, but also the wider UK.**	**In principle, there should be more opportunities to achieve carbon reductions through changes in agriculture and land use practices,** compared with more built-up areas. A key intervention would include releasing agricultural land for other uses e.g., woodland creation. This potentially offers a major opportunity for Mid Sussex and if done correctly would also deliver significant wider ecological benefits – recognising that biodiversity issues are as important as climate change. Such projects would need to be carried out in a way that avoids emissions 'leakage', i.e., if the same farming activities are simply relocated elsewhere. **There is also more space to deliver large-scale renewable energy projects and/or bioenergy crops,** albeit recognising the areas of landscape sensitivity. These interventions would not necessarily decrease emissions from Mid Sussex 'on paper', because renewables would contribute towards national grid decarbonisation and BECCS facilities might be located outside of the district. However, they could still deliver overall benefits to the UK that will be important for reaching the national net zero target.

To illustrate the potential impact that these opportunities could have, an accelerated carbon pathway has been developed that aims to reach net zero by 2040. This pathway assumes that the same changes occur as in the BAU scenario, but in addition:

a) The Government delivers on its ambition for UK grid electricity to be net zero by 2035.

b) As a result, it becomes more advantageous to push for higher levels of electrification in buildings and transport. Doing so would achieve faster emissions reductions and also minimise *cumulative* emissions over time, which is critical for achieving the Paris Agreement targets. It is therefore assumed that 100% of buildings switch to electric heating systems, and 100% of vehicles (other than HGVs) switch to EV.

c) All other industrial fossil fuel use is displaced by green hydrogen, BECCS or some combination of the two. The rationale is that green hydrogen might be more widely available due to the large-scale increase in renewables implied by point (a). In principle, some bioenergy could also be produced within Mid Sussex to feed into a BECCS supply chain; however, at the time of writing those technologies are not yet commercialised.

d) Similar changes in the agricultural and waste sectors are achieved as in the 2050 scenario, but these have been adjusted to reflect the shorter timeframe for uptake. In particular, the shift in the agricultural sector will likely take more time to realise and as some of the waste measures rely on new technologies such as CCS and EfW plants.

The modelling shows that a combination of (a) grid decarbonisation and (b) electrification of heat and transport alone would reduce emissions in Mid Sussex by roughly 90%. A further reduction of around 5% would be achieved if (c) industry was fully decarbonised, while (d) agriculture and waste measures would make up most of the remaining 5%. At that stage, Mid Sussex would essentially have achieved net zero for its area-wide emissions – *provided that steps are taken to avoid any other increase in emissions, whether from energy, land use, or any other sources.*

This is illustrated in Figure 68 to Figure 70 below. In particular, and as with the 2050 scenario, a comparison of energy use versus emissions by fuel type shows how the level of progress is dependent on grid decarbonisation.

Figure 68. Emissions by sector in 2040 scenario

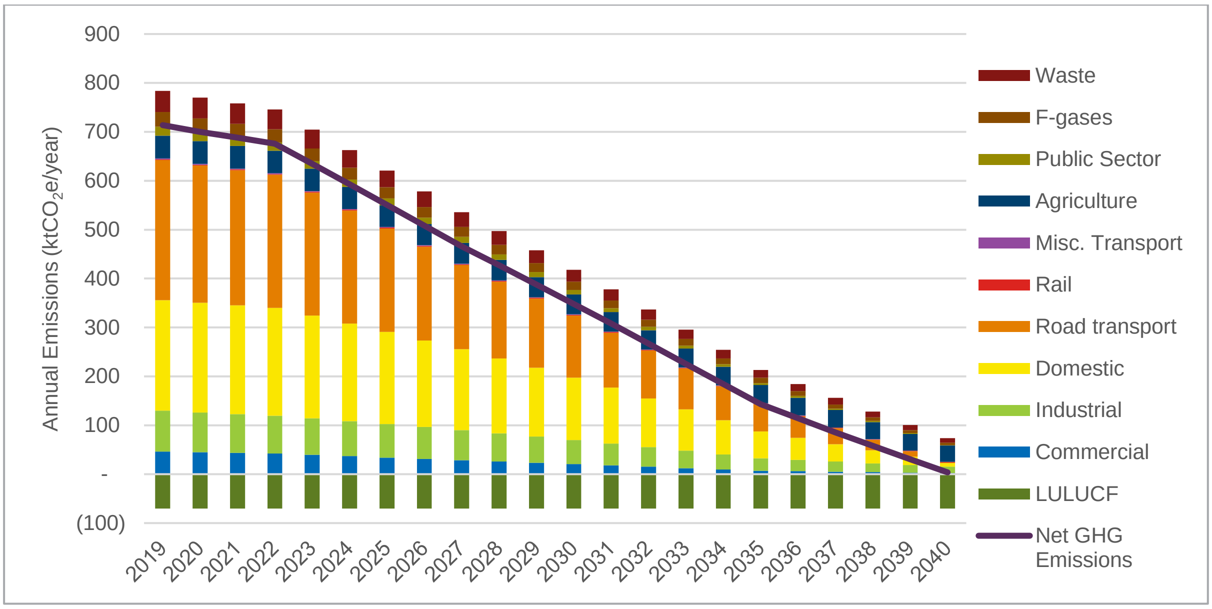


Figure 69. Energy use by fuel in 2040 scenario

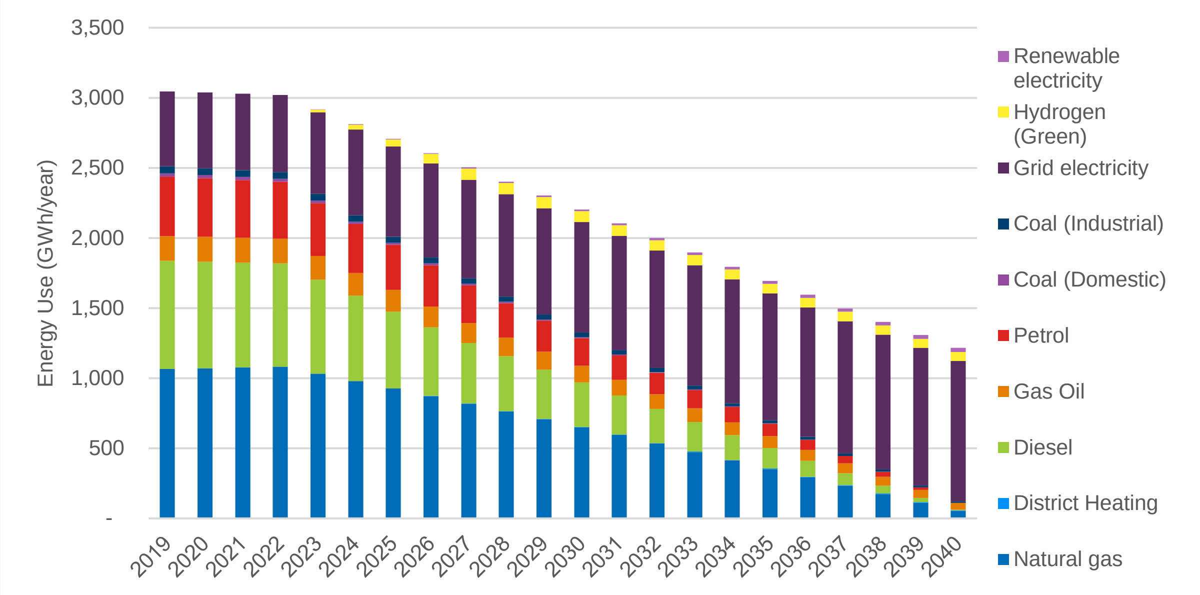
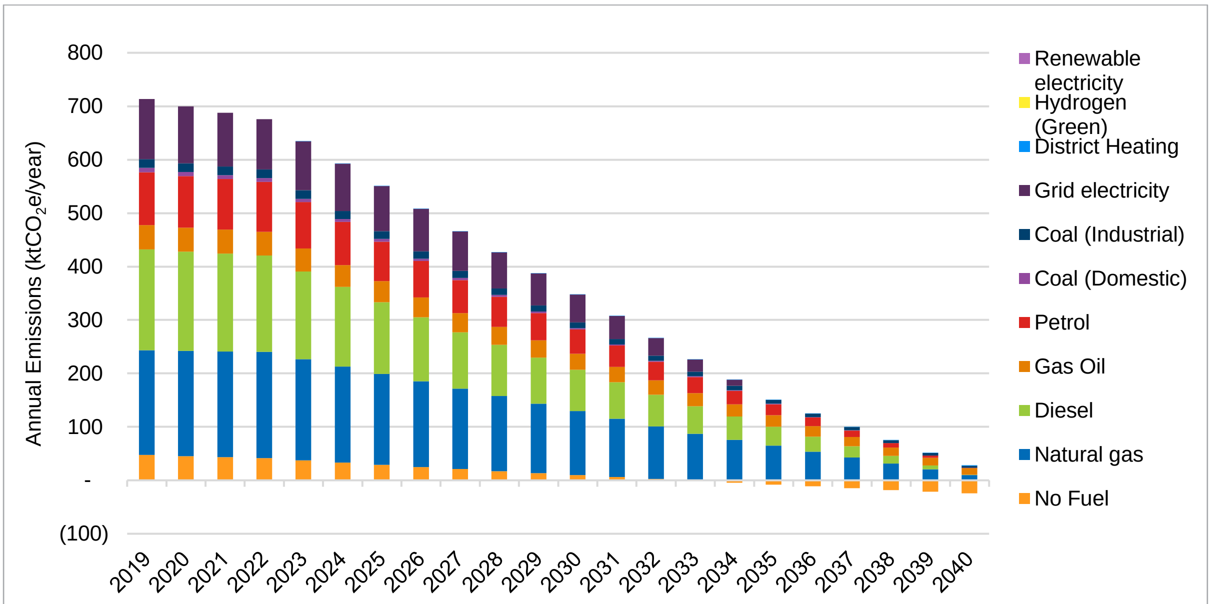


Figure 70. Emissions by fuel in 2040 scenario



It is important to acknowledge that the Government aspiration for grid electricity is not certain to be met and is considered ambitious in the context of current UK energy policy. If the rate of grid decarbonisation is lower than the Government hopes, the same measures would only reduce emissions by 50-80% by 2040. Among other things, these results reinforce the points that:

- Reaching net zero in Mid Sussex will rely on wider changes across the UK (though this in no way minimises the importance of actions taken within the district); and
- Even though there are technological solutions available, they are not a 'silver bullet'. Again, a credible pathway to net zero will need to include other forms of demand reduction, including behaviour change.

Although electrification offers a major opportunity to decarbonise heat and transport in Mid Sussex from a purely technological standpoint, it would still require huge effort to overcome obstacles. The major challenges differ for transport versus heat and buildings, as summarised below.

- **Transport:** EVs have rapidly decreased in cost which has resulted in higher uptake. The Government has also proposed a ban on the sale of new petrol and diesel cars and vans by 2030. If implemented, then considering the average lifespan of vehicles, the majority would be EV by 2040, assuming that sufficient charging infrastructure is available.[41]
- **Heat and buildings:** Among the major practical challenges, three stand out:
    - Cost: At present, heat pumps are much more expensive than boilers and it is not certain how fast the costs will come down. The Government has promised[42] to work towards achieving this but the specifics have not been announced.
    - Retrofitting is a prerequisite: Due to the impacts on fuel bills as well as system performance, electric heating systems (whether those are heat pumps or any other form) need to be installed in buildings that are already reasonably energy efficient. In other words, the rollout would need to be preceded by a large-scale retrofitting initiative. At present there is very little funding (existing or planned) available to achieve this.
    - Natural replacement cycles: The average lifespan of a boiler is around 15 years. So, replacing all fossil fuel heating systems by 2040 would require an almost immediate ban on new ones being sold or installed. That is not within MSDC's legal remit, and the Government is not considering introducing such a ban until c. 2035, so it is not clear how this would be achieved. Also, heating systems are usually replaced when they break, which is usually in winter (the heating season). Therefore, replacement normally needs to happen very quickly, and a like-for-like solution is often the most practical.

Furthermore, significant action will be needed to avoid any *increase* in emissions. For example:

- **New developments:** The BAU projections account for some growth in domestic emissions, but the actual change will be determined largely by future Building Regulations. The Government has announced plans for the Future Homes Standard to reduce emissions by 75-80% compared with current standards but has not yet announced how this will be achieved.
- **Land use, land use change and forestry (LULUCF):** Projections for England show that the impacts of continual deforestation, converting grassland to cropland, and new settlements will result in worsening emissions from the LULUCF sector. This risk is particularly relevant to Mid Sussex given the amount of land used for agriculture. On the other hand, there could be complicated trade-offs – and potentially net benefits – if less land is used for grazing livestock and more is used to supply people with plant-based diets. So, any actions taken to address agricultural land uses would need to take a holistic view and be done in coordination with industry bodies and other Local Authorities.

What does this mean for Mid Sussex?

These results show that, with significant tailwinds, it would theoretically be feasible for emissions in Mid Sussex to reach net zero (or get very close) prior to 2050. The vast majority of emissions can be addressed using existing technologies. The remaining 5-10% of emissions reduction would rely on changes that are less certain, such as a shift in land use and agricultural practices, waste management, behaviour, and technological advances (particularly CCS). Despite the challenges, overall, this means

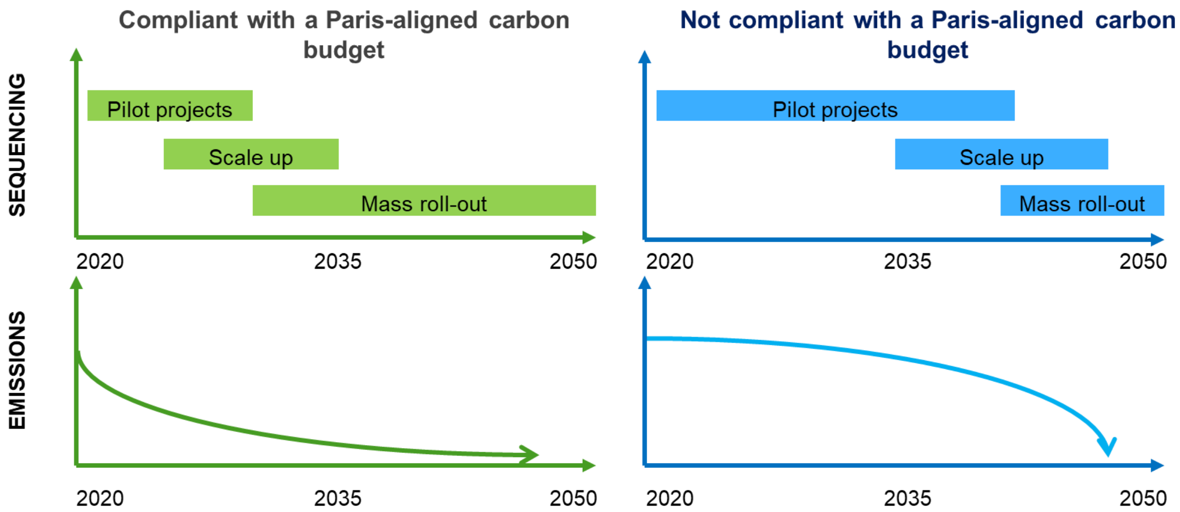
[41] Due to the wider resource implications of producing battery vehicles, there must also be a large-scale behavioural shift to reduce transport demand, even though from a strict carbon accounting perspective this would have minimal or no impact on emissions within the MSDC area boundary.

[42] In the Heat and Buildings Strategy (October 2021) the Government announced that there will be a consultation on options for working with industry to drive down costs. Heat and buildings strategy - GOV.UK (www.gov.uk)

that Mid Sussex is at an advantage compared with some other Local Authorities. This is a positive message, and a useful starting point for developing a net zero roadmap.

Ultimately, every Local Authority will need to take urgent action to achieve carbon reduction, despite the challenges this entails. It is not only the net zero target date, but the speed of decarbonisation, that makes a difference. As shown in Figure 71 below, delaying action results in much higher cumulative emissions over time, and these need to be managed in order to stay within a carbon budget that is aligned with the Paris Agreement targets.

Figure 71. Emissions trajectory under a Paris-aligned budget



4 CONCLUSIONS

This report provides a detailed evidence base around the pathways to net zero both for Mid Sussex District Council's own GHG emissions and for the GHG emissions across the whole of the district. It shows what will be needed to deliver net zero emissions in both cases and what some of the main benefits, barriers and challenges will be. This evidence base will underpin the development of net zero action plans at the Council and district level.

APPENDIX A – KEY POLICIES, PLANS AND STRATEGIES INFLUENCING GHG EMISSIONS IN MID SUSSEX

Coverage	Target or objective	Driver / mechanism
International	**Limit global temperature increase to 2°C and pursue efforts to limit global temperature increase even further to 1.5°C**	**Paris Climate Agreement**
International	To be agreed: Protect 30% of land by 2030	Convention on Biological Diversity
National	By 2050, reduce net emissions by 100% compared with a 1990 baseline	Climate Change Act (2050 Target Amendment Order) 2019
National	By 2035, a 78% reduction in UK territorial emissions on 1990 levels	The sixth Carbon Budget
National	Drive supply and demand of ultra-low emission vehicles and ensure a fit for purpose infrastructure to support the shift to electric vehicles • The sale of new petrol and diesel cars and vans will be prohibited by 2030 and all new cars will be fully zero emission at the tailpipe from 2035 • Decarbonise the whole central government fleet of 40,000 cars by 2027 • The sale of all non-zero emission HGVs will end from 2040, with lighter HGVs from 2035	Transport decarbonisation plan
National	To successfully decarbonise the UK's energy systems, the UK's government has set a number of national-level targets, including to increase offshore wind from 10GW (2019 levels) to 40GW by 2030 as well as growing the installation of electric heat pumps from 30,000 per year to 600,000 per year by 2028	Energy White Paper: Powering our Net Zero Future
National	To ensure the UK's industrial sector is aligned with net zero, the government ambition to reduce industrial emissions by two-thirds by 2035 and by at least 90% by 2050 with 3 $MTCO_2$ captured through Carbon Capture, Usage and Storage and around 20TWh switching to low carbon fuels by 2030	Industrial Decarbonisation Strategy
National	Tackle long-term problems to deliver growth which creates high-quality jobs across the UK	Build Back Better: Our plan for growth

National	**2021: An interim uplift will deliver high-quality homes that are expected to produce 31% less CO_2 compared to current standards** **2025: Zero-carbon ready homes. The report also aims to clarify the longer-term role of local planning authorities in determining local energy efficiency standards.** **2028: 600,000 heat pump installations per year** **2030: Improve around 1.5 million homes to EPC C standard**	**The Future Homes Standard**
National	Double resource productivity and eliminate avoidable wastes by 2050 75% recycling rate for packaging by 2030 65% of municipal waste (by weight) to be recycled by 2035 with no more than 10% ending in landfill Eliminate food waste to landfill by 2030	Our Waste, Our Resources: A Strategy for England (2018)
National	Increase woodland coverage from 10.1% to 12% by 2050	England Trees Action Plan 2021 to 2024
Regional	Four scenarios for decarbonisation of the UK's energy system	Distribution Future Energy Services (UKPN)
Regional	The group of three LEPs aim to deliver clean growth, whilst continuing to provide an affordable, sustainable and secure energy supply. The plan has two main goals, 1. the tri-LEP Region will play a leading role in the UK's decarbonisation, 2. the tri-LEP region will foster clean growth by supporting public and private sector investments in novel low carbon technologies	'South2East Local Energy Strategy', Coast to Capital, Enterprise M3 and South East Local Enterprise Partnerships
Regional	The strategy establishes how West Sussex County Council can build upon the work completed to date and address the key issues facing the authority, whilst looking for ways to support its residents	'West Sussex Energy Strategy, West Sussex County Council
Regional	**The strategy sets out the first actions for delivering the West Sussex Energy Strategy. It spans a three-year period, and will be monitored and reviewed regularly.**	'West Sussex Energy Strategy Action Plan', West Sussex County Council

Regional	The West Sussex Transport Plan 2011-26 sets the strategy for guiding future investment in highways and transport infrastructure. The plan's main objective is to improve quality of life for the people of West Sussex by helping to provide; a high quality transport network, a resilient low carbon transport network, access to services, employment and housing and finally a transport network that feels, and is, safer and healthier to use In April 2021, there were 194 publicly accessible electric vehicle charging points in West Sussex including 43 rapid (43kw or above) chargers	West Sussex Transport Plan', West Sussex County Council
Regional	The strategy sets out the role of electric vehicles in West Sussex to deliver the county's vision for transport and interventions the county council will deliver to support West Sussex residents to a transition to electric transport Modelling conducted for the strategy estimates that across West Sussex public charging points needs to increase from 89 to 3,305 by 2025, and 7,346 by 2030.	'Electric Vehicle Strategy', West Sussex County Council
Regional	At least 70% of all new cars in the county to be electric by 2030. • There is sufficient charging infrastructure in place to support the vehicles predicted to be reliant on public infrastructure to charge. • Ensure a renewable energy source for all charging points on County Council land or highway.	Electric Vehicle Strategy (2019 – 2030)
Regional	The bus strategy aims to achieve general improvements to the bus network in West Sussex that will improve users' experience and accessibility while achieving broader social, environmental and economic benefits for the county.	West Sussex Bus Strategy 2018 – 2026
Local	The District Plan is the main planning document used by the Council when considering planning applications. Key considerations: - minimum provision of 16,390 homes in the 17-year period 2014 – 2031 - Ashdown Forest Special Protection Area (SPA) and Special Area of Conservation (SAC)	*'Mid Sussex District Plan'*, Mid Sussex District Council (2018) – and ongoing review
Local	The Economic Recovery Plan has been prepared as a response to the Covid-19 pandemic and sets out over 30 actions which the Council will deliver in line with the government's pillars of economic recovery: Backing Business, Increasing Opportunities, Securing High Value Inward Investment, Accelerating Innovation, and, Encouraging a Green Recovery. Amongst the actions is the Council's Covid-19 Recovery Grant which offers £300k grant support to communities and businesses in addition to government support funding.	*'Mid Sussex Economic Development Strategy'*, Mid Sussex District Council (2018)

Local	Delivered through three themes, a sustainable council, environment and communities, the strategy aims to; embed sustainability in all corporate actions, support communities in implementing sustainable actions and becoming more resilient to a changing climate and support businesses in achieving savings through energy efficiency and other sustainability initiatives.	*'Mid Sussex Sustainability Strategy'*, Mid Sussex District Council (2018)

APPENDIX B – NET ZERO SITE AUDIT

A net zero audit was undertaken by Ricardo to inform the measures that were entered into modelling tool. The sites that were selected for the audit were chosen as a representative sample of MSDC's broader site portfolio. These include:

- Oaklands Main Office
- St Johns Pavilion
- Sheddingdean Community Centre

FINDINGS

The following tables summarise the identified energy saving opportunities associated with each site.

Oaklands Main Office

Opportunity ID	Title			Scope
Opportunity 1	Oaklands - Implement energy management system			1
Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	
£1,986	41,902	8.8		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
£100		0.1	1,986%	£6,775
Description & Assumptions	Whilst energy use is monitored by the Council at a high level and a number of energy saving projects have been implemented, there are no formal management processes in place to ensure energy use is tracked and managed on a systematic basis in order to drive down energy use and associated carbon emissions. To this end it is recommended the Council look to implement a formal energy management system with endorsement from the most senior levels. The system should look to track energy use across the portfolio with heavy focus on the significant energy users such as the Oaklands office. It should consider both technical aspects of energy use and include staff engagement activities. The energy management standard ISO 50001 is useful point of reference however it should be kept in mind that the objectives should be to both reduce energy use and work toward decarbonising the Council's operations. It has been assumed that savings of 3% of electricity and 5% of gas use could be achieved through the implementation of an energy management system.			

Opportunity ID	Title	Scope
Opportunity 2	Oaklands - Implement site wide energy sub metering with energy management software	1

Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	
£1,986	41902	8.8		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
		0.0	-	£6,873
Description & Assumptions	Currently there is little visibility of energy use across the council portfolio and in the significant energy using facilities there there is no visibility of energy use by key areas or processes. Through the use of automatic meter reading (AMR), smart meters and energy submetering it is possible to track and analyse energy use at a more granular level. Energy management software is a powerful tool in the analysis and management of energy where is it possible to identify patterns of use, identify deviations and work toward reduction targets. The use of such tools will become increasingly important in the drive to net zero, for reducing consumption, sustaining savings made, and informing planning and specification of low carbon infrastructure where real world consumption data is key. It is recommended the council rolls out energy sub metering with suitable management software. It has been assumed that savings of 3% of electricty and 5% of gas use could be achieved through the implementation of a sub metering system with energy management software.			

Opportunity ID	Title			Scope
Opportunity 3	Oaklands - Convert heating systems from natural gas to electric air source heat pump			1
Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	
-£26,457	396,862	40.4		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
£800,000		-30.2	-	-£872,276
Description & Assumptions	Current boiler peak capacity: West Wing: 250kW, 76oC North Wing: 46kW, East Wing: 2 x 260kW = 520kW Total = 826kW With COP of 2.5 peak electric demand is 330kW Assume use of thermal stores - good space to reuse old boiler oil tank room by east wing boiler house.			

Opportunity ID	Title	Scope

Opportunity 4	Oaklands - Optimise BMS and other controls			1
Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	
£1,809	69,381	13.2		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
£10,000		5.5	-12%	-£3,501
Description & Assumptions	Optimise heating controls. Optimise air conditioning controls. It is assumed that savings of 10% of electricity use by HEVAC and related plant and 10% of gas could be realised. Assume costs of £10,000 are to optimise only, limited capital investment.			

Opportunity ID	Title			Scope
Opportunity 5	Oaklands - Reduce consumption by computing and related IT equipment			2
Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	
£442	2943	0.9		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
£20,000		45.3	-56%	-£17,990
Description & Assumptions	Prior to the onset of COVID the typical number of daily occupants in the office was circa 400; going forwards it is anticipated the future occupancy levels will be circa 200. Most desk workstations are equipped with 2 monitors whilst staff have either desktop or laptop computers. The majority of monitors are left on when the desks are unoccupied. There is however the opportunity to reduce energy use by implementing measures as follows: a) use of computer energy management software to ensure computers operate in energy saving mode and shut down when left unattended. b) instruct staff / fit power sockets to desks to switch off all power to workstations out of working hours. This assumes that IT and computing power accounts for 20% of site electricity and that 5% savings could be realised.			

Opportunity ID	Title	Scope

Opportunity 6	Oaklands - Implement onsite solar PV			
Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	
£22,800	152,000	46.7		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
£152,000		6.7	-18%	-£69,438
Description & Assumptions	Existing system is 28.6kWp Parking space suggests enough space for over 1,000m2 of panels. If 2.5m2 = 1kWp then enough space for 400kWp. For average summer daily load of circa 1,000kWh, suggest need to expand to capacity to 180kWp (extra 152kWp) in order to minimise summer exports. This means circa 152,000kWh saved pa. Assume £1,000 / kW to install.			

St John's Pavilion

Opportunity ID	Title			Scope
Opportunity 1	St Johns Pavilion - Remote controls for night storage heating			
Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	
£638	4256	1.3		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
£1,000		1.6	52%	£1,233
Description & Assumptions	St Johns Pavilion is heated by electric night storage heaters. There is limited control of the heating and being a tenanted building with multiple users it is apparent the heating is left on continuously regardless of occupancy levels. Installing improved controls with remote access will enable better management of the heating system and this could be coordinated with site bookings; this could be a simple system such as Nest, Hive or equivalent. It is assumed 20% of site heating could be saved with better management.			

Opportunity ID	Title			Scope
Opportunity 2	St Johns Pavilion - convert external lighting to LED with timers / light sensors			2
Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	

£99	657	0.2		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
£250		2.5	21%	£97
Description & Assumptions	Internal lighting has already been converted to LED. Some of the external wall lights are fluorescent and could be converted to LED. 5 units.			

Opportunity ID	Title			Scope
Opportunity 3	St Johns Pavilion - Install solar thermal heating to supplement existing electric DHW heating			
Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	
£393	2619	0.8		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
£3,500			-26%	-£2,056
Description & Assumptions	The shower rooms are principally used in the summer season only. The water is heated all year by electric resistance heaters in the hot water tank (calorifier). To reduce electricity consumption there are 2 options: 1. Fit point of use hot water heaters, or 2. Supplement heating with solar thermal heat collectors.			

Sheddingdean Community Centre

Opportunity ID	Title			Scope
Opportunity 1	Sheddingdean - Convert gas fired warm air heaters to electric air source heat pump			2
Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	
-£437	9711	1.2		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
£18,000		-41.2	-	-£19,078

Description & Assumptions	The heating in Sheddingdean Community Centre is provided by 5 x wall mounted gas fired warm air heaters (5.8kW each). It is recommended the heating system in the main hall is replaced by air source heat pump technology such as a multi split system with 2 or 3 ceiling mounted cassettes in the main hall. Small infrared radiant electric heaters could be used in the toilets and storeroom. The kitchen domestic hot water boiler will have to be converted to electric point of use heater.

Opportunity ID	Title			Scope
Opportunity 2	Sheddingdean - convert lighting to LED with occupancy sensors			1
Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	
£240	1601	0.5		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
£1,360		5.7	-13%	-£496
Description & Assumptions	The lighting in Sheddingdean Community Centre is predominantly T8 fluorescent tube technology. This could be upgraded/swapped out to LED equivalent.			

Opportunity ID	Title			Scope
Opportunity 3	Sheddingdean - Convert domestic hot water supply from gas fired boiler to point of use (POU) electric water heaters			
Estimated annual savings			Other savings	ECA/loan eligibility
(£)	(kWh)	(tCO_2)	(£/yr)	
-£233	-291	-0.3		
Est Capital cost (£)	Est. O&M cost (£/yr)	Simple payback (yrs)	IRR (4 years)	NPV
£2,000		-8.6	-	-£2,758
Description & Assumptions	Domestic hot water in Sheddingdean Community Centre is provided by a 27kW rated domestic hot water boiler. To decarbonise, the facility will have to either fit electric resistance heating to the hot water tank (calorifier) or fit point of use electric water heaters. It is assumed point of use water heaters will be fitted as this will reduce energy losses			

	associated with maintaining a continuously heated tank. The losses are assumed to be 20% in terms of boiler efficiency and radiated heat. A cost of £2,000 is assumed for converting to POU units.

APPENDIX C – NET ZERO DISTRICT MODELLING ASSUMPTIONS

Site/Site Category	Emissions Source	Modelled Changes	Energy savings (%)	Years applied scenario – 2040 scenario	Years to implement – 2040 scenario	Years applied scenario – 2050 scenario	Years to implement – 2050 scenario	Growth (+% y-o-y)	Efficiency (-% y-o-y)
Other operational assets	Electricity	Implement energy management system	3%	2022	1	2022	2	1%	0.5%
		Energy sub metering / reporting systems	3%	2022	1	2022	2	1%	0.5%
		Optimize BMS/BEMS control algorithms and setpoints	3%	2022	1	2022	2	1%	0.5%
		On site solar (car park) – Oaklands Offices - Oaklands Road, Oaklands - East Wing Boltro Road. Scaled to proportion of other operational sites.	57%	2023	2	2025	4	1%	0.5%
	Natural gas	Implement energy management system	5%	2022	1	2022	2	1%	-
		Energy sub metering / reporting systems	5%	2022	1	2022	2	1%	-

Site/Site Category	Emissions Source	Modelled Changes	Energy savings (%)	Years applied scenario – 2040 scenario	Years to implement – 2040 scenario	Years applied scenario – 2050 scenario	Years to implement – 2050 scenario	Growth (+% y-o-y)	Efficiency (-% y-o-y)
		Optimize BMS/BEMS control algorithms and setpoints	10%	2022	1	2022	2	1%	-
		Change technology, E.g. boilers to heat pumps	Coefficient performance (COP) 2.5	2022	2	2032	10	1%	-
Halls & community centres	Electricity	Organisation wide - Improve energy management systems / processes	3%	2022	1	2022	2	1%	0.5%
		Energy sub metering / reporting systems	3%	2022	1	2022	2	1%	0.5%
		On site solar (roof top) – Sheddingdean Community Centre Site - Maple Room	-85%	2023	2	2025	4	1%	0.5%

Site/Site Category	Emissions Source	Modelled Changes	Energy savings (%)	Years applied scenario – 2040 scenario	Years to implement – 2040 scenario	Years applied scenario – 2050 scenario	Years to implement – 2050 scenario	Growth (+% y-o-y)	Efficiency (-% y-o-y)
	Natural gas	Organisation wide - Improve energy management systems / processes	5%	2022	1	2022	2	1%	-
		Energy sub metering / reporting systems	5%	2022	1	2022	2	1%	-
		Change technology, E.g. boilers to heat pumps	Coefficient performance (COP) 3	2022	2	2032	10	1%	-
Parks & recreational grounds	Electricity	Organisation wide - Improve energy management systems / processes	3%	2022	1	2022	2	1%	0.5%
		Energy sub metering / reporting systems	3%	2022	1	2022	2	1%	0.5%

Site/Site Category	Emissions Source	Modelled Changes	Energy savings (%)	Years applied scenario – 2040 scenario	Years to implement – 2040 scenario	Years applied scenario – 2050 scenario	Years to implement – 2050 scenario	Growth (+% y-o-y)	Efficiency (-% y-o-y)
		Improved heating controls	20%	2022	1	2022	2	1%	0.5%
		On site solar (roof top) – New Pavilion - Mount Noddy Recreation Park St Johns Road East Grinsted. Scaled to proportion of parks & recreational grounds.	4%	2023	2	2025	4	1%	0.5%
Offices	Electricity	Implement energy management system	5%	2022	1	2022	2	1%	0.5%
		Energy sub metering / reporting systems	5%	2022	1	2022	2	1%	0.5%
		Upgrade to lighting to LED with occupancy sensor	25%	2022	2	2024	4	1%	0.5%
		Improve lighting controls - zones, occupancy controls, dimming	10%	2022	1	2022	2	1%	0.5%

Site/Site Category	Emissions Source	Modelled Changes	Energy savings (%)	Years applied scenario – 2040 scenario	Years to implement – 2040 scenario	Years applied scenario – 2050 scenario	Years to implement – 2050 scenario	Growth (+% y-o-y)	Efficiency (-% y-o-y)
		Optimise BMS/BEMS control algorithms and setpoints	5%	2022	1	2022	2	1%	0.5%
	Natural gas	Organisation wide - Improve energy management systems / processes	5%	2022	1	2022	2	1%	-
		Energy sub metering / reporting systems	5%	2022	1	2022	2	1%	-
		Change technology, E.g. boilers to heat pumps	Coefficient performance (COP) 2.5	2022	2	2032	10	1%	-
	Waste	Domestic waste prevention and reuse	30%	2022	2	2022	6	1%	-
		90% recycling rate/ 10% incineration. Waste energy heat.	-	2022	2	2022	6	1%	-
Temporary housing	Electricity	Upgrade to lighting to LED with occupancy sensor	25%	2022	2	2024	4	1%	0.5%

Site/Site Category	Emissions Source	Modelled Changes	Energy savings (%)	Years applied scenario – 2040 scenario	Years to implement – 2040 scenario	Years applied scenario – 2050 scenario	Years to implement – 2050 scenario	Growth (+% y-o-y)	Efficiency (-% y-o-y)
		Improve window and door sealing	5%	2022	1	2022	2	1%	0.5%
		On site solar (roof top). 33 Mocatta Way, Burgess Hill, RH15 8UR. Scaled to proportion of temporary housing.	49%	2023	2	2025	4	1%	0.5%
	Natural gas	External / internal wall insulation, and loft / roof insulation	10%	2022	1	2022	2	1%	-
		Change technology, E.g. boilers to heat pumps	Coefficient performance (COP) 2.5	2022	18	2022	28	1%	-
Residential	Electricity	Upgrade to lighting to LED with occupancy sensor	25%	2022	2	2024	4	1%	0.5%
		Improve window and door sealing	5%	2022	1	2022	2	1%	0.5%
		On site solar (roof top and car park) – Orchards Shopping Centre.	62%	2023	2	2025	4	1%	0.5%

Site/Site Category	Emissions Source	Modelled Changes	Energy savings (%)	Years applied scenario – 2040 scenario	Years to implement – 2040 scenario	Years applied scenario – 2050 scenario	Years to implement – 2050 scenario	Growth (+% y-o-y)	Efficiency (-% y-o-y)
	Natural gas	External / internal wall insulation, and loft / roof insulation	10%	2022	1	2022	2	1%	-
		Change technology, E.g. boilers to heat pumps	Coefficient performance (COP) 2.5	2022	2	2032	10	1%	-

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