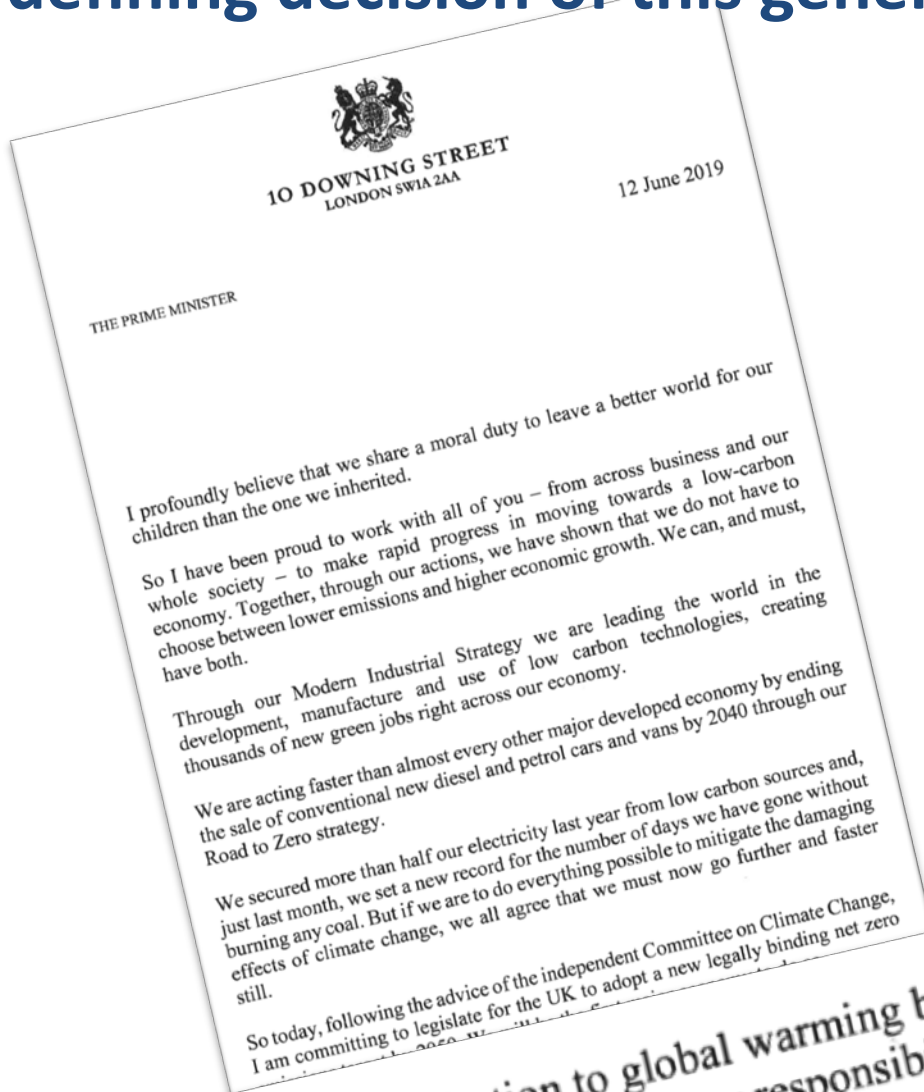


Agricultural emissions on a path to Net Zero

Myles Allen, Edd Hornsby, Stuart Jenkins, John Lynch
& Michelle Cain

Environmental Change Institute, School of
Geography and the Environment & Department of
Physics, University of Oxford

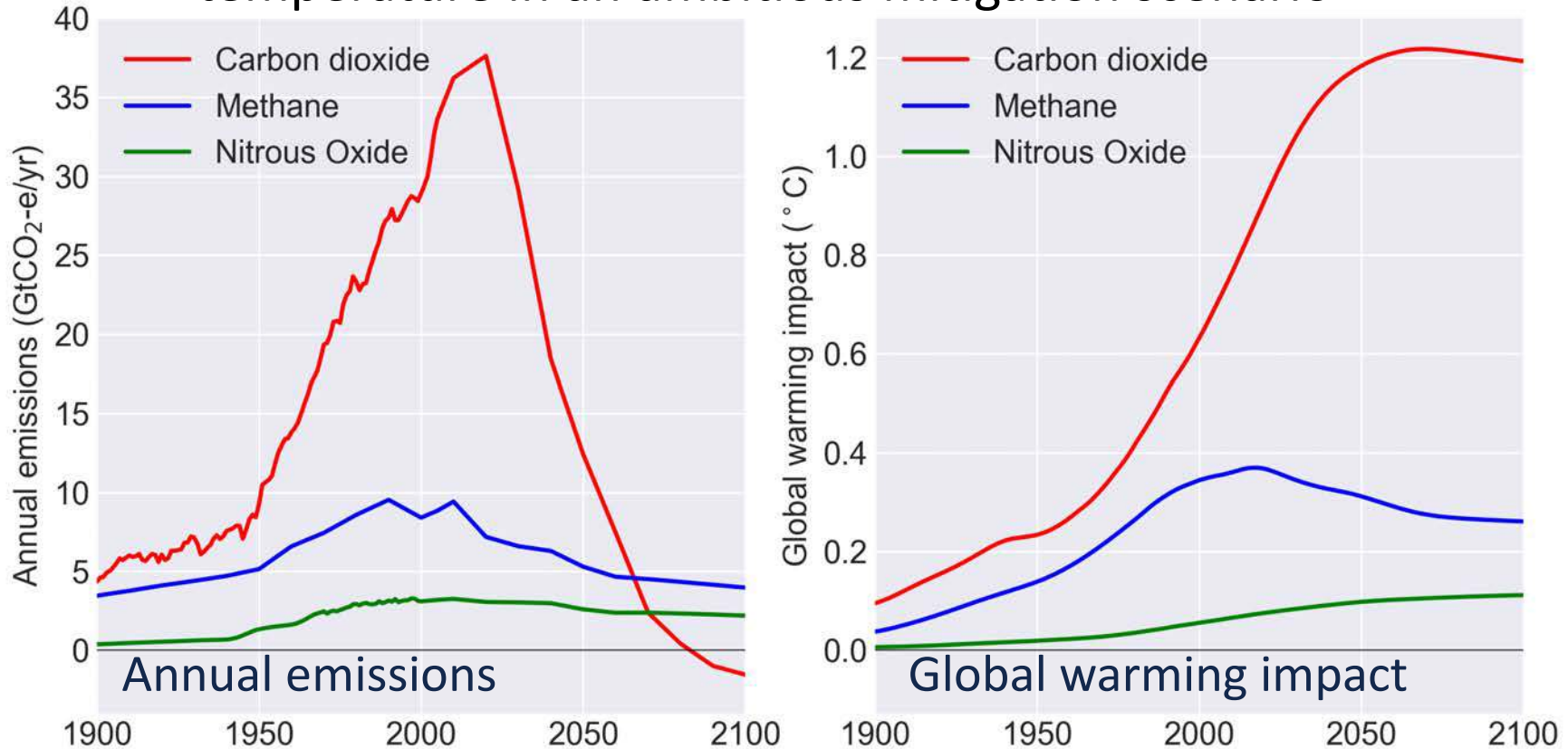
“The defining decision of this generation”



Ending our contribution to global warming by 2050 can be the defining decision of this generation in fulfilling our responsibility to the next.

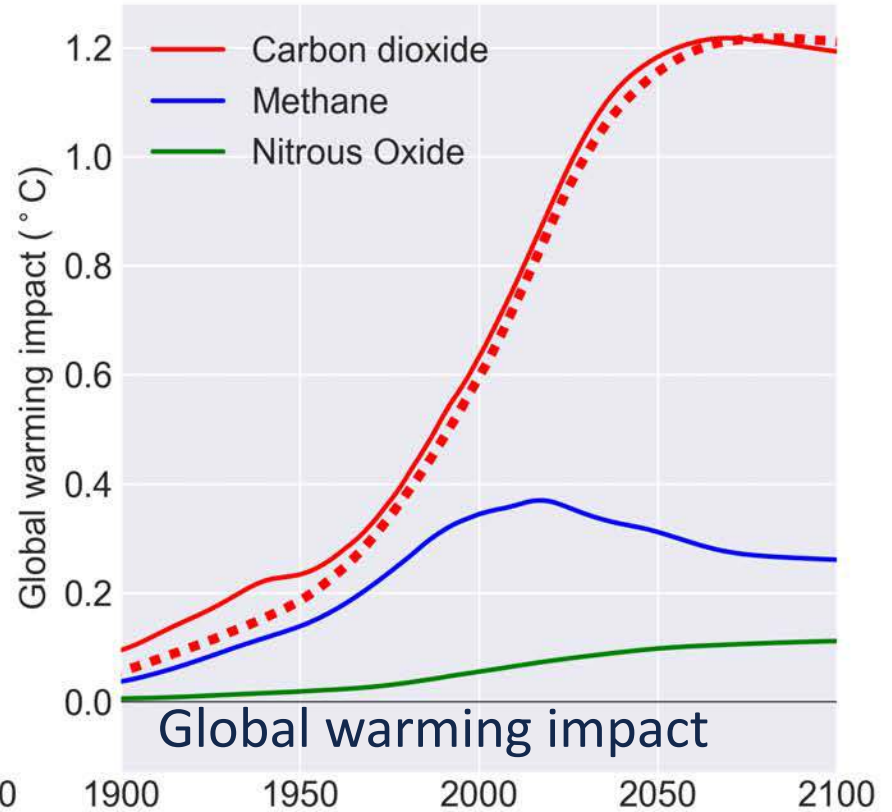
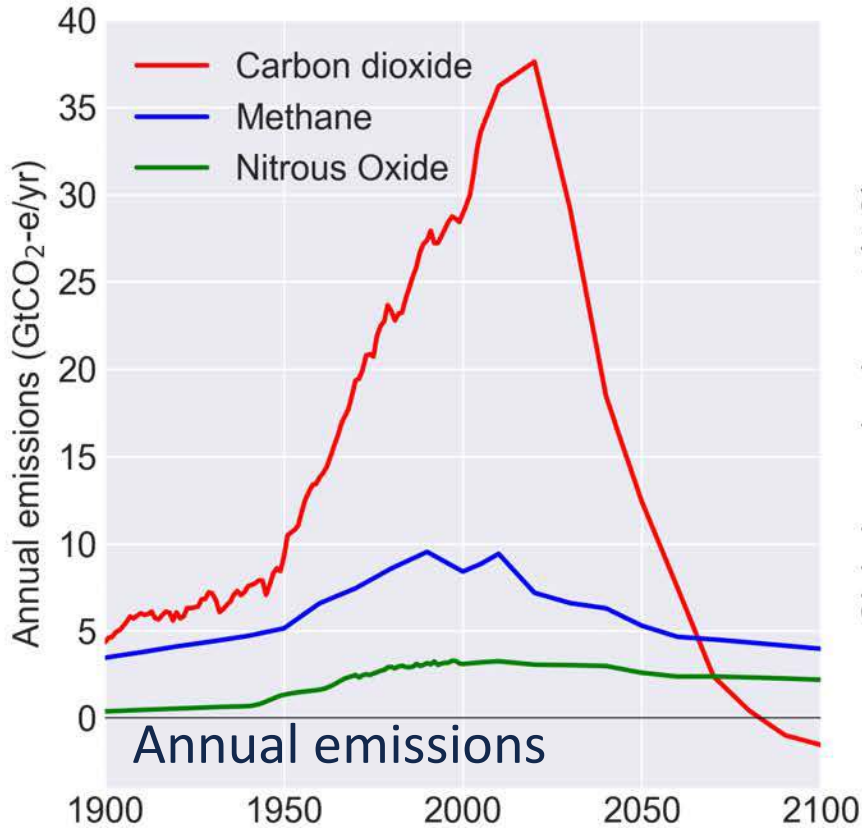
What will it take to “end our contribution to global warming”?

Annual emissions 1900-2100 and their impact on global temperature in an ambitious mitigation scenario



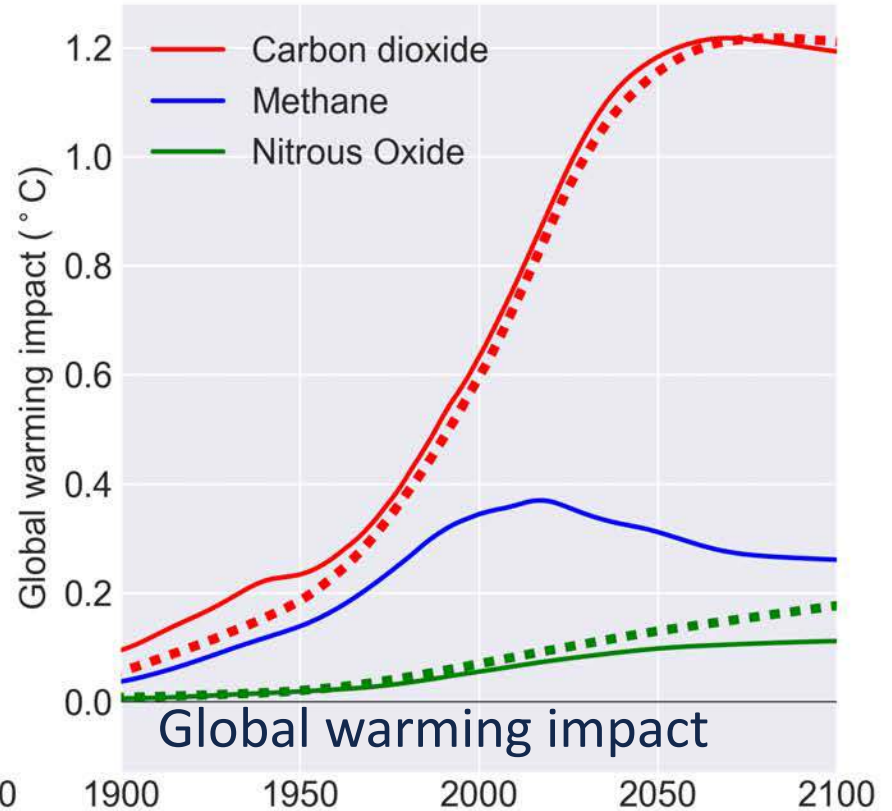
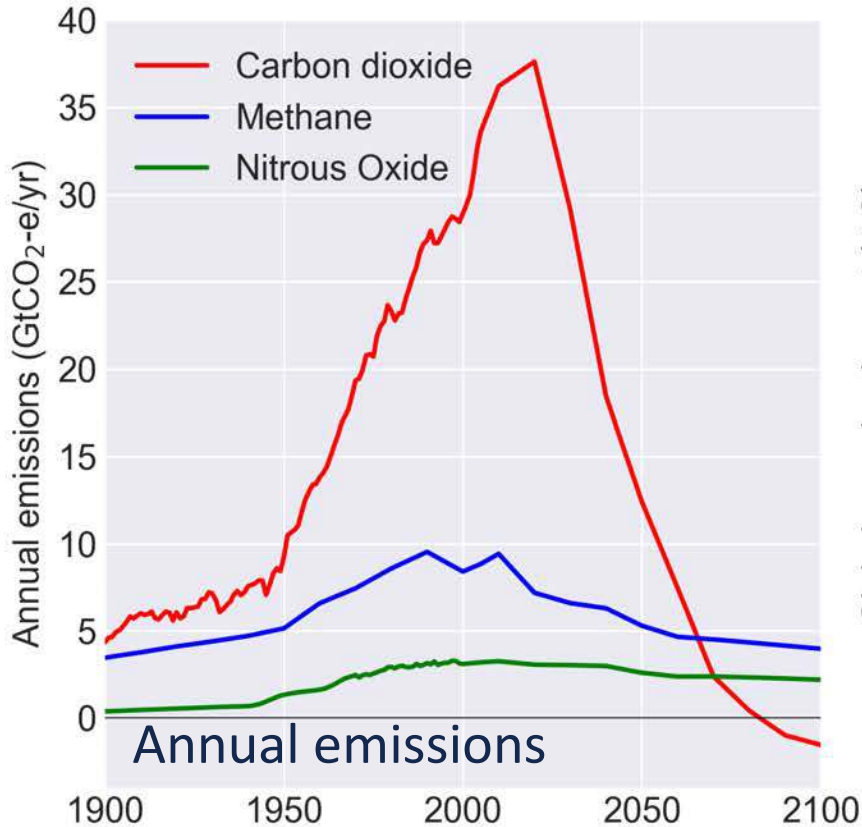
For CO₂, the answer is simple: just stop emitting

Dotted red line: CO₂ emissions added up over time



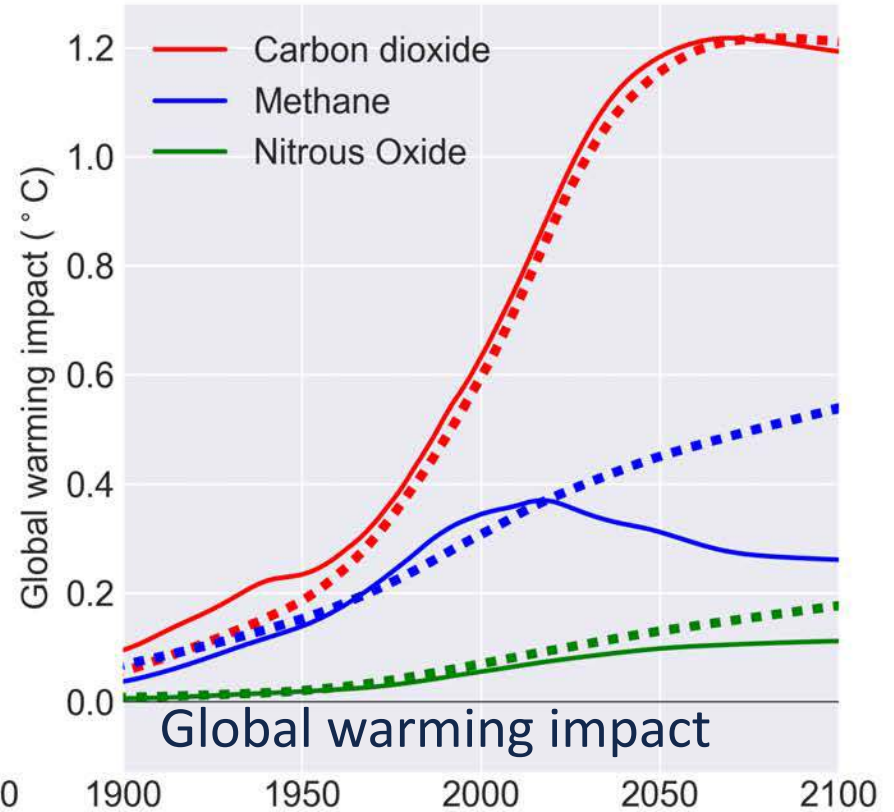
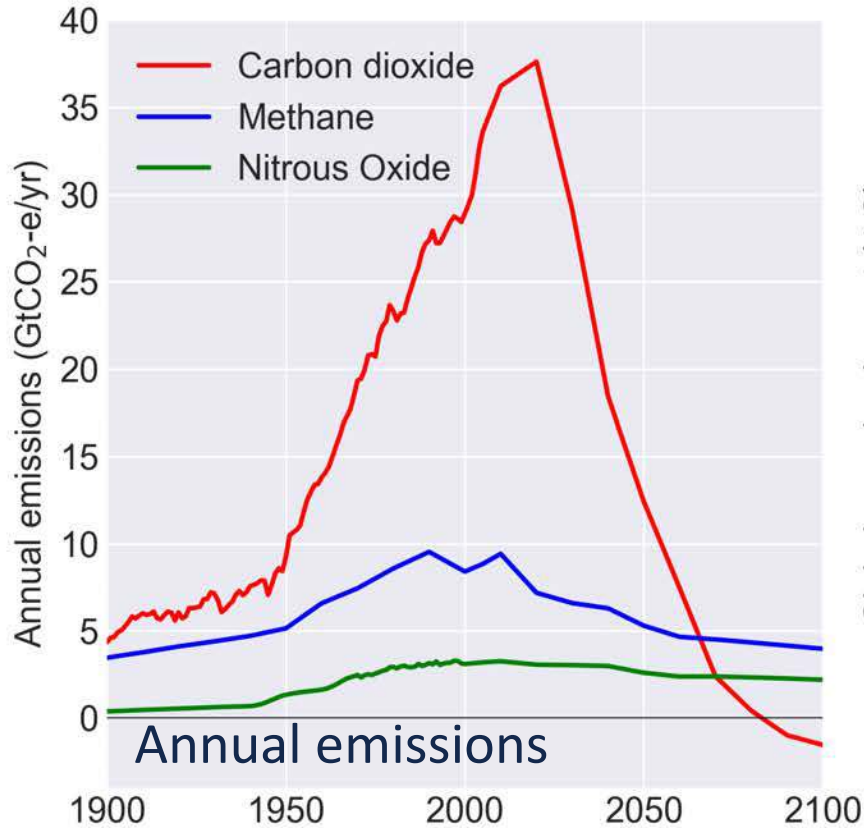
The same goes for nitrous oxide (more or less)

Dotted green line: N₂O emissions added up over time



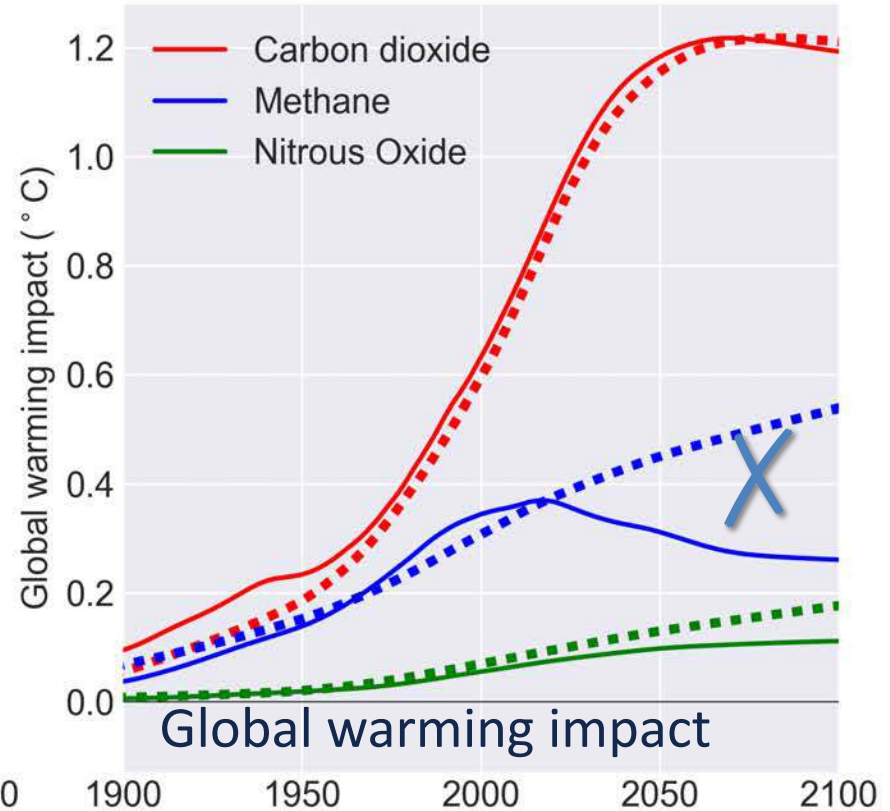
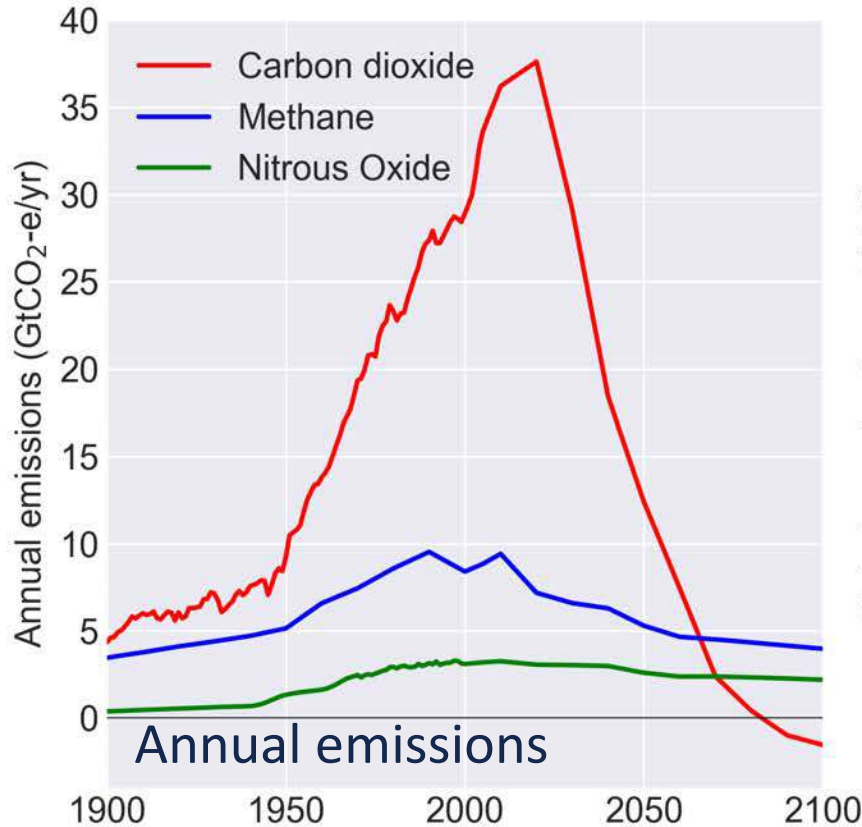
But methane emissions don't need to reach zero to stop and reverse methane-induced warming

Dotted blue line: CH₄ emissions added up over time



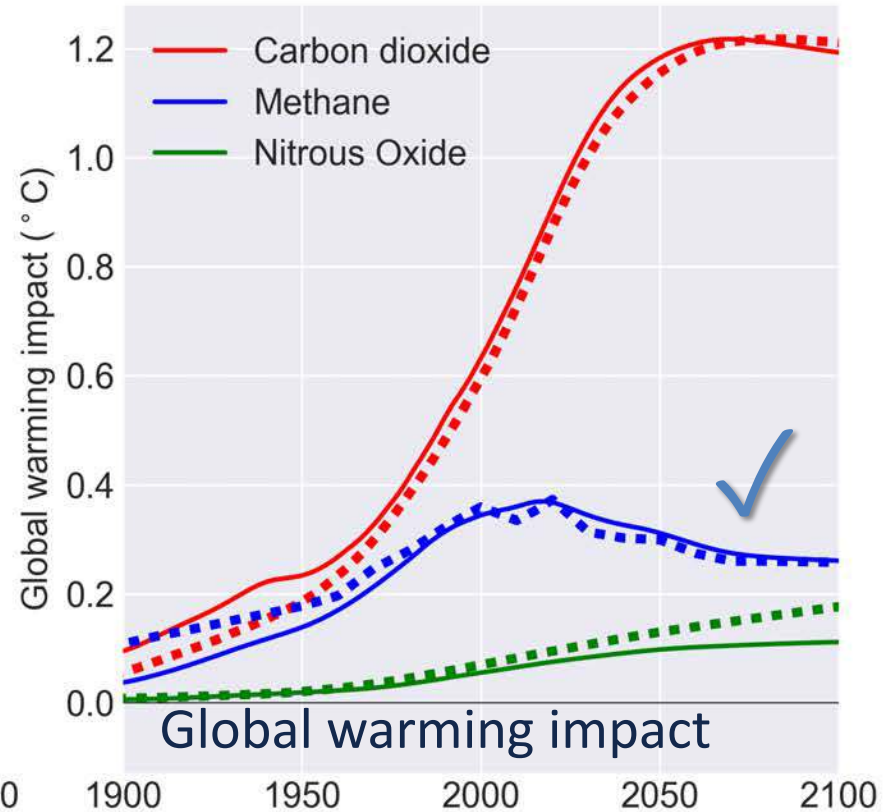
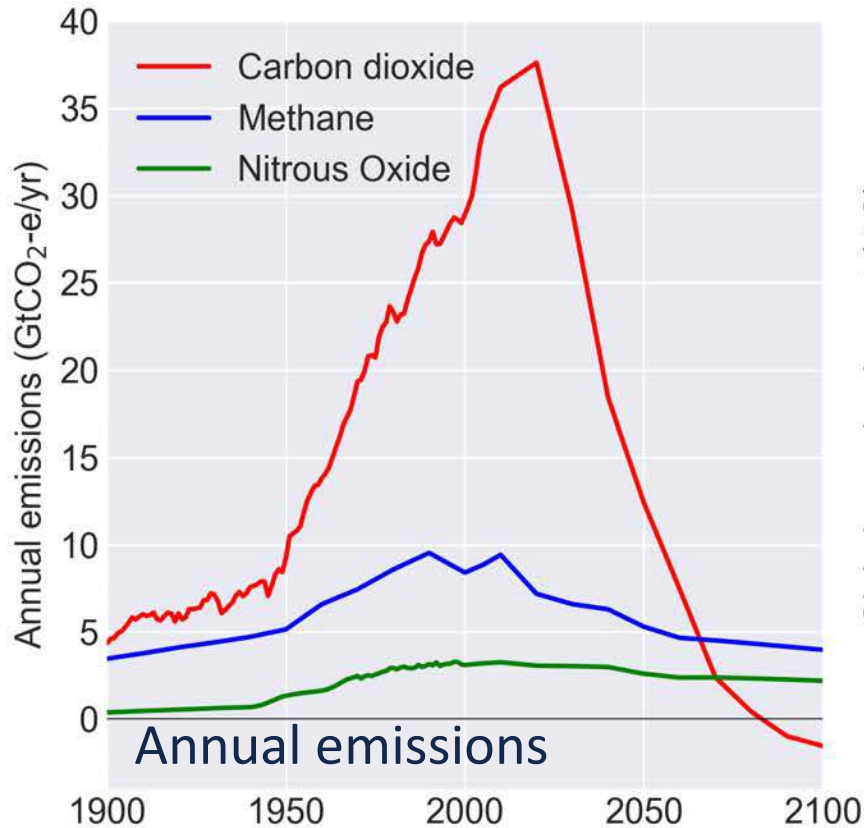
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Dotted blue line: CH₄ emissions added up over time

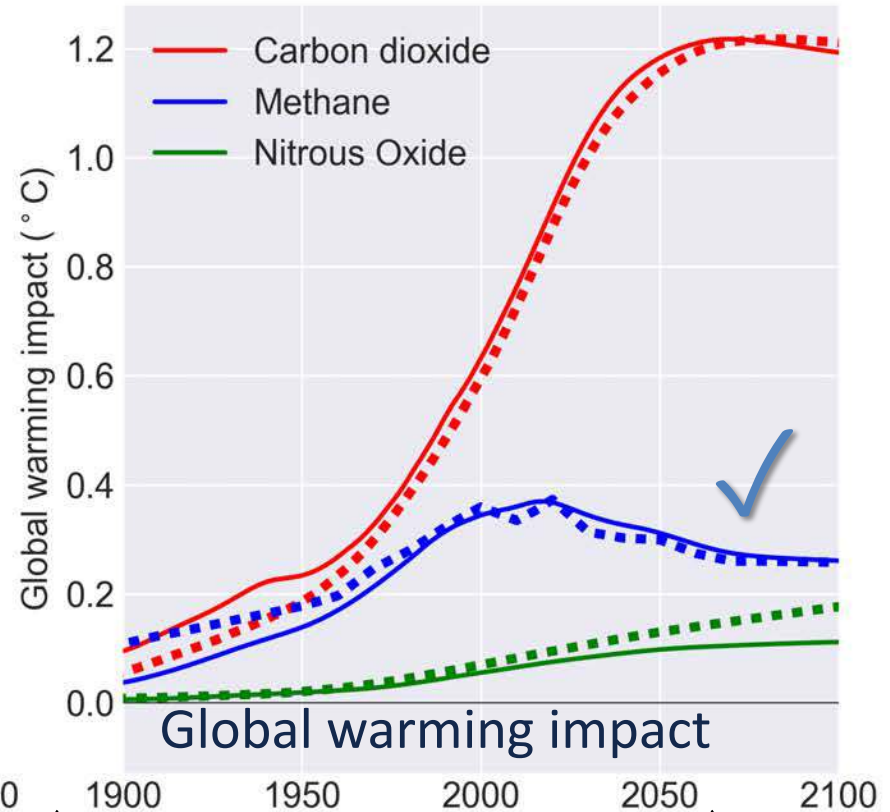
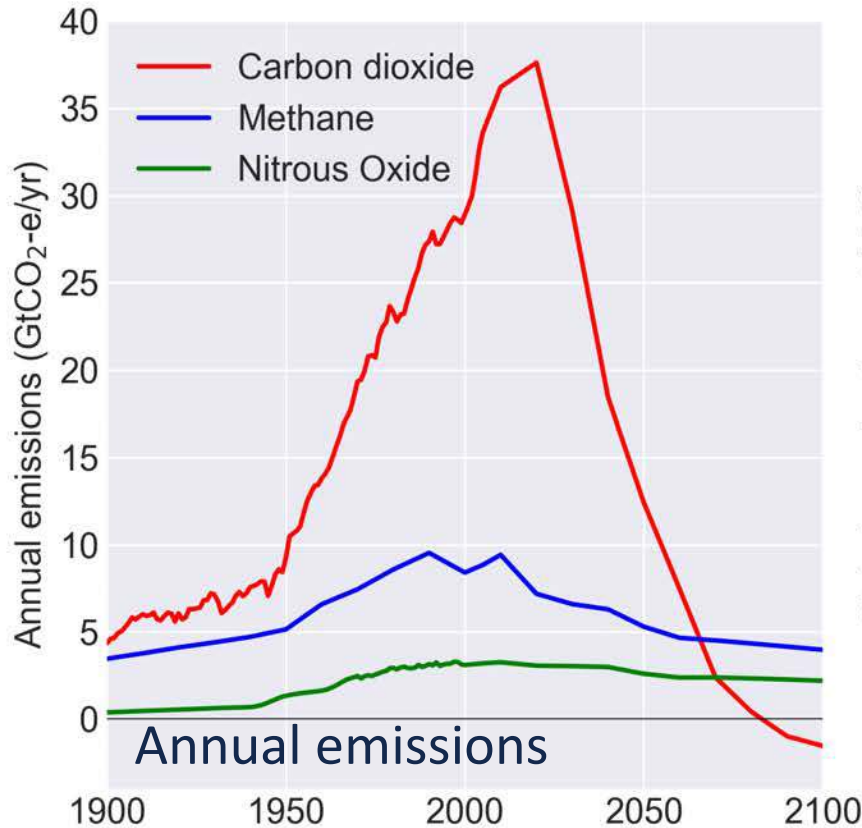


Methane does not accumulate

Combining cumulative methane emissions & annual methane emission rates predicts warming response

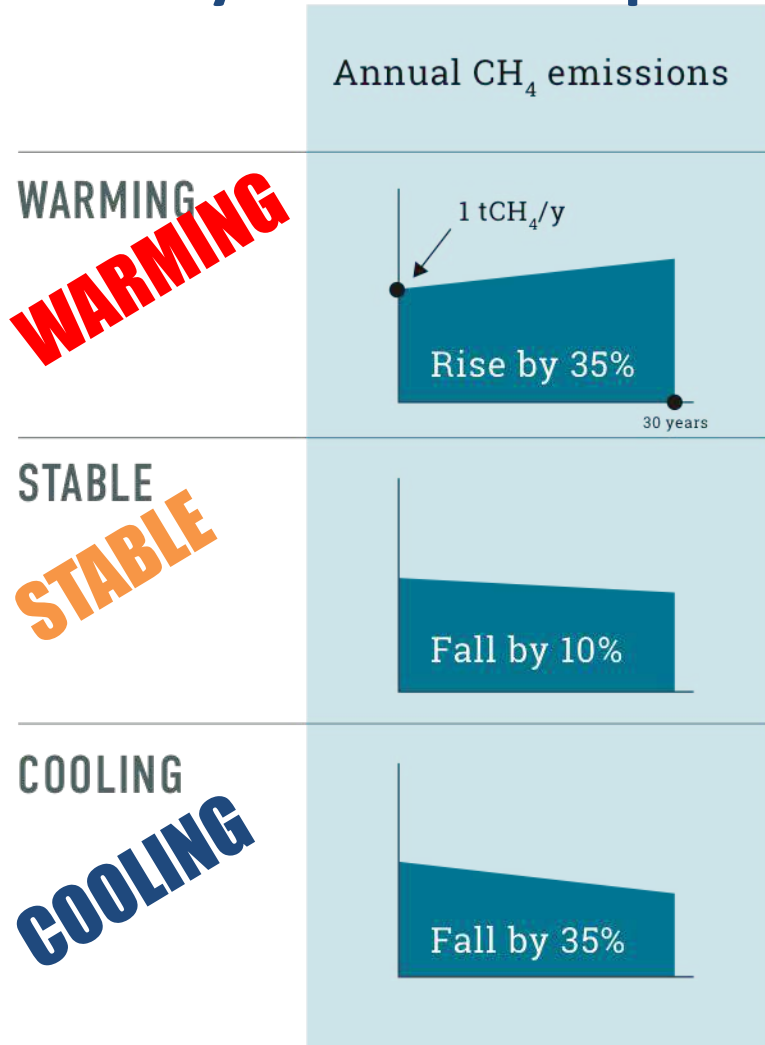


Combining cumulative methane emissions & annual methane emission rates predicts warming response



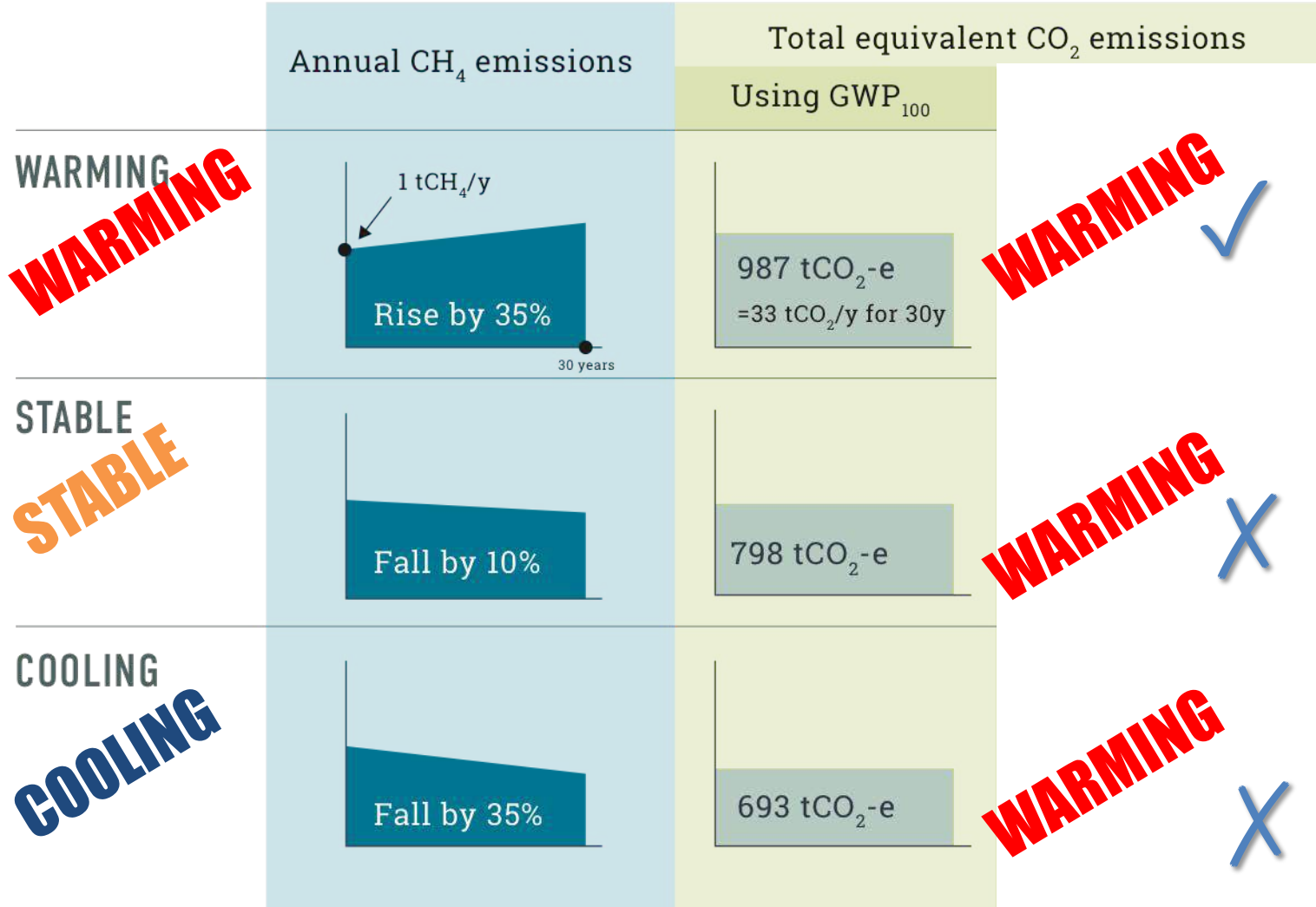
$$E_{\text{CO}_2\text{-e}^*} = \text{GWP}_{100} \times \left(0.25 \times E_{\text{CH}_4} + 75 \times \frac{\Delta E_{\text{CH}_4}}{\Delta t} \right)$$

Nominally “equivalent” emissions of CO₂ and methane have very different impacts on temperature

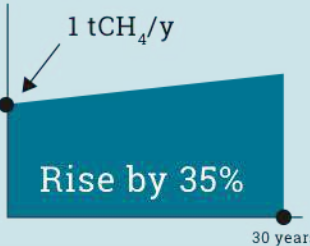




From Climate metrics for ruminant livestock, Oxford Martin Programme on Climate Pollutants briefing: <https://www.oxfordmartin.ox.ac.uk/publications/view/2714>

GWP does not represent this difference between scenarios well

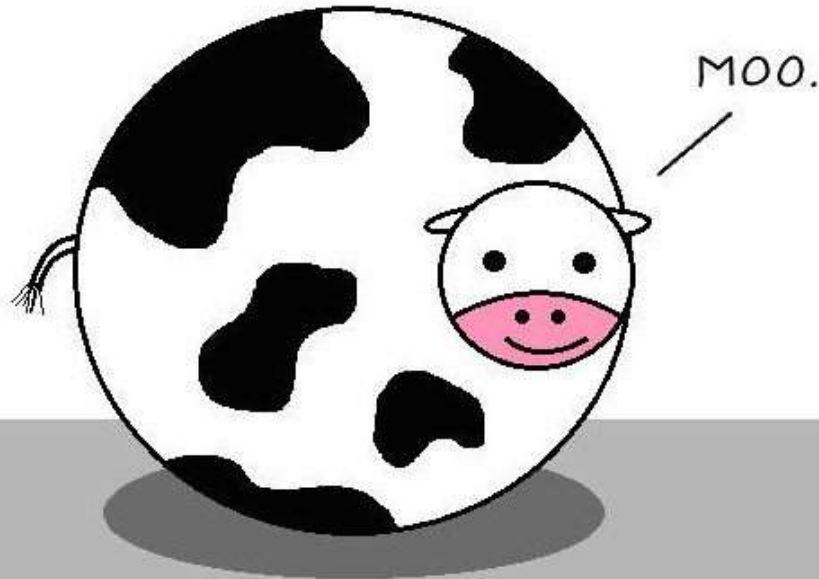


Redefining equivalence between methane and CO₂ with GWP*

	Annual CH ₄ emissions	Total equivalent CO ₂ emissions	
		Using GWP ₁₀₀	Using GWP*
<p>WARMING</p>  <p>1 tCH₄/y Rise by 35% 30 years</p>	<p>987 tCO₂-e =33 tCO₂/y for 30y</p>	<p>982 tCO₂-we =33 tCO₂/y for 30y</p>	<p>WARMING ✓</p>
<p>STABLE</p>  <p>Fall by 10%</p>	<p>798 tCO₂-e</p>	<p>-10 tCO₂-we</p>	<p>STABLE ✓</p>
<p>COOLING</p>  <p>Fall by 35%</p>	<p>693 tCO₂-e</p>	<p>-562 tCO₂-we</p>	<p>COOLING ✓</p>

A physics professor's explanation of the impact of methane emissions on global temperature

Assume a spherical cow of uniform density.



Assume a spherical (and immortal) cow...

$$E_{\text{CO}_2\text{-e}^*} = \text{GWP}_{100} \times \left(0.25 \times E_{\text{CH}_4} + 75 \times \frac{\Delta E_{\text{CH}_4}}{\Delta t} \right)$$

- Creating one new cow increases methane emission rate by 100kg methane per year, which has the equivalent impact on global temperature as:
 - A one-off release of 210 (28x75x0.1) tonnes CO₂ *plus*
 - Sustained emission of 0.7 (28x0.25) tCO₂/year from now on

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- Creating one new cow increases methane emission rate by 100kg methane per year, which has the equivalent impact on global temperature as:
 - A one-off release of 210 (28x75x0.1) tonnes CO₂ *plus*
 - Sustained emission of 0.7 (28x0.25) tCO₂/year from now on
- Destroying one old cow decreases methane emission rate by 100kg methane per year, equivalent to:
 - A one-off removal of 210 tonnes CO₂ *plus*
 - Sustained removal of 0.7 tonnes CO₂ per year from now on

Assume a spherical (and immortal) cow...

$$E_{\text{CO}_2\text{-e}^*} = \text{GWP}_{100} \times \left(0.25 \times E_{\text{CH}_4} + 75 \times \frac{\Delta E_{\text{CH}_4}}{\Delta t} \right)$$

- Creating one new cow increases methane emission rate by 100kg methane per year, which has the equivalent impact on global temperature as:
 - A one-off release of 210 (28x75x0.1) tonnes CO₂ *plus*
 - Sustained emission of 0.7 (28x0.25) tCO₂/year from now on
- Under a European-style emission trading scheme, 100kg methane per year is considered equivalent to:
 - Sustained emission of 2.8 tonnes CO₂ per year
 - No consideration of changing methane emission rates

If methane were included in a traditional emission trading system @ €25/tCO₂

- Farmers increasing their methane emissions pay exactly the same rate for “new” vs. “old” cows, even though the impact of every new cow is equivalent to a one-off release of €5000 worth of CO₂.
- Farmers managing to reduce their methane emissions by -0.3% per year would still pay €70 per year per cow even though these emissions are not causing global warming.
- Farmers reducing their methane emissions faster than 0.3% per year get no credit for helping offset the warming impact of other emissions.

Equivalent drivers of climate change



A closed power station

A gently declining (10% over 30 years) herd of cattle

