



Annual Review 2024

Agriculture and Land Use, Land Use Change and Forestry



CLIMATE
CHANGE
ADVISORY
COUNCIL

Annual Review 2024: Agriculture and Land Use, Land Use Change and Forestry

Submitted to the Minister for the Environment, Climate and
Communications on 2 September 2024

Climate Change Advisory Council
McCumiskey House
Richview, Clonskeagh Road, Dublin 14, D14 YR62

Tel: 01 2680180

Email: info@climatecouncil.ie

www.climatecouncil.ie

© Climate Change Advisory Council 2024

ISBN: 978-1-80009-196-2

How to cite:

Climate Change Advisory Council (2024), *Agriculture and Land Use,
Land Use Change and Forestry Sectoral Review: Annual Review 2024*.
<https://www.climatecouncil.ie/councilpublications/>



Acknowledgements

The Climate Change Advisory Council would like to acknowledge the significant contributions of the Secretariat of the Climate Change Advisory Council to the drafting of this part of the Annual Review 2024, especially:

Phillip O'Brien

Bryn Canniffe

Katherine Dooley

Stephen Flood

Jodie Colgan

George Hussey

The Climate Change Advisory Council also acknowledges the contributions of the following in the preparation of this Review:

- ▶ the Adaptation Committee of the Climate Change Advisory Council,
- ▶ the Environmental Protection Agency (EPA).

The Climate Change Advisory Council would also like to thank:

- ▶ Ecodiversity for their provision of technical and project management services,
- ▶ Prepress Projects for their copy-editing, proofreading, design and typesetting of this Review.



Summary for All

In this fifth part of the 2024 Annual Review, the Climate Change Advisory Council considers emissions from the Agriculture and Land Use, Land Use Change and Forestry (LULUCF) sectors.

Agriculture emissions have fallen by 2.9% since 2018. Despite a fall in emissions of 4.6% in 2023, largely due to a drop in nitrogen fertiliser use and a shift towards protected urea fertilisers, the sector will need to implement all the proposed measures in the latest Climate Action Plan to reach its emissions reduction targets by 2030. The Agri-Climate Rural Environmental Scheme and the Organic Farming Scheme are popular with farmers. Since 2021, the area farmed organically has trebled, to 225,500 hectares in 2023.

Emissions from LULUCF increased substantially in 2023, with further increases projected in coming years as forests become a source of emissions rather than a sink, posing a major challenge to meeting sectoral climate objectives.

Key recommendations

- ▶ The Government must urgently complete the Land Use Review and implement policies and actions arising that align with long-term climate and biodiversity objectives.
- ▶ The Government should develop a robust implementation plan for the Biomethane Strategy in Q1 2025, and provide the necessary support and incentives to underpin the business case for biomethane production and use.
- ▶ The Government needs to incentivise the rapid uptake of the high-impact and cost-effective measures from the Teagasc marginal abatement cost curve to reduce agricultural emissions, including:
 - ▶ increased uptake of protected urea fertilisers,
 - ▶ the use of approved feed additives indoors and the incorporation of additives in slurry that reduce emissions.
- ▶ Reaching target carcass weights of livestock at an earlier age can significantly reduce emissions. Meat processors are encouraged to adjust bonus payments to incentivise farmers to reduce the age of finishing.
- ▶ The Government must urgently engage with landowners and communities, to highlight the financial opportunity for and crucial role of forestry in achieving climate and biodiversity goals and provide improved guidance on the Forestry Programme.
- ▶ Once established, the Just Transition Commission should consider a sector-specific Just Transition Dialogue with farmers, rural workers and communities.
- ▶ The Government, with retailers and consumer organisations, should launch an information initiative to empower people to make low-cost, healthy and sustainable diet choices.
- ▶ The Government should provide the resources necessary for local authorities and Government departments to engage urban and rural communities in an inclusive, incentive-based catchment-level approach to implementing nature-based solutions to manage flood risk.



Abbreviations

CAN	calcium ammonium nitrate
CAP24	Climate Action Plan 2024
DAFM	Department of Agriculture, Food and the Marine
DECC	Department of the Environment, Climate and Communications
EPA	Environmental Protection Agency
IPCC	Intergovernmental Panel on Climate Change
LESS	low emission slurry spreading equipment
LULUCF	Land Use, Land Use Change and Forestry
MACC	marginal abatement cost curve
WAM	with additional measures
WEM	with existing measures

Glossary of terms



Green Book – The Teagasc Green Book Major & Micro Nutrient Advice for Productive Agricultural Crops is a key reference resource used extensively across the sector.

Inventory – A database of greenhouse gas emissions to date from a particular country or sector, updated annually to show year-on-year changes. The Environmental Protection Agency has responsibility for compiling the official national inventory.

Low emission slurry spreading equipment (LESS) – Refers to a range of equipment used in the spreading of slurry that can significantly reduce nitrous oxide and ammonia emissions to the atmosphere and reduce nutrient losses. Use of LESS can improve nutrient use efficiency, reducing the need for additional fertiliser, and so lower farm costs.

Marginal abatement cost curve (MACC) – A MACC ranks the climate impact of potential emissions reductions measures ('abatement') against economic cost-benefit.

Protected urea – A urea (nitrogen) fertiliser that uses an enzyme to slow ammonium production, thus reducing harmful ammonia emissions and the production of the strong greenhouse gas nitrous oxide relative to the use of calcium ammonium nitrate.

With existing measures (WEM) – An emissions projection scenario where all measures currently in force (i.e. legislated for and resourced) are assumed to be implemented. Compiled using EU guidelines to allow consistent assessment of mitigation plans across all Member States.

With additional measures (WAM) – As WEM above but also incorporating all measures outlined in Government plans at the time the projections are compiled. Compiled using EU guidelines to allow consistent assessment of mitigation plans across all Member States.



Acknowledgements	iii
Summary for All	iv
Abbreviations	v
Glossary of terms	vi
Contents	vii
Key observations	viii
Key recommendations	viii
1. Introduction	1
2. Sectoral emissions and key Climate Action Plan targets	1
2.1. Agriculture	1
2.2. Land Use, Land Use Change and Forestry	3
3. Progress on previous Climate Change Advisory Council recommendations	4
4. Indicators	5
4.1. Observations on primary production	5
5. Analysis and discussion	6
5.1. Agriculture	6
5.2. Engagement, communications and shared understanding	9
5.3. Land Use, Land Use Change and Forestry	10
5.4. Resilience and biodiversity	16
5.5. Just Transition within the Agriculture and Land Use, Land Use Change and Forestry sectors	18
References	19



Key observations

- ▶ Provisional inventory figures for the Agriculture sector indicate that emissions fell by approximately 4.6% in 2023 relative to 2022. This represents only a 2.9% reduction in emissions relative to 2018. To continue progress towards meeting its sectoral emissions ceilings, the sector must implement, in full, the mitigation actions envisaged in the Climate Action Plan.
- ▶ Net emissions from the Land Use, Land Use Change and Forestry (LULUCF) sector increased significantly in 2023 relative to 2022. Forest land is likely to have transitioned from a net sink to a net source of greenhouse gas emissions in 2023, and LULUCF emissions are projected to continue to increase further in the period to 2030, making it challenging to achieve the EU emissions reduction target for the sector.
- ▶ The decreased use of nitrogen fertiliser and increased use of protected urea is encouraging, contributing to an estimated 16.9% decrease in Agriculture emissions of nitrous oxide relative to 2018.
- ▶ Both the Agri-Climate Rural Environmental Scheme and the Organic Farming Scheme, under the Common Agricultural Policy 2023–2027, have the potential to reduce emissions and have proven popular. In 2024, there are approximately 5,000 farmers engaged in the Organic Farming Scheme and the area farmed organically in Ireland has trebled since 2021, to 225,500 hectares (5% of farmed land). Ireland is therefore halfway towards its target of 10% organically farmed land by 2030.
- ▶ The high volume of autumn, winter and spring rainfall caused significant disruption to livestock and tillage in Ireland during 2023 and the first half of 2024. Fields were flooded, and farmers faced difficulties gaining access to plant and harvest crops and had to delay the turn-out of animals to grazing. Ongoing monitoring and analysis will be required to fully assess the implications for resilience and need for adaptation at farm and infrastructure level within the sector.

Key recommendations

Strategic

1. As a matter of urgency, the Government should complete the Land Use Review and initiate the implementation of strategic policies and actions consistent with the long-term National Climate Objective of climate neutrality by 2050, including carbon storage and nature protection and restoration.
2. The Government should develop a robust implementation plan for the Biomethane Strategy by the end of Q1 2025, to achieve the ambition in the strategy, and provide the necessary support and incentives to underpin the business case for the production and use of biomethane.



Engagement

3. Once established, the Just Transition Commission should consider a sector-specific Just Transition Dialogue with farmers, rural workers and communities. The dialogue could support stakeholders in fully understanding the costs, benefits and incentives of actions on climate change and could inform knowledge transfer programmes, funding mechanisms, and upskilling and training aimed at farmers, rural workers and communities.
4. The Government must urgently engage with foresters, farmers and communities, highlighting the financial opportunity for and crucial role of forestry in achieving climate and biodiversity objectives, and provide guidance on procedures for the existing Forestry Programme. Administrative barriers to participation in the existing Forestry Programme also need to be addressed urgently.
5. The Council recommends that the Government, led by the Department of Health, launches a policy initiative to empower the public to make cost-effective, healthy and sustainable diet choices.

Technical

6. The Government needs to urgently support and incentivise the uptake of the cost-effective measures identified in the Teagasc marginal abatement cost curve. This includes accelerated roll-out of targeted measures to:
 - ▶ increase the use of protected urea fertilisers, in particular ensuring that suppliers make sufficient product available,
 - ▶ accelerate the implementation of knowledge transfer systems to enable uptake of improved land and nutrient management practices,
 - ▶ create the necessary incentives and support to enable farmers to invest in the routine use of approved feed and manure additive products.
7. Early finishing of livestock has the potential to deliver significant emissions reductions. The Council urges meat processors to reconfigure the carcass specification bonus payment scheme to favour animals finished at an earlier age.

Adaptation and resilience

8. The Government should ensure that local authorities, the Office of Public Works and Department of Agriculture, Food and the Marine have the resources to create broad engagement across urban and rural communities. They should also take a strong, inclusive, incentive-based catchment-level approach to implement nature-based solutions for flood risk management, including rainwater and surface water run-off at the catchment scale.



1. Introduction

Although greenhouse gas emissions from the Agriculture and Land Use, Land Use Change and Forestry (LULUCF) sectors are reported separately under United Nations and EU reporting conventions, the Climate Change Advisory Council examines these together, as their activities are closely integrated. The dominant land use in Ireland is agriculture, followed by forestry.

The Agriculture sector is the largest single source of greenhouse gas emissions, accounting for 34.3% of Ireland’s emissions in 2023.^[1] Agriculture sector emissions account for 48.5% of emissions under the EU Effort Sharing Regulation. Methane (CH₄) and nitrous oxide (N₂O) emissions associated with livestock and dairy production dominate the sector’s emissions profile.

The LULUCF sector is a net source of emissions in Ireland, accounting for 9.3% of total national emissions,^[1] which is unusual in a European context. The sector is complex, with the largest sources of emissions being the management of wetlands and grasslands (see *Section 5.3.4*). Critically, the forest category is switching from net sink to net source of emissions (see *Section 5.3.3*) due to a large proportion of the national forest estate approaching harvesting age, while afforestation rates have been insufficient to balance the removal of stored carbon.

2. Sectoral emissions and key Climate Action Plan targets

2.1. Agriculture

The provisional inventory figures for the Agriculture sector indicate that emissions fell in 2023 by approximately 4.6% relative to 2022.^[1] However, emissions from the sector have decreased by only 2.9% relative to 2018, far short of the mitigation potential of measures identified in the Climate Action Plan.

The Environmental Protection Agency (EPA) has implemented a number of improvements to the methodology for estimating Agriculture sector emissions, largely associated with estimating emissions from livestock.^[1] While these adjustments have reduced the estimated emissions across the full time series, they do not impact Ireland’s performance with respect to targets under the EU Effort Sharing Regulation. The accelerated deployment of mitigation options included in the Climate Action Plan^[2] is required to achieve emissions reduction targets.

The Agriculture sector emitted 61% of its sectoral emissions ceiling in the period 2021–2023 (see Table 1).

Table 1: Reported Agriculture sector emissions for 2021–2023 in the context of the sectoral emissions ceiling (SEC) for the first carbon budget period, 2021–2025.

(Source: Ireland’s Provisional Greenhouse Gas Emissions 1990–2023.^[1])

Carbon budget period	SEC	Reported emissions 2021–2022	Provisional emissions 2023	SEC used 2021–2023 (%)
2021–2025	106 Mt CO ₂ eq	43.73 Mt CO ₂ eq	20.78 Mt CO ₂ eq	60.9%



Table 2 shows the contribution to emissions reductions from key source activities within the Agriculture sector in 2023 relative to 2022 and 2018 (the base year). Emissions reductions occurred across nearly all source activities.

Table 2: Change in Agriculture sector emissions by source activity in 2023 relative to 2022 and the 2018 baseline.

(Source: Ireland’s Provisional Greenhouse Gas Emissions 1990–2023.^[1])

Source activity	Emissions (Mt CO ₂ eq)			Annual change 2023 against 2022 (%)	Change 2023 against 2018 base year (%)
	2018 (base year)	2022	2023		
Enteric fermentation	12.92	13.38	13.09	-2.2%	+1.3%
Manure management	2.56	2.50	2.45	-2.3%	-4.2%
Agricultural soils	4.70	4.23	3.80	-10.1%	-19.0%
Liming	0.46	0.62	0.46	-26.6%	-0.7%
Urea application	0.09	0.13	0.12	-3.6%	+37.7%
Agriculture/forestry fuel combustion	0.59	0.88	0.80	-8.8%	+35.5%
Fishing	0.08	0.05	0.06	+13.7%	-27.9%
Total	21.39	21.80	20.78	-4.6%	-2.9%

The change in emissions between 2018 (the base year) and 2023, shown in Table 2 and Figure 1, indicates that there have been increases in greenhouse gas emissions associated with fossil fuel use (carbon dioxide (CO₂)), enteric fermentation (CH₄) and urea application (CO₂). However, these increases have been offset by a larger reduction in emissions from agricultural soils (N₂O), and smaller reductions in emissions from manure management (CH₄ and N₂O) and reduced use of lime (CO₂). The decreased emissions from agricultural soils are due to reduced nitrogen fertiliser use and an increased use of protected urea, displacing calcium ammonium nitrate (CAN), both contributing to an estimated 16.9% decrease in nitrous oxide emissions relative to 2018. It is important to maintain this progress and to ensure a limited rebound in fertiliser use if or when fertiliser costs fall or output prices rise.

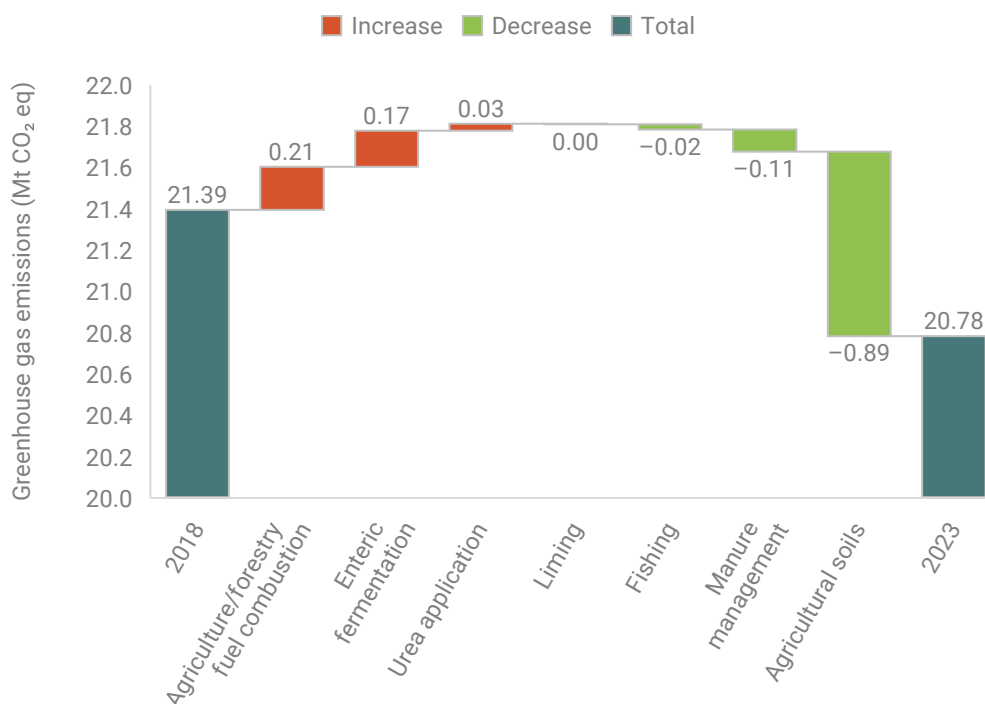


Figure 1: Change in Agriculture sector emissions by source activity in 2023 relative to 2018 base year.

(Source: Ireland’s Provisional Greenhouse Gas Emissions 1990–2023^[1]).

The Climate Action Plan 2024 (CAP24)^[2] asserts that several additional effective mitigation policies and measures have been identified that can help in achieving cost-effective emissions reductions by 2030. However, it was not possible to describe the implementation plan for these measures in sufficient detail to allow the EPA to include their impact in the emissions projections. The Council has previously urged the Government to address this shortfall in the description of policies and measurements.

2.2. Land Use, Land Use Change and Forestry

The EPA has implemented several significant improvements in the methodology used to produce the LULUCF inventory and projections for 2023, informed by the findings of published peer-reviewed research, including improved activity data and country-specific emission factors for agricultural grasslands.^[3] Additional revisions to the LULUCF methodology and activity data are likely over the next few years, particularly related to the management of wetlands and mineral grassland soils.

A sectoral emissions ceiling has not been set for the LULUCF sector. However, the CAP24^[2] includes proposed actions that aim to enhance removals and avoid emissions across forest land, grasslands, croplands and wetlands. These are aimed primarily at achieving the 2030 LULUCF emissions reduction target of 0.626 Mt CO₂ eq relative to the annual average from the period 2016–2018, agreed under the EU LULUCF Regulation.^[4]



Based on both the ‘with existing measures’ (WEM) and ‘with additional measures’ (WAM) projections, the LULUCF sector is not projected to achieve the emissions reduction necessary to meet the EU 2030 target (see Figure 2).

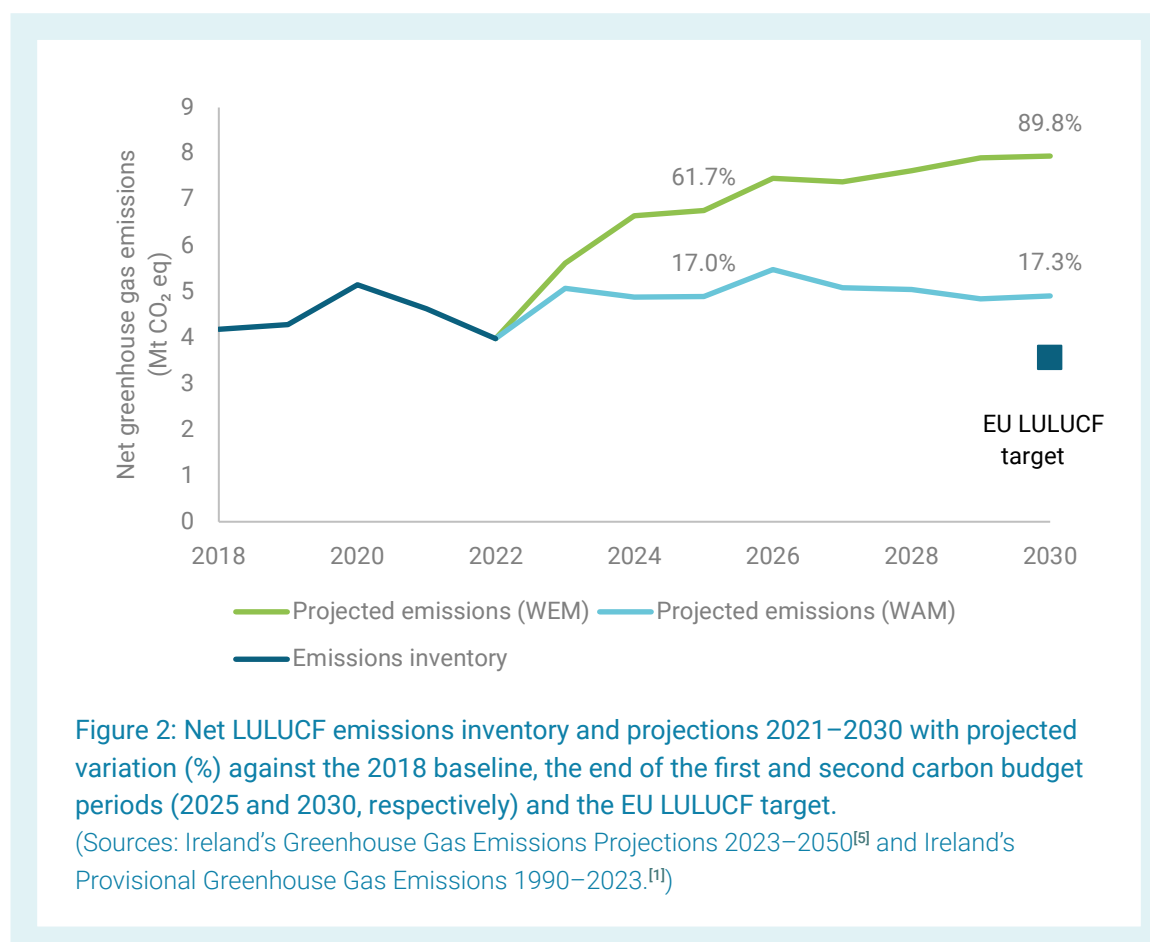


Figure 2: Net LULUCF emissions inventory and projections 2021–2030 with projected variation (%) against the 2018 baseline, the end of the first and second carbon budget periods (2025 and 2030, respectively) and the EU LULUCF target.

(Sources: Ireland’s Greenhouse Gas Emissions Projections 2023–2050^[6] and Ireland’s Provisional Greenhouse Gas Emissions 1990–2023.^[1])

3. Progress on previous Climate Change Advisory Council recommendations

In its 2023 Annual Review, the Council noted the publication of the marginal abatement cost curve (MACC),^[6] which identified pathways to achieving significant Agriculture sector emissions reductions by 2030. The Council recommended that the Government should ensure a rapid uptake of the proven and effective mitigation measures. While the CAP24^[2] included some additional specific actions that reflected the MACC analysis, there is insufficient communication, support and follow-on policy design to ensure deployment of the measures. This communication should also include analysis of the impact on emissions of specific policy initiatives.

In 2023, the Council also recommended that farmers need to be supported in the diversification of on-farm activities to reduce emissions and enhance carbon removals. Co-benefits for mitigation, adaptation, water quality and biodiversity should be quantified, and the impacts monitored. Support should be provided on the basis of payments for ecosystem services and include the value of co-benefits. The Council notes the enhanced environmental focus of the Common Agricultural Policy 2023–2027, especially in relation to support provided under the Agri-Climate Rural Environmental



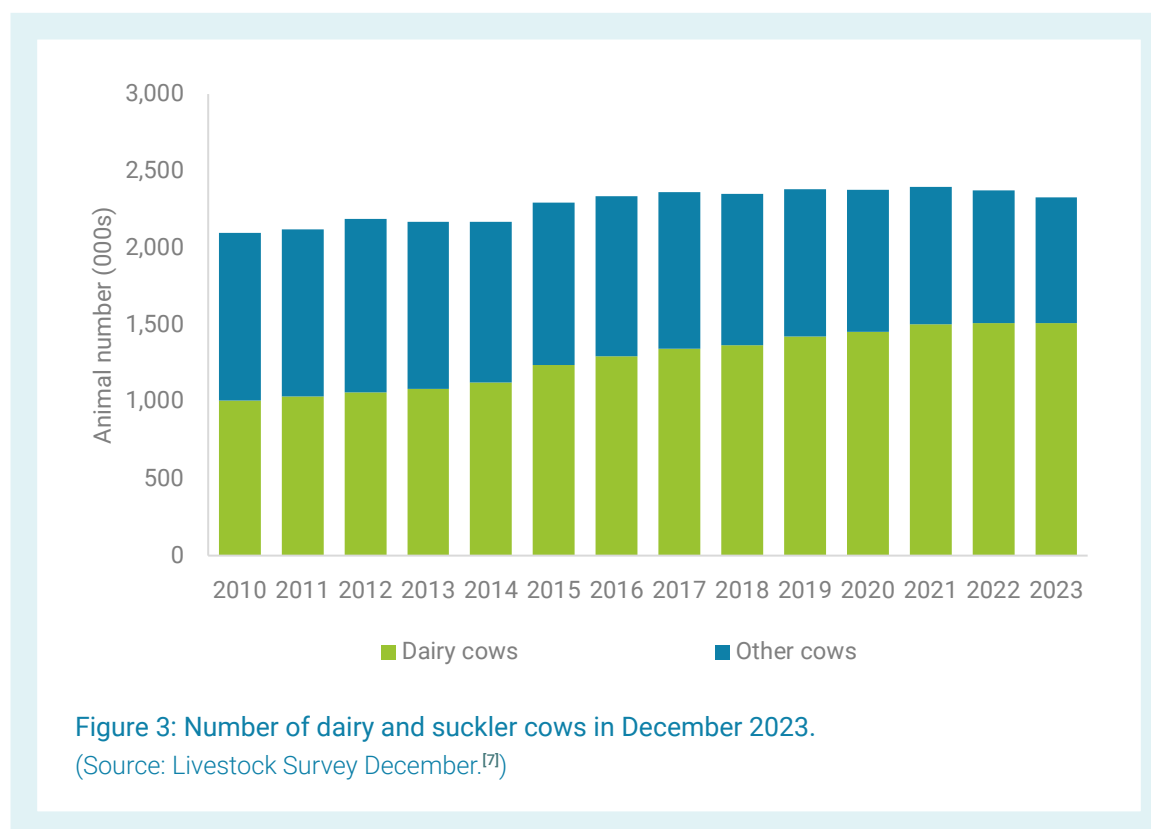
Scheme and the Organic Farming Scheme. Nevertheless, there is a need to ensure that the changes in practices and land use required continue to be supported, including the design of longer-term incentives and market structures that reward good practices and provision of ecosystem services.

Previous Council adaptation scorecards have highlighted a greater Department of Agriculture, Food and the Marine (DAFM) focus on mitigation measures in agriculture as opposed to adaptation, significant gaps in research on understanding the impacts of climate change on agriculture, forestry and seafood production, and the need for greater adaptation measures and measures with co-benefits across the sector. The findings of the 2024 adaptation scorecard will be published in September 2024.

4. Indicators

4.1. Observations on primary production

The total numbers of cows and cattle decreased in 2023.^[7] Figure 3 shows the clear trend in the relative numbers of dairy and suckler cows. The overall number of breeding animals has reduced by 2.2% since 2021.^[7] The population of dairy cows appears to have largely stabilised, relative to 2018, following a period of growth after the removal of quota in 2015. The number of sheep has been quite variable in recent years, with a 6.9% decrease in 2023, bringing numbers back to 1.5% below the 2018 figure.^[7]





There have been two simultaneous trends related to nitrogen fertilisers driving the decrease in nitrous oxide emissions. First is a very significant decrease in nitrogen fertiliser sales, which have decreased by approximately 31% since 2018. In 2023, nitrogen fertiliser sales decreased to below the target level for 2030 set in the Climate Action Plan. Second, the use of protected urea has increased significantly, with an increase of 15% in 2023. Protected urea accounted for 22% of straight nitrogen fertilisers in 2023, compared with 49% CAN and 29% straight urea (unprotected).^[8]

5. Analysis and discussion

5.1. Agriculture

In July 2023, Teagasc published a major update to its MACC, which identifies a diverse range of measures and pathways to meet the Agriculture sectoral emissions ceiling by 2030.^[6] The Council is focused on ensuring that the deployment of the most immediate and effective measures is advanced.

5.1.1. Nitrogen fertiliser type and use

The observed decrease in fertiliser use contributed to a 9.2% decrease in annual Agriculture sector nitrous oxide emissions in 2023 and a 16.9% decrease relative to 2018.^[1] It is important to maintain this progress and ensure a limited rebound in fertiliser use if, or when, fertiliser costs fall or output prices rise.

Recent observed volatility in nitrogen fertiliser sales is broadly consistent with previous analysis of elasticity of demand.^[9] However, there are several targeted actions in the Climate Action Plan that focus on ensuring that reductions in fertiliser use can be sustained without adverse impacts on production efficiency.

Furthermore, in recent years, there has been an increase in the use of both protected and straight urea as a proportion of total nitrogen fertiliser sales. Nevertheless, additional commitment of resources is required for the deployment of protected urea to displace CAN to meet the target of 80–90% displacement by 2025 set in the Climate Action Plan. DAFM should deliver the support and resources needed to accelerate the communications and advisory programmes to ensure the rapid uptake of protected urea to replace CAN and other conventional nitrogen fertilisers as appropriate. DAFM should liaise with fertiliser suppliers to ensure that proven protected urea products are fully available across the market.

There are several additional instruments, beyond the use of incentives, that the Government can use to create the necessary conditions for accelerated deployment of proven nitrous oxide mitigation technologies and practices. These include the mandated use of specific nitrogen fertiliser types in intensive systems and the appropriate use of additives in manure management systems.

DAFM, with the support of research and analysis from Teagasc and other research and advisory bodies, should ensure that recent progress made in reducing the use of nitrogen fertiliser is maintained. This will require concerted action to communicate the best available information on efficient fertiliser use to all farmers, across all farm types, and to deploy appropriate mitigation options as identified in the Teagasc MACC analysis, for example accelerating the roll-out of knowledge transfer systems to enable the uptake of improved nutrient management practices and updating the 'Green Book', as appropriate, to reflect the agro-economic and environmental measures.^[10]



5.1.2. Age of finishing

The Climate Action Plan has identified the potential for mitigation associated with early finishing of livestock, informed by the Teagasc MACC analysis. The CAP24^[2] has set a target of reducing the age of finishing to 24 months by 2025. The most recent analysis from DAFM indicated that the average age of finishing in 2023 was 28.2 months for steers and 26.8 months for heifers (DAFM, personal communication, July 2024). DAFM and Teagasc have a key role in the communication and knowledge transfer required to achieve the target of reducing the age of finishing, and hence lower lifetime emissions.

The industry, especially meat processors, also has an important role in creating the necessary market signal to farmers to reduce the age of finishing. In general, younger animals have lower levels of carcass fat, an attribute that the market incentivises. However, the current bonus payment scheme related to carcass fat specifications is not fully aligned with the target of finishing at an earlier age. As can be seen in Figure 4, farmers ensure that the majority of animals processed fall within the bonus bands. Lowering and tightening the bands would be likely to encourage farmers to finish animals earlier. The Council urges the private sector to reconfigure the bonus payment scheme to favour finishing at an earlier age.

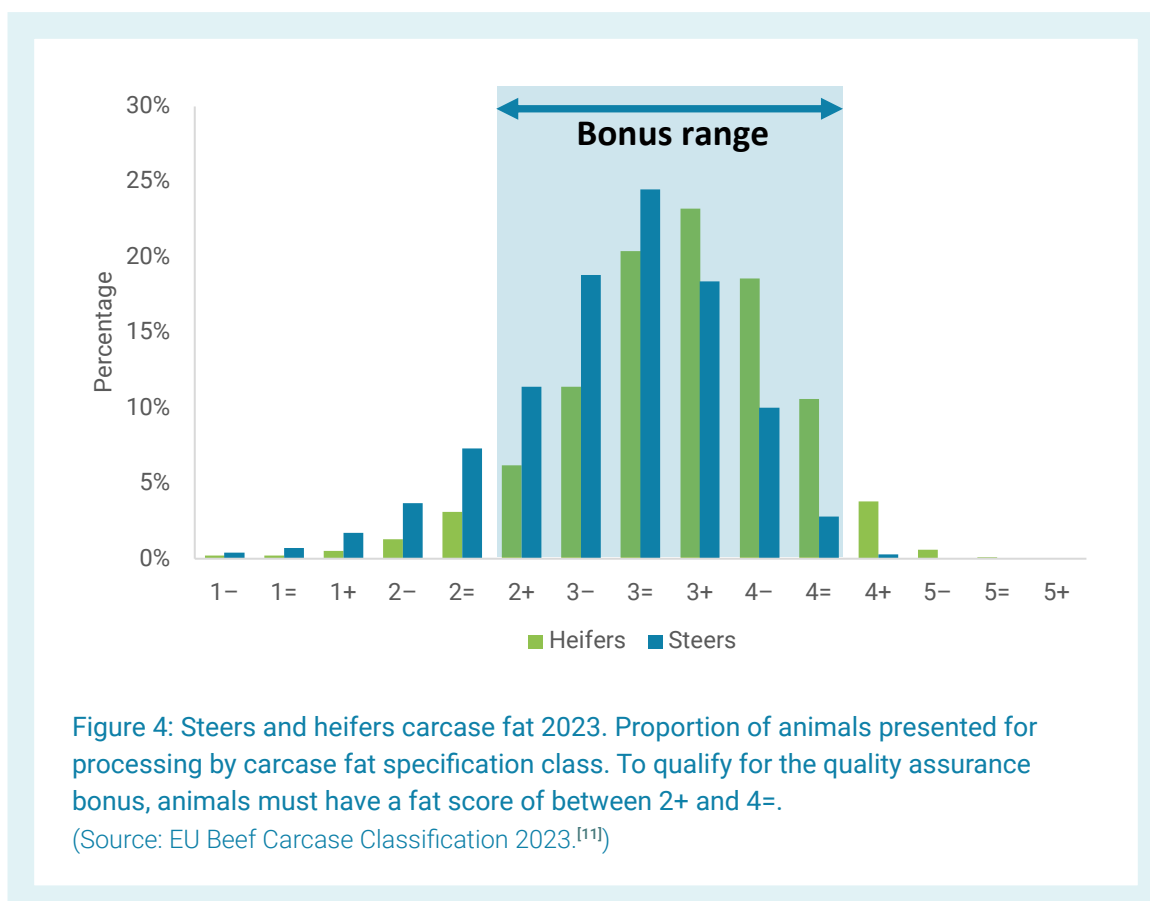


Figure 4: Steers and heifers carcass fat 2023. Proportion of animals presented for processing by carcass fat specification class. To qualify for the quality assurance bonus, animals must have a fat score of between 2+ and 4-.

(Source: EU Beef Carcass Classification 2023.^[11])

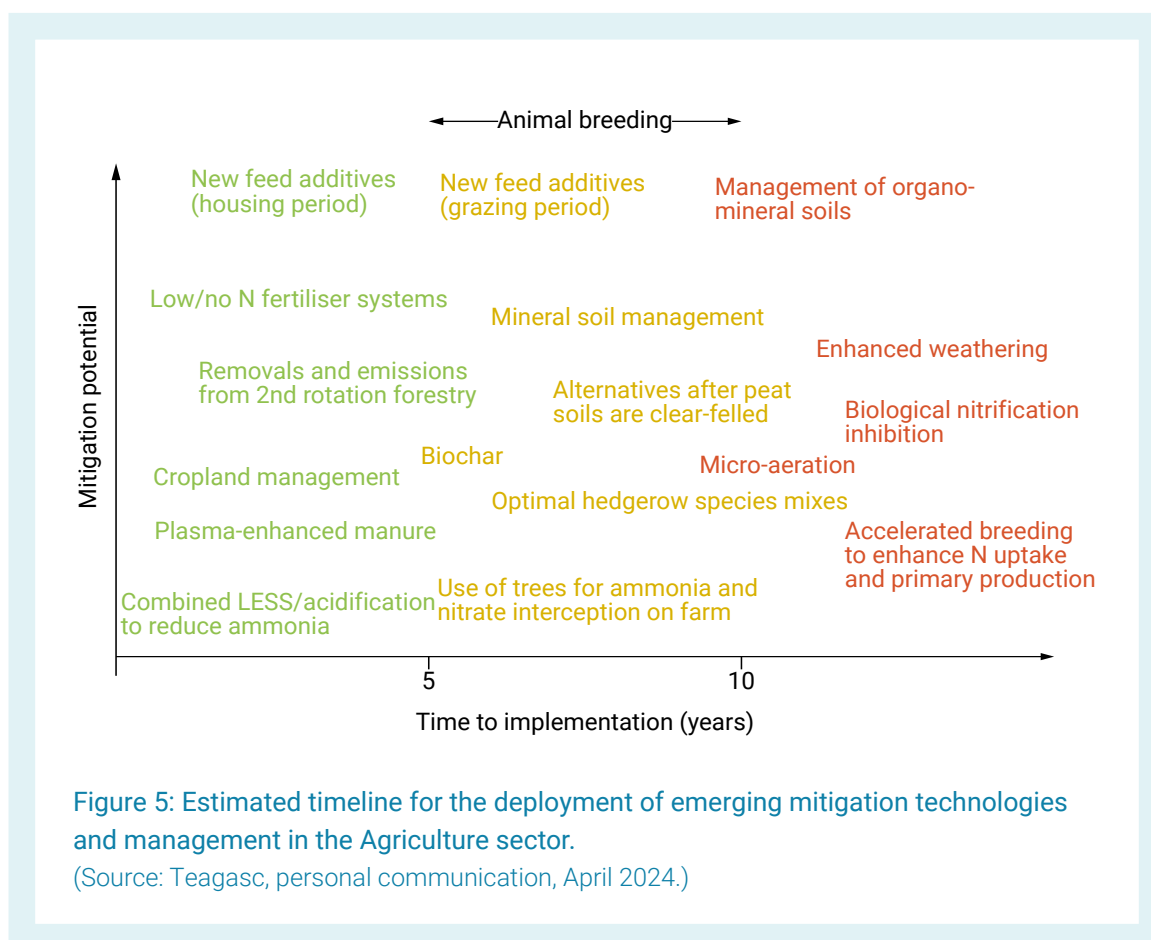


5.1.3. Feed and manure additives

Teagasc and other researchers have successfully demonstrated a range of feed and manure additives and animal supplements with significant potential to reduce methane and nitrous oxide emissions.^[6,12] Given the urgency of deploying emissions reduction activities in agriculture, there is a need to ensure that there is a business case for farmers to rapidly adopt these innovations.

The Council notes the advanced stage of development of several feed and manure additives, which can be deployed when livestock are housed, and urges DAFM to create the necessary incentives and support to enable farmers to invest in, and report on, the routine use of ‘off-the-shelf’ feed and manure additive products, for example the feed additive 3-nitrooxypropanol (3-NOP).

Figure 5 shows the estimated timelines for emerging mitigation options and their deployment in the Agriculture sector. Consistent with national climate, agricultural and industrial policy, there is a need for the Government to redouble research and innovation support to ensure the rapid deployment of emerging mitigation measures to reduce methane and nitrous oxide emissions from the Agriculture sector.





5.2. Engagement, communications and shared understanding

In this review, there is a focus on the communication, knowledge transfer and skills training required to implement the specific technical measures necessary to address greenhouse gas emissions and to implement appropriate adaptation measures. However, there is concern that the imperative for the sector to make progress on its contribution to climate action has not been communicated effectively to stakeholders by the relevant Government departments and agencies.

5.2.1. Timely publication of progress on actions

The CAP24^[2] identifies 26 specific actions to be taken in the Agriculture sector and a further 13 to be taken in the LULUCF sector. It is important that the emissions and removals potential of these actions are quantified by DAFM and the Department of the Environment, Climate and Communications (DECC) and that the implementation and impact of actions are monitored and reported.

The Council recommends the publication of detailed and frequent updates on the progress of implementation and outcomes for all climate actions undertaken within the sector. DAFM should develop and publish a plan for the dissemination of this information before the end of 2024. For example, immediate progress can be made in areas such as nitrogen fertiliser sales and fertiliser type through analysis of data in the recently established National Fertiliser Database.^[13] In addition, existing comprehensive livestock data collated by DAFM^[14] can be analysed to provide timely estimates of metrics such as 'age of finishing' and 'age of first calving'.

This will enable the Council, sectoral stakeholders and the general public to monitor progress with respect to the specific targets set out in the Climate Action Plan and enable the Council to better advise on remedial actions to keep the sector on track.

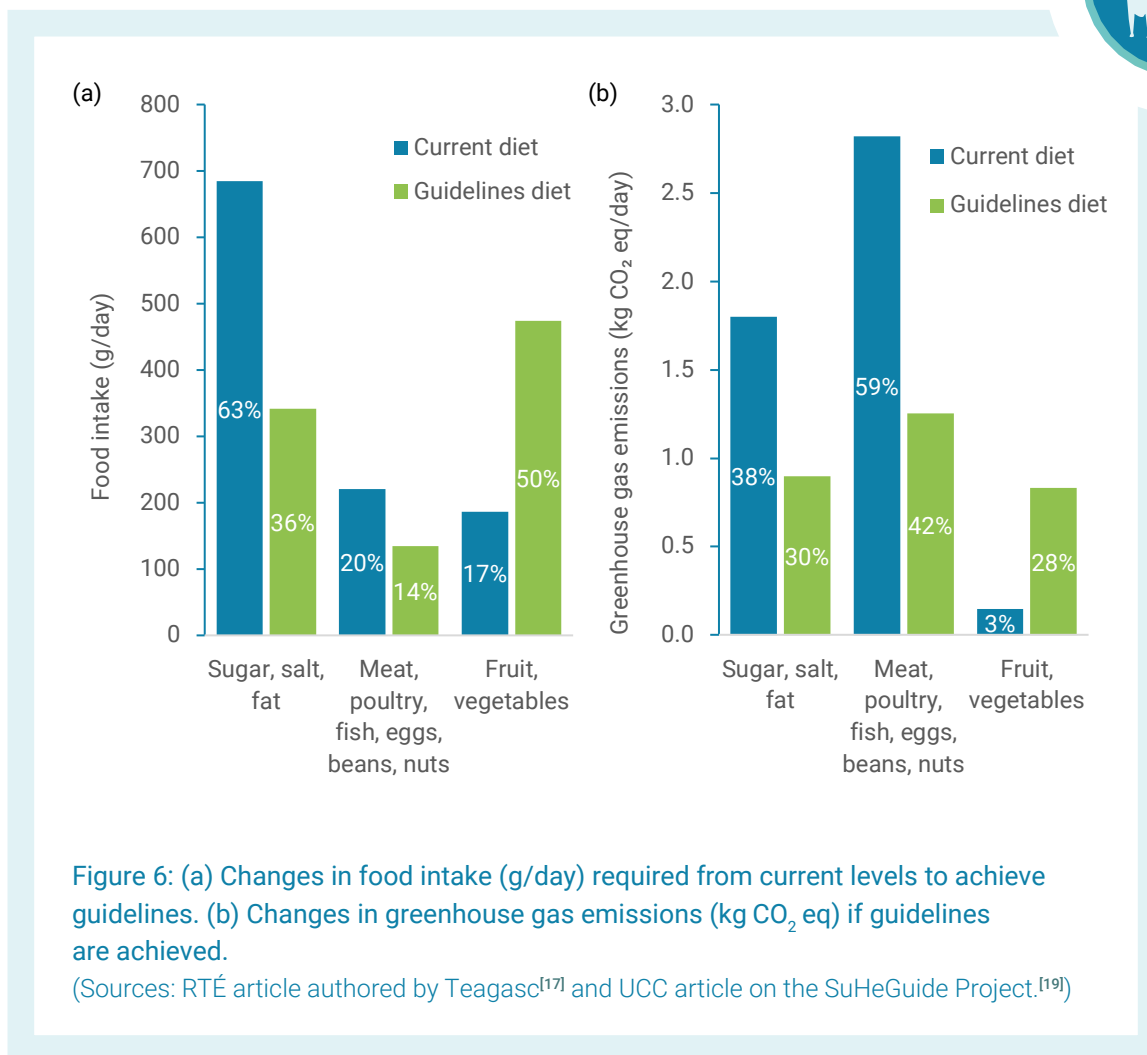
5.2.2. Informing consumer dietary choices

The Intergovernmental Panel on Climate Change (IPCC) has noted that shifting to healthy and sustainable diets has significant potential to achieve global greenhouse gas mitigation, as well as public health and environmental co-benefits.^[15] The global technical potential reduction in emissions is approximately 3.6 (0.3–8.0) Gt CO₂ eq per year, of which 2.5 (1.5–3.9) Gt CO₂ eq per year is plausible when non-technical barriers, including cultural and behavioural norms, are also considered. The IPCC also identifies the important role food systems have in shaping dietary choices, and the role of policy in enabling the transition to sustainable systems.

Recent research in Ireland by the Economic and Social Research Institute, which investigated barriers to individual climate action, concluded that there is a need to improve awareness of the link between the type of food consumed and greenhouse gas emissions.^[16] Public misconceptions about diet-related emissions persist. The study also found that the most common perceived difficulty among those who say they are willing to change their diet (42%) is higher cost, despite evidence that total food costs can decrease, followed by a lack of awareness (23%) of which food types have greatest impact on health and sustainability.

Ongoing Teagasc research has identified the potential to reduce personal carbon footprint by shifting to a healthy diet, based on data from the National Adult Nutrition Survey and revised food pyramid dietary guidelines from the Health Service Executive (see Figure 6).^[17,18]

The Council recommends that the Government, led by the Department of Health, implements a comprehensive consumer information initiative, with the support of retail outlets and consumer organisations, to better empower consumers to choose healthy and sustainable diets.^[17]

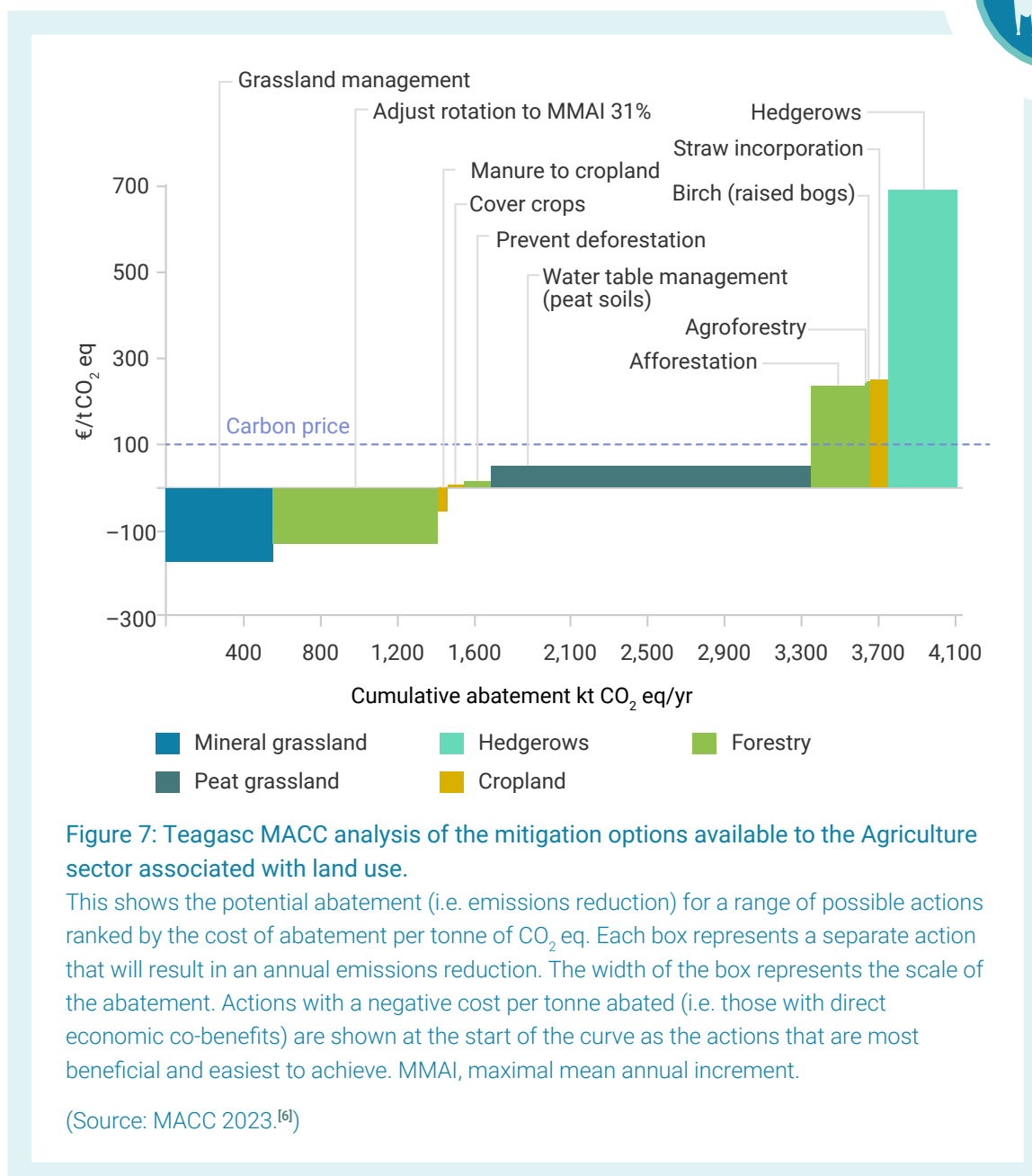


5.3. Land Use, Land Use Change and Forestry

5.3.1. Land Use Review

The LULUCF sector is currently a net source of emissions and is projected to continue as a source over the next decade (see Section 2.2). Figure 7 shows an outline of the findings from the latest MACC^[6] analysis of the carbon management options relevant to agriculture, as reported under the LULUCF sector. Other measures have also been identified in the Climate Action Plan related to the management of other land uses, such as degraded wetlands and forest land.

Phase 2 of the Land Use Review is under way within the Department of Housing, Local Government and Heritage, DAFM and DECC. They are tasked under the Climate Action Plan with developing policies and measures that will support environmental and socio-economic objectives at national and local levels. The Government must complete the Land Use Review and set out a clear and detailed implementation plan of actions necessary to maintain and enhance the sequestration and storage of carbon associated with land use and land management and to balance the additional diverse ecosystem services demanded in the transition to a low-carbon economy. The implementation plan should be consistent with the long-term National Climate Objective of climate neutrality by 2050 and include nature protection and restoration of land.



5.3.2. Organic farming and nature restoration

Under the Common Agricultural Policy 2023–2027, a budget of €256 million has been assigned to the organic sector, with the aim of enabling conversion to organic farming and reaching a target of 10% organically farmed land by 2030. In 2024, there are approximately 5,000 farmers engaged in the Organic Farming Scheme. The area farmed organically in Ireland has trebled since 2021, to 225,500 hectares (5% of farmed land). Under the recently approved EU Nature Restoration Law, the Government must prepare a nature restoration plan that includes voluntary actions in the Agriculture and LULUCF sectors.

DAFM should build on the potential of the schemes under the Common Agricultural Policy Strategic Plan 2023–2027 to ensure long-term financial support to farmers for the improved management and practices, to benefit climate, carbon stocks, environment and biodiversity on agricultural and forest land.



5.3.3. Forest management and afforestation

Figure 8 shows the emissions and removals associated with forest land and harvested wood product categories from 2010 to 2023, and the WEM and WAM projections from 2024 to 2030. There has been a steady decline in the rate of removal associated with forest land since 2016, and its transition from carbon sink to carbon source is imminent, and may have occurred in 2023 (pending confirmation in the inventory analysis due in April 2025). While ongoing removals in harvested wood

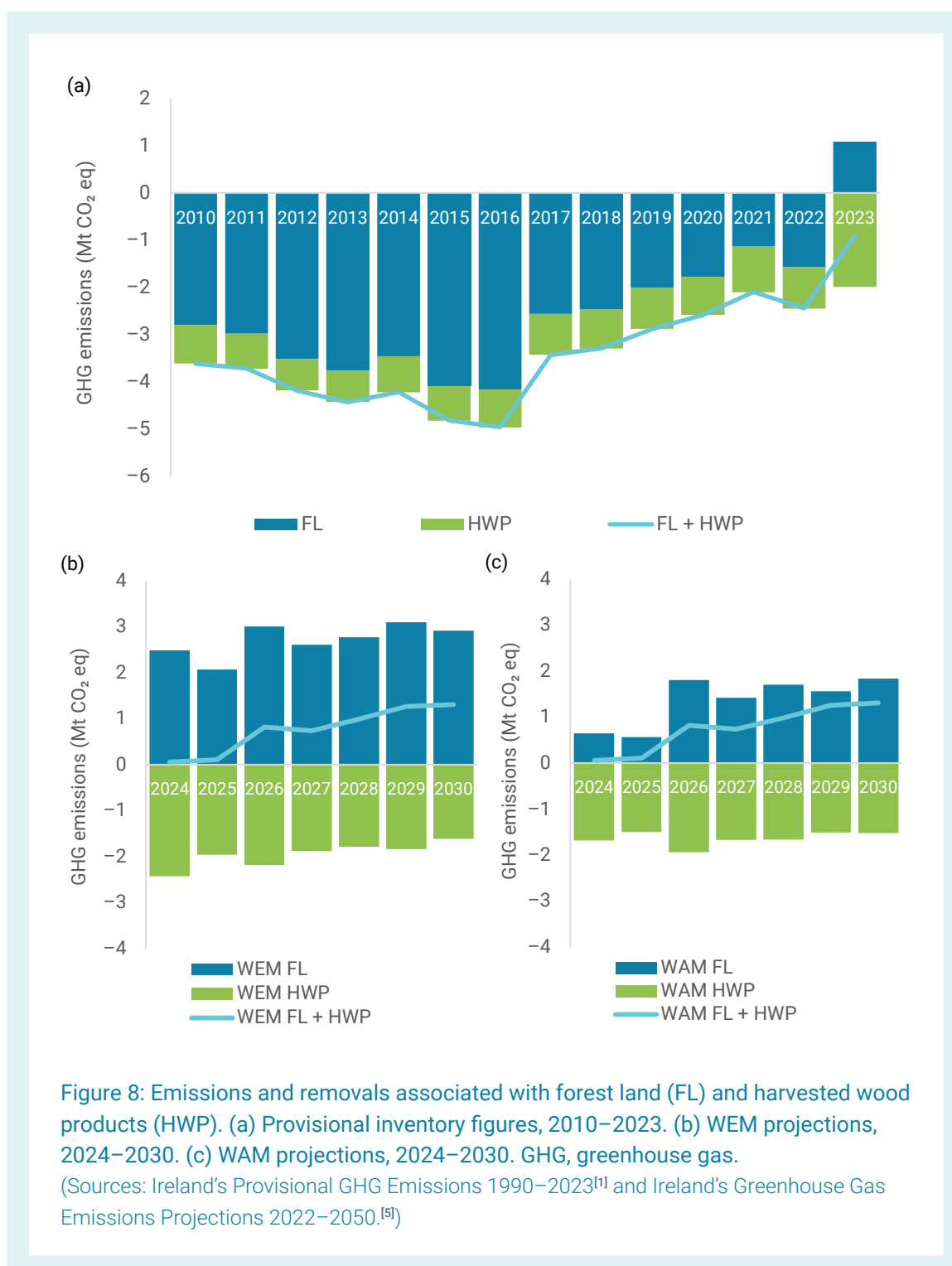


Figure 8: Emissions and removals associated with forest land (FL) and harvested wood products (HWP). (a) Provisional inventory figures, 2010–2023. (b) WEM projections, 2024–2030. (c) WAM projections, 2024–2030. GHG, greenhouse gas.

(Sources: Ireland’s Provisional GHG Emissions 1990–2023^[1] and Ireland’s Greenhouse Gas Emissions Projections 2022–2050.^[5])



products may delay it, a transition of the Forestry sector from sink to source is projected for both scenarios.

Figure 9 shows the rates of afforestation supported under the new Forestry Programme 2023–2027, in comparison with activity under the previous scheme. Although the programme is still in an early phase, it is very clear that farmers and landowners have not engaged with it to the extent required to achieve the rates of afforestation needed to meet the target of 8,000 hectares per year, as specified in the Climate Action Plan.

There is opportunity within the existing forest estate to enhance carbon sequestration and storage through alternative forest management approaches, such as extended rotation and continuous forest cover, while also adding value to the harvest from increased timber production.^[20] Coillte is ideally placed in the Forestry sector to demonstrate alternative management approaches that enhance the longevity of carbon storage in harvested wood products, while being mindful of increasing demand for high-quality timber in construction and elsewhere. Changes in approaches to forest management are also required to ensure the societal and environmental acceptability of forests and to address the current negative impacts of forest management practices such as mono-species plantations, including habitat degradation and biodiversity loss.

DAFM should initiate urgent engagement with stakeholders to communicate the critical role of forestry in Ireland’s transition to a low-carbon, resilient, biodiversity-rich economy. There needs to be meaningful dialogue with all stakeholders, focused on management options, to enhance carbon storage within the existing forest estate while ensuring broad social acceptability through improved environmental and biodiversity outcomes, as well as addressing barriers to participation in the Forestry Programme.

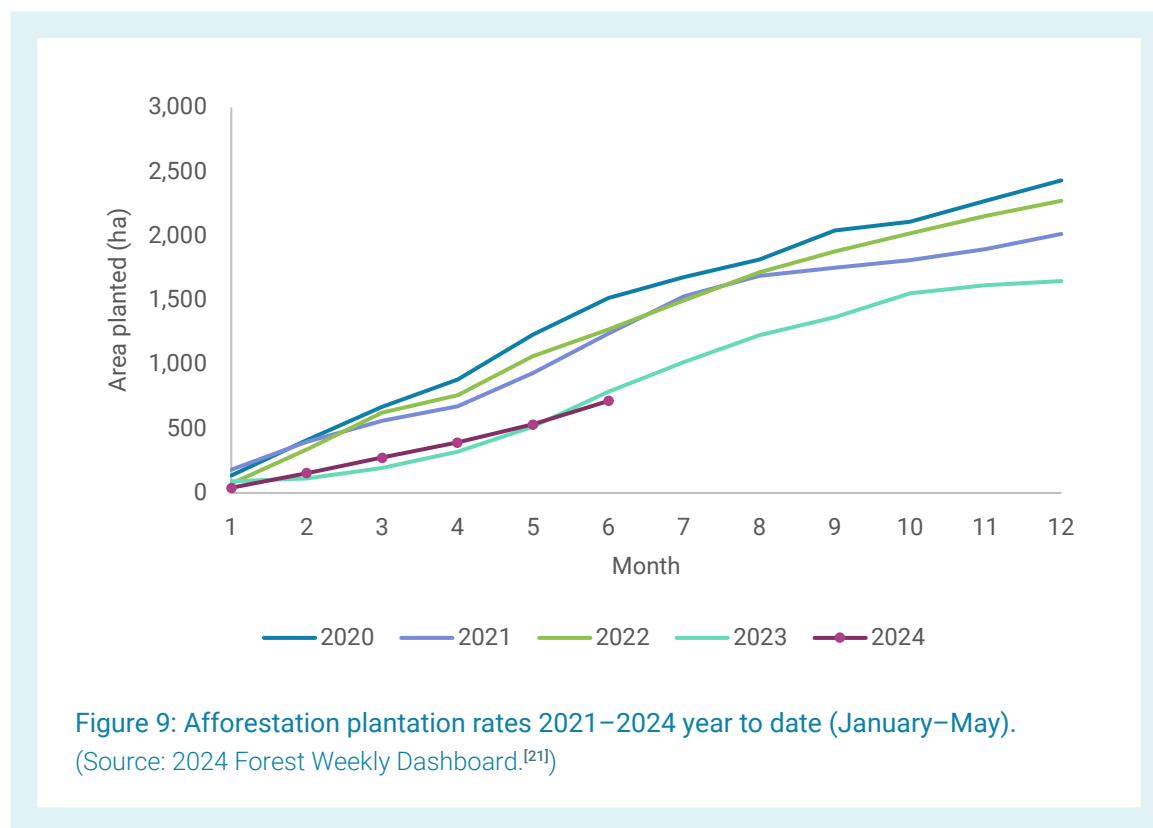


Figure 9: Afforestation plantation rates 2021–2024 year to date (January–May).
(Source: 2024 Forest Weekly Dashboard.^[21])



5.3.4. Grasslands and wetlands

Figure 10 shows the emissions and removals associated with wetland and grassland categories from 2010 to 2023 and the WEM and WAM projections from 2024 to 2030.

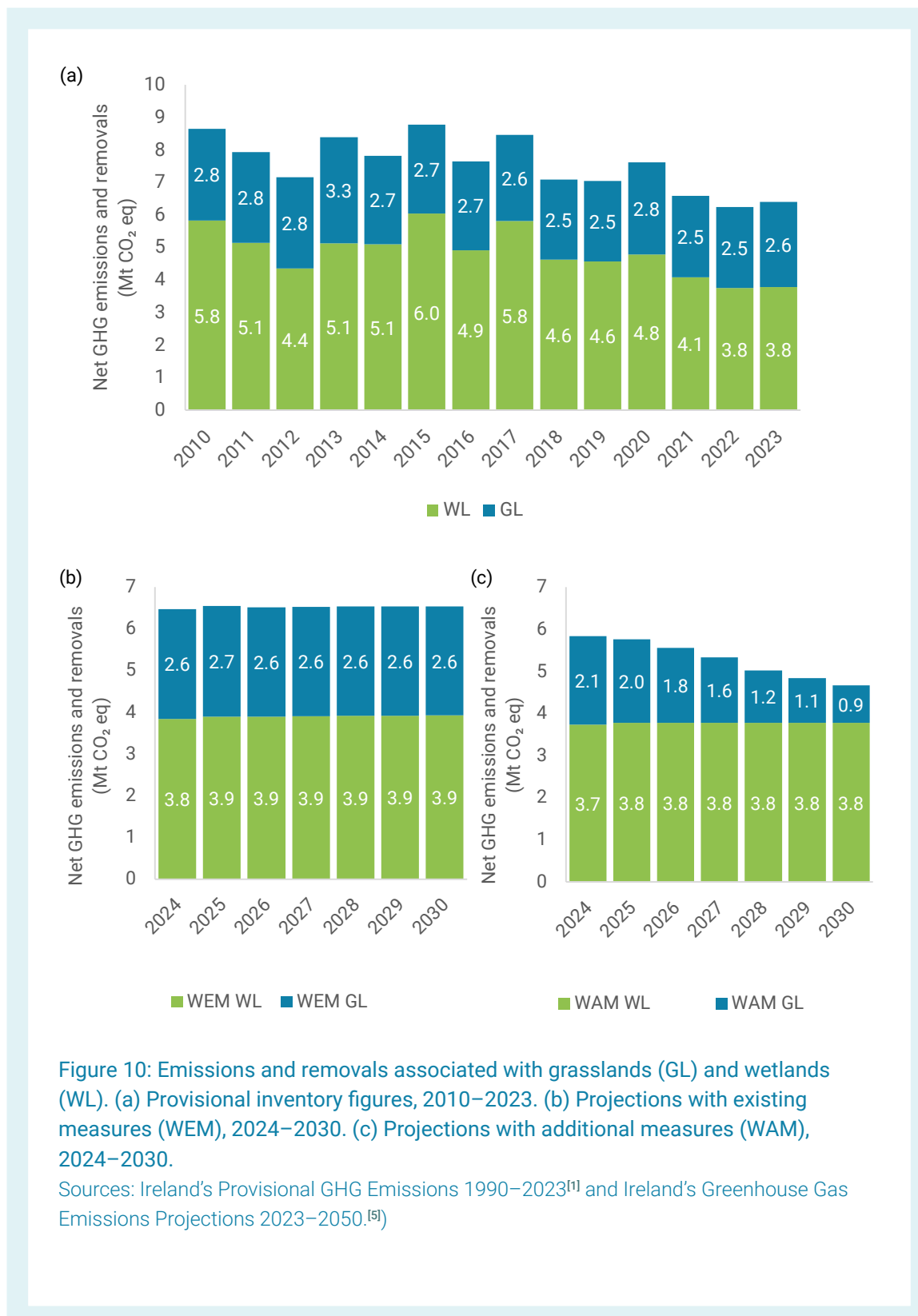


Figure 10: Emissions and removals associated with grasslands (GL) and wetlands (WL). (a) Provisional inventory figures, 2010–2023. (b) Projections with existing measures (WEM), 2024–2030. (c) Projections with additional measures (WAM), 2024–2030.

Sources: Ireland’s Provisional GHG Emissions 1990–2023^[1] and Ireland’s Greenhouse Gas Emissions Projections 2023–2050.^[5]



Historically, wetlands and grasslands have been reported as net sources of emissions. This is largely because of the management of peatlands and organic soils. There has been a slow, steady underlying trend towards reduced reported emissions in both categories, largely due to the conversion of land from grassland and wetland to forest land, through afforestation. The WEM projection confirms the lack of progress in policy implementation and shows the extent to which existing policies will not drive a significant reduction in activities. However, the WAM projections see significant reductions in emissions from grasslands following the introduction of policies to enable water table management, rewetting and improved management of grasslands, based on new actions under the Climate Action Plan. Although similar actions have been identified for degraded wetlands in the Climate Action Plan, policy development has not progressed to the level that can be used to reliably inform the WAM projection of emissions reductions to 2030. It is important that methodological issues are addressed to ensure that the potential impact of measures that incentivise changes in land management can be incorporated into the projections analysis.

5.3.5. Biomethane Strategy

The Council notes the publication of the Biomethane Strategy.^[22] The Climate Action Plan envisages the roll-out of 1.0 TWh indigenous biomethane capacity by the end of 2025, and up to 5.7 TWh by 2030. The strategy anticipates biomethane playing a role in reducing fossil fuel use and in the long-term decarbonisation of the Transport and Heating sectors.

Currently, Ireland has only two operational biomethane facilities injecting biomethane into the gas grid. The volume of biomethane injected into the grid is small, equating to approximately 75 GWh per annum. This biomethane is mainly generated from waste feedstocks. Currently, most biomethane produced in Ireland is used in the Transport sector under the Renewable Transport Fuel Obligation. There are currently only around 100 heavy-duty vehicles capable of using biomethane in use in Ireland. There is also a major opportunity under the Renewable Heat Obligation for industry to deploy biomethane.

According to the European Biogas Association,^[23] there are 43 facilities in Ireland producing 580 GWh of biogas, in addition to the two biomethane facilities. This biogas is used in electricity generation and is not upgraded to biomethane. The feedstock for these anaerobic digestion plants includes landfill waste, municipal solid waste, sewage waste and animal slurries. These anaerobic digestion biogas plants could be upgraded to develop biomethane.

Biomethane has the potential to provide farmers with an alternative income stream. Both animal slurry and biomass feedstock (grass) will be required as feedstock to meet the demands of a growing Biomethane sector. This may also incentivise some farm enterprises to reduce livestock production, without an adverse impact on farm income.

The Council is concerned that the business case for the production and use of biomethane needs to be further developed to create confidence among farmers that the market will grow, become stable and provide competitive returns in comparison with conventional farming activities.

The Council recommends that the Government develops a robust implementation plan to achieve the ambition in the strategy, by the end of Q1 2025, and provides the necessary support and incentives to underpin the business case for the production and use of biomethane.



5.4. Resilience and biodiversity

5.4.1. Increasing resilience to climate-driven impacts

To counter the stresses and shocks from climate change on agriculture and food production, the Global Food Security Index report of 2022^[24] highlighted the need to adopt a systemic approach and build resilience in the supply of food and in the environment and infrastructure in which food is grown and distributed. It notes the need for a resilient food system that is robust and able to resist disruption, recover quickly after disruption and reorient itself towards more sustainable food system outcomes.

Adaptation actions to help support agricultural resilience and reduce the impacts of extreme precipitation and drought include changes in livestock movements, the expanded use of fodder reserves, changes in land drainage, the use of water reservoirs and, in some instances, sprinkler irrigation.^[25] For the practices of land drainage and sprinkler irrigation, the potential conflicts and trade-offs with rewetting as an action to reduce emissions from peat soils must be carefully considered and managed. Alternative land management practices also include soil nutrient management, changes in tillage intensity, crop choice and rotation and livestock choice, the use of mixed swards and agricultural diversification.^[26] It is also important to note that, for some farmers, accessing environmental payments may play a significant part in supporting diversification.

5.4.2. Nature-based solutions and flood management

The National Implementation Strategy for Nature-Based Solutions is focused on the management of rainwater and surface water run-off in urban areas. Focusing on urban areas is seen as necessary as they contain the largest populations, residential, commercial and other buildings, and other infrastructure.^[27] However, to effectively manage urban flooding, it is important to take a catchment-level approach to flood management.^[28] Increasing the permeability of urban areas is essential in preventing heavy rainfall from causing flood damage and should be carried out in combination with catchment-level flood management to help increase the overall resilience of urban areas. Land use and land management practices (e.g. forest cover, agricultural land, peatlands, wetlands and river configuration) within the catchment will affect urban flow. By providing 'sponge' habitat higher up in the catchment to slow water flow (e.g. maintaining forest cover, peatland restoration, wetland restoration and raising the water table) and providing 'spread' habitats in flood plains (e.g. flood plain restoration), flooding can be mitigated before it impacts urban centres.

The Council working paper^[29] on the identification and assessment of best practice in nature-based solutions for climate action and ecosystem restoration in Ireland contains a number of recommendations aiming to support effective nature-based solutions and flood management in Ireland. Key recommendations include the following:

- ▶ A comprehensive and shared definition of nature-based solutions for policymakers for implementation across sectors. A shared vision will allow more effective monitoring and evaluation frameworks to be implemented, as it will be clear what constitutes a nature-based solution, what the outcome of an effective solution is, and what services and co-benefits it provides.
- ▶ Further funding support for nature-based solutions in Ireland and the integration of nature-based solutions into existing climate-related funding schemes are required.
- ▶ A permanent national database of nature-based solutions that have been implemented across sectors in Ireland should be established and maintained by a unit within a Government



department or agency with responsibility for nature-based solutions. This should be publicly available and easily used by stakeholders looking to apply nature-based solutions to specific issues.

The Office of Public Works' National Catchment-based Flood Risk Assessment and Management Programme will provide helpful inputs when looking to systematically assess the application of nature-based solutions in urban areas, taking a catchment-level approach. Existing work carried out in the Cloontagh catchment in Clonmany, County Donegal,^[30] can serve as a template going forward. The project uses natural flood management and natural water retention measures to help alleviate flooding through the use of natural processes. The project takes a catchment-scale approach to slow the flow of flood water and create and improve opportunities to improve soil infiltration (the movement of water through soil). Involving the community has been identified as a critical element in the success of the project. The project demonstrates the value of involving the community and landowners in the co-design and co-production process to harness local knowledge and combine it with scientific knowledge to help deliver effective flood management solutions.

5.4.3. Economic costs of climate change

Economic research examining climate impacts in the Agriculture sector is focused on crop modelling and currently does not consider impacts associated with the livestock sector or consider extreme events more broadly.^[31] The consideration of crop models in isolation and incremental changes in climate presents only one small aspect of the full suite of potential economic impacts on Ireland's Agriculture sector. To bridge this gap, research is urgently needed that not only captures the impact of climate change on crop and animal agriculture in Ireland but also explores the wider socio-economic impacts of potential shocks in the Agriculture sector and the cascading and transboundary climate impacts. Without a clearer understanding of more complete economic costs in the Agriculture sector, the business case for securing investment in adaptation actions will be more challenging to make. There is a clear need for the Government to lead on funding and supporting this research.

A current challenge of creating resilience in the Agriculture sector is not only estimating the economic costs to the sector specifically but also linking these to impacts on other environmental and social policy objectives. For example, complex interlinkages exist between biodiversity, agriculture and international trade.^[32] Biodiversity is often absent from studies of the impact of food production on the environment. By not considering biodiversity, key trade-offs between environmental outcomes of agricultural production and international trade will be missed. Moreover, the positive impacts that biodiversity can have on the system, which could contribute to system resilience, will also be missed. What is clear from considering these types of interconnections and complexities between objectives is the value and also the limitations of economic analysis alone. Economic analysis can provide a powerful tool for highlighting present and future risks. However, it must be used in combination with qualitative work that aims to understand interdependencies between sectors.

5.4.4. Nature Restoration Law

The EU Regulation on nature restoration, adopted by the European Parliament and Council of the EU in June 2024, will have considerable impacts for agriculture and land use in Ireland. The regulation sets binding targets and commitments to restore ecosystems, habitats and species across the EU's land and sea areas.

Ireland must submit its National Restoration Plan to the European Commission by mid-2026. The plan will contain specific national targets and measures to enhance biodiversity within agriculture, forest, marine and urban ecosystems to 2050, which is similar to the timeframe for achieving the



National Climate Objective. The National Restoration Plan will apply to areas both within and outside protected areas and will lead to the adoption of more nature-friendly management approaches and land uses. The National Restoration Plan should be developed through a highly participatory and inclusive approach and should contain clear and adequate financial incentives.

5.5. Just Transition within the Agriculture and Land Use, Land Use Change and Forestry sectors

A Just Transition Dialogue Framework specifically for the Agriculture and LULUCF sectors must be established. An inclusive dialogue process between farmers and communities and policymakers must ensure that the transformational change needed across the sector is accepted by farmers and the wider community. Inclusive dialogue can empower farmers and the wider community to want to take action by promoting a shared understanding of the urgency to mitigate and adapt to climate change.

The Just Transition Dialogue Framework, established under the Climate Action Plan 2021, seeks to integrate social dialogue across all climate policy development to ensure that affected citizens and communities are empowered and are core to the transition to climate neutrality.^[33] The National Economic and Social Council published a report in 2023 on Just Transition in the Agriculture and LULUCF sectors, which strongly advises prioritising socially inclusive dialogue with farmers and communities when transitioning to climate neutrality.^[34] The Council notes that DAFM has incorporated engagement and consultation processes with farmers as steps necessary for the delivery of some actions in the CAP24 Annex of Actions.^[35] However, a sector-specific dialogue process that is directed at solving the problems faced by farmers and communities is required, concluding with a joint agreement, or way forward, to ensure a Just Transition.

The development of the dialogue framework can be led by a newly established Just Transition Commission and supported by DAFM. The Just Transition Commission is tasked with providing the Government with impartial, strategic and evidence-based advice to inform policy planning related to a Just Transition across different sectors affected by climate policy. The Commission can play an important supporting role in progressing Just Transition considerations in the Agriculture and LULUCF sectors.^[36] Given the urgency of adopting the practices identified in the MACC, the establishment of an effective, inclusive dialogue process in 2025 is necessary.

The Council recommends that, once established, the Just Transition Commission should consider a sector-specific Just Transition Dialogue with farmers, rural workers and communities. The dialogue should promote broad support for climate action, ensure that stakeholders build a shared understanding of the costs and benefits of and incentives for taking action on climate change, and inform knowledge transfer programmes, funding mechanisms, and upskilling and training aimed at farmers, rural workers and communities.



References

- 1 Environmental Protection Agency, 'Ireland's Provisional Greenhouse Gas Emissions 1990–2023', Jul. 2024. Accessed: Jul. 10, 2024. [Online]. Available: <https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-provisional-greenhouse-gas-emissions-1990-2023.php>
- 2 Government of Ireland, 'Climate Action Plan 2024', May 2024. Accessed: May 21, 2024. [Online]. Available: <https://www.gov.ie/pdf/?file=https://assets.gov.ie/284675/70922dc5-1480-4c2e-830e-295afd0b5356.pdf#page=null>
- 3 Environmental Protection Agency, 'Ireland's National Inventory Submissions 2024', Mar. 2024. Accessed: Jul. 10, 2024. [Online]. Available: <https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-national-inventory-submissions-2024.php>
- 4 EUR-Lex, 'Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework and amending Regulation (EU) 525/2013 and Decision 529/2013/EU'. Accessed: Jun. 13, 2024. [Online]. Available: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02018R0841-20230511>
- 5 Environmental Protection Agency, 'Ireland's Greenhouse Gas Emissions Projections 2023–2050', May 2024. Accessed: May 29, 2024. [Online]. Available: <https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/EPA-GHG-Projections-Report-2022-2050-May24--v2.pdf>
- 6 Teagasc, 'MACC 2023: An Updated Analysis of the Greenhouse Gas Abatement Potential of the Irish Agriculture and Land-Use Sectors between 2021 and 2030', Jul. 2023. Accessed: Jun. 28, 2024. [Online]. Available: <https://www.teagasc.ie/publications/2023/macc-2023.php>
- 7 Central Statistics Office, 'Livestock Survey December'. Accessed: Jul. 08, 2024. [Online]. Available: <https://www.cso.ie/en/statistics/agriculture/livestocksurveydecember/>
- 8 Teagasc, 'News release: Irish farmers achieve key 2030 nitrogen fertiliser reduction target'. Accessed: Jul. 24, 2024. [Online]. Available: <https://www.teagasc.ie/news--events/daily/environment/irish-farmers-achieve-key-2030-nitrogen-fertiliser-reduction-target.php>
- 9 J. P. Breen, D. Clancy, T. Donnellan, and K. F. Hanrahan, 'Estimating the elasticity of demand and the production response for nitrogen fertiliser on Irish farms', Paper presented at the 86th Annual Conference of the Agricultural Economics Society, University of Warwick, UK, 2012. doi: [10.22004/AG.ECON.134965](https://doi.org/10.22004/AG.ECON.134965).
- 10 D. P. Wall and M. Plunkett, *Major and Micro Nutrient Advice for Productive Agricultural Crops*, 5th ed. Teagasc, 2020. Accessed: Aug. 29, 2024. [Online]. Available: <https://www.teagasc.ie/publications/2020/major--micro-nutrient-advice-for-productive-agricultural-crops.php>
- 11 Department of Agriculture, Food, and the Marine, 'EU Beef Carcase Classification'. Accessed: Aug. 01, 2024. [Online]. Available: <https://www.gov.ie/en/collection/bc95b-eu-beef-carcase-classification-scheme/#useful-links>
- 12 The AgriBusiness Group and Journeaux Economics, 'Report on Agricultural Greenhouse Gas Mitigation Technologies', Oct. 2023. Accessed: Jul. 10, 2024. [Online]. Available: <https://www.climatecommission.govt.nz/public/Uploads/EB4/supporting-docs/Report-on-agricultural-mitigation-technologies-Final.pdf>
- 13 Department of Agriculture, Food and the Marine, 'National Fertiliser Database'. Accessed: Jul. 10, 2024. [Online]. Available: <https://www.gov.ie/en/collection/98355-national-fertiliser-database/>



- 14 Department of Agriculture, Food and the Marine, 'Animal Identification and Movement Database'. Accessed: Jul. 10, 2024. [Online]. Available: <https://datacatalogue.gov.ie/dataset/animal-identification-and-movement-database>
- 15 Intergovernmental Panel on Climate Change, 'Climate Change 2022: Mitigation of Climate Change', Apr. 2022. Accessed: Jul. 10, 2024. [Online]. Available: <https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/>
- 16 S. Timmons, Y. Andersson, M. Lee, and P. Lunn, 'What is Preventing Individual Climate Action? Impact Awareness and Perceived Difficulties in Changing Transport and Food Behaviour', ESRI, Dublin, Ireland, May 2024. doi: [10.26504/RS186](https://doi.org/10.26504/RS186).
- 17 M. Conway and S. McCarthy, 'What's the carbon footprint of the meat and veg we eat?' Accessed: Jul. 24, 2024. [Online]. Available: <https://www.rte.ie/brainstorm/2023/1114/1415344-carbon-footprint-food-meat-vegetables-ireland/>
- 18 Health Service Executive, 'Healthy eating guidelines'. Accessed: Jul. 24, 2024. [Online]. Available: <https://www.hse.ie/eng/about/who/healthwellbeing/our-priority-programmes/health/healthy-eating-guidelines/>
- 19 University College Cork, 'Food based dietary guidelines for sustainable and healthy lifestyles (SuHeGuide)'. Accessed: Jul. 24, 2024. [Online]. Available: <https://www.ucc.ie/en/vitamind/history/suheguide/>
- 20 K. Black, K. Byrne, D. McNerney, and J. Landy, 'Forests for Climate: Report on Carbon Modelling of the Coillte Estate', Aug. 2022. Accessed: Jul. 24, 2024. [Online]. Available: https://www.coillte.ie/wp-content/uploads/2022/08/Report-on-Carbon-Modelling-of-the-Coillte-Estate_August2022.pdf
- 21 Department of Agriculture, Food and the Marine, '2024 Forestry Weekly Dashboard'. Accessed: Jun. 28, 2024. [Online]. Available: <https://www.gov.ie/en/collection/abb8d-2024-forestry-weekly-dashboard/>
- 22 Department of the Environment, Climate and Communications, and Department of Agriculture, Food and the Marine, 'National Biomethane Strategy', May 2024. Accessed: Jul. 10, 2024. [Online]. Available: <https://www.gov.ie/en/publication/d115e-national-biomethane-strategy/>
- 23 European Biogas Association, 'EBA Statistical Report 2023', Dec. 2023. Accessed: Jul. 10, 2024. [Online]. Available: <https://www.europeanbiogas.eu/eba-statistical-report-2023/>
- 24 Economist Impact, 'Global Food Security Index 2022', Sep. 2022. Accessed: Jun. 13, 2024. [Online]. Available: <https://impact.economist.com/sustainability/project/food-security-index/>
- 25 R. Anderson, P. E. Bayer, and D. Edwards, 'Climate change and the need for agricultural adaptation', *Current Opinion in Plant Biology*, vol. 56, pp. 197–202, Aug. 2020, doi: [10.1016/J.PBI.2019.12.006](https://doi.org/10.1016/J.PBI.2019.12.006).
- 26 C. Mbow et al., 'Food security', in *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*, P. R. Shukla et al., Eds., 2019. doi: [10.1017/9781009157988.007](https://doi.org/10.1017/9781009157988.007).
- 27 Department of Housing, Local Government and Heritage, 'Nature Based Management of Urban Rainwater and Urban Surface Water Discharges – A National Strategy', May 2024. Accessed: Jun. 28, 2024. [Online]. Available: <https://www.gov.ie/en/publication/d9a24-nature-based-management-of-urban-rainwater-and-urban-surface-water-discharges-a-national-strategy/>
- 28 L. Liu, B. Dobson, and A. Mijic, 'Optimisation of urban–rural nature-based solutions for integrated catchment water management', *Journal of Environmental Management*, vol. 329, p. 117045, Mar. 2023, doi: [10.1016/J.JENVMAN.2022.117045](https://doi.org/10.1016/J.JENVMAN.2022.117045).



- 29 A. Molloy, M. J. Collier, and Y. M. Buckley, 'Climate Change Advisory Council Working Paper No. 26: Identification and Assessment of Best Practice in Nature-based Solutions for Climate Action and Ecosystem Restoration in Ireland', 2024. Accessed: Aug. 05, 2024. [Online]. Available: <https://www.climatecouncil.ie/councilpublications/councilworkingpaperseries/Identification%20and%20assessment%20of%20best%20practice%20in%20nature-based%20solutions%20for%20web.pdf>
- 30 Inishowen Rivers Trust, 'Natural flood management'. Accessed: Jun. 13, 2024. [Online]. Available: <https://inishowenriverstrust.com/nfmclonmany/>
- 31 K. de Bruin and C. Kweku Kyei, 'Policy Brief: Climate Change Impacts and Adaptation in Ireland', Climate Change Advisory Council, 2024 (forthcoming).
- 32 A. M. D. Ortiz, C. L. Outhwaite, C. Dalin, and T. Newbold, 'A review of the interactions between biodiversity, agriculture, climate change, and international trade: research and policy priorities', *One Earth*, vol. 4, no. 1, pp. 88–101, Jan. 2021, doi: [10.1016/j.oneear.2020.12.008](https://doi.org/10.1016/j.oneear.2020.12.008).
- 33 Government of Ireland, 'Climate Action Plan 2023', Dec. 2023. Accessed: Jun. 05, 2024. [Online]. Available: <https://www.gov.ie/en/publication/7bd8c-climate-action-plan-2023/>
- 34 National Economic and Social Council, 'Just Transition in Agriculture and Land Use', Jun. 2023. Accessed: Jun. 13, 2024. [Online]. Available: https://www.nesc.ie/app/uploads/2023/06/162_just_transition_in_ag_land_use-1.pdf
- 35 Government of Ireland, 'Climate Action Plan 2024 – Annex of Actions', May 2024. Accessed: Jun. 28, 2024. [Online]. Available: <https://www.gov.ie/pdf/?file=https://assets.gov.ie/296415/0e12782b-50bd-4cf1-bbcb-7ee7a488cdec.pdf#page=null>
- 36 Department of the Environment, Climate and Communications, 'Just Transition Commission – Terms of Reference', Apr. 2024. Accessed: Jul. 11, 2024. [Online]. Available: <https://www.gov.ie/pdf/?file=https://assets.gov.ie/292130/50c502ee-2e58-4e8c-80dc-48a61af0b82b.pdf#page=null>