AVOID 2
Can we avoid dangerous climate change?

What contribution can mitigation of non-CO_2 greenhouse gases make towards achieving long-term temperature goals?

Greenhouse gases (GHGs) other than CO_2 made up about 28% of total GHG emissions in 2010. There are a number of relatively inexpensive options to reduce emissions of these gases. Setting a "carbon-equivalent" price on non-CO_2 GHGs could reduce their emissions by over two-thirds relative to a reference scenario, and significantly reduce the total cost of meeting long-term temperature goals.

Latest results

Major sources of the five main non-CO_2 GHGs – methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and sulphur hexafluoride (SF_6) – are shown in Figure 1, along with potential mitigation strategies for reducing emissions. Emissions are measured according to their global warming potential over a 100 year timeframe (GWP100), relative to CO_2. By this measure, these primary classes of GHG make up the great majority of non-CO_2 emissions.

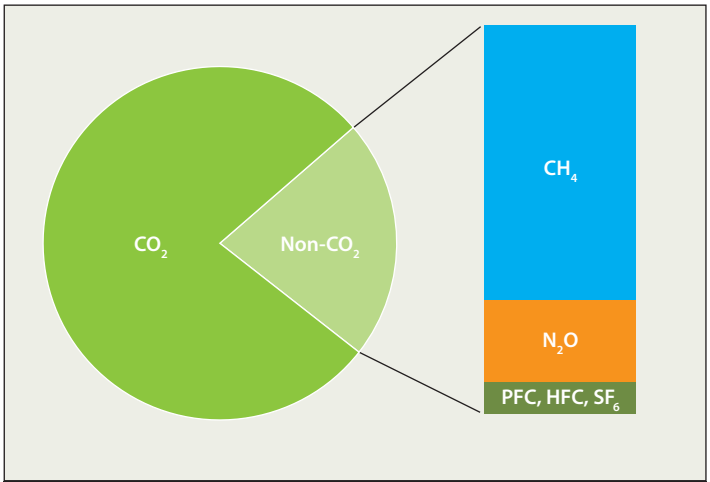

Figure 1: Major anthropogenic sources of three main classes of non-CO_2 gases and options for mitigation of these sources, colour-coded by relative cost estimates and weighted by GWP100. Typically cheap <(2005)$50/$tCO_2$e; medium <$100/tCO_2e; expensive >$100/$tCO_2$e. For further detail, please see the longer AVOID 2 report C2b on our website.

Methane and nitrous oxide emissions from agriculture have been relatively consistent over the last three decades, with emissions growth in Africa, Asia and the Americas offset by corresponding reductions in Europe. Waste, fossil fuel extraction and refining and industrial processes are other important sources of methane and nitrous oxide.

Policy measures could include carbon-equivalent pricing, encouraging changes in practices in areas such as fertiliser application, rice field cultivation and waste disposal, as well as regulations to phase out certain chemicals and processes (such as the regulation of CFCs by the Montreal Protocol).

Co-benefits and other side effects of reducing non-CO_2 GHG emissions are not considered here.

Major sources ■ CH_4 (methane) ■ N_2O (nitrous oxide) ■ PFC, HFC, SF_6 (F-gases)	**Mitigation options (typically)** ● Cheap or cost-saving ● Medium cost ● Expensive
Agriculture and waste • Livestock (enteric fermentation) • Rice cultivation • Crop residue burning • Wastewater; municipal waste; industry waste	● Dietary changes; anaerobic digestion of manure with biogas capture ● Field water management ● Baling/mulching of crop residue ● Capture of CH_4 from waste for energy
Fossil fuel production • Emissions of CH_4 from extraction and distribution of fossil fuels	● Flaring of CH_4 to CO_2, use for energy, leakage control through pipe maintenance
• Agricultural soils • Industrial acid production	● Precision nitrogen application ● Catalytic reduction of N_2O
• Aluminium production • Insulation • Refrigeration; air-conditioning	● Retrofit with new anode materials ● Replacement with alternatives ● Leak repairs

Read more

AVOID 2 report C2b: *The contribution of non-CO_2 greenhouse gas mitigation to achieving long-term temperature goals* available on our website *www.avoid.uk.net*.

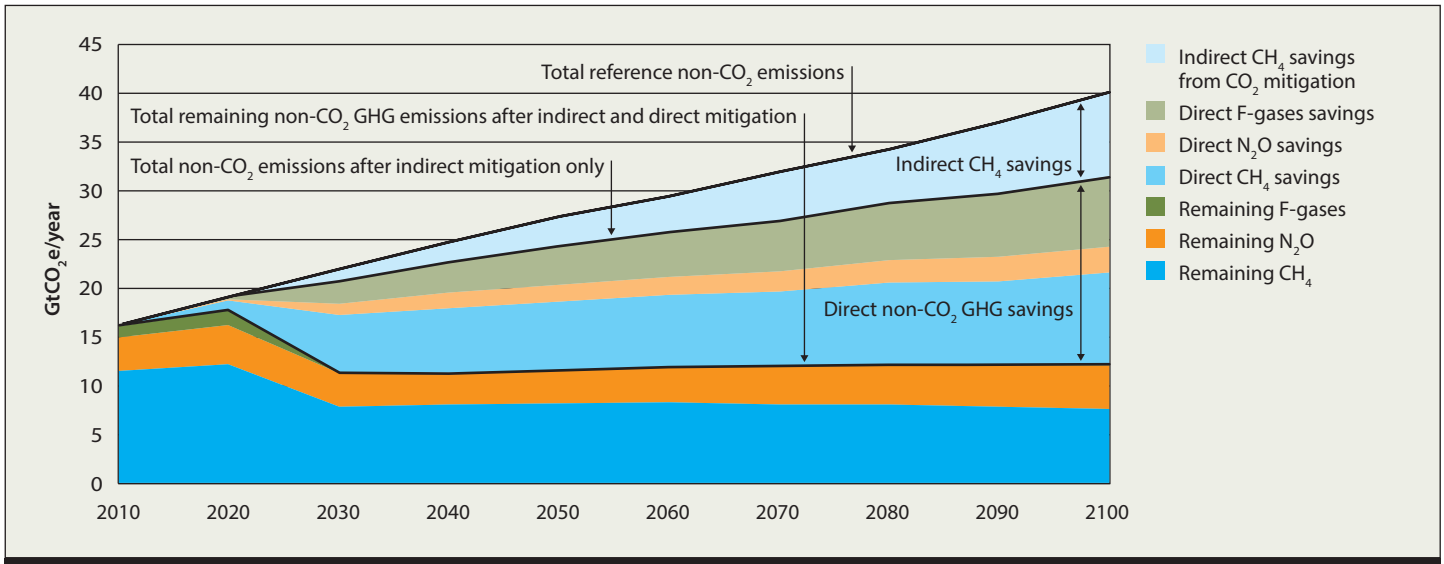

Figure 2: Direct and indirect mitigation of non-CO_2 greenhouse gas emissions for a 2°C scenario with global coordinated mitigation action delayed until 2020 (from the GAINS model). Emissions are measured in CO_2-equivalent, according to the 100-year global warming potential (GWP100). F-gases have been grouped together for simplicity although the different F-gases (HFCs, PFCs, SF_6) have different global warming potentials.

Significant indirect mitigation of non-CO_2 gases (mainly CH_4) occurs as a by-product of CO_2 mitigation even where no specific non-CO_2 policies are in place, resulting from the shift away from fossil fuels and toward a renewable-based energy system.

Direct mitigation occurs when measures specifically targeted at non-CO_2 gases are put in place. Such measures are modelled in the AVOID 2 study by setting a CO_2-equivalent price for emissions of these gases based on their 100-year Global Warming Potential. The modelled least-cost pathway takes the cheapest mitigation options ("easy wins") early in the century, resulting in a quick reduction followed by plateau.

In the model, imposing full equivalent pricing of non-CO_2 gases reduces their emissions by over two thirds compared to the reference scenario by 2100.

In policy terms, this means that the overall cost of mitigation can be reduced by including non-CO_2 gas mitigation strategies in the portfolio of emission reduction efforts.

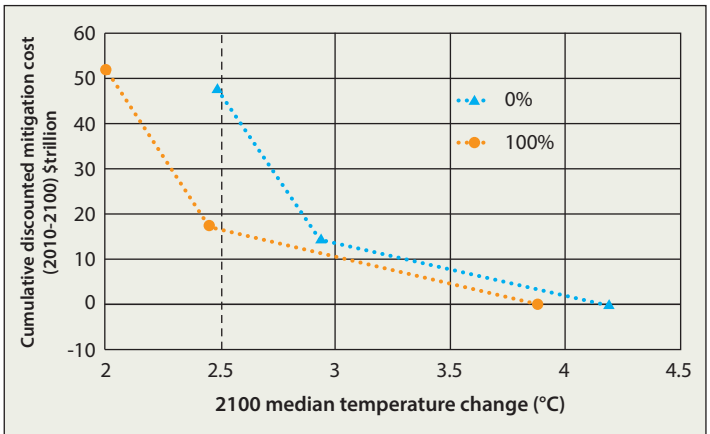

Figure 3: Illustrative modelled cost of meeting alternative temperature targets under two alternative pricing schemes for non-CO_2 gases (no price applied, and 100% of equivalent CO_2 price, weighted by GWP100). Present value cumulative costs in 2005 $, based on 5% discount rate.

Note: further analysis would be required to calculate cost for temperatures between those points shown.

What is the impact of pricing non-CO_2 gases on the overall cost of mitigation?

Pricing non-CO_2 gases can either allow the same temperature target to be achieved at a lower net cost, or the same financial expense to result in a greater chance of limiting global warming below a given level, such as 2°C. Figure 3 shows the total modelled cost of meeting alternative temperature targets in 2100, when applying different pricing schemes.

To take a specific modelled example, consider a 2.5°C level. The total cost of this scenario in this single, illustrative model is $48trn if only CO_2 itself is priced, but drops to $17trn when the other gases are subject to the same pricing mechanism at an equivalent rate. The gains appear to be larger for more stringent temperature targets.