# Background briefing note to the Joint Committee on Agriculture, Food and the Marine

## Meeting on Calculation of Methane Emissions

Professor Myles Allen, University of Oxford

Since this is a relatively technical matter, I would like to provide a short background paper, in case it may be useful to refer to in questions. Ireland is already setting an example for ambitious and transparent climate action, and could have even more influence by demonstrating two innovations that could also defuse the perceived tension between climate policy and agricultural interests:

1) set a goal for stopping any continued fossil fuel use from causing global warming, and
2) report the climate warming impact of emissions over the transition.

## Stopping fossil fuels from causing global warming: the need for geological net zero

It is important to keep the climate policy debate over methane and agriculture in perspective. To meet the goals of the Paris Climate Agreement, the world must do two things: we need to stop fossil fuels from causing global warming, and we need to stop agriculture and other land-use change from causing global warming. It is not an either-or, we need to do both. Agriculture and land-use cannot be relied on to compensate indefinitely for warming due to continued fossil fuel use, nor vice versa.

To stop fossil fuels from causing global warming we need to reduce the amount of fossil fuels burned as far and fast as possible, and we need to ensure we dispose permanently, meaning geological-timescale storage, of one tonne of carbon dioxide ($CO_2$) for every tonne generated by unavoidable fossil fuel use thereafter. $CO_2$ can be stored temporarily in the biosphere, by planting trees or restoring peatlands, but the global biosphere is both limited and vulnerable.[1] As the world warms, an increasing fraction of the carbon stored in the biosphere is likely to be re-released into the atmosphere through droughts, fires and the impact of warming on soils.

So, one thing Ireland could do immediately would be to introduce the concept of "geological net zero" into your climate goals, a target year beyond which you will no longer rely on agriculture, forestry and the natural world to offset fossil-origin $CO_2$, and start monitoring progress towards it. This alone might go a long way to reassure farmers that they will not be expected to compensate indefinitely for continued fossil fuel use in other sectors.

## Reporting the climate warming impact of emissions

As well as stopping fossil fuels from causing global warming, we also need to stop food production from causing global warming. Ireland is one of the first countries with a substantial agricultural sector to develop an ambitious climate policy, providing considerable opportunities to be policy pioneers. Innovation is needed, because despite the Paris Agreement having set a long-term goal in terms of global temperature, the standard method used for characterising the climate impact of emissions in terms of "carbon footprint" or "$CO_2$-equivalent emissions" does not (surprisingly) actually reflect the impact of human activities on global temperature. It was introduced over 30 years ago, long before the need for net zero was recognised, and was never intended to drive policy in pursuit of such an ambitious temperature goal.

This has long been recognised as a problem for agriculture because of the substantial contribution of methane to agricultural emissions (agriculture also generates nitrous oxide, but because this is a long-lived gas, treating it as $CO_2$-equivalent is unproblematic). As the 6th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)[2] put it:

> *"Expressing methane emissions as $CO_2$-equivalent using $GWP_{100}$ (the standard method) overstates the effect of constant methane emissions on global temperature by a factor of 3 to 4, while understating the effect of any new methane emission source by a factor of 4 to 5 over the 20 years following the introduction of the new source."*

These are errors in implied warming impact of 300-500%, so worth unpicking. The IPCC is *not* saying that methane, whether biogenic or fossil-origin, does not cause global warming, nor even that

methane emissions always cause less warming than the standard carbon footprint calculation suggests: the error depends on whether those emissions are rising, constant or falling. This is best explained with an example.

A herd of 10 cows generates about 1 tonne of methane per year. The standard carbon footprint calculation suggests that this methane is equivalent to 28 tonnes of $CO_2$ per year, whereas if (like the Irish average) that herd was built up over last century, it is only causing an ongoing warming equivalent to about 8 tonnes of $CO_2$ per year, a factor of 3 to 4 times less than 28. But if the herd is increased by just one cow, that increase alone causes warming equivalent to an additional 13 tonnes of $CO_2$ per year over the next 20 years, and 0.8 tonnes of $CO_2$ per year thereafter. Conversely, if emissions are decreased by just 3% per decade (either by gradual reduction in head-count, or adding seaweed to fodder, for example) then that herd's methane emissions cause no further warming, because the impact of the decline cancels the warming impact of the ongoing methane emissions.

Some object to this "no further warming" statement because, they argue, cows need to be replaced continuously to maintain the herd, so, by its existence, the herd is propping up global temperatures, and if the owner of the herd "does nothing", these methane emissions would naturally decline, drawing global temperatures down with them. This, however, is inconsistent with the conventional treatment of $CO_2$. An empty field is regarded as carbon neutral if it is neither absorbing nor releasing $CO_2$, even if, were the field to be left alone, vegetation regrowth would absorb $CO_2$ from the atmosphere, drawing down global temperatures. Farmers may even earn carbon credits for allowing vegetation to regrow in this way, even if the $CO_2$ taken up is only undoing the warming impact of clearing vegetation from that field a century ago. Reducing methane emissions faster than 3% per decade has precisely the same impact, undoing the warming caused when the herd was built up, yet is treated completely differently by the conventional carbon footprint calculation.

The solution is to report the climate warming impact of emissions, accounting for the different impact of changing versus constant methane emissions, such that this information is available to inform policy discussions and the design of incentives. Warming impact is straightforward to calculate, either with a simple formula or using a climate model. The Irish Climate Change Advisory Council could calculate and publish the warming impact of different sectors of the Irish economy under different scenarios for future emissions, just as the UK Climate Change Committee does.[3]

To illustrate the importance of reporting climate warming impact, panel a in the figure shows Ireland's territorial emissions[4] from 1990 to 2050, under a stylized scenario assuming emissions of all three main greenhouse gases, $CO_2$, methane and nitrous oxide, are constant from 2018 to 2020 (so ignoring the impact of Covid-19), then reduced by 51% by 2030 and to net zero in 2050. Panel b shows the climate warming impact of these emissions calculated using the IPCC's standard model.

Since 2000, both $CO_2$ and methane emissions have followed a similar path of decline and recovery. Over this period, warming due to $CO_2$ emissions has continued to increase, because $CO_2$ has a cumulative impact, while there has been no additional warming due to Ireland's methane emissions, because methane does not accumulate in the climate system over these timescales. As emissions decline after 2020 in this scenario, warming due to $CO_2$ and nitrous oxide slows down, but it does not stop increasing (the red and green lines in b do not go flat) until those emissions reach net zero. In contrast, warming due to Ireland's methane emissions reverses within a decade of methane emissions starting to fall (the blue line in b declines steeply after 2030).

The impact of these methane reductions on global temperature is equivalent to the active removal of over 600 million tonnes of $CO_2$ from the atmosphere between 2020 and 2050. This exceeds Ireland's total $CO_2$ and $CO_2$-equivalent nitrous oxide emissions over this period, resulting (solid black line on the right) in Ireland's contribution to global warming peaking around 2030 and returning to below the 2020 level by 2050. This behaviour is completely obscured by treating methane as $CO_2$-equivalent using $GWP_{100}$ (dotted line), which both underestimates the warming impact of Irish methane emissions to date while failing to capture the impact of these future methane reductions.

## Negative consequences and a simple solution

Treating methane emissions as $CO_2$-equivalent using $GWP_{100}$ has a number of negative consequences. From the perspective of minimising impact on global temperature, farmers have less incentive than they should to avoid increasing methane emissions. Methane emissions are rising rapidly in many of Ireland's trading partners, causing substantial unacknowledged warming. Likewise, farmers have less incentive than they should to reduce methane emissions, even though any reduction faster than 3% per decade has the same impact on global temperature as active removal of $CO_2$ from the atmosphere. Finally, owners of long-established herds may feel, with justification, they are being blamed for more global warming than they are actually causing, because, as the IPCC notes, the conventional carbon footprint overstates the warming impact of constant methane emissions by 300-400%, unnecessarily alienating the farming community.

The solution is simple: report the climate warming impact of emissions, at the farm and sector level, and in Ireland's Nationally Determined Contribution (NDC) submitted to the UNFCCC. The UNFCCC encourages countries to supplement standard $CO_2$-equivalent emissions in NDCs with "information needed for clarity, transparency and understanding". In the context of a long-term goal of limiting global warming, it is hard to think of a more relevant piece of information than the contribution of a country's emissions to increasing global temperature, yet no country currently reports this information. Simply by reporting the warming impact of Ireland's emissions in your NDC, Ireland could have a transformative impact on the transparency of global climate policy.

Finally, and nothing to do with methane, but important for the climate: set a goal for geological net zero, a date beyond which Irish farmers, other land-owners and the natural world will no longer be expected to compensate for warming caused by any ongoing fossil fuel use.

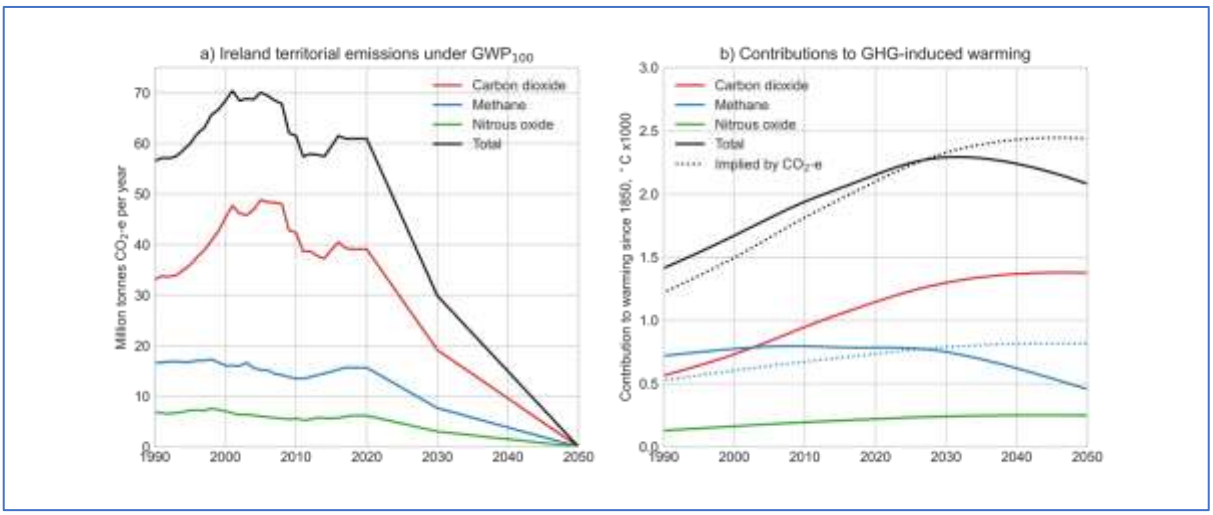


Figure: **a) Ireland's territorial emissions** under a stylized ambitious climate policy, expressed conventionally as $CO_2$-equivalent ($CO_2$-e) using $GWP_{100}$. **b) warming impact of Ireland's emissions** calculated with the standard IPCC impulse-response model[2] (solid lines). Dotted lines show the incorrect warming implied by treating methane as $CO_2$-equivalent.

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[1] Fankhauser, S., Smith, S.M., Allen, M. et al. (2022) The meaning of net zero and how to get it right. *Nat. Clim. Chang.* **12**, 15–21. https://doi.org/10.1038/s41558-021-01245-w

[2] Forster PM, Storelvmo T, Armour K, Collins W, Dufresne JL, et al. (2021). The Earth's energy budget, climate feedbacks, and climate sensitivity. In *Climate Change 2021: The Physical Science Basis*, ed. V Masson-Delmotte, P Zhai, A Pirani, SL Connors, C Péan, et al., pp. 923-1054. Cambridge, UK: Cambridge Univ. Press

[3] UK Climate Change Committee (2019) https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/, figure 2.3

[4] Gütschow, J.; Günther, A.; Pflüger, M. (2021): The PRIMAP-hist national historical emissions time series (1750-2019). v2.3.1. zenodo. https://doi.org/10.5281/zenodo.5494497