Northern Ireland Assembly

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Briefing Paper

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Methane and Biogenic methane – an overview

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1 Introduction

This paper has been prepared in response to a request from the Assembly's Agriculture, Environment and Rural Affairs Committee for the purpose of supporting the Committee's scrutiny of the Climate Change Number 1 and Number 2 Bills.

The paper provides an overview of methane and biogenic methane in the following key areas:

- Background – including methane cycle;
- Methane emissions and emissions removal;
- Significance of methane – climate change impacts;
- Overall emissions targets and specific methane targets;
- Biogenic methane in other climate change legislation – selected jurisdictions.

2 Methane and biogenic methane: background

Methane is a colourless and odourless gas, composed of one carbon atom and four hydrogen atoms (CH4). Methane accounts for 0.00018%[1] of the earth's atmosphere in terms of volume, which makes it one of the smallest trace gases by volume.

As well as being the primary component of natural gas, and a by-product from the burning of fossil fuels, methane is also produced through a series of natural processes across nature and agriculture such as emissions from animals and the decay of organic matter. The actual methane cycle in terms of source of emissions, capture and breakdown of methane is set out in figure 1 below.

Figure 1: Simplified methane cycle[2]

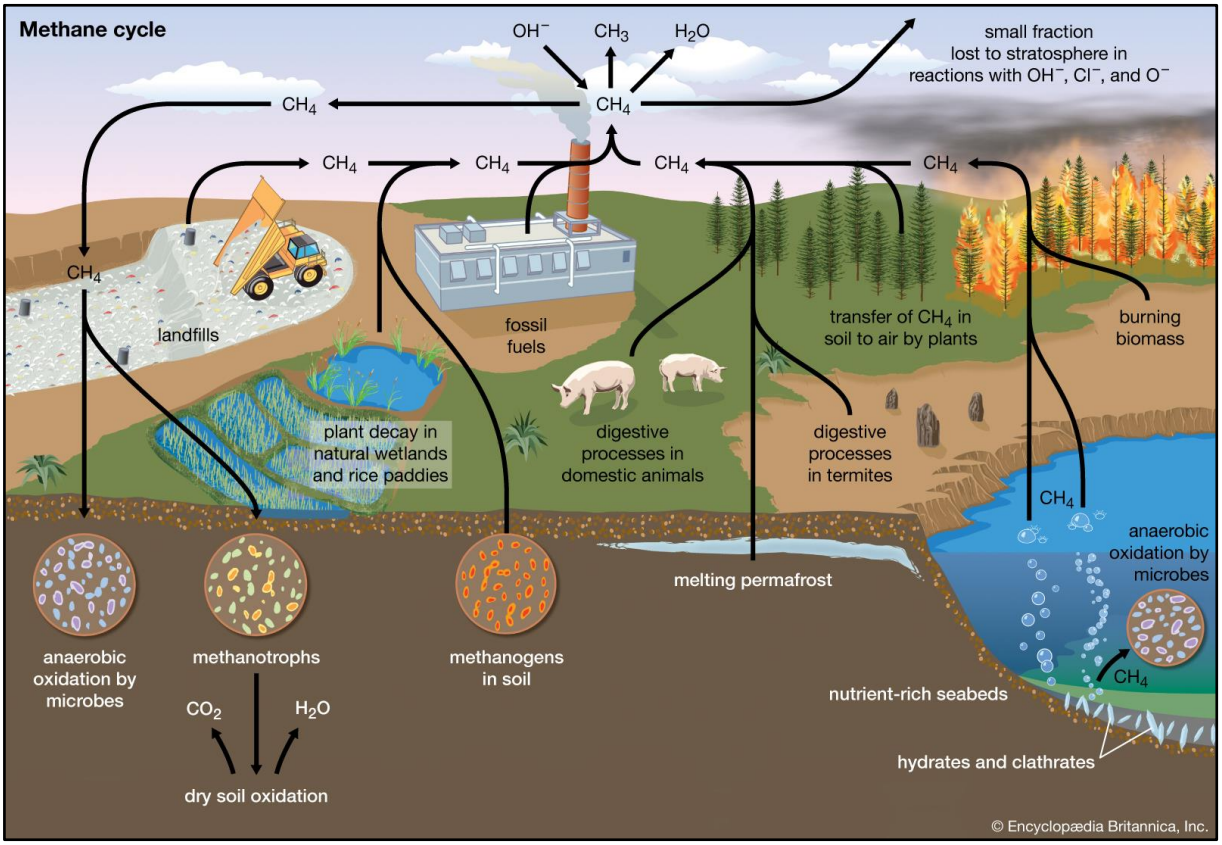


Figure 1 is very much a simplified version of the methane cycle but it does highlight the multiple sources for methane within the earth's atmosphere.

In should be noted that efforts to distinguish the source of atmospheric methane have resulted in the adoption of terminology such as biogenic methane. This term effectively refers to methane emissions from either animals or plants.

[1] The Atmosphere: Getting a Handle on Carbon Dioxide, NASA's Jet Propulsion Laboratory website, 9 October 2019
[2] Methane cycle, Encyclopaedia Britannica website, 23 August 2021

Additionally, figure 1 illustrates how methane is broken down within the atmosphere. Whilst this process is complex, oxidation by hydroxyl radicals[3] (OH) within the atmosphere results in methane being broken down into a number of other compounds such as[4]:

- water (H20),
- carbon monoxide (CO),
- carbon dioxide (CO2) ,
- methyl radical (CH3),
- methyl hydroperoxide (CH3OOH)
- formaldehyde (HCHO)

The breakdown of methane within the atmosphere, and in particular, the troposphere (lower atmosphere), makes it the most significant 'sink' for methane, with this tropospheric removal estimated to be 506 million tonnes(Mt)[5] of methane per year globally, whilst stratospheric removal accounts for an estimated 50 Mt[6] per year globally.

In addition to atmospheric oxidation, methane can be oxidised within the soil by methanotrophic bacteria and this process leads to the production of water and carbon dioxide. This process is estimated to remove around 30 Mt annually at a global scale[7].

3 Methane emissions and removal: statistics

3.1 Global emissions and removal

The Global Carbon Project (GCP), established in 2001, holds data on global methane emissions derived from both observational networks and modelling groups. In July 2020 the GCP published their most recent methane budget document[8] and figure 2 below, taken from the report presents the global methane budget[9] for 2017.

[3] Hydroxyl radicals are effectively a chemical scavenger in the troposphere, controlling the atmospheric lifetime of most gases in the troposphere

[4] C N. Jardine, B Boardman, A Osman, J Vowles and J Palmer, Environmental Change Institute, University of Oxford, Methane UK, page 89

[5] C N. Jardine, B Boardman, A Osman, J Vowles and J Palmer, Environmental Change Institute, University of Oxford, Methane UK, Chapter 2, Climate science of methane,

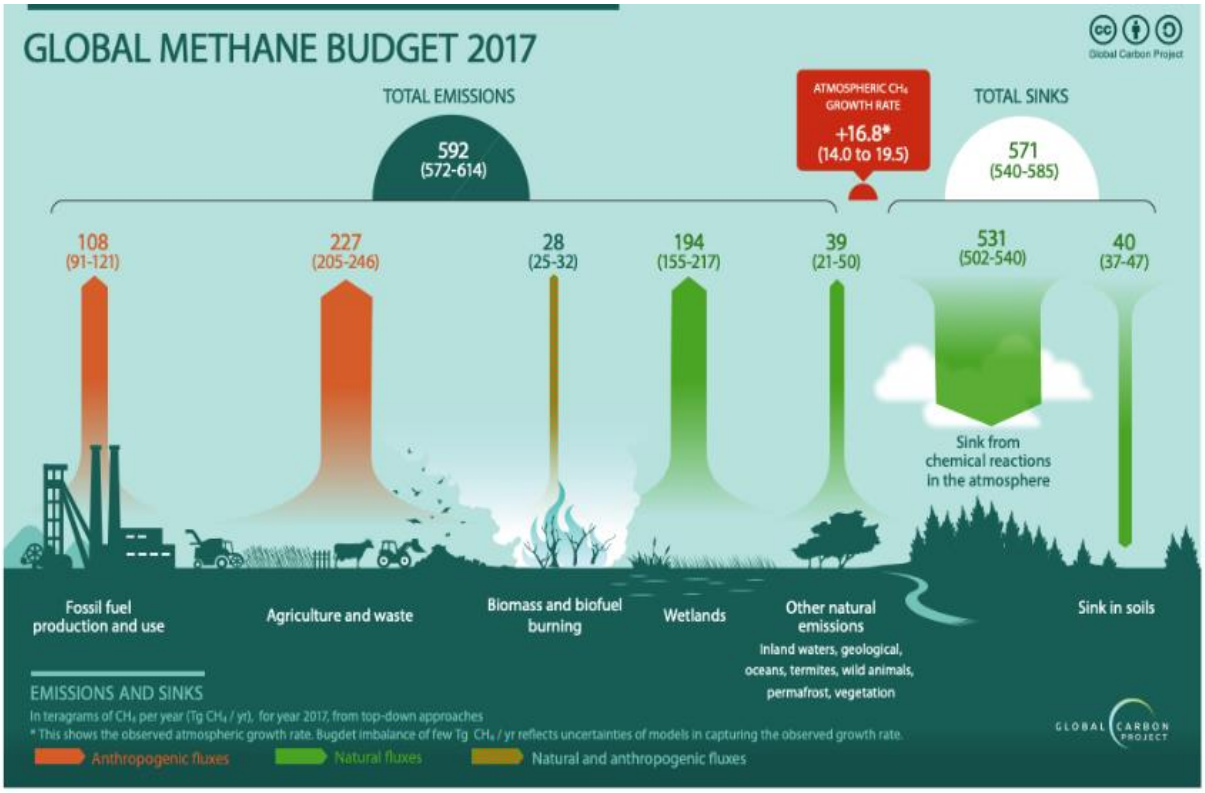
[6] ibid

[7] ibid

[8] Powerpoint and figures on the Methane Budget 2020, Global Carbon Project website, 23 August 2021

[9] The Global methane budget process is a means of accounting for levels of methane added to and removed from the world's atmosphere

Figure 2: Global Methane Budget[10]



Based on the data in figure 2, global methane emissions in 2017 equated to 592 teragrams/million tonnes and the actual source breakdown for this total was as follows:

- Agriculture and waste – 227 teragrams/million tonnes (38%);
- Wetlands – 194 teragrams/million tonnes (33%);
- Fossil fuel production and use – 108 teragrams/million tonnes (18%);
- Other natural emissions (inland waters, geological, oceans, termites, wild animals, permafrost, vegetation) - 39 teragrams/million tonnes (6%);
- Biomass and biofuel burning – 28 teragrams/million tonnes (5%).

Agriculture and waste emissions were the most significant source of atmospheric methane, followed by emissions from wetlands.

A key point to notice in relation to 2017 global methane emissions is the fact that total emissions exceeded the ability of sinks to remove methane by 21 teragrams/million tonnes.

The GCP data also makes a number of observations around the geographical distribution of methane emissions in 2017 as follows[11]:

- 64% of global methane emissions come mostly from tropical sources;

[10] ibid
[11] ibid

- Largest emissions in South America, Africa, South-East Asia and China (50% of global emissions)
- Dominance of wetland emissions in the tropics and boreal regions;
- Dominance of agriculture and waste in Asia;
- Balance between agriculture and waste and fossil fuels at mid-latitudes – which includes UK and Ireland.

3.2 Local emissions and removal

In 2019 Northern Ireland's methane emissions were estimated to be 4.8[12] million tonnes of CO_2 equivalent (MtCO2e).

This 4.8 million tonnes (MtCO2e) equated to 22% of Northern Ireland's total greenhouse gas emissions of 21.4 million tonnes (MtCO2e) in 2019. Comparatively, methane accounted for 12% of total UK emissions for 2019[13] and 24.6%[14] of total greenhouse gas emissions in Ireland in 2019.

With regards to the sources of methane emissions in Northern Ireland, the 2019 data identifies agriculture as being responsible for 77% (3.7 million tonnes (MtCO2e)) of total methane emissions. Table 1 below highlights the sources from the 2019 data.

Table 1: Methane emission sources in Northern Ireland 2019[15]

Source	Emissions (MtCO2e)	Percentage
Agriculture	3.7milion tonnes	77
Waste management	0.7 million tonnes	15
Land use change	0.3 million tonnes	6
Residential	0.1 million tonnes	2

Comparing the sectoral share of methane emissions for the whole UK and Ireland (see table 2 below) it is apparent that agriculture is a less significant source across the whole UK and a more significant source in Ireland as compared to Northern Ireland.

Table 2: Methane emission sources UK and Ireland 2019

Source	Whole UK – percentage of methane emissions from source – most recent data 2019[16]	Ireland – percentage of methane emissions from source – most recent data 2019[17]
Agriculture	47% (25.2 million tonnes (MTCO2e))	93% (13.72 million tonnes (MTCO2e))
Waste management	32% (17 million tonnes MTCO2e)	5% (0.7million tonnes (MTCO2e))
Land use, land use change	9% (4.9 million tonnes MTCO2e)	No data

[12] Northern Ireland Greenhouse Gas Emissions 2019, DAERA, 2020
[13] ibid
[14] Latest emissions data, Environmental Protection Agency website, 23 August 2021
[15] Northern Ireland Greenhouse Gas Emissions 2019, DAERA, 2020
[16] Derived from table 1.4 Final UK greenhouse gas emissions national statistics: 1990 to 2019, national statistics, Department for Business, Energy and Industrial Strategy, February 2021
[17] Derived from Green House Gas Emissions, summary by gas, Environmental Protection Agency website, 23 August 2021

Source	Whole UK – percentage of methane emissions from source – most recent data 2019[16]	Ireland – percentage of methane emissions from source – most recent data 2019[17]
Energy supply	10% (5.4 million tonnes MTCO2e)	0.5% (0.08 million tonnes (MTCO2e))
Residential	2% (1 MTCO2e)	0.8% (0.13 million tonnes (MTCO2e))

The 2019 emissions data presented in tables 1 and 2 also suggest land use change, is currently a net emitter rather than a sink for methane, within the UK as a whole and Northern Ireland. There appears to be no comparable data for Ireland.

Land use change is defined within the DAERA Green House Gases emissions 2019 report as follows:

> *sinks and sources of emissions from land use, land use change and forestry. Sinks remove GHGs from the atmosphere whilst sources emit GHGs. Emissions are affected by deforestation rates and land management.*

With specific regards to the 2019 DAERA Northern Ireland emissions statistics, it is worth noting that the statistical report includes the following qualifying statements in relation to methane and nitrous oxide emissions data:

> *There remains greater uncertainty around emissions in Northern Ireland compared to other parts of the United Kingdom due to the relative importance of methane and nitrous oxide emissions in the agriculture sector. Emissions of these gases are more difficult to estimate than carbon dioxide, and the agriculture sector makes up a larger share of Northern Ireland's emissions than in other parts of the UK. In addition, the fuel activity data for Northern Ireland is more uncertain than other devolved administrations, due to the greater use of solid fuels and oils[18].*

Potential questions/observations

- Given the particular concerns that the DAERA emissions statistics flag around methane and nitrous oxide emissions in relation to limitations of the available data, what steps is the department taking to both better understand and accurately measure methane emissions here? When are any such steps likely to yield results?
- Building on the previous point, are we likely to see either an upgrading or downgrading of the level of methane emissions here with more robust data? Is there any potential for significant change in the sources of methane emissions if more comprehensive and accurate data can be produced?
- Given the apparent discrepancy at a global and local level in relation to landuse/soil acting as either a sink or source for methane, why is Northern Ireland a net emitter

[18] ibid

from this source? Is this an indication of an inadequacy in our soils and if so what can be done to make them an effective sink for methane? What level of resource would this require and how long would any such approach take to deliver results?

- Within the context of our local landuse/soil being a net emitter for methane and the apparent dominance of agriculture as the chief methane emitter, what are the potential ramifications for local agriculture and other sectors if significant methane emissions reductions are required as part of local climate change legislation? Does the absence of the methane land use sink locally, make it harder for methane mitigation measures within agriculture to deliver potentially required reductions?

4 The significance of methane

Methane is one of the six main so called 'greenhouse gases'. The available evidence, which is summarised below and based on the Global Warming Potential metric, also suggests that methane is one of the more potent greenhouse gases in terms of its capacity to contribute to warming.

It should be noted that the science around this issue continues to develop. A key issue driving this development is how best to model and assess the impacts of the various greenhouse gases.

The commonly deployed methodology of global warming potential (GWP) is used by the Intergovernmental Panel on Climate Change (IPCC) in its work and table 3 below provides an overview of the GWP for a number of key greenhouse gases, including methane.

In basic terms, the global warming potential (GWP) methodology is based upon equivalence in terms of warming effects using carbon dioxide as a reference point. By way of illustration, and utilising the data in table 3, 1 tonne of emitted methane equates to 28 tonnes of carbon dioxide under GWP 100 and 1 tonne of emitted methane equates to 84 tonnes of carbon dioxide under GWP 20. In effect methane is either 28 or 84 times more potent than carbon dioxide in terms of its warming effects, using the predominant GWP 100 and GWP 20 metrics.

Table 3: Global Warming Potential and Lifetime data for selected greenhouse gases[19]

Gas	Lifetime	GWP 20 (over 20 years)	GWP 100 (over 100 years)
Carbon dioxide	Variable – can be thousands of years	1	1
Methane	12.4 years	84	28

[19] Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forc-ing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Table 8:A:1,page 731

Gas	Lifetime	GWP 20 (over 20 years)	GWP 100 (over 100 years)
Nitrous oxide	121 years	264	265
Tetrafluoromethane	50,000 YEARS	4880	6630

Whilst the data in table 1 illustrates the potency of methane in terms of its warming potential, it is also important to point out that it is a relatively short-lived gas within the atmosphere, with a lifetime of 12.4 years.

Whilst GWP remains the predominant metric/methodology at this moment in time in terms of assessing climate impacts from emissions, there is another less commonly utilised metric/methodology referred to as Global Temperature change Potential (GTP)[20]. The GTP metric focuses on the actual temperature impact of a pulse/release of gas relative to the actual temperature impact of a pulse/release of carbon dioxide with equal mass, over the same period of time. Similarly to GWP, GTP values are generally considered over either a 20 year or 100 year period.

The relatively short life of methane is one of the main reasons why there is continuing debate around how best to provide a comprehensive and accurate assessment of the potential warming impacts from methane.

As an added complication, the IPCC now accepts that differing sources of methane have differing warming potentials. Methane from fossil fuel sources for example has slightly higher emission metric values than those from biogenic sources (high confidence)[21], largely due to the release of carbon dioxide from combustion.

It should be noted that there are potentially other emerging metrics that could be utilised for the measurement of the warming effects of methane and other gases. The science here is continuing to develop and the IPCC's recent Sixth Assessment Report identifies a number of emerging metrics including Combined – Global Temperature Potential (C-GTP) and Global Warming Potential *(GWP*)[22]. Whilst the nature of this paper does not allow a detailed analysis of these emerging and relatively complex metrics, in broad terms they have been conceived in order to try and take account of the short-lived nature of gases such as methane, and by so doing provide a more accurate assessment of emission impacts.

[20] Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forc-ing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA., Chapter 8, Section 8.7.1.3, Page 712

[21] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change[Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press.In Press, Chapter 7 page 122 (7-122)

[22] ibid

The IPCC sixth assessment report includes the following commentary around the measurement of greenhouse gases including methane

> *As pointed out in AR5, ultimately, it is a matter for policymakers to decide which emission metric is most applicable to their needs. This Report does not recommend the use of any specific emission metric as the most appropriate metric depends on the policy goal and context*[23].

Potential questions/observations

- What consideration is being given locally to capturing the differing impacts of methane from different sources? Is this issue being actively addressed within the current legislative process and any associated targets?
- What metric/methodology is forming the basis for any potential green house gas emissions reductions effort within the UK and Northern Ireland at present? Is GWP100 the predominant metric being deployed?
- Given the IPCC sixth assessment report comments around the choice of metric being up to policy makers and the objectives they are seeking to deliver, what are the policy objectives relating to methane emissions and other greenhouse gases in Northern Ireland? Is the focus on directly limiting or reducing world temperature increases, or limiting or reducing emissions, and by so doing limiting or reversing temperature increases?
- Is there any potential merit in Northern Ireland setting green house gas emissions targets informed by the use of emerging metrics such as Combined Global Temperature Potential (C-GTP) and Global Warming Potential *(GWP*)?
- Would policy makers in Northern Ireland have the power or interest in utilising some of these emerging metrics? Have DAERA assessed which metric is most appropriate to our needs in Northern Ireland?
- Has there been any local assessment as to what the impacts would be from the adoption of one of the emerging metrics? What could this mean for a net zero green house gas emissions target for example?
- If we did adopt one of the emerging metrics, would it change our approach to reducing methane emissions, particularly those from agriculture? How would this affect overall targets for greenhouse gas emissions reductions within proposed local climate change legislation? Would there be a knock-on disproportionately higher burden on sectors/sources producing more carbon dioxide to compensate for any associated lower reductions in methane?
- Would the use of emerging metrics better enable the agricultural sector here to reduce their emissions in a more sustainable but no less effective way?

[23] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change[Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press.In Press, Technical Summary page 66 (TS-66)

5 Overall emissions targets and specific methane targets

The following section explores overall emission targets across selected local jurisdictions with primary climate change Acts: UK jurisdictions, Ireland, the two recently introduced Climate Change Bills for NI (Climate Change Bill No.1 and Climate Change Bill No.2) and the UK CCC advice.

Table 4 explains what the CCC advises and what the Climate Change Bill No.1 (Bill No.1), Climate Change Bill No.2 (Bill No.2) and the recently enacted (23 July 2021) Irish Climate Action and Low Carbon Development (Amendment) Act 2021 state in relation to their overall target. It also explains what this means in relation to reduction of all GHGs, carbon and biogenic methane.

Table 5 gives a brief overview of the difference between all GHG targets and carbon only targets in other countries (Netherlands, Finland, Austria, Sweden and NZ.).

5.1 Net zero

Net zero GHG is described as means "*achieving a balance between the amount of greenhouse gas emissions produced and the amount removed from the atmosphere*". It does not mean reducing all emissions to zero (which would be gross zero). Net zero recognises that there will be some emissions, and that these need to be off set through natural sinks and carbon removal technologies[24].

Before considering the different targets displayed in the following table, it is important to establish the difference in terms and differences used, from net zero carbon, a reduction of net emissions account and a climate neutral economy. All of which require a net contribution from all GHG.

Achieving net zero for all GHGs, means that all gases must contribute to an overall zero, and therefore some may be required to make up any shortfall in the gases not able to reach zero.

It is important to note here that the NI Climate Change Bill No.1 refers to achieving "net zero carbon" in its overall 2045 target, but later defines this as meaning net zero all GHGs (cl2 (6)).

Consideration:

There appears to be a complexity around the range of terms and definitions used in association with emissions targets. For example, the use of net zero carbon (which in some cases is defined as including all GHGs e.g. Bill No.1) and net zero CO2 (which the CCC advice for NI (2021) refers to as meaning CO2 only). These inconsistencies make consideration of methane emissions and comparisons of targets across different legislation, using different terminologies, challenging.

[24] https://www.instituteforgovernment.org.uk/explainers/net-zero-target

5.2 Overall emissions targets from selected local jurisdictions/legislation

Table 4 refers to the following:

- The CCC Advice for NI (April 2021): https://www.theccc.org.uk/publication/letter-economic-costs-of-setting-and-delivering-a-2050-emissions-target-for-northern-ireland/
- NI Climate Change Bill No.1 (Bill No.1) sponsored by Clare Bailey MLA (as introduced) - http://www.niassembly.gov.uk/assembly-business/legislation/2017-2022-mandate/non-executive-bill-proposals/climate-change-bill/
- Climate Change Bill No.2 (Bill No.2) brought by the Executive (as introduced) - http://www.niassembly.gov.uk/assembly-business/legislation/2017-2022-mandate/primary-legislation---bills-2017---2022-mandate/climate-change-bill/
- The Irish Climate Action and Low Carbon Development (Amendment) Act 2021 enacted 23 July 2021 (the Irish Act 2021) amending the Climate Action and Low Carbon Development Act 2015.

Table 4: Local Overall Targets

	CCC advice	Bill No.1	Bill No.2	Ireland
Overall target	*To **reduce all greenhouse gas (GHG) emissions by at least 82% by 2050.*** *This contribution to the UK Net Zero target would require Northern Ireland to reach **net-zero CO2 emissions by 2050**, as well as significantly reducing emissions of other GHGs including methane* CCC Letter (April 2021)	The establishment in Northern Ireland of a net-zero carbon, climate resilient and environmentally sustainable economy by the year 2045	The Northern Ireland departments must ensure that the net Northern Ireland emissions account for the year 2050 is at least 82% lower than the baseline	National Climate Objective: The State shall, so as to reduce the extent of further global warming, pursue and achieve, by no later than the end of the year 2050, the transition to a climate resilient, biodiversity rich, environmentally sustainable and climate neutral economy 51% reduction under the carbon budget by 2030 relative to a baseline of 2018.
What this means	NI would be required to meet reduction of 82% Green House Gas (GHG) emissions by 2050. This would also require net zero CO2 by 2050.	The Bill defines "net zero carbon" as: "a net reduction of greenhouse gas emissions by at least 100% from the 1990 baseline" (cl.2(6)) This definition means the target relates to net zero all GHGs, so all GHGs must collectively contribute to net zero, 5 years ahead of any of	Net Northern Ireland emissions refer to all GHGs as defined under clause 37 of the Bill (carbon dioxide; methane; nitrous oxide; hydrofluorocarbons; perfluorocarbons; sulphur hexafluoride; nitrogen trifluoride) Therefore, all GHGs must contribute to 82% reductions.	The face of the Act does not explicitly mention net zero, but refers to terms such as **climate resilient**[25], and **climate neutral economy**[26] by 2050. Government commentary[27] around the development of the Act suggests it is the main mechanism for delivering net zero by 2050, in line with Ireland's Programme for Government (PfG) *Our Shared Future* (detailed below) The 51% reduction of GHGs by 2030 is to be **proposed** in the carbon budget by the Advisory

[25] The Irish Act 2021, nor its predecessor (the Climate Action and Low Carbon Development Act 2015) appear to define climate resilience. The National Adaptation Framework and Mitigation Plan refer to the EU New Green Deal and commitments to climate resilience. The EU Commission describes a climate resilient Europe to include resilience of environmental, social and economic and political systems. For more detail see **A Climate Resilient Europe by 2030 (2020).**

[26] The Irish Act 2021 defines climate neutral economy as: "a sustainable economy and society where greenhouse gas emissions are balanced or exceeded by the removal of greenhouse gases" (s.3). The Oireachtas Bill Digest refers to the term "climate neutrality" by 2050 under the National Objective (p.4 and 6). While the Act itself does not define "climate neutrality" a proposed EU Climate Law (March 2020) links it's *Climate Neutrality Objective* (Article 2) as achieving net zero by 2050: "*Union-wide emissions and removals of greenhouse gases regulated in Union law shall be balanced at the latest by 2050, thus reducing emissions to net zero by that date."*

[27] https://www.gov.ie/en/press-release/22e97-government-approves-landmark-climate-bill-putting-ireland-on-the-path-to-net-zero-emissions-by-2050/ and https://www.gov.ie/en/publication/984d2-climate-action-and-low-carbon-development-amendment-bill-2020/ and Leo Varadkar states the Act's commitment to net zero during Bill stage, at a joint press conference: https://www.irishtimes.com/news/politics/cabinet-approves-climate-bill-which-commits-state-to-net-zero-carbon-by-2050-1.4517917

	CCC advice	Bill No.1	Bill No.2	Ireland
		the other examples in this table. This target cannot be adjusted to lower the target or move the date back.		Council, and made binding through approval of the Government and Oireachtas ((cl.9 6A 6B)).
Carbon (CO2)	Net zero by 2050	Contributes to net zero by 2045	Contributes to 82% by 2050	As above - currently not specifically defined in legislation, but net zero by 2050 is implied, along with all other GHGs. The Carbon budget – states 51% reduction all GHGs, not just carbon. Further detail will emerge through the Long-Term Strategy, Climate Action Plan, sectoral plans and sectoral emissions ceilings.[28]
Methane	To achieve 82% for all other GHGs (apart from CO2), methane would be required to reduce by 42% between 2020 and 2050.	Even though the overall target says "net zero carbon" the Bill defines this as net zero all GHGs,. This means methane must contribute to net zero by 2045. • does this mean methane itself does not have to be net zero, in order to contribute to overall net zero? • Will other gases have to compensate for any shortfall e.g. negative CO2?	Methane must contribute to a collective 82% reduction for all GHG. However, unlike the CCC advice, as yet, this Bill does not provide detail on methane's contribution to collectively reach 82% reduction 2050.	There is no separate methane (or biogenic methane) target. Currently, in the development of the climate action plan and national long-term climate action strategy, the Minister and Government must have regard to "*the special economic and social role of agriculture, including with regard to the distinct characteristics of biogenic methane"* However an amendment at the Dáil Report stage suggested a separation of biogenic methane in relation to the overall National climate objective: *", other than biogenic methane, which shall be accounted for separately due to its distinct characteristics".* However, the Act was enacted without such an amendment

[28] For more info: https://www.gov.ie/en/publication/984d2-climate-action-and-low-carbon-development-amendment-bill-2020/

Table 5: Overall targets from other countries

Country	Emissions Targets
Netherlands	All GHGs - 95% by 2050 and 49% by 2030 (Climate Act 2019)[29] Climate Agreement under the Climate Act aims for carbon neutrality by 2050 across its 5 sectors: electricity, industry, the built environment, mobility, and agriculture and land use.[30] It produces carbon dioxide reduction objectives across sectors: • reduction of 3.4 Mt of carbon dioxide in the built environment by 2030 (includes 50% CO2 reduction of 1990 levels in non-residential buildings by 2030) • carbon free electricity system by 2050. Requires reduction of carbon emissions by at least 20.2 Mt by 2030.
Finland	Carbon neutral by 2035[31]
Sweden	Net zero all GHGs by 2045[32]
Austria	Carbon neutral by 2040[33]
New Zealand	Net zero all GHGs by 2050 except biogenic methane Biogenic methane - 24%-47% below 2017 levels by 2050

**Carbon neutrality: according to the European Parliament, this means "having a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks." More information can be found here https://www.europarl.europa.eu/news/en/headlines/society/20190926STO62270/what-is-carbon-neutrality-and-how-can-it-be-achieved-by-2050*

[29] https://www.government.nl/topics/climate-change/climate-policy
[30] IEA (2020) https://www.iea.org/reports/the-netherlands-2020
[31] https://sustainabledevelopment.un.org/partnership/?p=33186
[32] https://www.swedishepa.se/Environmental-objectives-and-cooperation/Swedish-environmental-work/Work-areas/Climate/Climate-Act-and-Climate-policy-framework-/
[33] https://www.iea.org/reports/austria-2020

Potential question/observations

- The CCC advice states that to reach 82% reduction of GHGs, CO2 would have to go further and reach net zero.
- Does a net reduction under local Climate Bill No.2 and net zero under local Climate Bill No.1 mean other gases will have to make up the shortfall for those gases not able to reach the target? For example, could this require carbon (through reduction or removal) to do the heavy lifting?
- If so, is this possible? Do the larger carbon emitting sectors in NI, (transport, energy supply, residential[34]), feel this is possible by 2045?
- Unlike the CCC advice, local Climate Bill No.2 does not suggest net zero CO2 along with an 82% reduction of GHG emissions. Does DAERA feel net zero CO2 is not required for an overall 82% reduction, given NI's methane levels and ability to reduce it?
- Will DAERA suggest contributions from other gases to the overall reduction, similar to the CCC advice of methane 42% reduction 2020-2050?
- Both local Bill No.1 and the Irish Act 2021 aim for net zero all GHGs. While the face of the Irish Act does not explicitly mention net zero, commentary on the Act and Ireland's Programme for Government (PFG) *Our Shared Future* (June 2020), suggests it is the mechanism to deliver net zero 2050:

  > *…an average 7% per annum reduction in overall greenhouse gas emissions from 2021 to 2030 (a 51% reduction over the decade) and to achieving net zero emissions by 2050. The 2050 target will be set in law by the Climate Action Bill, which will be introduced in the Dáil within the first 100 days of government, alongside a newly established Climate Action Council. The Bill will define how five-year carbon budgets will be set.*

  However, the definition of a climate neutral economy under the national target "*a sustainable economy and society where greenhouse gas emissions are balanced or exceeded by the removal of greenhouse gases*" (clause 3), may suggest net zero GHGs without explicitly saying it.

- The Irish Act 2021 provides for an interim target of 51% 2030. This is to be provided under the carbon budget, and applies to all GHGs. This appears to be the only specific emissions target written on the face of the Act. Is this set with the aim of achieving net zero by 2050?
- Similar to net zero under local Climate Bill No.1, may some gases be required to reduce further to make up for shortfalls in other gases not able to reduce enough by 2050? Could this potentially result in negative levels for other gases e.g. CO2?
- In terms of methane, none of the examples in Table 4 provide for a separate target similar to New Zealand. New Zealand does not require biogenic methane to

[34] DAERA (2021) NI GHG Inventory 1990-2019 Statistical Bulletin (p.10) https://www.daera-ni.gov.uk/sites/default/files/publications/daera/NI%20Greenhouse%20Gas%20Statistics%201990-2019_2.pdf

contribute to its net zero 2050 target. Biogenic methane is to be reduced at a lower rate of 24%-47% below 2017 levels by 2050 (see Table 5 and 6). The CCC advice does not suggest a separate target for methane/biogenic methane. However, it is of the opinion that methane should make a fair contribution towards the overall 82% reduction target of 42% from 2020-2050. This is different to the local Climate Bill No.1 which requires all GHG (including methane) to contribute to net zero by 2045. Local Climate Bill No.2 is similar to the CCC advice, where methane is included in the overall 82% reduction. However, unlike the CCC advice, local Climate Bill No.2 has not stated methane's specific contribution to the overall target. What does DAERA envisage methane's contribution to the overall target to be, similar to the CCC or not? And how will this impact the reduction of other gases, e.g. will others be required to reduce further in order to reach an overall 82% reduction?

- The Irish Act 2021 does not provide for a separate methane (or biogenic methane) target. However, discussion around the inclusion of a separate target has been ongoing since the pre-legislative stage[35] and the CCC has acknowledged Ireland's consideration for one[36]. An amendment for accounting for biogenic methane separately under the overall objective, had been suggested at the Dáil Report stage (as mentioned in the table)[37]. That being said, the Act was passed without any amendment for the inclusion of a separate methane target[38].
- In terms of methane, the local Climate Bill No.1 and Ireland are most similar with both aiming for net zero contribution. However, Bill No.1 aims for it 5 years earlier than Ireland. With both regions' agricultural sectors contributing the most to Greenhouse Gas (GHG) emissions, it remains to be seen what targets will be imposed in Ireland under their emissions ceilings in order to reach this. Local Climate Bill No.1 does not have similar sector specific targets or ceilings under its sectoral plans. It remains to be seen what measures will be required to reach net zero in Northern Ireland ahead of Ireland, and whether sector agreements, as used by the Netherlands, would be a mechanism.
- Any scenario under Northern Ireland requires a net contribution, whether it's net zero, or 82%. Should methane struggle to meet this, would other gases, such as CO2, be required to reduce further in order to meet any shortfall from methane? Would other sectors have the ability for this in order to reach net zero all GHGs under the local Climate Bill No1. Would DAERA envisage CO2, or other gases, to reduce further than 82%, depending on methane's contribution under Bill No.2?

[35] Oireachtas Joint Committee PLS Report https://www.oireachtas.ie/en/press-centre/press-releases/20201218-joint-committee-on-climate-action-launch-report-on-pre-legislative-scrutiny-on-the-draft-of-the-climate-action-and-low-carbon-development-amendment-bill-2020/ (p.12/13)

[36] See CCC (2020) Advice on the UK's Sixth Carbon Budget 2033-37 – implications for Northern Ireland (p.30). Available at https://www.theccc.org.uk/publication/sixth-carbon-budget/

[37] Oireachtas Report Stage (15 June) Amendment 35 https://data.oireachtas.ie/ie/oireachtas/bill/2021/39/dail/4/amendment/numberedList/eng/b39a21d-drnl.pdf

[38] Oireachtas Climate Action and Low Carbon Development (Amendment) Act 2021 https://www.oireachtas.ie/en/bills/bill/2021/39/

- Other countries in Table 5 display other examples of terminology: Finland and Austria have early carbon neutral targets (2035 and 2040 respectively). Sweden is net zero all GHGs by 2045, and New Zealand by 2050, except for biogenic methane which has a separate lower target. Similar to the local Climate Bill No 2, Netherlands is not aiming for net zero with any of its GHGs, but 95% for all GHGs by 2050. It also had a non-CO2 target for methane and nitrogen (25-30% by 2020). This was achieved early in 2015 due to reduction in nitrogen, despite increases in methane emissions.[39]
- Sweden and the local Climate Change Bill No. 1 appear to have the highest and earliest overall target of all examples in the table with net zero all GHGs by 2045. Climate Change Bill No.1 appears to be the only one that refers to its overall target as net zero carbon, but defines this as meaning net zero all GHGs (clause 2 (6)).

6 Biogenic methane in other climate change legislation – selected jurisdictions

Table 6 provides examples of other legislation and how it deals with methane (or biogenic methane). For example, as contributing with all other GHGs to the overall target (Netherlands), or with a separate target from the overall target (New Zealand), or how it was considered on a separate basis, but not enacted (Ireland).

Table 6: Biogenic in other legislation

	New Zealand	Netherlands	Ireland
Where targets found	The Climate Change Response (Zero Carbon) Amendment Act 2019 which requires for net zero GHGs by 2050 (except biogenic methane)	Set out in the Climate Agreement to achieve the overall GHG reduction target under the Climate Act 2019 (binding objective of 95% reduction of GHG emissions by 2050 with a 2030 target of 49%). Also written under the Coalition Agreement 2017-2021	Draft Climate Action and Low Carbon Development (Amendment) Bill 2020 .This amends the Climate Action and Low Carbon Development Act 2015.
Methane/Biogenic methane targets	Separate target for biogenic methane: Reduction of 24%-47% below 2017 levels by 2050 and 10% by 2030.	Climate Agreement contains agreements with the sectors on their contribution to the overall target. It sets sector specific reduction amounts (in megatonnes) by 2030 to achieve the overall 2050 - 49%,. For methane:	The final Act does not provide for a separate biogenic methane or methane target under its National Climate Objective. However an amendment at the Dáil Report stage suggested a separate account for biogenic methane in

[39] OECD (2020) https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=COM/TAD/CA/ENV/EPOC(2019)20/FINAL&docLanguage=En p.25

	New Zealand	Netherlands	Ireland
		- 1MT reduction in methane from agri sector by 2030 – p.125 - land use sector - reduction of 1.5 Mt of methane and nitrous oxide by 2030 These contribute to the overall reduction of 3.5MT in *all GHG* emissions from agri and land use sector by 2030 under the Coalition Agreement (2017-2021). This sets out that "*technical measures (e.g. manure processing, mixed feed and energy-producing greenhouses) will take preference over measures aimed at curbing volumes." (p.*125) Non- CO2 reduction target (methane and nitrogen) – reduction of 25-30% by 2020 compared to 1990. (Target achieved by 2015 due to reduced use of nitrogen fertiliser. Methane increased due to increase of dairy cattle.)[40]	relation to the overall National climate objective: *"other than biogenic methane, which shall be accounted for separately due to its distinct characteristics."* However, this was not accepted into the enacted Act. Further detail on targets etc. will not be known until the National Long-term Strategy, climate action plan, sectoral plans and sectoral emissions ceilings emerge[41].

Observations

- New Zealand provides for a separate biogenic methane target that does not contribute to its overall net zero 2050 target.
- Netherlands does not have a separate methane target. Methane, like all the other GHGs must contribute to the overall binding reduction objective of the Climate Act (95% by 2050). In relation to methane, the government of the Netherlands is of the opinion that:

> *The agriculture and land use sectors will continue down the path previously set out and pursue significant emissions reduction at an accelerated pace.* ***However, even by 2050, greenhouse gas emissions from this sector will be inevitable****. This is because greenhouse gases are inherent to natural products, such as methane and nitrous oxide from animal*

[40] OECD (2020) https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=COM/TAD/CA/ENV/EPOC(2019)20/FINAL&docLanguage=En p.25

[41] For more info: https://www.gov.ie/en/publication/984d2-climate-action-and-low-carbon-development-amendment-bill-2020/

husbandry and fertilisation (even from "green fertilisers"). At the same time, the sector will increasingly be capturing carbon in soils, forests and materials, produce biomass and generate renewable energy. The sector's aim is to achieve an equilibrium between the unavoidable emissions of greenhouse gases, on the one hand, and the capture of greenhouse gases and production of renewable energy and biomass, on the other hand, by 2050

- While specific sectoral targets do not appear to be stated on the face of the Netherlands Act, sector specific agreements (for electricity, industry, built environment, traffic and transport, and agriculture) under the accompanying Climate Agreement are described as providing sector specific "indicative" targets[42]. The Climate Agreement itself is described as a voluntary agreement between the sectors:

  Each sector discussed possible measures and delivered a statement on how their sector would achieve the number of megatonnes of greenhouse gases emissions reduction necessary for that sector by 2030 in order to reach the joint 49 per cent reduction target. The measures presented and their consequences for greenhouse gas emissions are indicative[43].

- For example, under the Climate Agreement, by 2030: 1MT reduction in methane from the agri sector and 1.5MT reduction of methane and nitrous oxide from the land use sector. The "indicative" nature of the agreement targets imply that these are not binding targets, but agreements set between individual sectors. Sectors are responsible for implementing the agreements. However, the indicative nature suggest they are not held accountable. While both NI Bills do not provide for sector specific targets, could we see similar agreements between sectors in NI?
- Ireland does not have a separate methane or biogenic methane target. An amendment was suggested for one, but not accepted into the final Act. However, sectoral targets/emissions ceilings are yet to be developed and whether methane's contribution and ability to reduce will be considered is yet to be seen.
- A NI target of net zero all GHGs under Bill No.1 would require NI methane levels to contribute to net zero. How close to zero could methane levels go given natural processes from livestock and peatlands and the LULUCF sector currently being more of an emitter than a sink, based on the latest NI GHG Inventory?[44] The addition of peatlands and wetlands to the inventory has seen an overall increase in

[42] Netherlands Climate Agreement (p.6) https://www.klimaatakkoord.nl/documenten/publicaties/2019/06/28/national-climate-agreement-the-netherlands

[43] Gerrit Van Der Veen and Kars De Graaf (2020) Chapter XXIII Climate Litigation, Climate Act and Climate Agreement in the Netherlands (p.467) https://rgakdwebsitep.blob.core.windows.net/akdfiles/2753/Climate-Litigation-Climate-Act-and-Climate-Agreement-in-The-Netherlands.pdf

[44] DAERA (2021) NI GHG Inventory 1990-2019 Statistical Bulletin (p.18) https://www.daera-ni.gov.uk/sites/default/files/publications/daera/NI%20Greenhouse%20Gas%20Statistics%201990-2019_2.pdf

NI's emissions (from 19.4 $MtCO_2e$ to 21.7 $MtCO_2e$ for 2018.[45] However, this revision to the 2018 emissions for NI is different to the higher figure reported by the CCC of 25 MtCO2e for 2018[46]).

- Has DAERA identified what gas this overall increase is attributed to? Is it methane, CO2, other, or a combination? If it's a combination, what is the mix?
- In fact, Scotland has attributed its latest figure increase to peatlands:

> *Therefore, whilst year-on-year emissions are falling in Scotland, figures for all years have been revised up significantly, meaning more GHGs were released than previously thought. Peatlands (within the Land Use, Land Use Change and Forestry - LULUCF sector), have contributed most to this upward revision of emissions estimates. LULUCF has traditionally been considered to be a "carbon sink", which absorbs and stores CO_2. However, a new assessment of peatlands shows that historical draining and rewetting of these areas means Scotland's land use is actually a net-contributor to emissions*[47]

- Similar to the CCC's contribution figure for methane to the overall 82% reduction (42% 2020-2050), would Bill No1 provide a methane contribution to net zero? And would Bill No.2 provide for a methane contribution to the overall 82% reduction?
- Would either approach require other GHGs, e.g. CO2, to make up for a higher contribution from other GHGs, such as methane? Could this potentially result in carbon negative to reach net zero overall in Bill No.1, or a greater than 82% reduction under Bill No.2?
- Removals of GHGs, in relation to the net account in both Bills, refer to the LULUCF sector – what is the ability of this sector as a sink? What about the potential contribution of removal technologies?

[45] DAERA (2021) NI GHG Inventory 1990-2019 Statistical Bulletin (p.18) https://www.daera-ni.gov.uk/sites/default/files/publications/daera/NI%20Greenhouse%20Gas%20Statistics%201990-2019_2.pdf

[46] CCC (2020) Letter to Minister Poots (Table 4.1) https://www.theccc.org.uk/wp-content/uploads/2020/12/Lord-Deben-CCC-Letter-to-DAERA-Minister.pdf

[47] Scottish Parliament SPICe Briefing (June 2021) Climate Change Subject Profile (p.25) https://digitalpublications.parliament.scot/ResearchBriefings/Report/2021/6/25/be8e66fd-d94c-424f-8f58-715187431c77-1