

# Keeping global warming to 1.5°C

## Challenges and opportunities for the UK

### Introduction

*The Intergovernmental Panel on Climate Change (IPCC) special report on the impacts of global warming of 1.5°C* outlines the advantages of limiting the rise in average global temperature to 1.5°C above pre-industrial levels, and the pathways needed to achieve this. Whilst this requires major and widespread action within the next decade, it could avoid many damaging impacts. This briefing provides a summary of the IPCC's findings and what these mean for the UK, identifying what UK policymakers can do now, both in terms of UK policy and globally, to enable the UK to play its role in limiting warming to as close as possible to 1.5°C.



© mrtom-uk.

# Limiting global warming to 1.5°C: why and how

## Why a 1.5°C target?

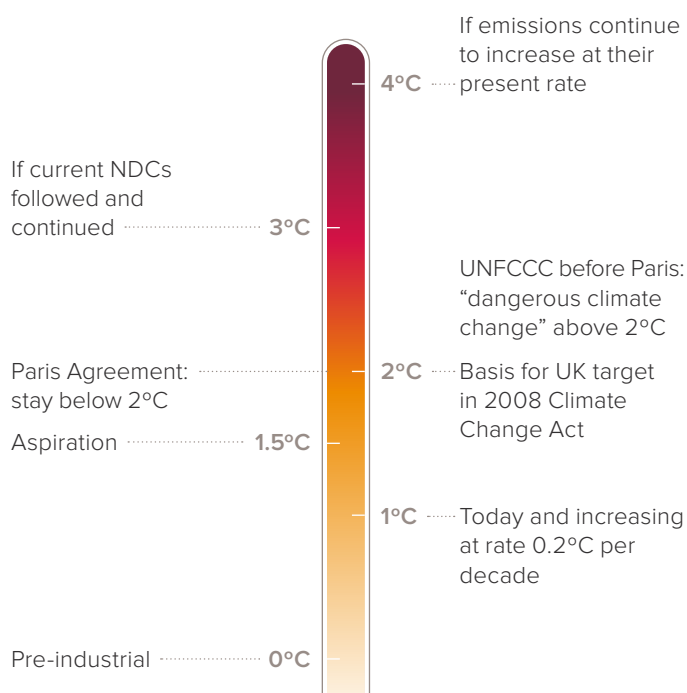
As global temperatures increase, the negative impacts of climate change on people and the environment become more severe and adaptation becomes harder, costlier, and in some cases, impossible.

For many years, the countries meeting under the United Nations Framework Convention on Climate Change (UNFCCC) considered 2°C to be the level of warming above which 'dangerous' climate change would occur (see figure).

However, concerns have increased about the impacts of climate change – both those already apparent and those expected at 2°C, including the effect of sea-level rise on low-lying island states. These led governments to sign the Paris Agreement in 2015 to set a goal of holding warming to "well below 2°C" and pursue efforts to limit it to 1.5°C (see figure).

**FIGURE – Global temperatures and targets**

Overview of past, current and likely future global temperatures and temperature targets depending on what level of action is taken to reduce emissions.



## Where we are – impacts and prospects

Human activity has increased atmospheric carbon dioxide (CO<sub>2</sub>) concentration by more than 40% since pre-industrial times. This, and increases in other greenhouse gases, such as nitrous oxide, has led so far to a global average temperature rise of 1°C above pre-industrial levels, with much greater warming in some regions, particularly the Arctic. Global temperatures are currently rising at about 0.2°C per decade.

This temperature increase is already having an impact. Sea levels are rising and this will continue for many centuries. Warming has contributed to more frequent and more intense extreme weather events such as heat waves and heavy rainfall. This trend is expected to continue, with impacts becoming progressively more severe as temperature increases.

The current projected path for global emissions, taking account of the emission reductions volunteered by countries under the Paris Agreement – called nationally determined contributions (NDCs) – is likely to result in global warming of about 3°C by 2100 (see figure).

If emissions continue to increase at their present rate, temperatures could rise by more than 4°C by 2100 (see figure).

Limiting global warming to 1.5°C may still be feasible. In the next decade urgent, ambitious and concerted action is required across all countries and sectors to deliver rapid emissions reductions, as well as removal of some greenhouse gas from the atmosphere.

## How global warming can be limited to 1.5°C

To achieve a 1.5°C target, the net emissions of long-lived greenhouse gases, principally CO<sub>2</sub>, would have to be reduced by up to 50% by 2030 on 2010 levels, and reach 'net-zero' level by around 2050<sup>1</sup>. For a 2°C limit, net-zero emissions need to be reached soon afterwards.

There would also need to be a reduction to a low level in the emissions of other greenhouse gases such as methane, and black carbon that remain in the atmosphere for shorter periods.

1. Emissions of CO<sub>2</sub> accumulate in the atmosphere on a century time-scale, so limiting global warming by CO<sub>2</sub> requires moving its emissions to net-zero (any sources balanced by sinks). There are other long-lived greenhouse gases, such as nitrous oxide, and it is the net emissions of all of them that has to be brought to zero. Because of the dominant importance of CO<sub>2</sub> emissions, this will be referred to, hereafter, as net-zero CO<sub>2</sub> emissions.

For this to happen, rapid and unprecedented changes in energy, land use, urban development, transport, infrastructure and industrial systems are needed. These include reducing demand for energy, particularly through improvements in energy efficiency but also through lifestyle choices which could have health benefits, such as dietary change or shifting transport modes to walking, cycling or mass-transit.

Emissions that are particularly difficult to reduce, such as from agriculture and aviation, are likely to have to be offset by the removal of CO<sub>2</sub> from the atmosphere (see pull-out box on CO<sub>2</sub> removal) to achieve the net-zero goal.

If NDCs are not significantly strengthened before 2030, stabilizing global warming at 1.5°C (or even 2°C) is not projected to be possible without 'overshoot' – temporarily exceeding the 1.5°C target – and would rely on very high, and perhaps unachievable, levels of carbon dioxide removal (CDR). Such an overshoot will increase the risk of irreversible change to natural and human systems such as the collapse of some ecosystems.

### Keeping global warming to 1.5°C reduces risks

Limiting global warming to 1.5°C, rather than 2°C or more, is projected to reduce the negative impacts of climate change in several ways, for example:

- at least 10 cm less average sea level rise by 2100 than for 2°C, with 10 million fewer people facing risks as a result;
- fewer droughts and floods;
- significantly less damage to ecosystems and biodiversity, including highly vulnerable coral reefs and polar regions;
- reduced impacts on human health from heat stress and vector-borne diseases;
- reduced tendency for conflict in severely affected regions and consequent increased migration pressures.

### Adaptation needs at 1.5°C and beyond

Most adaptation needs will be lower at 1.5°C compared to 2°C.

There are limits to the adaptive capacity of some human and natural systems even at 1.5°C and below. These include island states and coastal areas affected by sea level rise, where infrastructure, homes and land areas might have to be abandoned.

## BOX – The role of CO<sub>2</sub> removal<sup>2</sup>

**Even though carbon dioxide removal (CDR) is expected to be required to achieve the 1.5°C target, it cannot replace drastic emissions reductions, as large-scale CDR is both challenging and expensive.**

In addition to drastically reducing emissions across all sectors, each of the future energy scenarios examined by the IPCC to achieve the 1.5°C target relies on removing a significant amount of CO<sub>2</sub> from the atmosphere.

Studies reviewed by the IPCC assume this CDR would mainly be achieved by both changing land use to increase carbon absorption, for example by afforestation, and by the use of bioenergy with carbon capture and storage (BECCS) (burning biomass for power and capturing the carbon emissions).

Extensive use of biomass, with or without BECCS, would require very strong governance to ensure sustainability and low/negative CO<sub>2</sub> emissions, and to avoid competition for land between energy, food, and ecosystems.

Biological carbon storage methods, like afforestation, are likely to become saturated within a few decades, so research and development on sustainable CDR methods in the longer term is vital.

There are a number of other approaches to achieve CDR. Using a flexible, mixed, system of CDR methods could help to meet targets and lessen environmental stress related to overuse of a single approach.

If well managed, adaptation options that reduce the vulnerability of human and natural systems have many synergies with sustainable development, such as ensuring food and water security, reducing disaster risks, improving health, maintaining ecosystem services and reducing poverty and inequality.

### Limitations in knowledge

Limitations in knowledge of the climate system mean that it is not possible to specify emissions pathways that result in global temperature being exactly 1.5°C or 2°C. However, the general nature of these pathways, and in particular the need to reach zero CO<sub>2</sub> emissions within the next few decades, is known with confidence.

2. See Royal Society and Royal Academy of Engineering report *Greenhouse gas removal*.

# Implications of a 1.5°C target for UK policy

## The UK's track record on climate change

The 2008 Climate Change Act was world-leading: it put in place legally binding emissions reduction targets, and a framework for climate change mitigation and adaptation. Under the Act, the Committee on Climate Change was charged with advising on targets and carbon budgets, and monitoring progress.

The UK's domestic emissions have decreased by about 40% since 1990 levels, in large part due to a reduction in emissions from power generation. At the same time Gross Domestic Product has grown by around 70%.

However, the UK's emissions arising from its consumption of goods and services, including those associated with imports, remain significantly higher than 1997<sup>3</sup> levels, though they have fallen since 2007.

## Existing targets and progress

The UK's current 2050 target is to reduce emissions by at least 80% from 1990 levels. This long-term target was developed to enable the UK to contribute to the reduction in global emissions necessary to keep global warming to near 2°C (see figure).

The Committee on Climate Change's 2018 Progress Report concluded that the UK is not on course to meet its five-year carbon budgets<sup>4</sup> after 2022 and progress on reducing emissions from transport, buildings and agriculture are key concerns.

Shortly after the publication of the IPCC special report on 1.5°C, the UK Government has asked the Committee for analysis and advice on requirements for a UK ambition consistent with a global 1.5°C limit on warming.

## Opportunities for the UK in adopting a 1.5°C target

Demonstrating leadership in technologies that are required to reduce emissions and remove CO<sub>2</sub> from the atmosphere offers a range of strategic and commercial opportunities for the UK.

Such action could give a stimulus to sectors of the UK economy working on green growth, including wind and solar power, advanced batteries and energy storage, electric vehicles, hydrogen, carbon capture and storage, and CDR technologies. Industries based on these technologies are becoming an important and expanding component of the UK economy.

According to the Office for National Statistics, the low carbon and renewable energy sectors were already growing about 3 times faster than the wider economy in 2016.

## Keeping global warming to 1.5°C reduces UK risks

Limiting global warming to 1.5°C would reduce risks and related costs in the UK, for example from:

- river and surface water flooding from heavy rainfall, and coastal flooding and erosion from sea level rise;
- higher temperatures, including effects on wellbeing;
- water shortages;
- impacts on the natural environment such as further declines in native wildlife, decreased soil quality, reduced traditional fish stocks;
- spread of invasive pests and diseases.

In addition, climate change impacts elsewhere could negatively affect UK trade and food supply and increase migration as a result of displacement and conflict in severely affected regions.

---

3. The first year for which official figures are available.

4. A carbon budget is the cumulative amount of CO<sub>2</sub> emissions permitted over a period of time.

# How the UK can help limit global warming to 1.5°C

## Reducing greenhouse gas emissions

Consistent with the UK's leadership role in climate change mitigation and its contribution to limiting global warming to 1.5°C, the UK would need to reach net-zero emissions of CO<sub>2</sub> by about 2050. Emissions of other greenhouse gases would also need to be reduced or completely removed.

This transition would require major emissions reductions from all sectors of the economy. If emissions are reduced as far as possible, a significant degree of CDR is still expected to be required to reach net-zero.

Much more needs to be done to decarbonise the economy, this includes:

- **Power:** further development of renewables, energy storage and smart systems, and substantial carbon capture and storage (CCS) infrastructure to apply to gas plants and to support CDR methods<sup>5</sup>;
- **Transport:** increased efficiency and electrification of vehicles, encourage behavioural change to reduce demand, potential use of hydrogen fuel cells in vehicles, and increased efficiency and alternative fuels in aviation and shipping;
- **Agriculture, forestry and land use:** human diet change leading to reduced livestock numbers and associated methane emissions, increased soil carbon storage, afforestation, restoration of wetlands to store more carbon, and decreased mineral nitrogen fertiliser use;
- **Industry:** shift to low, zero, or negative carbon emissions, for example by using carbon-negative building materials (wood, carbonated aggregates), capturing CO<sub>2</sub> from cement manufacture, and the use of alternate heat sources such as hydrogen;
- **Residential and commercial heat:** improved insulation, use of heat pumps, and potential use of hydrogen to replace natural gas;
- **CDR methods:** research and planning for application of a suite of CDR methods<sup>6</sup>;
- **Waste:** increased reuse and recycling, collection of household food waste, banning wastes containing bio-degradable carbon from landfill and capturing methane emissions.



Such actions will often carry short-term costs, but also provide long-term economic gains in the form of co-benefits such as industrial advantage and health improvements.

## UK support for global action

The UK has a role in supporting global action to deliver 1.5°C. Academic strength in areas leading to green growth is notable. There are technologies emerging that through international trade, can bring economic opportunities and environmental benefits. There is also the potential for leadership in the crucial area of international agreements on verification and monitoring of national budgets of greenhouse gases.

In the overseas development sphere, there are opportunities to support industrialising nations meet their own development needs while limiting emissions. The UK's international networks and aid commitments position it to assist and enable low-carbon technologies and infrastructure and reduce reliance on fossil-fuel-intensive pathways.

UK support for protection and restoration of natural carbon-rich ecosystems overseas would support climate, biodiversity, and sustainable development goals.

5. See Royal Society and Royal Academy of Engineering report *Greenhouse gas removal*.

6. Op. cit. note 5.



The Royal Society is a self-governing Fellowship of many of the world's most distinguished scientists drawn from all areas of science, engineering, and medicine. The Society's fundamental purpose, as it has been since its foundation in 1660, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

The Society's strategic priorities emphasise its commitment to the highest quality science, to curiosity-driven research, and to the development and use of science for the benefit of society.

These priorities are:

- Promoting excellence in science
- Supporting international collaboration
- Demonstrating the importance of science to everyone

**For further information**

The Royal Society  
6 – 9 Carlton House Terrace  
London SW1Y 5AG

**T** +44 20 7451 2500

**W** [royalsociety.org](http://royalsociety.org)