Secretariat Briefing Note on Methane

Council mandate

The Climate Action and Low Carbon Development (Amendment) Act 2021, Article 6A (9) II mandates that the Council consider the "*relevant scientific advice, including with regard to the distinct characteristics of biogenic methane"* in its deliberations on carbon budgets.

Methane Overview

Methane currently contributes an effective radiative forcing of 0.54 Wm^{-2} compared to 2.16 Wm^{-2} for carbon dioxide (CO_2). Two key characteristics determine the impact of different greenhouse gases (GHG) on the climate: the length of time they remain in the atmosphere and their ability to absorb energy. An important distinction can be made between short-lived greenhouse gases (or short-lived climate forcers, (SLCF) such as methane (CH_4) with an atmospheric lifetime of approximately 12 years, and long-lived greenhouse gases (LLGHGs) including nitrous oxide with an atmospheric lifetime of 109 years and CO_2 with an indeterminate lifetime. In order to simplify international negotiations and policy development it was seen as important to be able to compare potential climate impacts of each GHG, and therefore it was agreed to use a common metric for reporting under the UNFCCC i.e., GWP 100.

Table 1: Comparison of global warming potential values relative to CO_2 for 100-year time horizon in IPCC assessments reports

GHG	Fourth Assessment Report (AR4)	Fifth Assessment Report (AR5)	Sixth Assessment Report (AR6)
CO_2	1	1	1
CH_4	25	28	27
N_2O	298	265	273

Biogenic methane emissions arise from biological processes such as microbial activity in soils or the gut of ruminants; processes which effectively remove carbon from atmospheric CO_2, convert it to atmospheric CH_4 for a period before it is recycled to atmospheric CO_2 through oxidation. This definition distinguishes biogenic emissions from fugitive emissions from geological and fossil sources. Fugitive emissions have a slightly greater impact on climate than biogenic emissions because, following oxidation, they result in additional fossil CO_2 in the atmosphere.

Atmospheric concentration of CH_4 has increased from pre-industrial levels of approximately 729 ppb to 1866 ppb in 2019[1]. Currently, biogenic CH_4 from agriculture and waste represents 39% and 18% of global anthropogenic CH_4 emissions respectively. Biomass and biofuels represent approximately 8% of global emissions while the remaining 35% of CH_4 emissions are predominantly from fossil fuel extraction, distribution and combustion[2]. It is important to note, there are a number of significant natural sources of methane, such as wetlands, and there is major concern that climate change itself will result in an increase in natural emissions.

[1] IPCC AR6 WG1 Chp 2: Climate Change 2021: The Physical Science Basis | Climate Change 2021: The Physical Science Basis (ipcc.ch)

[2] https://www.globalcarbonproject.org/methanebudget/

A recent study from Jones *et al*[3] have used estimated historical annual emissions from 1850 to 2021 of the three major GHG, including CH_4, to estimate their contribution to global temperature increase. Despite a steady increase in the rate of global CH_4 emissions from agriculture and land use, these were overtaken by emissions from other anthropogenic sources in the late-1960s.

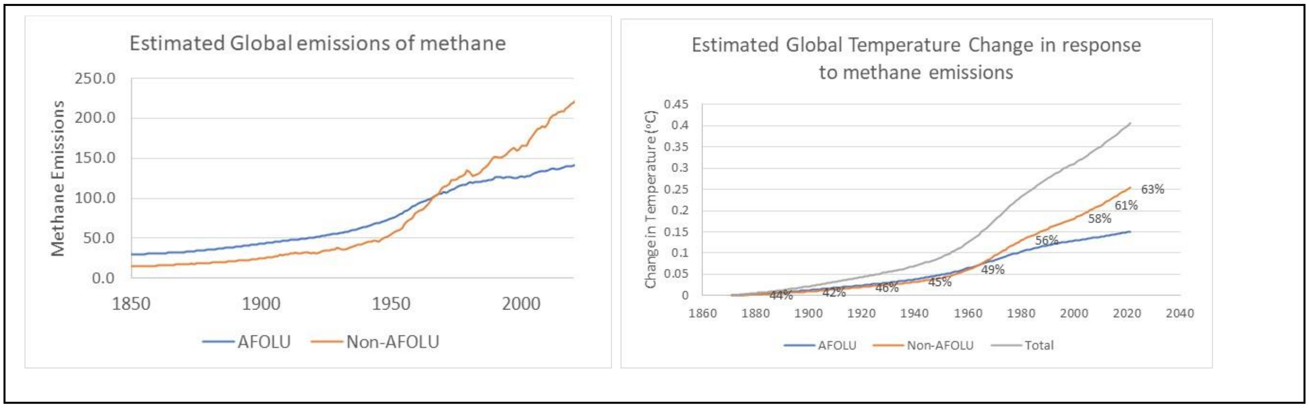

Figure 1: A Methane Emissions (unit) from 1850 to present. B) Estimated change to global temperature. Based on supplementary data provided from Jones et al 2023

Ireland differs significantly from the global pattern as anthropogenic CH_4 emissions are dominated by biogenic sources: from agriculture (93%) and waste (5%). Therefore, in an Irish context, mitigation of anthropogenic CH_4 predominantly relates to biogenic CH_4, the principal source of which is ruminant livestock. At present, there are limited technical options for mitigation of these CH_4 emissions sources. However, research internationally and in Ireland is progressing and some potential innovations (animal's diet, additives and genetics) have emerged. Nevertheless, the difficulty of mitigating biogenic CH_4 at present means that large reductions in CH_4 emissions would require a reduction in animal numbers, and therefore a decrease in animal based food production (as discussed in section 3.2.2 of the Carbon Budgets Technical report[4]).

A change in the rate of CH_4 emissions leads to rapid response in radiative forcing. All else being equal, reducing the rate of CH_4 emission will result in a reduction of atmospheric CH_4 concentrations, and therefore a reduction in its contribution to global warming. However, the GWP_{100} metric does not fully capture this response to SLCFs.

In countries with significant SLCF contributions to their emissions profile, net zero emissions based on GWP_{100} would not correspond to temperature neutrality or similar climate stabilisation objectives. The limitation of GWP_{100} in respect to SLCFs such as methane has been recognised in the literature (e.g., Wheatley, 2022). Wheatley[5] outlines that CH_4 reductions make a more significant contribution to temperature stabilisation that implied by GWP_{100}. Nevertheless, national, EU and UN processes mandate the use of GWP_{100} to aggregate total emissions based on reported value of absolute emissions of each gas. The use of the GWP_{100} metric to treat SLCFs

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[3] Jones, M.W., Peters, G.P., Gasser, T. *et al*. National contributions to climate change due to historical emissions of carbon dioxide, methane, and nitrous oxide since 1850. *Sci Data* **10**, 155 (2023)

[4] https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/Technical%20report%20on%20carbon%20budgets%2025.10.2021.pdf

[5] *Ibid*

such as CH_4 as CO_2-equivalent has been found to be problematic as this both over and underestimates the impact of CH_4 emissions on global mean surface temperature at different timescales and as emissions increase or reduce[6]. A revised metric, GWP* has been developed to account for the behaviour of SLCFs such as CH_4. Under GWP*, the impact of CH_4 emissions on warming is larger when the trend in emissions is rising and lower when the trend is declining.

Some recent work[7][8] has avoided common metrics by utilising simplified climate models to estimate explicitly the impact of emissions on temperature. While intuitive, these approaches run counter to established reporting and challenge the established assumption of "net-zero emissions" being synonymous with "climate neutrality", especially with respect to SLCFs.

Carbon Budgets Background

The IPCC AR6 updated our understanding of the global carbon budget and the need for net zero emissions of LLGHGs and for a strong, rapid and sustained reduction in SLCF emissions. The IPCC AR6 definition of carbon budget relates to cumulative carbon dioxide emissions. Assumptions regarding future scenarios of emission of other greenhouse gases constrained the carbon budget of CO_2 consistent with any given global warming threshold. This definition of global carbon budget is not equivalent to the carbon budgets definition in the Climate Action and Low Carbon Development Act[9]. In simplest terms a carbon budget under the Act is upper limit of cumulative emissions of all greenhouse gases, evaluated on the basis of the GWP_{100}, allowable over the 5-year budget period.

In Ireland, the Act specifies carbon budgets (total amount of GHG emissions permitted during the budget period) are set so that the total amount of annual GHG emissions reported for 2030 is 51% that reported for 2018. The Act also states there must be achievement of a "climate resilient, biodiversity rich, environmentally sustainable and climate neutral economy" no later than 2050. A "climate neutral economy" is defined as a sustainable economy and society where GHG emissions are balanced or exceeded by the removal of GHG. In the Regulations[10], GHG emissions are those specified in the common reporting format tables of the EPA, with the manner for calculating and accounting for emissions specified with regard to the global warming potential in Annex to Commission Delegated Regulation (EU) 2020/1044 (GWP_{100}). The legislation therefore requires the Council to consider CH_4 as part of the overall suite of GHGs, on a GWP_{100} basis.

The Council's 2019 Carbon Budgets background letter[11] recommended that; '*Carbon budgets should include all gases from all sectors, cognisant of any different net reduction targets applying to GHGs. There should be provision for review and revision of carbon budgets in the case of changes in the science of measurement and reporting etc. These can be routinely adopted.*

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[6] https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/contentassets/publications/Allen%20and%20Cain%20(2018)%20Importance%20of%20different%20greenhouse%20gases%20in%20achieving%20Paris%20Goals.pdf

[7] Jones, M.W., Peters, G.P., Gasser, T. *et al.* (2023) National contributions to climate change due to historical emissions of carbon dioxide, methane, and nitrous oxide since 1850. *Sci Data* **10**, 155

[8] Wheatley, J. (2023) 'Temperature neutrality and Irish methane policy', Climate Policy, pp. 1–14.

[9] Revised Acts (lawreform.ie)

[10] S.I. No. 531/2021 - Climate Action and Low Carbon Development Act 2015 (Greenhouse Gas Emissions) Regulations 2021 (irishstatutebook.ie)

[11] WEB letter of Advice to DCCAE on approaches to carbon budgets.pdf (climatecouncil.ie)

Substantive revision to carbon budgets should be limited to only happen ex ante and in the case of significant change in understanding or circumstances.'

The 2019 Council letter also suggested that it would be appropriate to take a different approach to biogenic CH_4, recognising the consensus of the IPCC that the required pathway for biogenic CH_4 to 2050 is different to that for the fossil fuel and industrial LLGHGs. It noted that further work would be required to determine an appropriate target for biogenic CH_4 in an Irish context. Notably, the 'Paris Test' carried out as part of the first programme of carbon budgets did explicitly consider different pathways for CH_4 emissions with the analysis showing that the temperature impact of the carbon budgets depends on the assumed mix of gases.

Country Comparison of Methane Accounting Approach

In Ireland, 21% of GHG emissions are from CH_4. This is one of the highest shares of non-CO_2 GHGs in the world: the OECD average is 9% and the EU average is 6%[12]. New Zealand has a 38% share of GHG emissions from CH_4, the highest in the world. New Zealand has taken the approach of not including biogenic methane in their national carbon budget.

Table 2: Comparison of CH_4 accounting approach in selected countries

Country	Methane Accounting Approach
New Zealand	New Zealand has notably taken a split-gas approach, allowing an allocation for CH_4 emissions in 2050 that are stable, and below current levels, leading to a net zero of carbon forcing, rather than a net zero of greenhouse-gas quantities emitted Separate emissions reduction target for biogenic methane within the range of 24-47% below 2017 levels by 2050 including to 10% below 2017 levels by 2030.
UK	Includes all GHGs using GWP_{100}
Denmark	Includes all GHGs using GWP_{100}
France	Each 5-year period also has individual budgets for six distinct sectors: transport, buildings, industry, energy, agriculture, and waste. This includes all GHGs with four individual budgets by gas; CO_2, N_2O, CH_4, and F-Gases aggregated. The all-gases agriculture budget has gas-specific budgets for N_2O and CH_4, and the all-gases waste budget has a CH_4-specific budget. In total each budget period has 14 budgets. (Ministère de l'Écologie 2020, p34)

Scientific Advice including in Relation to Biogenic Methane

The IPCC SR1.5 and AR6 WG1 indicate that merely stabilising global CH_4 emissions at the current rate is not sufficient to achieve the Paris Agreement objectives: a significant reduction in

[12] EEA greenhouse gases — data viewer — European Environment Agency (europa.eu)

global CH_4 emissions is necessary to significantly reduce the warming effect, as can be seen in the trajectories of CH_4 emissions in the SSP1-1.9 and SSP1-2.6 scenarios in Figure 2.

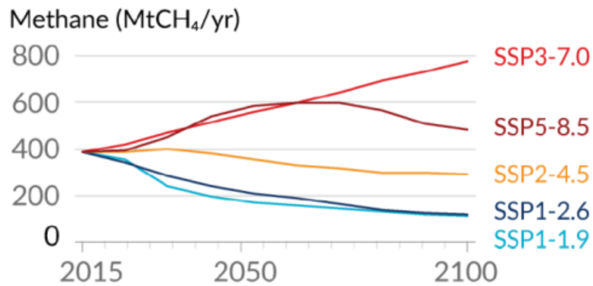

Figure 2: Global Methane emissions trajectories assumed in the Shared Socioeconomic Pathways, SSPS. Source IPCC AR6 WGI (2021) Broadly speaking, the SSP1 scenarios are consistent with the Paris Agreement objectives of limiting global warming to well below 2°C and pursue efforts to limit to 1.5°C.

Using outputs from Global Integrated Assessment Models, AR6 notes that pathways consistent with the 1.5°C goal require between 40% and 75% reduction in the rate of global CH_4 emissions. A large proportion of this mitigation can be achieved by tackling CH_4 emissions associated with energy and waste sectors. Nevertheless, reductions to global agricultural CH_4 emissions of between 11% and 30% by 2030 and between 24% and 47% by 2050 would be required for this outcome, combined with reductions at a slower pace for the rest of the century.[13]

The relatively high proportion of CH_4 in Ireland's emissions profile implies reducing these emissions can make an effective contribution to national climate policy objectives. However, the metric used and end-target (i.e., net zero or temperature neutrality) has important implications for policy makers. Recent work indicates less aggressive CH_4 reductions are required to reach temperature neutrality by 2050, rather than GWP_{100} net zero GHG emissions.[14]

Early CH_4 emission reduction limits temperature overshoot and can greatly limit the CO_2 removal required for temperature stabilisation on a global or national fair-share basis. Methane mitigation is crucial for any global scenario that limits warming to 1.5ºC. In addition to necessary rapid reductions to net zero LLGHG emissions, a substantial early, deep, and sustained cut in CH_4 emission rate is likely required for alignment with a 50% chance of 1.5ºC, globally, and in Ireland on a fair share basis.

[13] https://www.ipcc.ch/sr15/

[14] Wheatley, J. (2023) 'Temperature neutrality and Irish methane policy', Climate Policy, pp. 1–14.

CBWG Meeting 5 Submissions

Document Number	Document Name	Link
5.07	3.1 Mintz-Woo (2023) Compensation Duties	https://link.springer.com/referenceworkentry/10.1007/978-3-030-16960-2_54-1

Carbon Budgets Working Group Workshop AGENDA Date: 13th of September 2023 Start time: 13:30 – 16:30 Venue: EPA Offices, Dublin & Microsoft Teams	
Time	**Agenda Item**
13:15	**Welcome Tea and Coffee**
13:20	**Electronic meeting room to open**
13:30	**1. Building Blocks for scenarios for CB3 and CB4** • 2030 starting points: staying within carbon budget 1 and 2, underperformance (EPA WAM), overperformance (sensitivity) • Targets for 2050: based on an emissions trajectory consistent with specific temperature outcomes and based on an emissions trajectory towards net zero greenhouse gas emissions in 2050 • Considering the ESAB recommendation for an EU 2040 climate target
14:15	**2. Scenario development for 2nd Carbon Budget Programme** • Shared understandings to inform scenario development by Teagasc (FARPI), NUIG (GOBLIN), UCC (TIMES) and SEAI (NEMF) • Discussion of potential for integration and discrepancies • Anticipated outcomes
15:30	**3. Competing Land Use Requirements** • Land use and model representations of biodiversity constraints • Afforestation, Biomethane, Nitrogen demand (water quality/air quality)
16:00	**4. Timeline for Modelling/Analysis Iteration 1** • Checking in with the Carbon Budgets Work Plan
16:20	**5. Next Steps** • Secretariat to prepare an outcome report for CCAC meeting on 28th September • Modelling/Analysis Iteration 1 to commences following CB WG meeting No. 7 on 19th October
16:30	**Workshop Finish**

Commented [redacted]**:** Proposing to have a brief call with each to discuss in advance of workshop