Carbon Neutral Worcester

Greenhouse Gas Emissions and Decarbonisation Report May 2023

1. Introduction

This report explores the sources and scope of carbon emissions of Worcester and the reductions seen between 2005 (the baseline year used by Government) and 2020 (latest data available at the time of writing).

The report provides a summary of the remaining carbon budget. The carbon budget is the total remaining carbon which can be emitted for Worcester to 'make its fair contribution to delivering the Paris Agreement's commitment to staying "well below 2°C and pursuing 1.5°C" global temperature rise' (Tyndall Report, 2018). As the carbon budget shows, an immediate and rapid programme of decarbonisation is needed, with reductions of around 12.6% required from 2020 onwards.

This report then uses the SCATTER tool, a freely available tool provided by Anthesis together with public sector partners, to assess the potential ways in which emissions across the city may be reduced.

Emissions are expressed in tonnes of carbon dioxide equivalent (tCO2e). This is a term to describe the calculation including other greenhouse gases, not just carbon dioxide. All other greenhouse gases included are expressed as the amount of CO2 which would have the same global warming potential. The other main greenhouse gases taken into account are methane and nitrous oxides.

2. What does a carbon neutral Worcester look like?

The vision for a carbon neutral Worcester expressed in the Environmental Sustainability Strategy:

Visitors arriving in the city in their zero emission vehicle are provided with ample opportunities to charge their car. Visitors arriving into our key public transport hubs have a choice of electric taxi, e-bike or pedal cycle to continue their journeys. Commuters, when they do need to travel into work, have the same choices. Walking and cycling around the city is safe, convenient and is the mode of choice for many. New developments are all low carbon in construction and use, ensuring these buildings are comfortable and future proofed. The thermal energy of the River Severn is used to heat many city centre buildings through a heat network. Homes are much more energy efficient, comfortable to live in and affordable to heat with low carbon heating sources.

This report provides additional detail, supporting the Environmental Sustainability Strategy and Action Plan, on the route to decarbonisation and trajectories for the reduction of greenhouse gas emissions.

3. Target

The Environmental Sustainability Strategy aims towards carbon neutrality by 2030. Carbon neutrality or 'net zero' recognises that it may not be possible to eliminate emissions completely, but instead some residual emissions may need to be offset. There are various ways of doing this, including planting trees, generating excess renewable energy or taking part in a carbon offset scheme.

4. Calculation of Greenhouse Gas Emissions

Central Government reports on emissions for each local authority area annually. Data is published annually.

Up until 2020, the latest available data, the data published has been for carbon emissions only. In 2020, the data was for three greenhouse gases – carbon dioxide, methane and nitrous oxide.

5. Context behind the emissions

More detail on the sources of emissions and the context of those emissions can be found in the paper produced in 2020 alongside the Environmental Sustainability Strategy, Worcester's Carbon Emissions: Context and Evaluation. This report does not repeat the information included in the report.

6. Emissions Profile

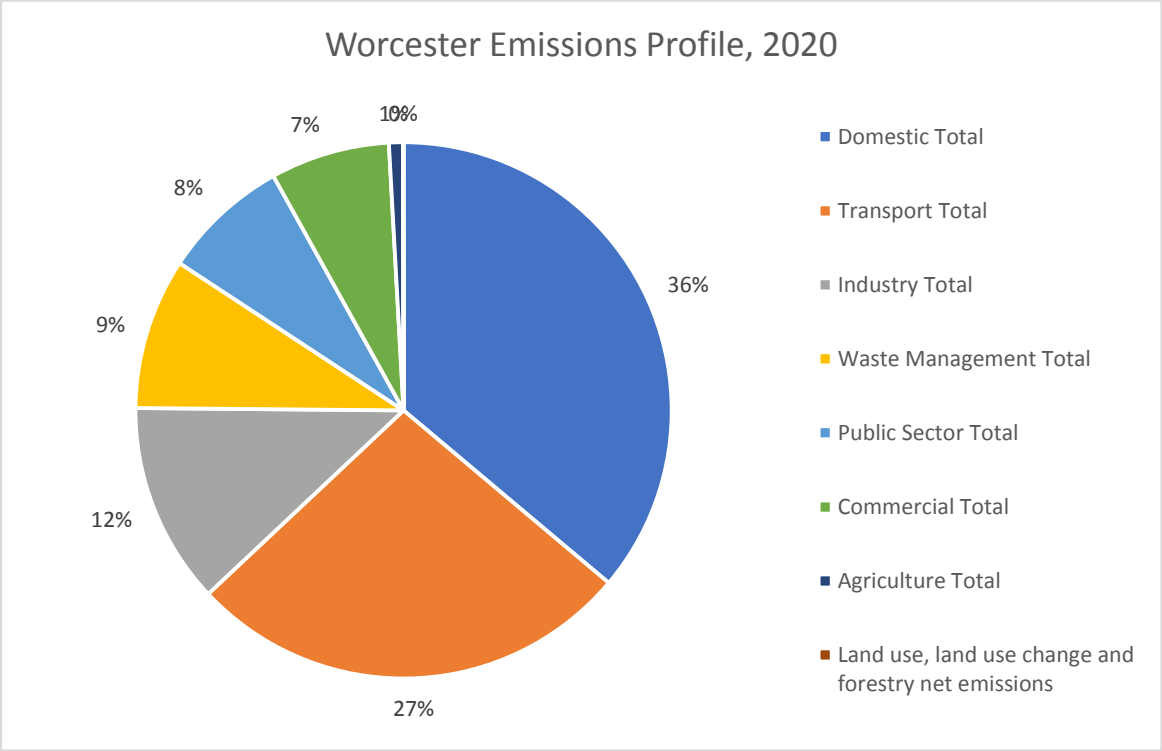


Figure 1. Worcester Emissions Profile, 2020

7. Emissions reduction trajectory to date

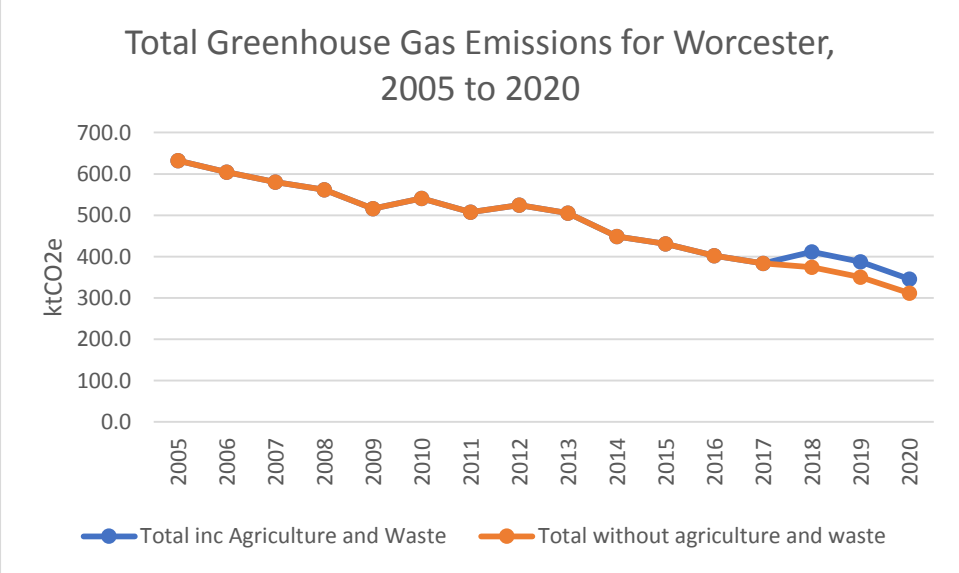


Figure 2. Total Emissions Reduction 2005-2020

Total emissions for Worcester in 2020, according to this dataset, are 345.8ktCO2e.

There has been a 45% reduction in Worcester's greenhouse gas emissions between 2005 and the latest data, 2020 (2021 data should be published imminently, due June 2023). This 45% reduction includes the emissions from the agricultural and waste sectors, for which data has only been available for the last few years (and so is not included in the 2005 baseline).

The biggest reductions have come from the industrial and commerical sectors (63% and 73% respective reductions), with emissions from the domestic sector falling by 43%. The lowest reduction is from the transport sector, where emissions have reduced by 32%. In Worcester, the domestic sector is still the sector with the highest carbon emissions.

The following graph breaks the reductions down by sector.

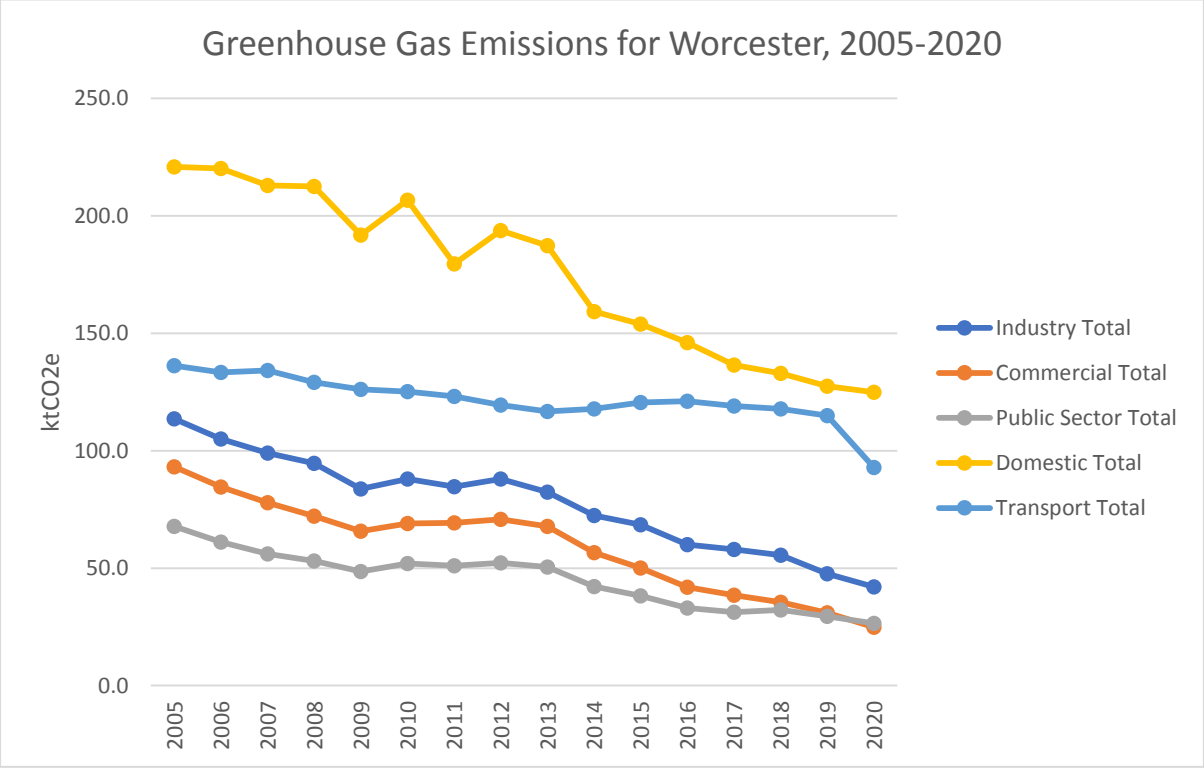


Figure 3. Emissions reductions for Worcester 2005-2020, broken down by sector

LULUCF is the land use, land use change and forestry sector. This consists of both emissions and removal of CO2 by land and forests. This sector is not included in the graph above as the values are very small – net emissions of 0.1ktCO2e in 2020 from land use.

8. Carbon budget

This information is taken from the University of Manchester and Tyndall Centre for Climate Change Research report, 'Setting Climate Commitments for Worcester: Quantifying the implications of the United Nations Paris Agreement for Worcester'. A report was published for each local authority, in 2019.

As this was written in 2019 and relied on the central Government data on carbon, the report is only for CO2 – the carbon budget does not include the other key greenhouse gases.

The report concludes that 'at 2017 CO2 emission levels, based on Worcester's 2016 CO2 emissions (excluding aviation, shipping, process CO2 emissions from cement production and those from LULUCF)., Worcester will exceed the recommended budget available within 7 years from 2020.

To stay within the recommended carbon budget Worcester will, from 2020 onwards, need to achieve average mitigation rates of CO2 from energy of around -12.6% per year. This will require that Worcester rapidly transitions away from unabated fossil fuel use.

For context the relative change in CO2 emissions from energy compared to a 2015 Paris Agreement reference year are shown in the table below.

	ktCO2	% change required based on recommended pathway	Emitted or recommended reduction
2015	418.9		Emitted
2020	314.76	25.1%	Recommended reduction. Actually emitted – 301.9
2025	133.9	61.8%	Recommended reduction
2030	81.27	80.6%	Recommended reduction
2035	41.47	90.1%	Recommended reduction
2040	20.94	95.0%	Recommended reduction
2045	10.9	97.4%	Recommended reduction
2050	5.45	98.7%	Recommended reduction

Table 1: Percentage reduction of annual emissions for the recommended CO2 - only pathway out to 2050 in relation to 2015

Year Reduction in Annual Emissions (based on recommended pathway)

To equate this to the data provided in the previous section, the data given in the carbon budget report which is in mega-tonnes of CO2, is given here in kilo-

tonnes of CO2. Total emissions in 2020 of CO2 (opposed to CO2e as given in the previous section) were 301.9ktCO2e (345.8ktCO2e).

Carbon budget period	Recommended carbon budget (MtCO2)	Recommended carbon budget (ktCO2)	Annual budget for the period (ktCO2)
2018-2022	1.5	1500	300
2023-2027	0.8	800	160
2028-2032	0.4	400	80
2033-2037	0.2	200	40
2038-2042	0.1	100	20
2043-2047	0.1	100	20
2048-2100	0.1	100	20

Table 2. Carbon budgets in different periods

Analysing the period to 2022 in detail (see table 3), shows that the recommended carbon budget for 2018-2022 was likely exceeded. This will not be confirmed until the data for 2022 is published in June 2024. However, using an assumed percentage reduction based on the reductions seen in 2019 and 2020, it is likely that Worcester's emissions over the first period of this carbon budget was 1521ktCO2, compared to the budget given by the Tyndall Centre research against the requirements of the Paris Agreement of 1500ktCO2.

Year	Actual or assumed ktCO2	Reduction
2018	363.3	
2019	340.4	6%
2020	301.9	11%
2021	271.71	Assumed 10% reduction
2022	244.539	Assumed 10% reduction
Total	**1521.849**	

Table 3. Carbon budget 2018-2022 split year by year

The 11% reduction seen in 2020 should also be viewed in the context of this being the first year of the Covid-19 pandemic, which led to significant changes in society which were mainly reversed the following year as the lockdowns eased. The annual reduction target of 12.6% per annum is therefore likely to be more difficult than portrayed here.

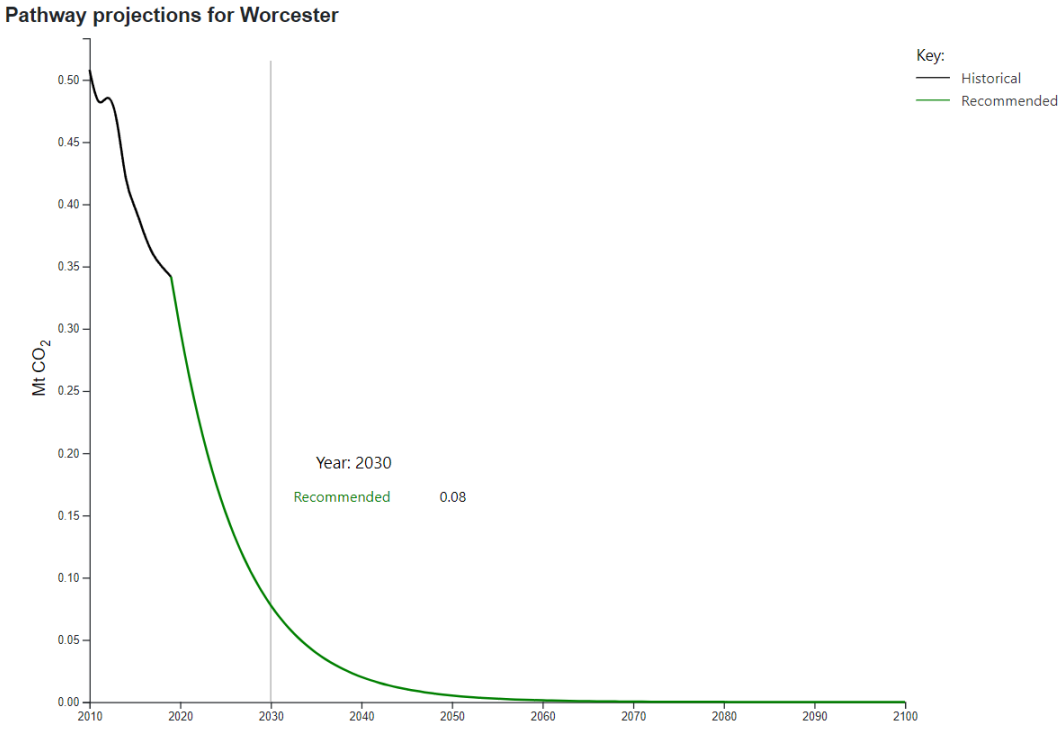


Figure 4. Pathway projections for Worcester from the carbon budget report

The Government publishes Energy and Emission Projections, with the latest projections being published covering the period 2021-2040. These projections take into account the policies which have been introduced or announced.

This graph is taken from the projections, showing the gap in policies to reduce emissions to the national carbon budgets:

Figure 2.2: Projected performance against carbon budgets under EEP-ready policies, $MtCO_2e$

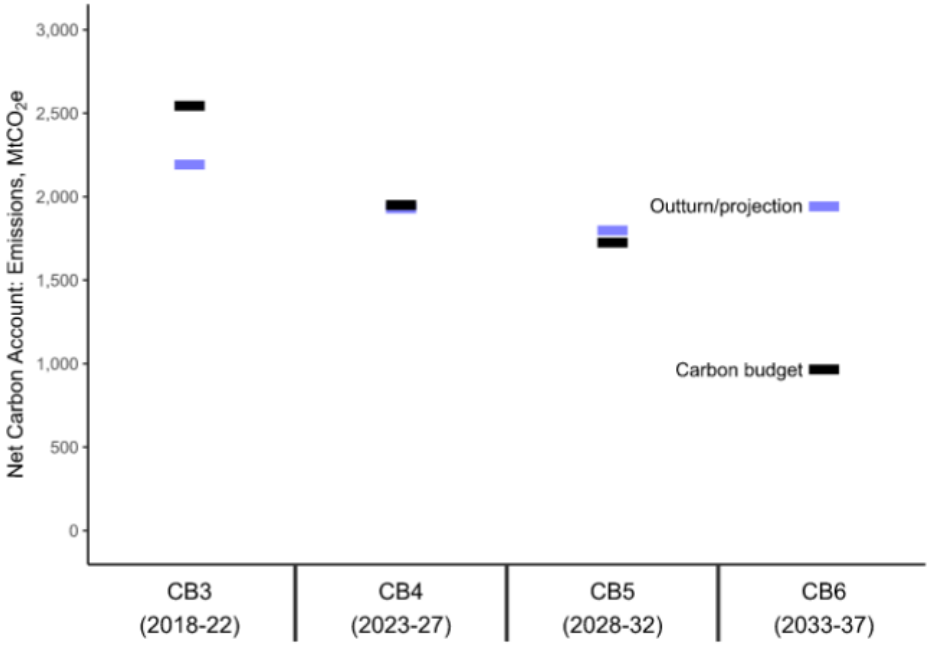


Figure 5. Government's national projected performance against carbon budgets (only approved and funded projects)

9. Per Capita emissions

Emissions per person resident in Worcester have fallen from 6.5tCO2e per annum to 3tCO2e per annum, between 2005 to 2020.

10. Potential emissions reduction pathways

This section uses information and graphs produced by the SCATTER tool. SCATTER stands for Setting City Area Targets and Trajectories for Emissions Reduction. SCATTER is a local authority focussed emissions tool, built to help

create low-carbon local authorities. SCATTER was funded by the (previously named) Department for Business Energy and Industrial Strategy (BEIS) in collaboration with Nottingham City Council, GMCA, the Anthesis Group and the Tyndall Centre.

The inventory of greenhouse gas emissions which the SCATTER tool uses is slightly different to that published by central Government, including different sources of emissions.

The differences are fairly immaterial in relation to the scale of the emissions profiles.

The SCATTER tool allows authorities to understand the impact of certain changes across the local authority area on the greenhouse gas emissions. This can aid understanding of the scale and type of changes which will be required in order for carbon neutrality to be achieved.

Potential emission reduction pathways are explored in this section.

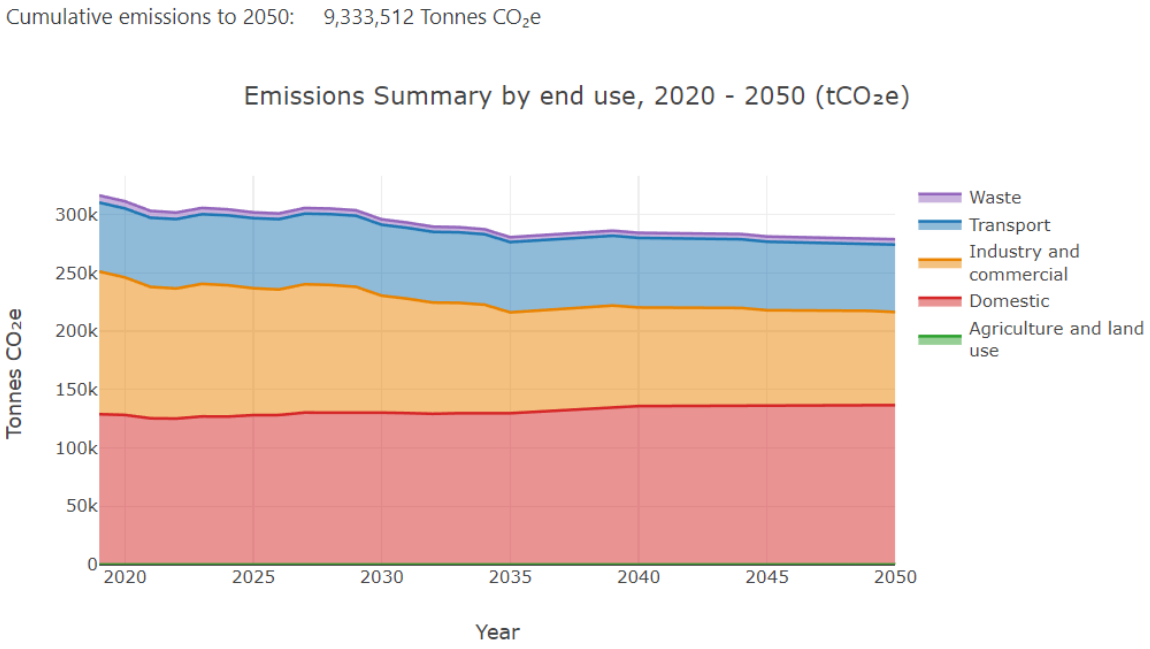
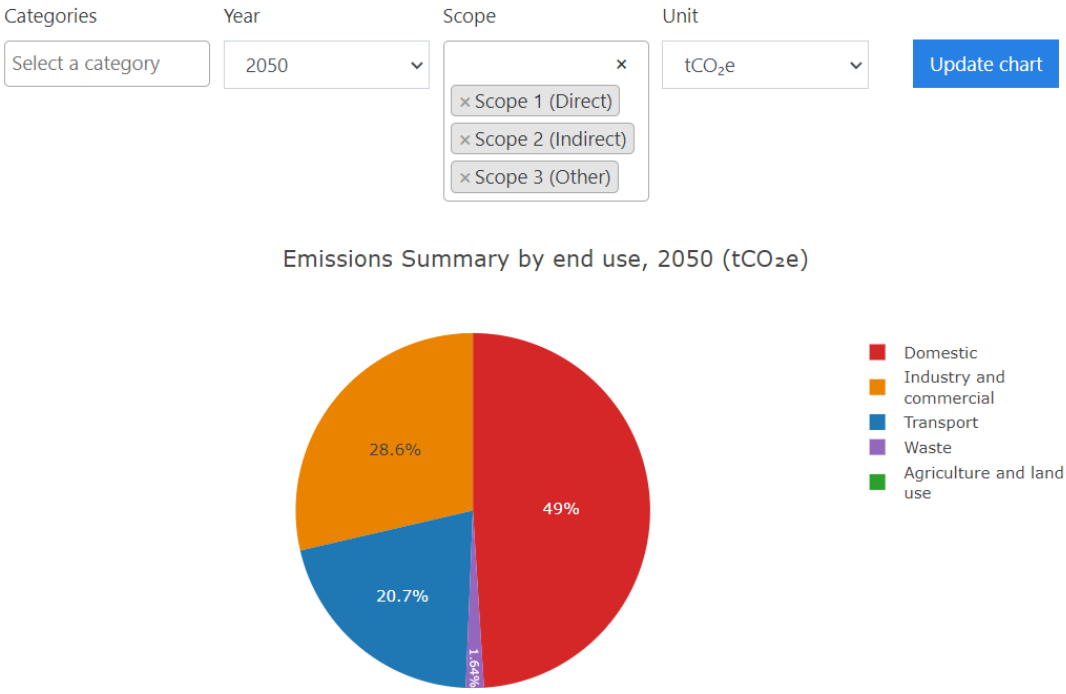


Figure 6. Emissions summary 2020-2050



The graph and pie chart above show the projected emissions in 2050 without any of the interventions, according to the SCATTER tool.

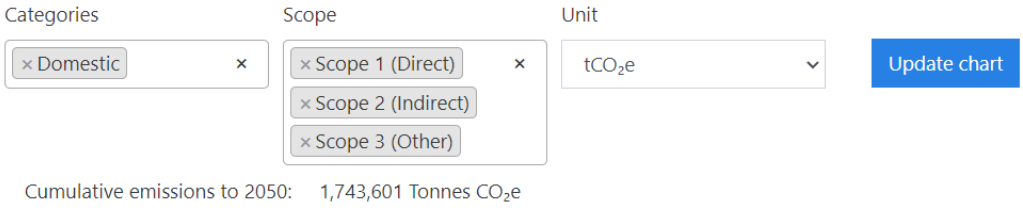
Domestic emissions

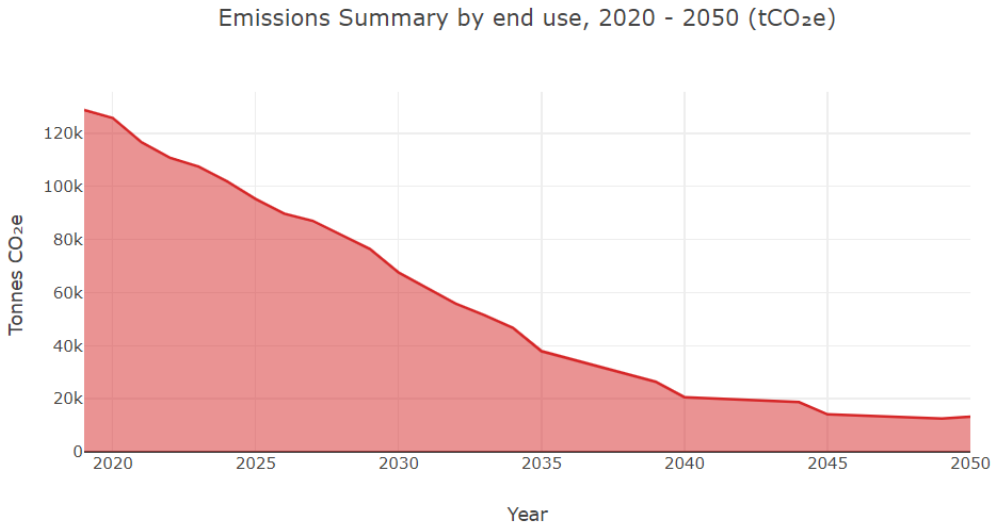
SCATTER outlines the following possible changes to domestic energy demand:

- Solar PV - 2500kWh generated per household in 2030, 5200 in 2050, from a baseline of 400kWh per household
- Demand for lighting and appliances to drop to 27% of current levels by 2050.
- 100% electrification of cooking by 2050.
- Hot water demand reduces by 8% every 5 years.
- All new build properties built to Passivhaus standards.
- Insulation - 80% of properties to have a deep retrofit by 2050, 10% retrofitted to medium level.
- Heating sources - by 2050, 7% resistive heating, 60% air source heat pumps, 30% ground source heat pumps, 3% district heating

In reality, the current level of energy generated from domestic solar PV in Worcester is around 132kWh per household (1,431 solar PV installations on households, out of a total of 39,300 households. Average 4kW system per house (national data), would generate average 10kWh per day, 3650kWh per year. Currently therefore per household total of 132kWh).

Result of the changes outlined above gives the following reduction:



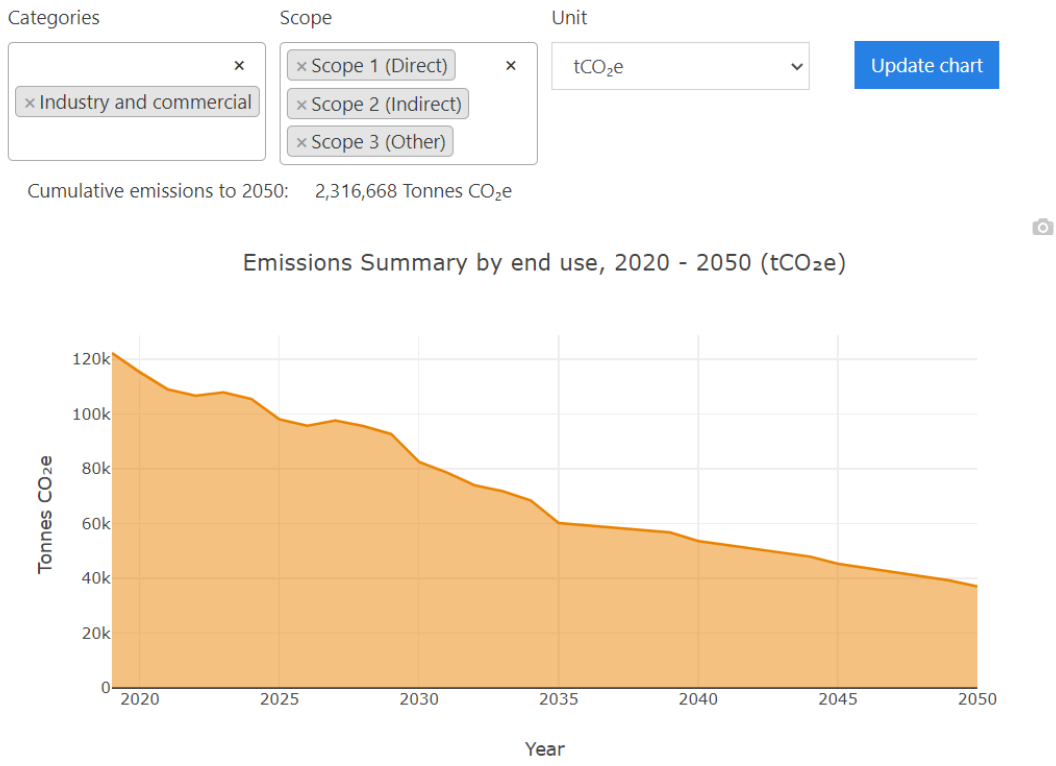


Industrial and commerical emissions

SCATTER outlines the following possible changes to industrial and commercial energy demand by 2050:

- Commercial heating, cooling and hot water demand is 60% of today's levels
- 60% of heating from air source heat pumps, 30% from ground source and the rest district heating
- Lighting and appliance demand decreases by 25%
- 100% of commercial cooking is electrified
- Industrial electrical consumption is 50% of total industrial energy demand by 2030, 60% by 2050. Output falls by 2% every year for non-heavy industry.
- Process emissions are reduced, by 4.5% every year from general industry.

Result of the changes outlined above gives the following reduction:

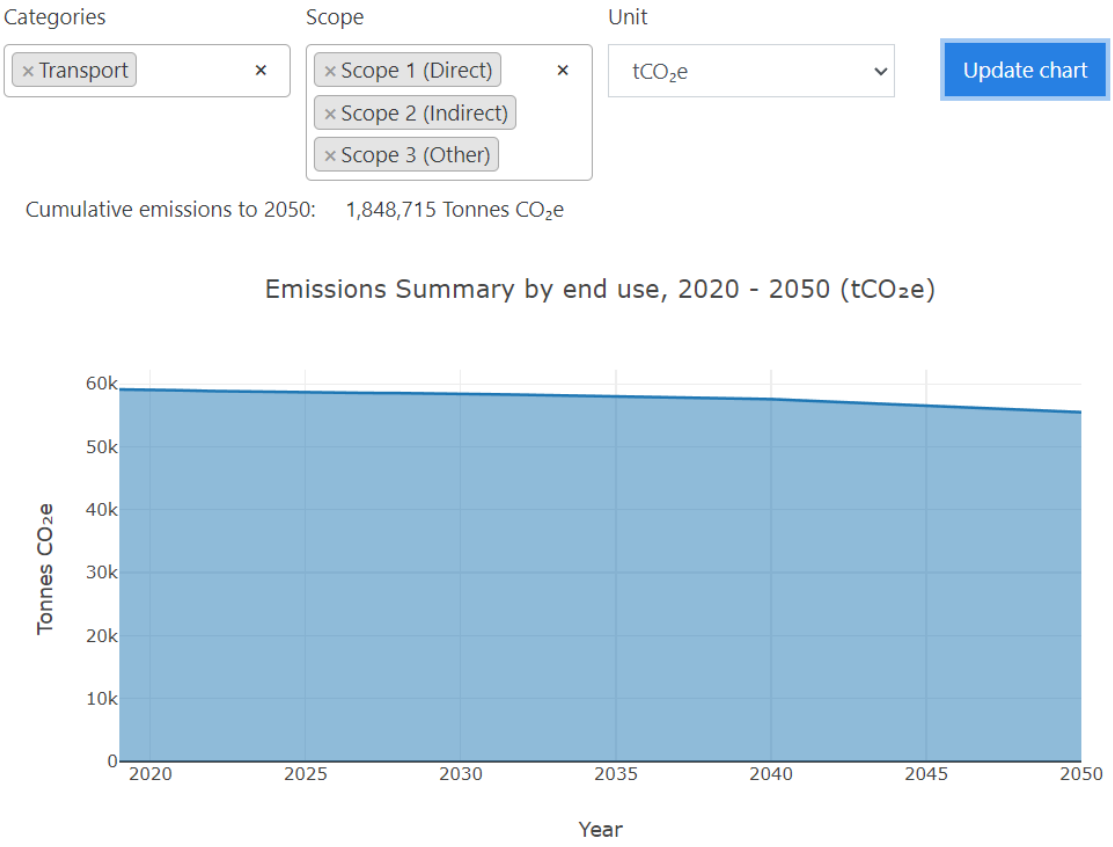


Transport emissions

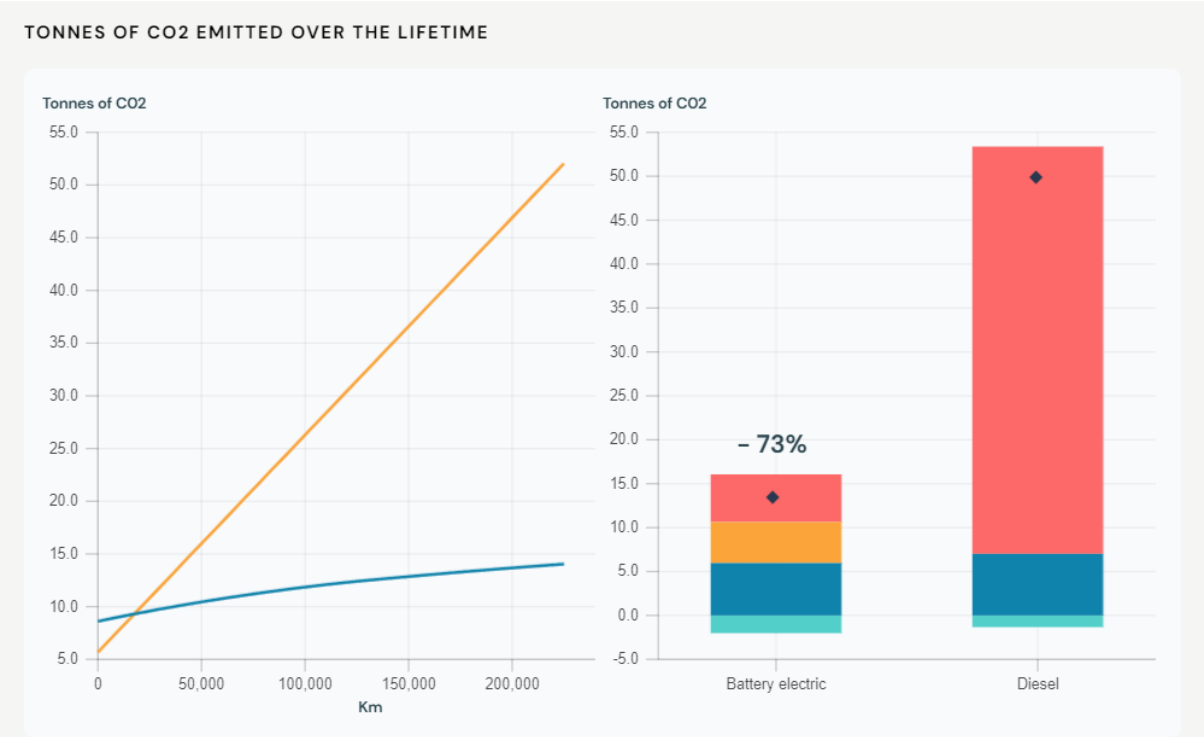
SCATTER outlines the following possible changes to transport by 2050:

- Cars and buses are 100% electric by 2035, rail is 100% electric by 2030. Average occupancies increase to 18 people per bus km (from 12), 1.65 people per car-km (up from 1.56), and 0.42 people per rail-km (from 0.32).
- Average modal share of cars, vans and motorbikes decreases from current national average 74% total miles to 38% in 2050.
- 22% decrease in distance travelled by road freight; 75% increase in efficiency. In waterborne transportation, 28 %increase in fuel use.
- 25% reduction in total distance travelled per individual per year by 2030.

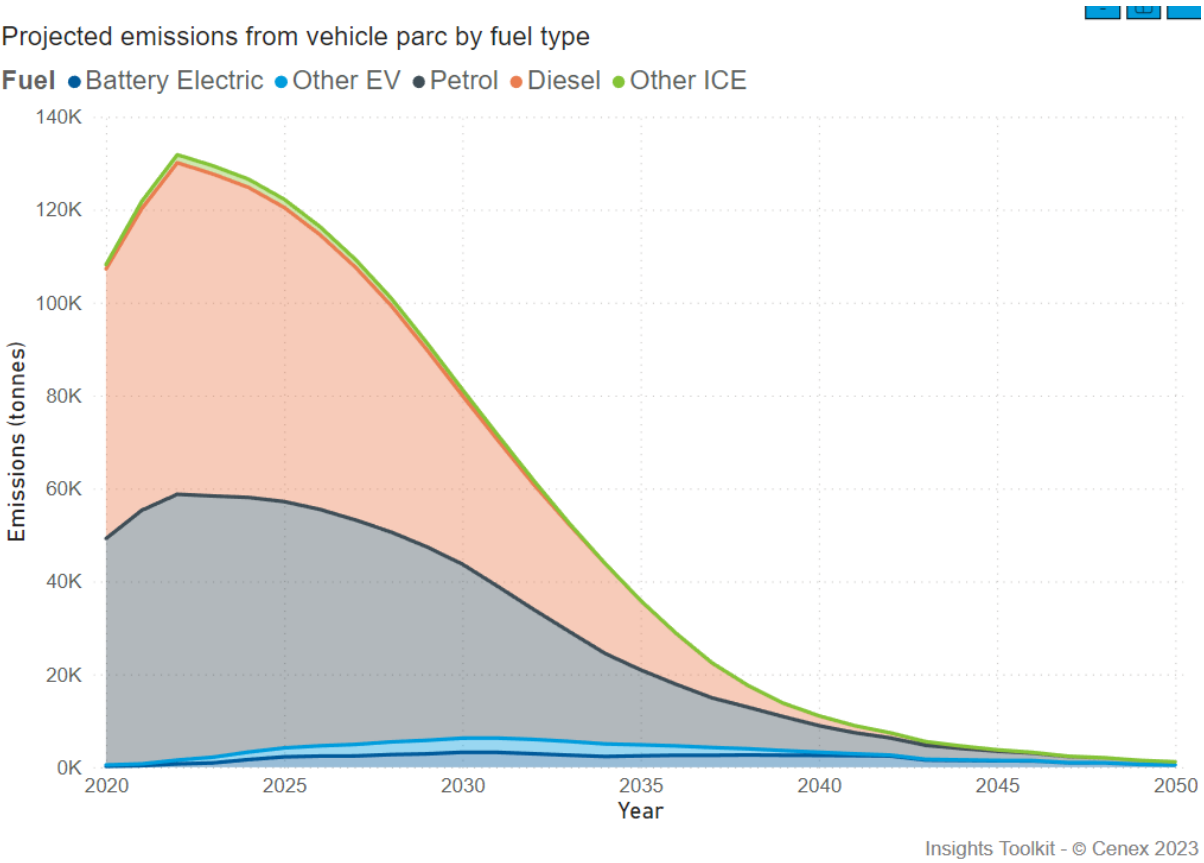
Result of the changes outlined above gives the following reduction:



Note. It is not yet understood why the emissions do not show a significant fall with the interventions outlined. It may be there is an error with the tool. This is being investigated and the graph provided above should be created with caution.



Graphs from [How much CO2 can electric cars really save? (transportenvironment.org)]


Projected emissions from vehicle parc by fuel type
Fuel
Battery Electric
Other EV
Petrol
Diesel
Other ICE
140K
120K
100K
80K
60K
40K
20K
0K
Emissions (tonnes)
2020
2025
2030
2035
2040
2045
2050
Year
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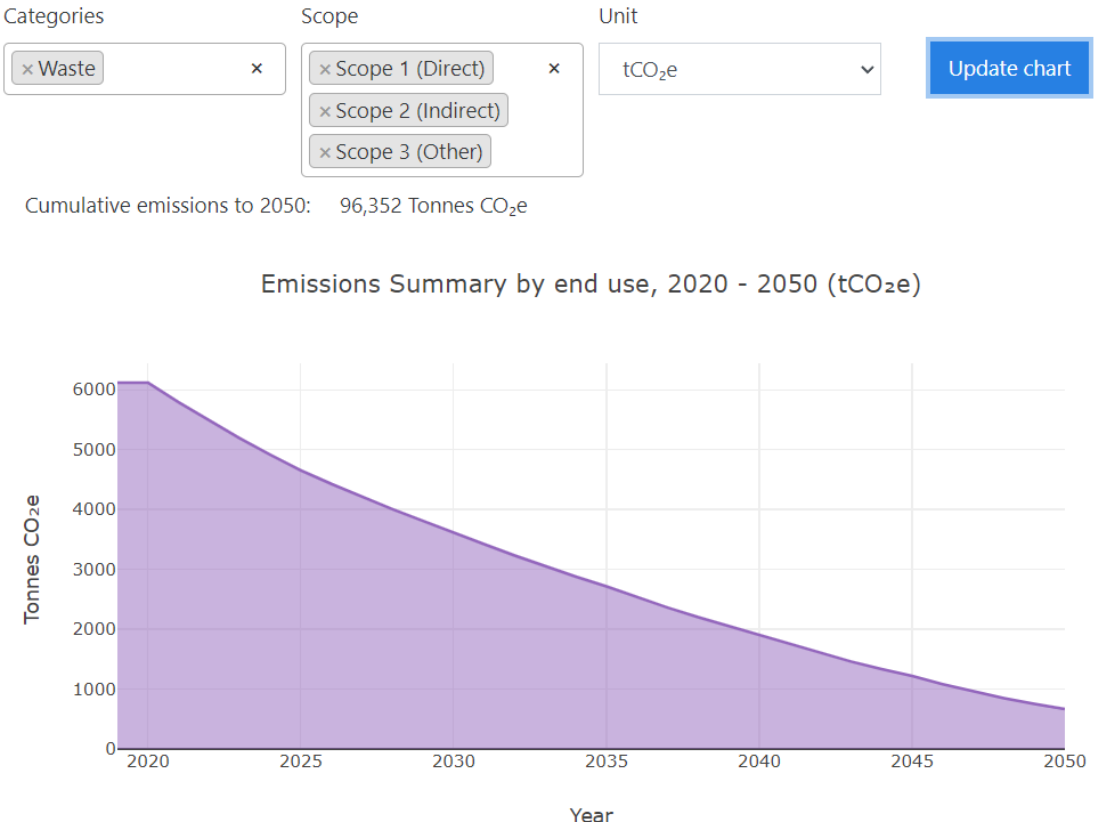
Waste emissions

SCATTER outlines the following possible changes to the rates of recycling and volume of waste by 2050:

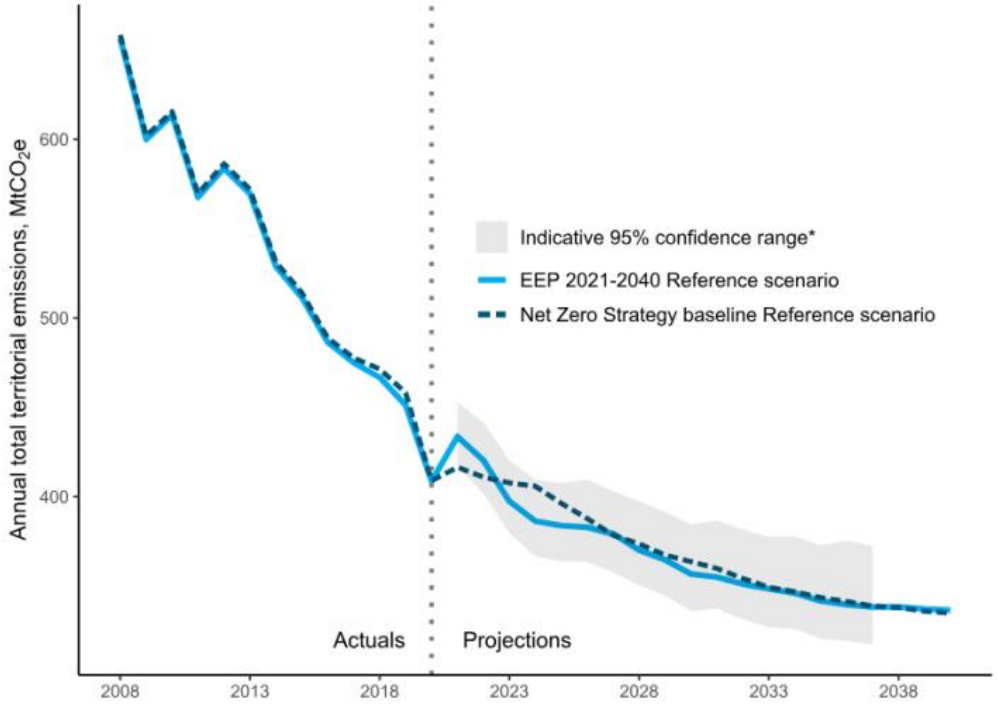
- 65% recycling, 10% landfill, 25% incineration achieved by 2035, recycling rates increasing to 85% by 2050
- Total volume of waste is 61% of 2017 levels by 2040.

Result of the changes outlined above gives the following reduction:



11. National projections – energy and emission projections

Figure 2.1: Uncertainty in UK projected territorial emissions (excluding IAS), $MtCO_2e$



Notes:
*- * The uncertainty ranges are indicative and are based on modelling from EEP 2018. The chart includes LULUCF*

From the UK energy and emissions projections 2021-2040 report:

The UK has domestic targets for reducing greenhouse gas emissions under the Climate Change Act 2008 (CCA). In June 2019, the CCA was amended to commit the UK to achieving a 100% reduction in net emissions by 2050 (Net Zero). The UK met the first (2008-12) and second (2013-17) carbon budgets. A final statement for the third carbon budget, covering the period 2018-22, will be published in May 2024. The latest carbon budget to be set is the sixth carbon budget covering the period 2033 to 2037. Performance against carbon budget targets is assessed by comparing the budget level against a metric called the UK "Net Carbon Account" (NCA).

It is projected the UK will meet the third carbon budget with headroom of 352 MtCO2e. Following that, it is projected there will be headroom of 20 MtCO2e in the fourth carbon budget under EEP-ready policies, and shortfalls of 73 and 976 MtCO2e in the fifth and sixth carbon budgets respectively. Projections of

performance under EEP-ready policies has improved slightly in all carbon budget periods. The NCA metric used to assess performance against targets includes IAS (international aviation and shipping) in the sixth carbon budget but not in earlier carbon budgets. Therefore, projected NCA emissions are higher in CB6 than in CB5.

Figure 4.1 shows our projections of generation by technology for all power producers up to 2040:

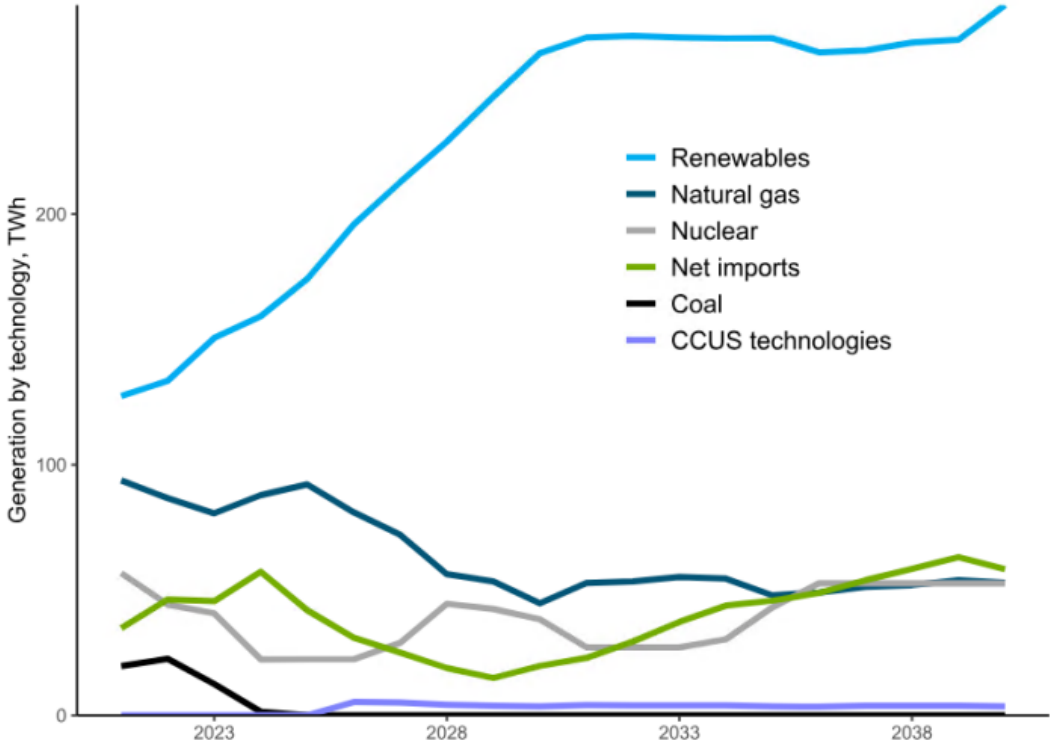


Figure 4.1: Electricity generation by fuel source, TWh

We project emissions from electricity production will fall steadily as generation switches away from fossil fuels (annexes B and C).

We project that the low carbon share of UK electricity generation will rise from 59% in 2020 to 87% in 2040, accounting for EEP-ready electricity supply policies. This is the proportion of all generation from renewables, nuclear or Carbon Capture and Storage (CCS) power producers.

They are also consistent with the Government's commitment to have all electricity by 2035 come from low carbon sources, subject to security of supply

Based on whole system modelling, power sector emissions may need to drop by 72 – 75% by 2030 (NDC), 83% by 2035 (CB6), and 98% by 2050 (Net Zero) relative to 2021 levels. In addition, the UK has an existing additional ambition to decarbonise the power sector by 2035, subject to security of supply. This would result in total emissions of around 1 MtCO2e by 2050. These scenarios have been constructed such that emissions are within these ranges for each of these years whilst ensuring that security of supply is met.

Table 2.1: Comparison of emissions figures across carbon budget periods, $MtCO_2e$ and per cent

		Carbon budget			
		CB3 (2018 -22)	**CB4 (2023 -27)**	**CB5 (2028 -32)**	**CB6 (2033 -37)**
Average annual required reduction vs. base emissions	%	-38%	-52%	-58%	-77%
EEP Net Zero Strategy baseline					
Territorial emissions exc. IAS	projected emissions, $MtCO_2e$	2,166	1,976	1,819	1,720
Territorial emissions inc. IAS	projected emissions, $MtCO_2e$	2,353	2,197	2,058	1,962
EEP 2021-2040					
Territorial emissions exc. IAS	projected emissions, $MtCO_2e$	2,181	1,930	1,798	1,714
Territorial emissions inc. IAS	projected emissions, $MtCO_2e$	2,354	2,152	2,024	1,941
Net Carbon Account [2]	projected emissions, $MtCO_2e$	2,192	1,930	1,798	1,941
Result vs. Budget with reference scenario	emissions, $MtCO_2e$	-352	-20	73	976
Projected average annual reduction vs. base emissions [3]	%	*-46%*	*-53%*	*-56%*	*-54%*