

Briefing

A pathway to 'net zero' greenhouse gas emissions

In a nutshell

Climate change is already causing great harm, and unless decisive and rapid action is taken much greater levels of harm will occur. The Paris Agreement requires the world to reach 'net zero' greenhouse gas emissions within the second half of the century, with wealthier developed countries reaching this goal earlier. This briefing illustrates that UK could reach 'net zero' by 2045 or earlier, and it makes policy recommendations. But more important than the date for 'net zero' is minimising cumulative emissions on the pathway. It is cumulative emissions that matter most and it was this logic that led to the Climate Change Act and its ground-breaking five yearly carbon budgets.

Executive Summary

The human cost of climate change is becoming more apparent every year as hurricanes, typhoons and floods batter parts of the world while other parts of the world suffer from record-breaking droughts and heatwaves. The changing climate is also slowly degrading the ecosystems upon which humans depend. For example, it won't take much more warming before coral reefs around the world are lost forever, robbing future generations of the chance to wonder at their beauty but more pressingly starving around a billion people of an important source of protein.

We cannot undo the climate change we are already suffering from. But we can prevent it from getting much worse. The Paris Agreement on Climate Change represents the best of humankind coming together in a shared endeavour to address a shared challenge. It was a solemn promise to those most vulnerable across the world and to future generations that politicians across the political spectrum and across the world will take their responsibilities seriously. It committed the world to 'net zero' greenhouse emissions "in the second-half of this century". The current UK government can rightfully take pride in its role in securing this agreement.

The UK has a history of international leadership on climate change. The Climate Change Act agreed ten years ago was a world first. The UK has cut its emissions by much more than any other G7 country at the same time as its economy has grown more as well. But right now according to the Committee on Climate Change there is a 'policy gap' that means that the UK is not on course to meet the legally binding fourth and fifth 'carbon budgets'. In any case the measure of success in climate change is not whether the UK is doing more than others but whether it is doing enough. It is clear that more must be done here in the UK and elsewhere.

This paper provides one pathway for the UK to achieve 'net zero' greenhouse gas emissions. It builds on the sectorial scenarios developed by the Committee on Climate Change for the fifth carbon budget, while taking into account more recent developments in technologies such as electric cars and also research more recently published into negative emissions (removing carbon pollution from the atmosphere). It suggests that the UK as a whole may be able to - with ambitious policies, fair wind and and political leadership - achieve 'net zero' by 2045 or even earlier¹.

Achieving 'net zero' by 2045 or earlier would be an achievement to be proud of, but more important is minimising the cumulative emissions on the pathway to this target. This is because it is cumulative emissions that matter most and it was this logic that led to the Climate Change Act and its ground-breaking five yearly carbon budgets.

It order to constrain cumulative emissions and be on-track for net zero Friends of the Earth is calling for the government to announce before the end of the year that it will:

¹ Parts of the UK should be able to achieve 'net zero' earlier. Friends of the Earth Scotland is calling for Scotland to set a target for 'net zero' by 2040 in the Scottish Climate Bill. Scotland already has out-performed the rest of UK on emissions reductions and has large potential for both more renewable energy and absorbing more carbon through forestry and land-use changes

- **Bring forward the date for phasing out the sale of petrol and diesel cars and vans to 2030.**
- **Begin to provide householders with capital grants to enable them to install insulation and low carbon heating, as part of an area by area coordinated action plan.**
- **Put in place funding mechanisms to double the area of land forested, in order to take carbon pollution out of the atmosphere and provide space for nature.**
- **Speed-up and significantly increase the scale of deployment of renewable power.**
- **Ensure the 2019 Spending Review, longer-term infrastructure plans, and other relevant financial mechanisms are focused on the need to deliver on climate change obligations.**
- **Request the Committee on Climate Change to provide advice on the changes needed to carbon budgets and long-term targets as a result of the Paris Agreement, recognising the UK's relative wealth and the need for fairness to poorer countries and future generations.**

Rapid action on climate change will bolster the economy and improve people's wellbeing. It will:

- **Improve our health** - our cities and towns will be transformed and will resemble places such as Copenhagen and Amsterdam which provide good quality living environments, with high quality public transport, cycling and walking facilities. Our air quality will improve considerably and traffic noise will be significantly reduced, all with very positive consequences for public health.
- **Ensure that everybody has a warm home** – well insulated homes heated by electricity and hydrogen provided by the UK's vast renewable energy resources.
- **Put the UK at the forefront of the industries of the future** – through supporting existing industry to be low carbon and building the low carbon industries of the future, such as off-shore wind, electric vehicles and low carbon heating.
- **Benefit wildlife** – through doubling the size of the UK's forests and transforming farming to provide us with the healthy (low meat & dairy) diets we need we also create space for nature and contribute to reducing the levels of greenhouse gases in the atmosphere.
- **Reduce our dependency on energy imports** - the UK powered by a home-grown renewables industry, providing jobs and clean energy at affordable prices for homes, heating, transport and industry.

The Paris Agreement represents the bold and necessary international response to a climate change challenge that left unchecked would devastate the lives of many of the poorest in the world and significantly harm the well-being of future generations for hundreds of years. It also represents a huge opportunity for healthier lives, jobs for the future, and more nature. Politicians can and must take decisive and swift action.

The pathway to 'net zero' greenhouse gas emissions

Background

As an organisation that lobbied for the 1.5 climate change threshold at the Paris climate talks and was instrumental in getting the precedent-setting Climate Change Act into UK law, Friends of the Earth is concerned that the UK government is not yet taking the ambitious or far-reaching action to reduce UK carbon in line with what is required to meet these targets. Friends of the Earth believes that we can achieve this level of emissions reduction given political will as long as we make the right decisions now to put the UK on the road to 'net zero'. This paper plots the pathway to net zero, and summarises key policy recommendations.

The UK currently has a greenhouse gas emissions reduction target of 80% by 2050, based on 1990 emission levels. This was agreed overwhelmingly by politicians of all political parties ten years ago as they passed the Climate Change Act, following a four year campaign by Friends of the Earth and many others.

The Act led to the formation of the Committee on Climate Change (CCC) one of whose jobs was to advise on the pathway to the 2050 target by setting 5 year 'carbon budgets'. The Committee has identified budgets in line with a roughly 50% chance of avoiding two degrees of global warming. It also worked on the basis of average UK per capita emissions being the same as the global average by 2050. This approach is one of the equity approaches identified by the International Panel on Climate Change, but it is also recognised as one of the weakest as it doesn't take into consideration historical emissions and capability (the UK being one of the wealthiest countries in the world). The choice of which approach to equity to use in setting carbon budgets has a very significant impact on the size of UK carbon budgets.

Since the passing of the Climate Change Act national governments have come together globally under the auspices of the UNFCCC to agree the Paris Agreement. This sets the ambition of " *Holding the increase in the global average temperature to **well below 2 °C** above pre-industrial levels and **pursuing efforts to limit the temperature increase to 1.5 °C** above pre-industrial levels (emphasis added)*". This means that the current UK carbon budgets need to be tightened to be in line with this higher level of ambition. The greater ambition at Paris was inspired by the realisation of human suffering caused already by only one degree of global warming and the likely impacts of future warming. It was also the realisation that a range of tipping points (e.g. irreversible loss of coral reefs) occur at relatively low levels of warming and that the previous adoption of two degrees as the threshold to 'dangerous climate change' was too high.

To contribute a fair share of emissions cuts to deliver on the Paris Agreement, the UK must tighten its carbon emissions to 'net zero' before 2050. The earlier the date before 2050 the more equitable the outcome. Friends of the Earth is of the view that net zero 2045 is possible and necessary.

Net zero recognises that some emissions cannot easily be altogether eliminated (e.g. in agriculture, aviation and some industries) but these can be offset by removing carbon from the atmosphere through 'negative emissions' e.g. land-use approaches such as afforestation, or technological approaches such as 'direct air capture'.

Overview of pathway

The pathway below is based on Friends of the Earth's analysis and judgements using research published by the Committee on Climate Change and others (see 'sources'). It will be updated and much more detail added once the government publishes its forthcoming carbon pathway calculator (The MacKay Calculator).

The UK has made reasonable progress in cutting emissions since 1990, and much better than many other nations. Much of this has been due to decarbonisation of electricity production. Industry has also seen large reductions, although sadly much of this has been as a result of manufacturing moving overseas. But transport has flat-lined and the heating of homes and businesses has only seen small reductions. These are the two big 'problem' sectors which require significant action if the Climate Change Act is to be delivered and deeper cuts made to honour the Paris Agreement. Achieving the necessary cuts in these 'problem' sectors will require the continued decarbonisation of electricity and greater levels of clean electricity production.

Table 1 below identifies the size of emissions reductions required in each sector according to our pathway, and the challenges this brings. Graph 1 illustrates the scale of emissions reductions needed in each sector. In addition to these changes negative emissions from land-use change and using new technologies will be needed (see Box 1)

Graph 1 – Reductions required in each sector.

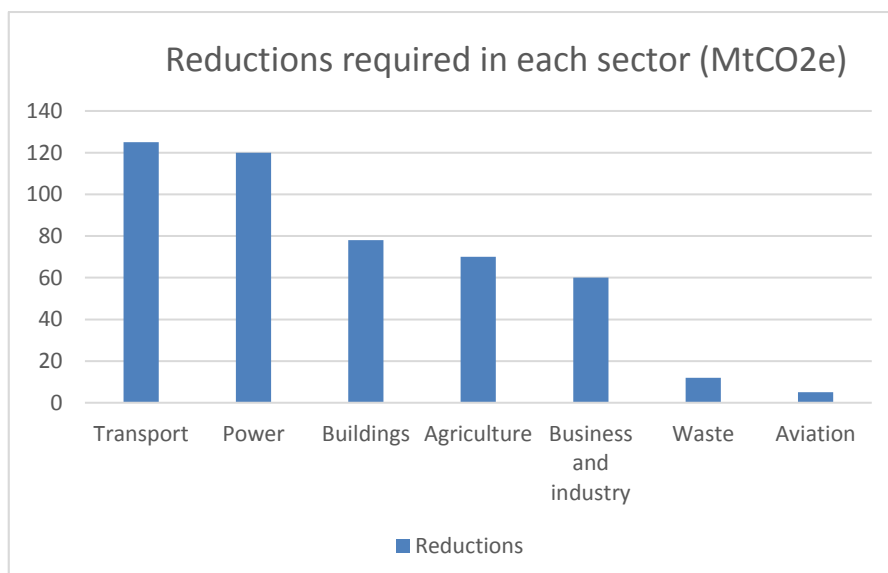


Table 1 – Overview of scale and challenges in sector (in order of scale of reductions)

Sector	Emissions reduction required	Challenges
Transport (excl. aviation)	125 MtCO ₂ e (from 125 MtCO ₂ e to zero by 2050)	<ul style="list-style-type: none"> • Need much faster transition to electric vehicles • Dept. for Transport promoting massive road-building programme, with strong lobby in support • Poor investment in sustainable urban transport, and bus services declining • Resistance from motor manufacturing sector • Behaviour change (cars to public transport) difficult
Power	120 MtCO ₂ e (from 120 MtCO ₂ e to zero by 2050)	<ul style="list-style-type: none"> • Carbon price floor under threat post Brexit • Need further 'contracts for difference' auctions funded to provide pipeline of faster and much greater growth (particularly off-shore wind)
Buildings (residential and public)	78 MtCO ₂ e (from 78 MtCO ₂ e to zero by 2040)	<ul style="list-style-type: none"> • Predominately space heating – very costly and disruptive to switch from natural gas to electric with hydrogen playing a supporting role. Needs to be infrastructure priority. • Big fight on whether hydrogen should be produced via renewable power or natural/unconventional gas
Agriculture and land-use	70 MtCO ₂ e (from 30 MtCO ₂ e to minus 40 MtCO ₂ e by 2050)	<ul style="list-style-type: none"> • Land-use change (afforestation, agroforestry, etc.) is needed to provide 'negative emissions' to offset remaining agriculture emissions plus recalcitrant emissions from industry and aviation. This in turn will require very significant dietary change to healthy low meat and dairy diets (behaviour change is not easy).

		<ul style="list-style-type: none"> • Post Brexit agriculture policy uncertain. Need for soil carbon, agroforestry and afforestation to be central to how farmers are funded, but likely to be strongly opposed by vested interests with different agenda.
Business and Industry	<p>60 MtCO₂e</p> <p>(from 92 MtCO₂e to 32 MtCO₂e by 2050)</p>	<ul style="list-style-type: none"> • Carbon price floor under threat, particularly but not only under 'no deal' Brexit due to competition concerns • Post Brexit pressure will be to slow down progress
Waste	<p>12 MtCO₂e</p> <p>(from 20 MtCO₂e to 8 MtCO₂e by 2050)</p>	<ul style="list-style-type: none"> • No significant challenges except money for increased recycling (e.g. separate food waste collections) in order to be able to ban biodegradable waste going to landfill.
Aviation and shipping	<p>3-5 MtCO₂e (from 42.6 MtCO₂e at present, and high growth forecast for 2050 at 44 MtCO₂e, to <40 MtCO₂e)</p>	<ul style="list-style-type: none"> • Aviation has no viable alternative fuel supply at scale. The industry is promoting the use of 50% biofuels by 2050 but this brings land-use conflict issues (e.g. impacts on food and nature). • This emissions reduction requires no new capacity (i.e. reversing the Heathrow decision). • Reducing emissions even further through further constraining passenger growth or even reducing passenger numbers would require fiscal measures (e.g. fuel tax, frequent flier levy) which are seen as politically challenging.

Box 1 - Negative emissions

Achieving 'net zero' emissions requires emissions that cannot easily be altogether eliminated (e.g. in agriculture, aviation and some industries) to be offset by removing carbon from the atmosphere through 'negative emissions'.

A report published in September 2018 by the Royal Society and the Royal Academy of Engineering suggests a UK scenario of 130 MtCO₂ removal by 2050¹. An analysis for Friends of the Earth suggests a *maximum* potential in the UK of around 80 MtCO₂ by 2050 from land-use change plus much greater levels of Direct Air Capture (160 MtCO₂). Achieving these rates would require an aggressive development programme. It should be recognised that at a cost of around \$100-200 per tonne it is also much more expensive than mitigation.

Both the analysis for Friends of the Earth and the Royal Society report are able to match the remaining emissions in the Committee on Climate Change 'max scenario', which has 131 MtCO_{2e} remaining in 2050. The pathway in this briefing has around 110 MtCO_{2e} remaining in 2050. Friends of the Earth is of the view that more rapid action on mitigation than recommended in the CCC max scenario – e.g. through a faster switch to electric vehicles – together with real effort on negative emissions would enable the UK to be net zero by 2045.

130MtCO₂ or more is a very sizable amount of carbon and demonstrates that developing negative emissions is as big a scale challenge as reducing emissions in sectors such as buildings, power and transport.

Policy priorities

Over coming pages we outline the main emissions reduction options for all the main sectors. There are many and varied policies that need to be put in place to deliver 'net zero'. However not all are equal and below we list our 6 key policy recommendations:

1. **Bring forward the date for phasing out the sale of petrol and diesel cars and vans to 2030.** Ensuring that the only new cars and vans that can be sold by this date are pure battery and long-range hybrids. Switching rapidly to electric vehicles will deliver the lion's share of cuts needed in the transport sector, which is now the largest source of greenhouse gas emissions in the UK.
2. **Begin to provide householders with capital grants to enable them to install insulation and low carbon heating, as part of an area by area coordinated action plan.** It is necessary to rapidly begin the process of switching heating from natural gas to predominately electricity in order to deliver on the existing climate change legal requirements. An area-by-area programme over the next three decades that combines whole house retrofits, including energy efficiency, and funded by capital grants is necessary. This needs to be a priority for infrastructure spending over coming years and decades and will cost many £10s billions. Decisions on whether this transition needs to be supported by a hydrogen gas grid should not hold-up the roll out of this programme. If a hydrogen gas grid is necessary then the hydrogen should be produced using renewable energy (electrolysis). Attempts to give the gas

industry a lifeline through using natural gas or unconventional gas to produce hydrogen should be rejected as incompatible with even existing carbon budgets.

3. **Put in place funding mechanisms to double the area of land forested.** The Agriculture Bill should ensure that farmers contribute to 'negative emissions' through enhancing carbon in soils, expanding agroforestry and doubling the area of the UK covered in forests. Other mechanisms, such as policy support for sustainable diets and reducing food waste, will also be required to complement this action.
4. **Ensure the 2019 Spending Review, longer-term infrastructure plans, and other relevant financial mechanisms are focused on the need to deliver on climate change obligations.** There are urgent calls on the limited infrastructure investment budget, such as transforming the heating sector, boosting renewables, electric car charging, Carbon Capture and Storage (CCS), smart electricity grids and storage, urban transport, and waste. Infrastructure spending on the roads building programme and the HS2 project with its vastly escalating costs should cease. As the government's Green Finance Taskforce report says, delivering the low carbon economy "will require unprecedented levels of investment". The Green Finance Taskforce makes a range of important recommendations (from issuing a Sovereign Green Bond to Green Growth Regeneration Zones). In addition it will be necessary to maintain the Carbon Price Floor (CPF) and increase it.
5. **Speed-up and significantly increase the scale of deployment of renewable power** by committing to further rounds of 'contract for difference' auctions for both mature renewable technologies (such as solar and on-shore wind) and less mature technologies (such as off-shore wind). Complement this by removing the barriers to deployment for on-shore wind and solar farms.
6. **Request the Committee on Climate Change to provide advice on the changes needed to carbon budgets and long-term targets as a result of the Paris Agreement, recognising the UK's relative wealth and the need for fairness to poorer countries and future generations.** The Committee on Climate Change has an incredibly important role in recommending carbon budgets, suggesting policy approaches and holding the government to account through regular reports to Parliament.

Sector descriptions

<p>TRANSPORT (excluding aviation & shipping)</p>																	
<p style="text-align: center;">Surface transport emissions (MtCO₂e)</p> <table border="1"> <caption>Surface transport emissions (MtCO₂e)</caption> <thead> <tr> <th>Year</th> <th>Emissions (MtCO₂e)</th> </tr> </thead> <tbody> <tr> <td>1990</td> <td>125</td> </tr> <tr> <td>1995</td> <td>128</td> </tr> <tr> <td>2000</td> <td>132</td> </tr> <tr> <td>2005</td> <td>135</td> </tr> <tr> <td>2010</td> <td>120</td> </tr> <tr> <td>2015</td> <td>120</td> </tr> <tr> <td>2017</td> <td>120</td> </tr> </tbody> </table> <p>Emissions – 1990 to 2017</p>	Year	Emissions (MtCO ₂ e)	1990	125	1995	128	2000	132	2005	135	2010	120	2015	120	2017	120	<p>Approx. date for zero: Possibly 2050</p> <p>The Committee on Climate Change’s ‘max scenario’, which reaches 97% emissions reductions by 2050, has surface transport at 5 MtCO₂e at 2050 compared to 120 MtCO₂e today (excluding domestic aviation and shipping). In other words a 96% reduction by 2050. The residual emissions at this date are largely some HGVs and buses not yet electric or hydrogen. They also state that ‘near zero’ could be achieved by 2055-2060.²</p> <p>The development and innovation in electric and hydrogen vehicles could perhaps mean that surface transport could now be zero by 2050, although further research would be needed.</p>
Year	Emissions (MtCO ₂ e)																
1990	125																
1995	128																
2000	132																
2005	135																
2010	120																
2015	120																
2017	120																
<p>Main actions (incl. what to stop doing):</p> <p>Emissions from surface transport have flat-lined since 1990 and the sector is significantly off-track from the reductions in emissions required, with a very significant policy gap for future emissions reductions. Meanwhile the Department for Transport (DfT) is embarking on the biggest roads spending programme since the 1970s and Highways England aims to develop some existing roads into ‘express ways’ that they say will “feel like motorways”. It is well established that new roads induce further travel. This roads programme will therefore increase emissions.</p> <p>The CCC ‘max scenario’ has 100% of cars and vans being electric vehicles (EVs) by 2050, 95% of buses low-carbon (half H₂, half EV). 50% of HGVs use H₂, 40% are EVs. The CCC has criticised the recent DfT ‘Road to Zero’ strategy for not being consistent with even the Climate Change Act decarbonisation targets (80% reduction by 2050). The CCC is particularly critical of the 2040 target for all new cars and vans to be zero carbon. It says that the target should be brought forward to 2035 and restricted to only pure battery electric vehicles and long range plug in hybrids. An earlier date would better enable the CCC ‘max scenario’ to be achieved and also recognise the speed of innovation and falling costs of EVs.</p>																	

The CCC scenarios identify that the vast bulk in reductions from transport will be through cleaner vehicles (70% of reductions to 2030) with modal shift playing a necessary supporting role (10% reduction to 2030).

Main actions required:

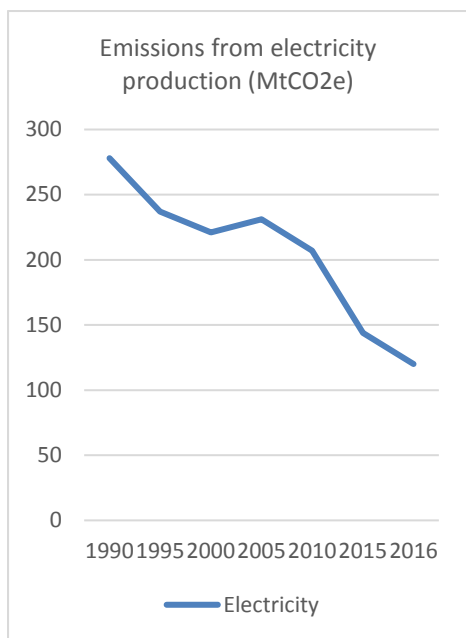
- Bring forward the deadline for all new cars and vans to be zero carbon to 2030, and support this with the rapid deployment of electric charging and economic incentives (e.g. reducing company car tax for EVs).
- As recommended by the National Infrastructure Commission³ invest at least £43 billion in transport urban areas with a strong focus on public transport, walking and cycling. Devolve powers and budgets to city and urban leaders. This money should come in part from scrapping much of the existing roads programme.

Vision in a nutshell:

Our cities and towns will be transformed and will resemble places such as Copenhagen and Amsterdam which provide good quality and improving public transport, cycling and walking. When we do drive cars they will be zero carbon. Our air quality will improve considerably and traffic noise will be significantly reduced, all with very positive consequences for public health.

Note Friends of the Earth will publish detailed research later this year on the changes needed to transform our urban transport.

POWER



Graph of emissions – 1990 to 2016

Approx. date for zero: 2050

The emissions from the sector are a success story for the UK but with much more to do to build on the 65% reduction in emissions from electricity supply since 1990 despite per capita increase in use.

The CCC 'max scenario' has this almost totally decarbonised by 2050 (99% reduction from 1990 levels). It may be possible to fully decarbonise this sector earlier even though it will need to expand considerably to provide all the energy needs for heating and transportation and much of industry. This will require significant action on energy storage.

Main actions (incl. what to stop doing):

The falling costs of renewable energy (solar, onshore and offshore wind) aided by financial support mechanisms and coupled with the carbon price floor, has seen the use of coal plummet by 90% and the use of gas in electricity production also decline, albeit still accounting for 40%. Maintaining the shift to renewable electricity while simultaneously rapidly increasing the production of electricity for heating and transport is the challenge ahead, as is dealing with intermittency issues (including seasonal storage).

The CCC has highlighted that the government needs to issue further 'contracts for difference' for what they call mature renewable energy (on-shore wind and solar). Given the low prices and the cost of fossil or nuclear based alternatives these can be considered subsidy free. It has also said that barriers to building on-shore wind need to be addressed. Friends of the Earth believes there is also large potential for decentralised solar power too.

The CCC has welcomed recent announcements by government that they will hold 'contracts for difference' auctions for Pot 2 'less mature' technologies in 2019 and every two years after that (although funding for post 2019 auctions have not been announced), which the government says will bring an additional 1-2 GW of off-shore wind to market each year in the 2020s. But Friends of the Earth believes much greater levels of off-shore wind are required to deliver 100% renewable energy powered electricity, heating and transport. The amount of additional renewable electricity

generation needed to decarbonise is around eight-times the current level whereas the government's (and CCC trajectories) are much slower.

The gas industry, as well as pushing for a lifeline through heating, is trying to keep its foot in the door of electricity production for use as a back-up to renewable energy, but alternative storage options are a more low carbon route, although the development of multi-day and inter-seasonal storage needs greatly increased investment and innovation. (Hydrogen is one attractive route).

Main actions:

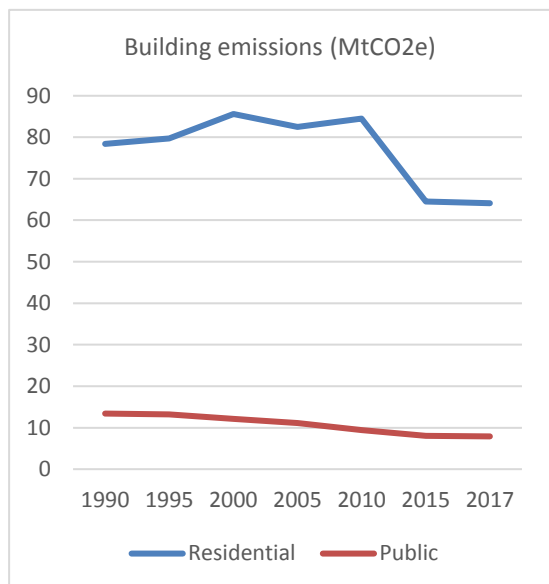
- Maintain and increase the carbon price floor.
- Provide a route to market and enable communities to say 'yes' to onshore wind by reforming the National Planning Policy Framework.
- Increase the investment through 'Contracts for Difference' for Pot 2 'less mature' technologies to increase off-shore wind capacity by at least 4GW per year in the 2020s and 2030s.
- Commit to biannual 'contracts for difference' for mature technologies such as solar and on-shore wind (Pot 1).
- Support the development of a renewable energy to hydrogen pathway for storage and use in heating.
- Provide a mechanism to allow the rapid development of decentralised rooftop solar power, and reverse proposed changes in the feed-in tariff that threatens the viability of roof-top solar and solar farms.

Vision in a nutshell:

The UK powered by a home-grown renewables industry, providing jobs and clean energy at affordable prices for homes, heating, transport and industry.

BUILDINGS (residential, commercial and public)

Graph of emissions – 1990 to 2017



Approx. date for zero: 2040

Nearly all the emissions in this sector are from the use of natural gas in heating (electricity use is captured in the 'power sector').

The CCC 'max scenario' has this sector reducing to 4 MtCO2e by 2050, a cut of 95% from current levels, and zero at 2055-70. This sector is particularly expensive to decarbonise fully.

There has been some limited progress in cutting emissions from this sector, for example through more efficient boilers. But only 22% reductions compared to 57% across all sectors (excluding international aviation and shipping).

An earlier net zero date is practically possible but will require a step-change in government action.

Main actions (incl. what to stop doing)

This sector requires a shift from natural gas in heating to predominately either electricity or hydrogen that is produced by renewable energy via electrolysis of water. The CCC max scenario doesn't reach zero by 2050 because it still has natural gas in use (10% domestic, 40% non-domestic). This will require changes to appliances in every home as well as changes to networks (electricity and gas). This is a very significant undertaking and will require very significant investment.

The gas industry is seeking to continue to use natural gas in heating, albeit transformed to hydrogen via steam methane reformation combined with carbon capture and storage. Research for the government shows that this approach is not compatible with the reduction in cumulative reductions required to meet the Climate Change Act⁴.

Friends of the Earth's recent work in this area recommended an area-by-area approach that delivers funded all-house upgrades to change heating appliances and install insulation. In the CCC's 'max scenario' just over half of the reductions in this sector are projected to come from changing the heat supply from natural gas and just

under half from insulation measures. As in other sectors behavioural measures are also a factor.

There are expected to be 5 million new homes by 2035 and while this only represents about 15% of total house numbers at that date not building these to be zero carbon with renewable energy generation on site (including heat pumps) would be a missed opportunity, and would undermine low carbon actions elsewhere.

Main actions required:

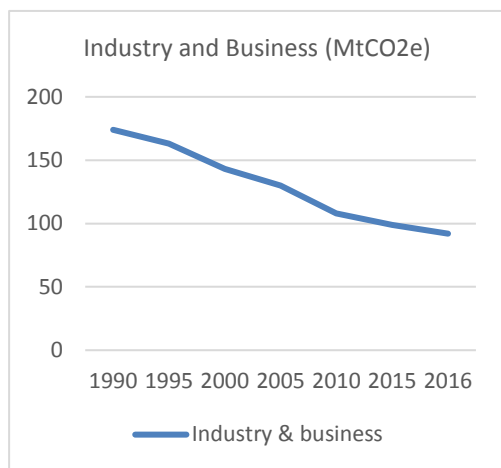
- Provide householders with capital grants that cover the full cost of replacing their natural gas heating through reform of the Renewable Heat Incentive, and include in this funding for insulation.
- Pilot at scale an area-by-area heating transformation programme.
- Reject the continued use of natural gas in heating through hydrogen production and instead kick-start a renewable energy to hydrogen industry.
- Ensure minimum energy efficiency standards for the private rented sector are enforced and strengthened, and explore mechanisms for extending these standards to the private sector.
- Ensure that all new homes and buildings are Zero Carbon and contain integrated renewable technologies where possible.

Vision in a nutshell:

Warm homes powered by the UK exploiting its vast renewable energy resources to provide electricity and produce hydrogen. Imports of natural gas and the use of natural gas in heating will have ceased.

BUSINESS & INDUSTRY

Graph of emissions – 1990 to 2016



Approx. date for zero: none, CCC 'max scenario' envisages 32MtCO2e residual emissions from this sector by 2050.

There have been very substantial emissions from this sector since 1990 although much of this has come from industries relocating outside of the UK or closing down. There is scope for further emissions reductions but in internationally competitive sectors these need to be supported to ensure industries don't become uncompetitive. Some reduction strategies may provide competitive advantages, e.g. through reduced energy costs.

Main actions (incl. what to stop doing)

This sector is very diverse so a wide range of actions are needed.

Manufacturing combustion is the largest source of emissions in this sector. The development of carbon capture and storage is seen as critical in this sector to enable it to decarbonise. However progress in developing this technology has stalled in the UK. Biomass as a feedstock to replace fossil fuels is also promoted within this sector by the CCC. Electrification is possible for some sectors (e.g. glass and ceramics) but not all industries. Hydrogen may have a significant role in the future according to the CCC.

The CCC 'max scenario' sees energy efficiency and, bioenergy as equally important in reducing emissions with electrification playing a much smaller role.

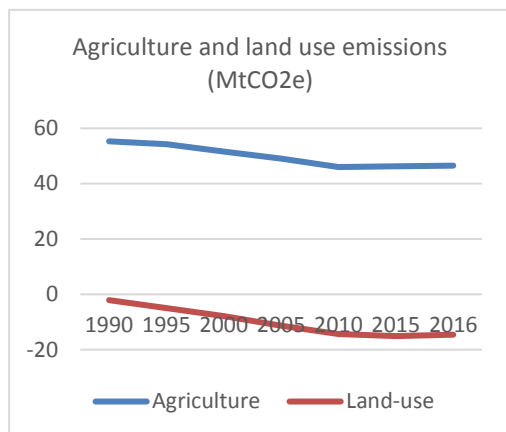
The latest CCC progress report identifies an urgent need to develop CCS. It also highlights the uncertainty created by leaving the EU as much of this sector is within the EU Emissions Trading Scheme (ETS). The Chequers EU Withdrawal Plan has the UK remaining in the ETS, but 'no deal' would see the UK crashing out of it. The CCC says that leaving the EU should not reduce the economic incentive for industry to invest. Some Conservatives, industry and consumer groups are calling for the carbon price floor to be scrapped (e.g. Iain Duncan-Smith, Engineering Employers Federation, and Consumers' Association)⁵. These voices are likely to be given more hearing post Brexit as the economy comes under increasing pressure.

Vision in a nutshell:

UK industry that has been supported to remain in the UK and leading the world in decarbonisation of industry.

AGRICULTURE & LAND USE

Graph of emissions – 1990 to 2016



Approx. date for zero: By 2035-2040

Agricultural emissions have reduced slightly but have scope to reduce further and to be more than offset through negative emissions.

The CCC has suggested emissions from agriculture could be slightly reduced to 45.3 MtCO2e by 2030 with scope for further unquantified emissions reductions later.

An analysis for Friends of the Earth has estimated that around 80 MtCO2e could be removed through land-use change. This is roughly the same as the CCC 'max scenario', which includes a total of 67 MtCO2e reductions.

Main actions (incl. what to stop doing)

Emissions from agriculture are dominated by the non-CO2 emissions of methane from livestock production and nitrous oxide from fertilisation of soils. This sector is one of the smaller contributors to the UK's overall greenhouse gas emissions at 10 per cent but reductions will still be necessary on the journey to net zero.

Some reductions in these emissions can be achieved through better farm management (e.g. manure planning, on-farm anaerobic digestion, increased soil carbon, and potentially changing the diets of livestock). The CCC says that incentives beyond advice will be necessary to achieve these outcomes and demand-side measures are also required. The Climate Coalition is calling for agriculture emissions to be net zero by 2050, including through afforestation, better soil management and changes in diet driving reduced livestock numbers.

The greatest contribution this sector can achieve is through its contributing to the level of negative emissions, as suggested within the CCC max scenario. Achieving this will require, amongst other measures, significant amounts of land to be converted to quality wildlife-rich forests and agro-forestry. In addition dietary changes and reductions in food waste will free-up more land to use for negative emissions. Legal changes to allow more food waste to be used as pig feed should also be explored.

Note that bioenergy can lead to greater emissions than even some fossil fuels unless the bioenergy sources are well-managed, and can also damage wildlife and impact on land-rights. Bioenergy should be UK based and well-managed.

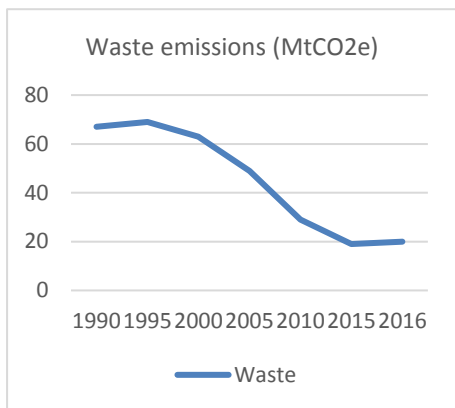
In considering changes in UK land use, it is important to avoid the exporting of emissions to other countries – e.g. through increased food imports. It is also important that the sequestration potential of low intensity pasture-based grazing systems is fully understood, as these systems can be more beneficial in terms of overall greenhouse gas emissions than more intensive systems.

Vision in a nutshell:

Agriculture that provides us with the healthy low meat and dairy diets we need while also contributing to reducing the levels of greenhouse gases in the atmosphere, enhancing nature and supporting rural livelihoods. A greener UK that has double the forests for people and wildlife.

WASTE

Graph of emissions – 1990 to 2016



Approx. date for zero: after 2050.

This sector is a very small part of total UK emissions. Much of the emissions from waste occurs from the production of methane in landfill sites from biodegradable wastes (food, paper, etc.), although this has reduced by three-quarters since 1990 due to better capture and reduced waste.

The CCC provide a reduction figure of 8 MtCO2e by 2050, although suggest this is a likely overestimate due to lack of data on waste-water treatment.

Main actions (incl. what to stop doing):

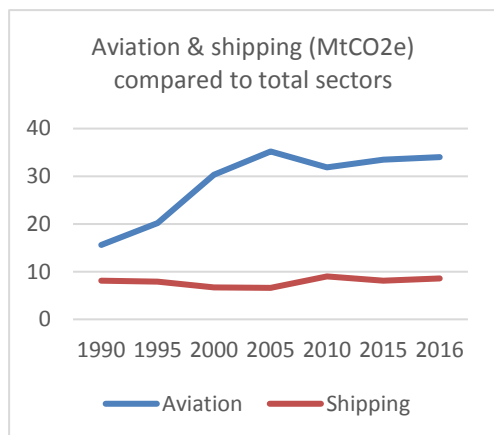
The most significant action in this area is diverting waste from landfill (e.g. recycling of paper and textiles; composting or anaerobic digestion of food waste). The CCC suggest the banning of most biodegradable waste to landfill by 2025. They applaud the more ambitious targets and policies in Scotland and Wales. Binding targets to halve UK food waste from farm to fork by 2030 should also be set.

Vision in a nutshell:

All waste minimised and reused or recycled as part of a circular economy.

INTERNATIONAL AVIATION AND SHIPPING

Graph of emissions – 1990 to 2016



Approx. date for zero: none, target emissions for aviation to be at least <32MtCO2e by 2050 and <5 for shipping (the CCC 'max ambition scenario').

International aviation and shipping represent only a small portion of the UK's total carbon budget (<10%) but it is a growing source of emissions (80% increase since 1990). It is also a sector which is difficult to decarbonise. Growth in passenger numbers and km travelled are outstripping efficiency gains. The more other sectors decarbonise the more aviation in particular will be seen to be being allowed to expand unsustainably.

The CCC central carbon budget allocations for 2050, based on an 80% reduction, allows for emissions from these sectors to be the same as in 2005. This represents an increase in the share of the carbon budget from 2% in 1990 to 25% of a much smaller carbon budget in 2050. They suggest this allows for a 60% growth in demand, with increased number of fliers more than offset by a 0.8% annual improvement in fuel efficiency and 10% use of biofuels.

The CCC have written to the DfT to express concern that its recent Airports National Policy Statement neglected to consider climate change.

Main actions (incl. what to stop doing):

Aviation growth demand is strong (roughly 4% increase per year), and the DfT forecasts of passenger numbers ranges from 410-495 million in 2050. These forecasts represent a 50-85% increase from the current level. Currently around 20% of passengers are frequent fliers (more than one return flight per year) and account for two-thirds of all flights taken. While most of these people are wealthy (top 2 deciles of income) not all are.

The aviation industry is banking on “sustainable biofuels” as a future energy source (with a target of 50% of fuel to be biofuel by 2050), and has agreed an offsetting programme. Both biofuels and offsetting have very significant drawbacks. Biofuels compete for land with food and other biomass uses, as well as in many cases having significant greenhouse impacts. Offsetting rarely achieves emissions reductions that wouldn't or shouldn't happen anyway. Electric planes are also being promoted, although these are likely to be short-haul only and carrying small numbers of passengers.

Although international shipping emissions have not grown since 1990 there is also a relatively few options for decarbonising this sector. Switching from dirty bunker fuels would increase costs which the industry will oppose.

The CCC carbon budget requires passenger growth at the lower end of the DfT forecasts. The lower end is a 'constrained' forecast where airport capacity is limited. With deeper reductions in emissions required to deliver on the Paris Agreement a tighter constraint is likely to be required. Sadly the government has just given the go-ahead to expand Heathrow.

Main actions:

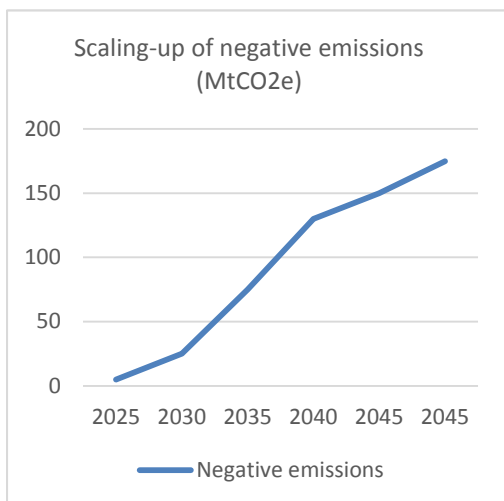
- Reverse the decision to allow Heathrow to expand.
- Introduce measures to constrain the growth of passengers across the UK, such as frequent flier levy, use of fuel taxes and limits on the use of airports (numbers of flights/timing of flights).
- Support to make alternative modes of travel more affordable than aviation and more attractive is needed, including affordable long distance train travel and comfortable and high-speed Wi-Fi enabled work stations on trains. The CCC suggests aiming these types of measures at shifting the choices of air passengers who are often able to absorb higher taxes or levies on aviation prices.

Vision in a nutshell:

Travel abroad by train and boat is more affordable and attractive than flying, with flying rarely used but its use available to a broad set of people and not limited to the wealthier.

NEGATIVE EMISSIONS

Possible scale-up of negative emissions



Approx. date for zero: n/a

Already land-use delivers some negative emissions in the UK (see agriculture and land-use sector) but further negative emissions are needed, at least in line with the CCC 'max scenario' of around 70MtCO2 by 2050.

In addition to this, other approaches, particularly 'direct air capture', are also needed to enable the UK to be 'net zero' and move to be 'net negative'. The Royal Society and Royal Academy of Engineering have suggested that the total basket of negative emissions approaches could remove around 130 MtCO2 from the atmosphere each year by 2050 (this is the same as the quantity of recalcitrant emissions in the CCC 'max scenario'). Research for Friends of the Earth suggests that with real effort and focus much greater levels are possible, particularly 'direct air capture' which would enable the UK to be net zero by 2045 or earlier.

Main actions (incl. what to stop doing)

Negative emissions through approaches other than land-use change are likely to be very expensive and much more expensive than most mitigation options (e.g. costs of >\$100-\$200 per tonne of CO2). However it is now widely accepted that negative emissions are needed to meet the Paris Agreement goal. Direct Air Capture – chemically capturing carbon dioxide from the atmosphere – requires carbon capture and storage (which is also needed for industry). Direct Air Capture is likely to be by far the biggest source of future negative emissions.

Vision in a nutshell:

Negative emissions are enabling the drawdown of carbon pollution in the atmosphere to return it to safe levels.

SOURCES

BEIS and National Statistics, 2018, 2016 UK Greenhouse Gas Emissions, final figures; and 2017 UK Greenhouse Gas Emissions, provisional figures

HM Government, 2017, Clean Growth Strategy (amended April 2018)

Committee on Climate Change, 2015, Sectoral Scenarios for the Fifth Carbon Budget
<https://www.theccc.org.uk/wp-content/uploads/2015/11/Sectoral-scenarios-for-the-fifth-carbon-budget-Committee-on-Climate-Change.pdf>

Royal Society Greenhouse gas removal, September 2018, <https://royalsociety.org/topics-policy/projects/greenhouse-gas-removal/>

Committee on Climate Change, 2016, *UK climate action following the Paris Agreement*,
<https://www.theccc.org.uk/wp-content/uploads/2016/10/UK-climate-action-following-the-Paris-Agreement-Committee-on-Climate-Change-October-2016.pdf>

National Infrastructure Commission, 2018, National Infrastructure Assessment,
https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf

Element Energy, 2018, Cost analysis of future heat infrastructure, National Infrastructure Commission.

Friends of the Earth, 2018, Delivering on the Paris Agreement - The future of home heating,
<https://cdn.friendsoftheearth.uk/sites/default/files/downloads/Future-of-Heating-August-2018.pdf>

House of Commons Library, 2018, Carbon Price Floor and the price support mechanism, briefing 05927, 8 January 2018

McLaren, 2018, Negative Emissions – fig-leaf or future, Friends of the Earth