Met Office

Limiting global warming to 1.5°C: What are the challenges?

The Paris Climate Agreement aims to limit warming to well below 2°C above pre-industrial levels and make efforts to limit it further to 1.5°C. How can this goal be achieved?

Summary

- Climate science, combined with wider expertise on subjects such as economics, electricity systems and engineering tells us that it is possible to limit warming to below 1.5°C.
- Given the rapid pace of change needed, the goal remains challenging. The longer it takes to start reducing emissions, the harder it becomes. It is likely the goal cannot be achieved with emissions reductions alone.
- One key aspect is to understand how to work with the earth system to maximise natural carbon uptake, whilst satisfying other development goals such as reducing hunger and maintaining biodiversity.

How much carbon can we afford to emit?

By understanding the relationship between greenhouse gas emissions and the resulting warming, we can estimate the amount of carbon we can emit to stay within a given level of warming. This is known as our 'global carbon budget'.

While all research suggests large greenhouse gas emission reductions need to begin rapidly if we are to stay below 1.5°C remains, there is some uncertainty about the exact size of the budget available to meet this goal.

Research continues to look at a number of factors, some of which may expand the current budget, while others may reduce it. An option that could increase the budget would be to make big reductions in non-CO2 greenhouse gases, such as methane.

An area that may bring a reduction to the budget is the thawing of permafrost and heating of wetlands as the world warms, which then gives off additional greenhouse gases. Recent research suggests that the additional methane emissions from wetlands could reduce carbon budgets by 9-15% for 1.5°C[1].

Another example is the nitrogen cycle, which could limit the rate at which plants can take up CO_2. This is one of several important processes which will be included in a new generation of 'Earth System Models', such as UKESM1, which enable scientists to study how our climate system responds to greenhouse gases and associated warming.

These models will help scientists to make updated estimates of carbon budgets over the coming years, but initial research suggest the additional processes in Earth System Models are much more likely than not to lead to a lower carbon budget, and the difference could be significant.[2]

[1] Comyn-Platt et al (2018), Carbon budgets for 1.5 and 2°C targets lowered by natural wetland and permafrost feedbacks, Nature Geoscience
[2] Lowe & Bernie (2018), The impact of Earth system feedbacks on carbon budgets and climate response, Phil Trans A
[3] 2017 UK Provisional Greenhouse Gas Emissions

What are the potential strategies to reduce emissions?

Most research shows that, regardless of which carbon budget is used, emission reductions need to begin immediately and reach zero in around 40 years' time or less to stay within 1.5°C. The longer we delay in reducing emissions, the faster we will need to make cuts in the future. Many nations are already implementing rapid reductions, such as the UK – which has, as of 2017, reduced total greenhouse gas emissions by about 43% since 1990[3].

Given the need for rapid cuts in greenhouse gas emissions to meet the 1.5°C, it will be challenging to achieve this by reducing CO_2 emissions alone. Partner strategies would therefore also need to be considered:

Negative emissions

Many pathways to meet the Paris goals suggest we may need to actively remove carbon from the atmosphere to enable us to reduce greenhouse gas emissions at a slower pace. One way of doing this is to utilise Bio-Energy Carbon Capture and Storage (BECCS). However, the short-term impact of land-use change can result in vegetation loss, adding more carbon to the atmosphere. This means it could take decades for BECCS to become carbon negative[4]. This and other research suggests negative emissions methods such as BECCS need to be carefully considered alongside other strategies.

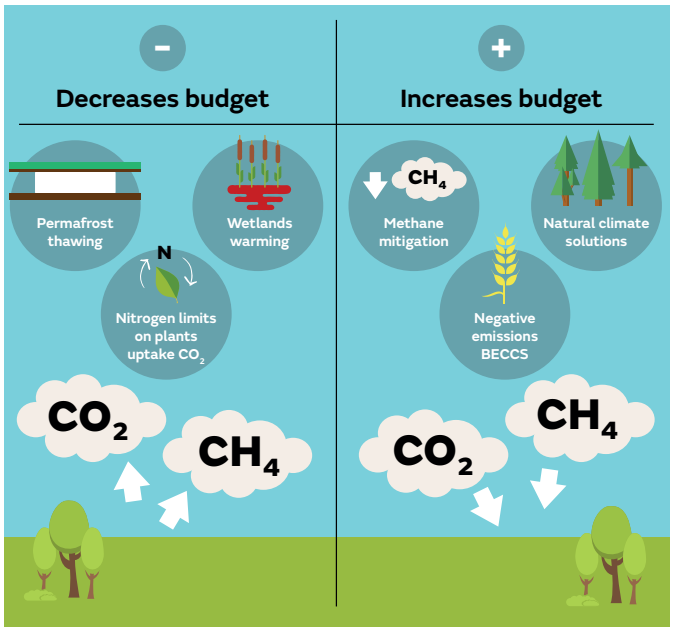
Natural Climate Solutions (NCS)

Conservation, restoration and management of natural resources such as forests could help limit warming by storing carbon. Research shows, however, that the effectiveness of forests and other natural 'carbon sinks' (processes that absorb and store carbon dioxide) depends on our future global emissions. In negative emissions scenarios, natural carbon sinks become less effective because there is less carbon available in the atmosphere for them to absorb. This could partially offset the intended outcomes of negative emission strategies. While NCS have a positive effect and are cost efficient, they are limited by land availability and other challenges which mean they would need to sit alongside other strategies.

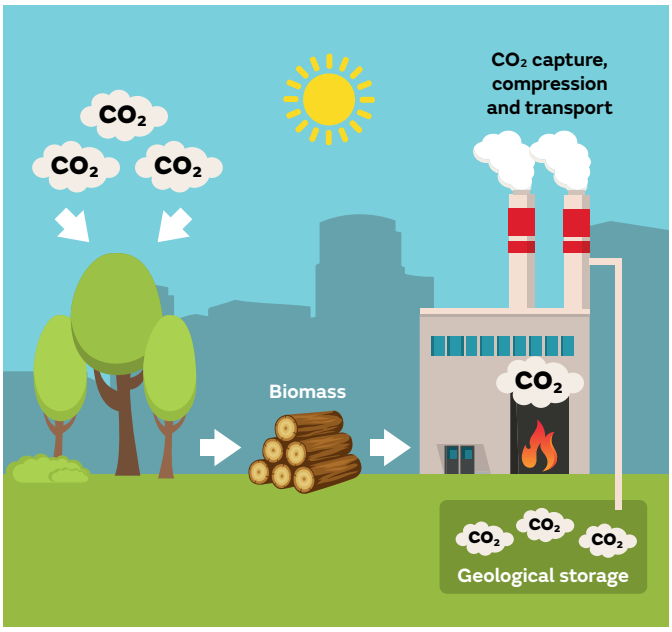
Methane Mitigation

Methane comes from the fossil fuel industry and agriculture, as well as other man-made sources. It has a much shorter lifespan in the atmosphere than CO_2 but is a much more potent greenhouse gas. Its atmospheric chemistry also leads to more ozone, which has impacts on human health and can contribute to further warming as it reduces the uptake of CO_2 by plants. This means early reduction of methane emissions would significantly increase the feasibility of limiting warming below 1.5 °C, while also having co-benefits for human and ecosystem health[6].

Carbon budget



What is BECCS?



[4] Fajardy & Mac Dowell (2017), Can BECCS deliver sustainable and resource efficient negative emissions?, Energy & Environmental Science
[5] Jones et al (2016), Simulating the Earth system response to negative emissions, Environmental Research Letters
[6] Collins et al (2018), Increased importance of methane reduction for a 1.5 degree target, Environmental Research Letters