Climate Change Advisory Council Secretariat

Carbon Budgets Working Group

Meeting No. 13
19th April 2024

Agenda

Time	Agenda Item
13:30	1. Opening of Meeting
13:35	2. Decarbonised Electricity System Study
14:10	3. Research on mitigation options available to agriculture
15:10	4. Just Transition Principles and Considerations in the Carbon Budget Process
16:10	5. Carbon Budgets Work Plan
16:15	6. Next Steps and Agenda for next meeting
16:20	7. AOB
16:30	Meeting Close

1. Opening of Meeting

Action Number	Date Raised	Description	Owner	Due	Status
15	29/02/24	Request for clarification on the role of the CBWG in terms of presenting a range of scenarios for Council consideration as opposed to proposing a particular feasible pathway.	CCAC Secretariat	April 2024	Open *Role of CBWG outlined in the ToR and is to be reiterated for clarity at the Council meeting on the 25th of April.*
16	29/02/24	Request for a more detailed discussion within the CBWG on the feasibility of various scenarios	CBWG Members	May 2024	Open *(1) Accompanying descriptive narrative for each of the modelled scenarios requested from core modelling teams.* *(2) Feedback from all CBWG members requested on the draft scenario dialogue tool to facilitate a collective narrative on impacts of various scenarios.*
17	29/02/24	Core and additional modelling teams to confirm delivery timelines for the 2nd iteration of modelling and analysis in line with Carbon Budgets Workplan	CBWG Members	Mar 2024	Propose to close *Core modelling teams confirmed delivery of 2nd iteration results on 23rd May.* *Additional modelling teams confirmed delivery of results on 28th June & 25th July.*

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16:30	Meeting Close

Action 16: Request for more detailed discussion on the feasibility of various scenarios

Accompanying Descriptive Narrative for Core Scenarios

- Technologies
- Rates of Deployment
- Costs
- Assessment of CB1 & CB2 overshoot
- Accounting for relevant NCAP24 targets
- Role of negative emissions
- Commentary on potential pitfalls and practical implications

CBWG Collective Narrative (Scenario Dialogue Tool)

- Short Scenario title & Description
- Scenario Coherency Issues
- Impacts and Opportunities
- Carbon Dioxide Removals
- Employment, Investment and Economy
- Biodiversity
- Climate Justice
- Just Transition, Fairness and Equity

5. Carbon Budgets Workplan: 2nd Iteration of Modelling & Analysis

Item	Description	2024											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	**Modelling / Analysis Iteration 2**												
2.1	Agree inputs, parameters and assumptions												
2.2	Core pathways development and modelling					→							
2.3	Paris Test Assessment					→							
2.4	Additional modelling and testing of results						→						
2.5	Post-hoc analysis												

- **CBWG Meeting No. 14, Thursday 23rd May 2024, 13:30 – 16:30:**
  - 2nd Iteration of Core Modelling Results
- **CBWG Meeting No. 15, Friday 28th June 2024, 13:30 – 16:30:**
  - Analysis of warming impact of selected core scenarios (2nd iteration),
  - COSMO Macroeconomic Modelling Results (based on 1st and 2nd iteration)
- **Thursday 25th July 2024, 13:30 – 16:30**
  - Agree inputs, parameters and assumptions for 3rd Iteration of Modelling/
  - Additional Testing of Scenario Results (SEAI & NTA)

New Action: Secretariat to schedule follow up call with the CBWG economists the week of the 13th of May
New Action: Secretariat to schedule a call with SEAI, UCC & NTA the week of the 27th of May 2024

5. Carbon Budgets Workplan: 2024 Meeting Schedule and Proposed Topics

CB WG Meeting No.	Proposed Date and Time	Topic(s) for Consideration
13	Friday 19th April 2024, 13:30 – 16:30	Just Transition principles and considerations in the Carbon Budget Process (NESC)/ *Decarbonised Electricity System Study (SEAI)* Teagasc research and implications for Carbon Budgets (Karl Richards, Teagasc)
14	Thursday 23rd May 2024, 13:30 – 16:30	*2nd Iteration of Core Modelling Results/* *Decarbonised Electricity System Study (SEAI)*
15	Friday 28th June 2024, 13:30 – 16:30	Analysis of warming impact of selected core scenarios (2nd iteration)/ *COSMO Macroeconomic Modelling Results (based on 1st and 2nd iteration)* *Discussion on various aspects of aviation and maritime (Secretariat)*
16	Thursday 25th July 2024, 13:30 – 16:30	Agree inputs, parameters and assumptions for 3rd Iteration of Modelling/ *SEAI & NTA Additional Analysis Results (based on 1st and 2nd iteration)* *Follow on discussion on Biodiversity Considerations (TBC)* Follow on discussion on CDR and Carbon Budgets (Oliver Geden)
17	Thursday 29th August 2024, 13:30 – 16:30	*3rd Iteration of Core Modelling Results/*
18	Wed 18th September 2024, 13:30 – 16:30	*Additional Analysis & Macroeconomic Modelling Results (based on the 3rd iteration)* Analysis of warming impact of selected core scenarios (3rd iteration) Economic assessment of climate change impacts and adaptation options in Ireland (ESRI)

5. Carbon Budgets Workplan: 2024 Meeting Schedule and Proposed Topics

CB WG Meeting No.	Proposed Date and Time	Topic(s) for Consideration
16	Thursday 25th July 2024, 13:30 – 16:30	Agree inputs, parameters and assumptions for 3rd Iteration of Modelling/ *SEAI & NTA Additional Analysis Results (based on 1st and 2nd iteration)* *Follow on discussion on Biodiversity Considerations (TBC)*
17	Thursday 29th August 2024, 13:30 – 16:30	3rd *Iteration of Core Modelling Results/*

- Proposed prioritisation of in-person attendance at the July and August CBWG meetings
- Potential to relocate to a more easily accessible central Dublin location and/or hold meeting (s) in Cork or Galway?
- Meeting start and end time could potentially be amended slightly to accommodate in person attendance if necessary

New Action: CBWG to provide feedback on in person attendance at selected CBWG meetings

6. Agenda for Meeting No. 14: Thursday 23rd May 2024, 13:30 – 16:30

1. Decarbonised Electricity System Study (SEAI)

- Kerrie Sheehan and John McCann to present on SEAI's work to cary out a Decarbonised Electricity System Study (DESS) to aid in the determination of Ireland's pathway to achieve a net-zero electricity system.

2. Presentation of the 2nd Iteration of Core Modelling Results

- Presentation and discussion of the 2nd iteration of core modelling results by Teagasc (FAPRI), NUIG (GOBLIN), and UCC (TIM)

6. Agenda for Meeting No. 15: Friday 28th June 2024, 13:30 – 16:30

1. Analysis of warming impact of selected core scenarios (2nd iteration)

- Joe Wheatley to present an assessment of the warming Impact of indicative emissions scenarios selected from the 2nd iteration of modelling and analysis

2. Macroeconomic Modelling Results (based on 1st and 2nd iteration)

- Niall to present COSMO macroeconomic modelling results

3. Discussion on various aspects of aviation and maritime (Secretariat)

- Secretariat to present a briefing paper on aviation and maritime emissions

7. AOB

- Update on Carbon Budgets Working Group Membership

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Rialtas na hÉireann
Government of Ireland

www.seai.ie

Decarbonised Electricity System Study

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Policy Imperative

DECC Requirement (CAP 23, 12.3.4 Further Measures):

The third carbon budget (2031-2035) is expected to require continued electrification of industry, the built environment, and transport, leading to substantial electricity demand growth which will need to be almost fully decarbonised. In that context, ***SEAI will report to the Department of the Environment, Climate and Communications in 2023 on an evidence-based decarbonisation pathway for the electricity system to net zero****, in order to provide support future iterations of the Climate Action Plan; inform future carbon budgets; and provide a basis for a long-term electricity system development strategy to achieve our 2050 objective.*

CAP 24, Action EL/24/3

Complete a stakeholder consultation for an evidence-based decarbonisation pathway for the electricity system to net-zero and support future iterations of the Climate Action Plan.

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Decarbonised Electricity System Pathway

What is a Decarbonisation Pathway?

- A societal process to develop a national consensus on the most viable long-term strategy to decarbonise the electricity system in Ireland?
- A technocratic process to support near term setting, and reporting on adherence to, electricity system decarbonisation targets?

The answer ultimately directs the project objectives and timeline

Prior Precedent – All Island Grid Study 2005 - 2008

What worked well

- Multi-body All-Island working group (DECC, DETI, CRU, NIAUR, SEAI, Action Renewables) collaborated to specify, commission & oversee pioneering studies suite
- Leveraged insights/resources in organisations, facilitated organisational buy-in
- Successfully stimulated collaboration between consultancies and academics
- Cutting edge analysis techniques from EU research
- International liaison (IEA Wind Task 25) for insights of new methods
- Involvement of academic experts as advisors
- International peer review
- Industry stakeholder meetings gave course corrections
- Study justified setting an ambitious 2020 renewable electricity target that was ultimately met

Not so well

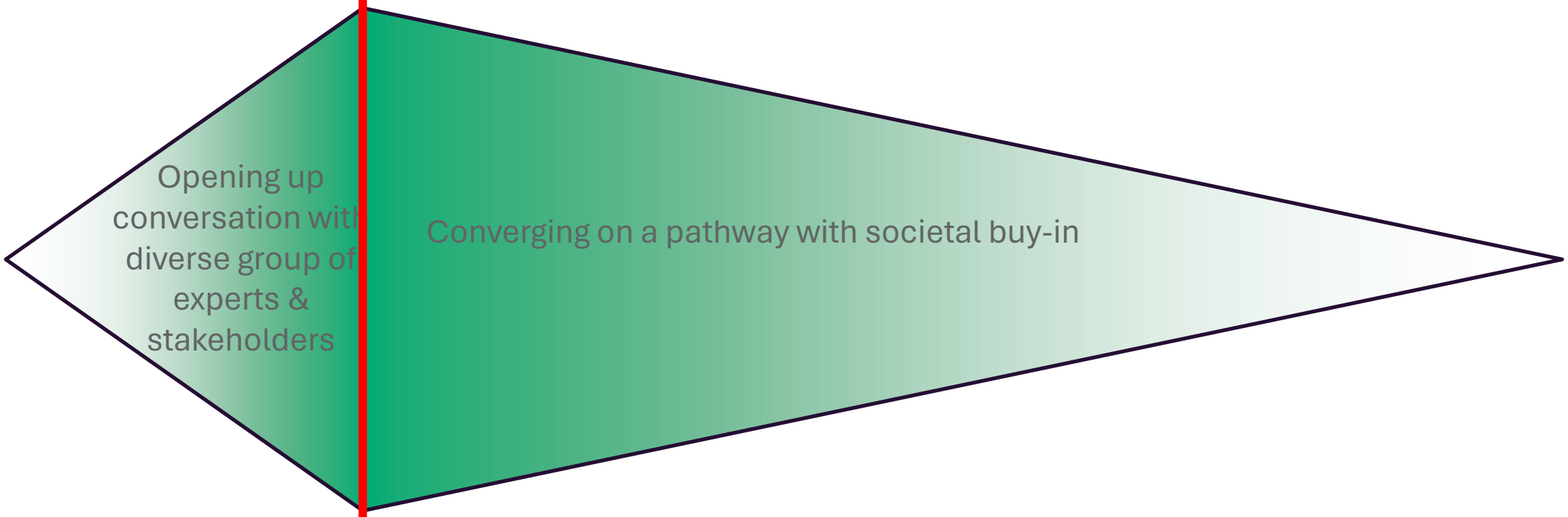
- Overfocus on cost, not much attention to technology maturity and market/regulatory readiness
- Too much credence given to immature technologies, resources & sectors that didn't ultimately deliver
- Solar PV opportunity missed
- No a lot of engagement outside of the electricity sector
- Social acceptance of new technologies and infrastructure not included in considerations

(MCDM might have addressed the above)

Focus for Phase 2

PHASE 1: OCT '23 – JUN '24
Sense check modelling assumptions for carbon budgets

PHASE 2: FEB 2024 – DEC 2026
Deliver evidence-based pathway(s) for decarbonising electricity system.



Methodology – Phase 2a

Phase 2a: MCDA (completed Q3 2025)

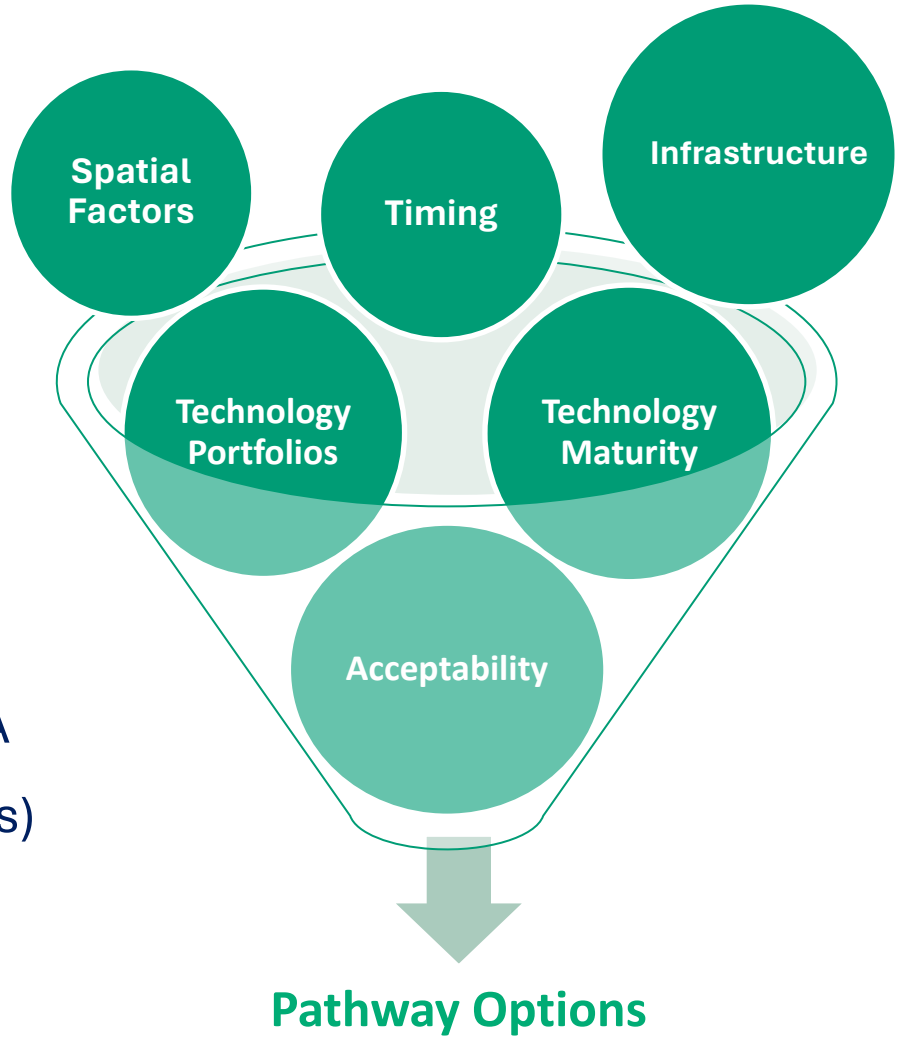
- Input from diverse stakeholders on range of potential pathways
- Rank based on viability & ability to meet key societal priorities

Outputs

- Project Scoping Report
- Stakeholder Consultation Report
- Technologies, evaluation criteria and criteria weightings for MCDA
- Report on priority pathways from MCDA (Phase 2b input scenarios)

Added value

- Early signal of most viable pathways for planning & policies
- Input to SEA & AA for electricity sector policies / plans / projects



Methodology – Phase 2b

Pathway Options from MCDA

Phase 2b: Techno-Economic Study (completed Q4 2026)

- Based on priority pathways from MCDA
- Full techno-economic study

Techno-Economic Study

Outputs

- Project Scoping Report
- High level Study Report
- Series of detailed topical reports
- Executive Summary for policy makers

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The Project Plan

MCDA

What?

A process to identify and agree the criteria to determine the best feasible solution

Output?

Viable Pathways

Indicative regulation requirements

Scoping Study

What?

High-level electricity system modelling to initially investigate scenarios, plant portfolios & infrastructure

Output?

Confirmed Scenarios

Functional Portfolios

Energy Flows

Energy Storage

New Infrastructure

Indicative Emissions

Indicative Costs

RE & Demand Time Series

Generating System Study

What?

Generating system dispatch model

Output?

System Adequacy

Plant Dispatches

Storage Flows

Interconnection Requirements & Flows

Systems Services

Detailed Emissions

Production Costs

Infrastructure Study

What?

Modelling of factors driving infrastructure requirements

Output?

System Services

Potential Location of Generation, Storage, Other Vectors - **Heat**

Electricity Network Development

Other Infrastructure Requirements

Capital Investment

Legislation Deficits

Economics & Policies

What?

Economic & Market Modelling

Viability Analysis

Policy Identification

Output?

Electricity market prices

Viability Gap

Cost of Support

Cost Recovery

Cost to Consumers

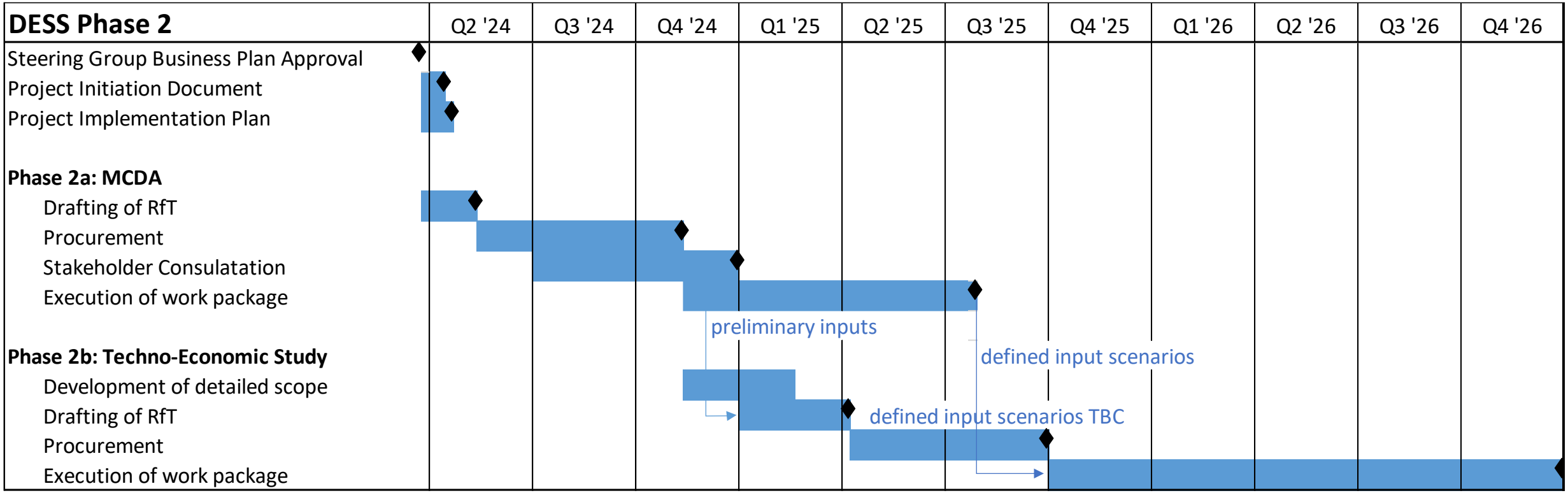
Support Mechanisms

Market Reform

Policy Requirements

Legislation

Workplan


DESS Phase 2
Q2 '24
Q3 '24
Q4 '24
Q1 '25
Q2 '25
Q3 '25
Q4 '25
Q1 '26
Q2 '26
Q3 '26
Q4 '26
Steering Group Business Plan Approval
Project Initiation Document
Project Implementation Plan
Phase 2a: MCDA
Drafting of RfT
Procurement
Stakeholder Consulatation
Execution of work package
preliminary inputs
defined input scenarios
Phase 2b: Techno-Economic Study
Development of detailed scope
Drafting of RfT
defined input scenarios TBC
Procurement
Execution of work package

Expert elicitation on plausible deployment rates of variable renewables in Ireland 2024 – 2040

PRELIMINARY RESULTS – SUBJECT TO CHANGE

CARBON BUDGETS WORKING GROUP – 19 APRIL 2024

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Structure of presentation

- Study objectives
- Method
- Results: Expert Pooled Opinion on VRE deployment 2024 - 2040
- Key messages
- Next steps

Study objectives

Deliverable:

Provide DECC information relevant to "validating critical assumptions that underlie model solutions informing the setting of the 3rd and 4th carbon budgets."

Critical assumptions prioritised:

Availability and deployment rates of onshore wind, offshore wind, solar PV, hydrogen generation, and generation with Carbon Capture and Storage (CCS) up to 2040

Working group:

Representation from CRU, ESB Networks, Eirgrid, DECC and SEAI. Prioritized topics of expert elicitation, reviewed method, selected experts, reviewing results.

Method

- Expert elicitation: pooling probability distributions from experts for use in E3 modelling
  - O'Hagan et al. 2006, Durbash et al 2017
- Interviews, in-person and online (1.5 – 2.5hrs), questions and intro brief shared in advance
- Most participants prepared forecasts beforehand, drew on institutional analysis, or followed up with data

Provide a probabilistic forecast of the cumulative installed capacity of [ONW / OFW / SPV] in IRL at 2030, 2035, 2040

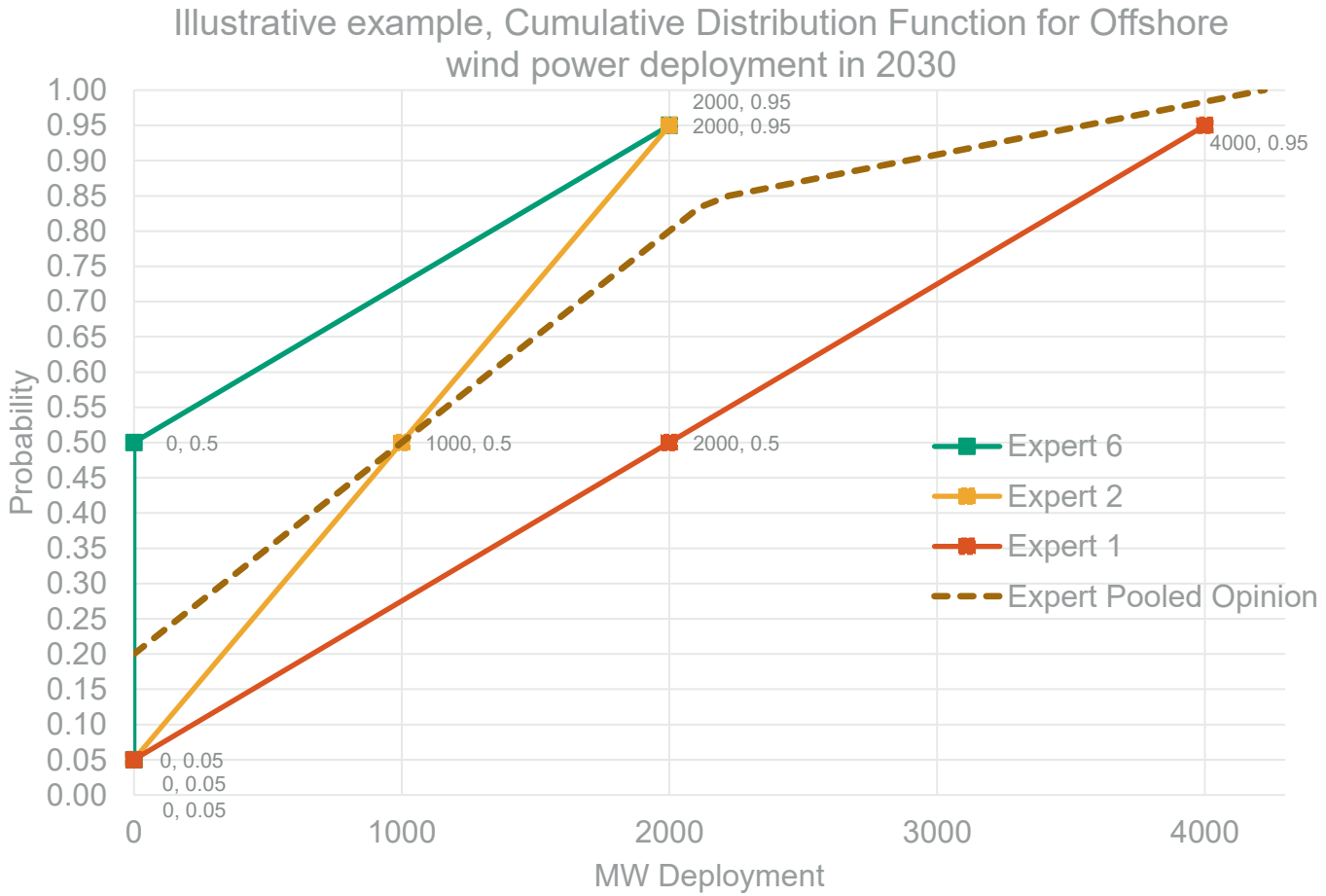
1. **Low deployment scenarios**: For [tech X] in [2030, 2035, 2040] what is a plausible ***low*** estimate for cumulative installed capacity (MW) such that *there is only a 5% probability it could be lower ? (You are almost certain it couldn't be lower)*

2. **Median (best guess) deployment scenario**: For [tech X] in [2030, 2035, 2040], what is a plausible ***median*** estimate for cumulative installed capacity (MW) such that *it is equally likely that the actual value will be higher or lower ?*

3. **High deployment scenarios**: For [tech X] in [2030, 2035, 2040] what is a plausible ***high*** estimate for cumulative installed capacity (MW) such that *there is only a 5% probability it could be higher ? (You are almost certain it couldn't be higher)*

Method

- Create a linear Cumulative Distribution Function (CDF) for each expert from 3 forecast data points for each of 2030, 2035, 2040
- Expert pooled opinion ('wisdom of the crowd') = weighted average of individual CDFs
- Each expert's forecast is weighted equally
- Approach: O'Hagan et al (2006)



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Method

- From expert pooled opinion, draw three forecasts to capture a plausible or credible interval

Forecast	Description
EPO90 (9 in 10 chance)	CDF of expert pooled opinion @ p = 0.9 *The lowest plausible bound for future deployment that captures the idea of being 'certain' or 'almost certain' that deployment would in fact be higher. Anything below this could be considered unbelievable, far-fetched, or unimaginable.*
EPO50 (1 in 2 chance)	CDF of expert pooled opinion @ p = 0.5 *A median or 'best estimate' deployment scenario*
EPO10 (1 in 10 chance)	CDF of expert pooled opinion @ p = 0.1 *The highest plausible bound for future deployment that captures the idea of a very unlikely but not impossible rate of deployment. Anything above this could be considered unbelievable, far-fetched, or unimaginable.*

Method

- Expert elicitation: pooling probability distributions from experts for use in E3 modelling
  - O'Hagan et al. 2006, Durbash et al 2017
- Interviews, in-person and online (1.5 – 2.5hrs), questions and intro brief shared in advance
- Most participants prepared forecasts beforehand, drew on institutional analysis, or followed up with data

Identify the conditions that are associated with the *low* and *high* deployment of [ONW / OFW / SPV]
QUESTIONS (in general form): 1. What conditions drive or constrain the deployment of [tech X] up to 2030, 2035, and 2040 in a [low / high] scenario? 2. What are the assumptions that underpin a low and high deployment scenario?
OUTPUT: Qualitative data on conditions that cause lowest plausible or highest plausible technology deployment rates

Method

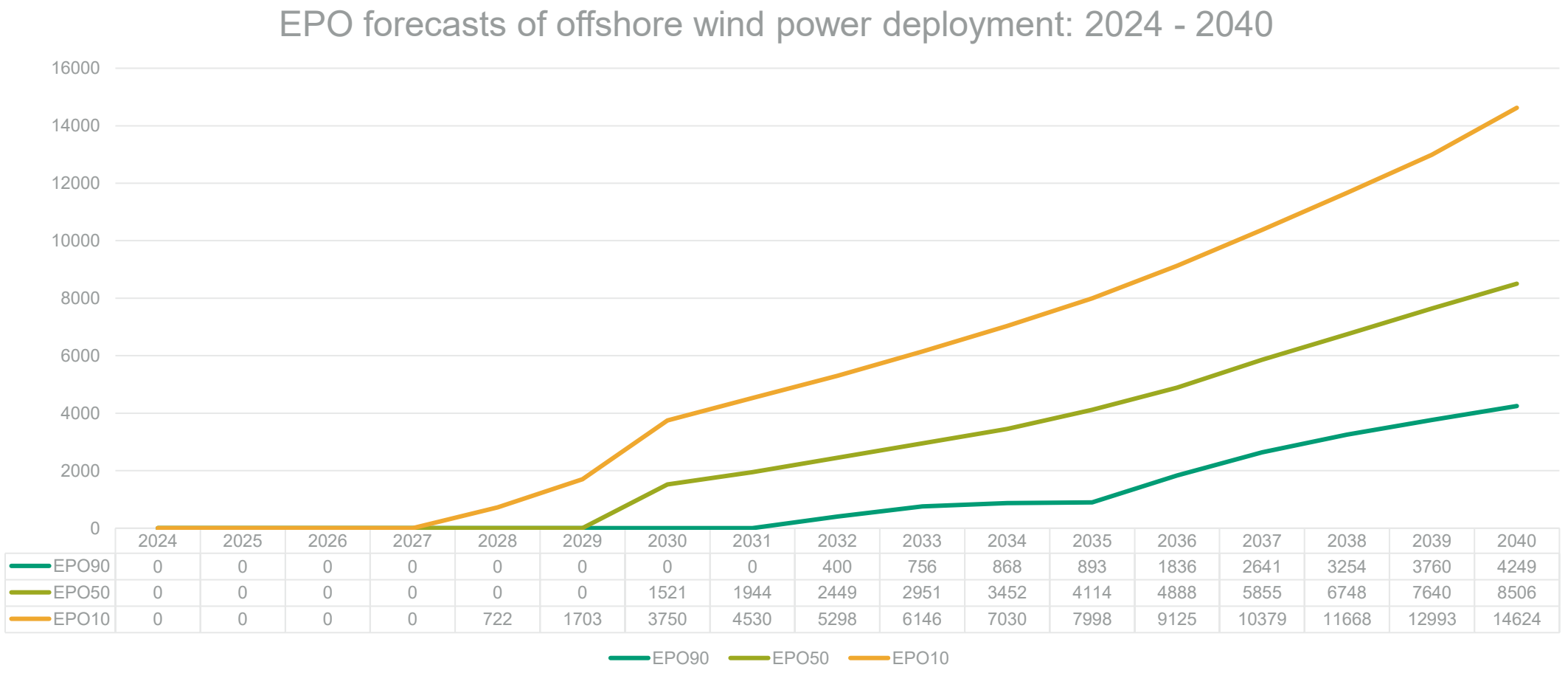
- Experts nominated by study Working Group (DECC, CRU, TSO, DSO, SEAI)
- Highly regarded experts with deep knowledge of Irish power sector.
- Interviews were confidential and not representative of institutional positions
- In some interviews, more than one individual contributed to a single forecast (group counted as 'one expert')
- Industry includes wind and solar industry associations, grid development and connection, and related engineering, economic and legal services

	Organisation	OFW	ONW	SPV
Expert 1	State agency	Y	Y	Y
Expert 2	Industry	Y	Y	Y
Expert 3	University	Y	Y	N
Expert 4	Industry	N	N	Y
Expert 5	State agency	Y	N	N
Expert 6	University	Y	N	N
Expert 7	Industry	N	Y	Y
Expert 8	University	Y	Y	Y
Expert 9	Industry	Y	Y	N
Expert 10	System Operator	N	Y	Y
Expert 11	State agency	Y	N	N
Expert 12	Industry	N	Y	N
Expert 13	State agency	N	Y	Y
Expert 14	Industry	Y	Y	Y
Expert 15	System Operator	N	Y	Y
		9	11	9

Participants	15
State Agencies	4
Industry	6
System Operators	2
University	3

Requests	22
Declines	5
Accepts	16
No response	1

Results: Expert Pooled Opinion 2024 - 2040



	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
EPO90	0	0	0	0	0	0	0	0	400	756	868	893	1836	2641	3254	3760	4249
EPO50	0	0	0	0	0	0	1521	1944	2449	2951	3452	4114	4888	5855	6748	7640	8506
EPO10	0	0	0	0	722	1703	3750	4530	5298	6146	7030	7998	9125	10379	11668	12993	14624

Results: Expert Pooled Opinion 2024 - 2040

Qualitative synthesis of *low deployment* scenario for 2030:

Several legal, planning and/or supply chain related challenges coincide to delay most or all Phase 1 projects, whilst successful Judicial Review (JR) challenges lead to one or more abandoned projects

- Some participants think that a lack of specialist resources and capacity in planning and permitting agencies could delay the consenting of Phase 1 projects. For some Phase 1 projects, these delays may affect them a second time if developers have to resubmit applications for planning consent following successful JR proceedings.
- All but one participant agree that most or all of the Phase 1 projects could be delayed by 18 months to 4 years by Judicial Review proceedings. Most participants think that JR proceedings would merely delay Phase 1 projects, but that most or all Phase 1 projects would connect *after* 2030. Some experts think that some JRs would be successful and that some Phase 1 projects would be unconsentable and abandoned.
- Some participants think that bottlenecks in international supply chains, especially long lead times to schedule installation vessels, secure cable, or secure/develop necessary port facilities, will delay construction further for most Phase 1 projects.

Due to the above conditions, most participants think that it is plausible (if unlikely) that no OFW capacity will be connected by 2030, but some experts think that at least one or two Phase 1 projects may still connect by 2030 in a low deployment scenario.

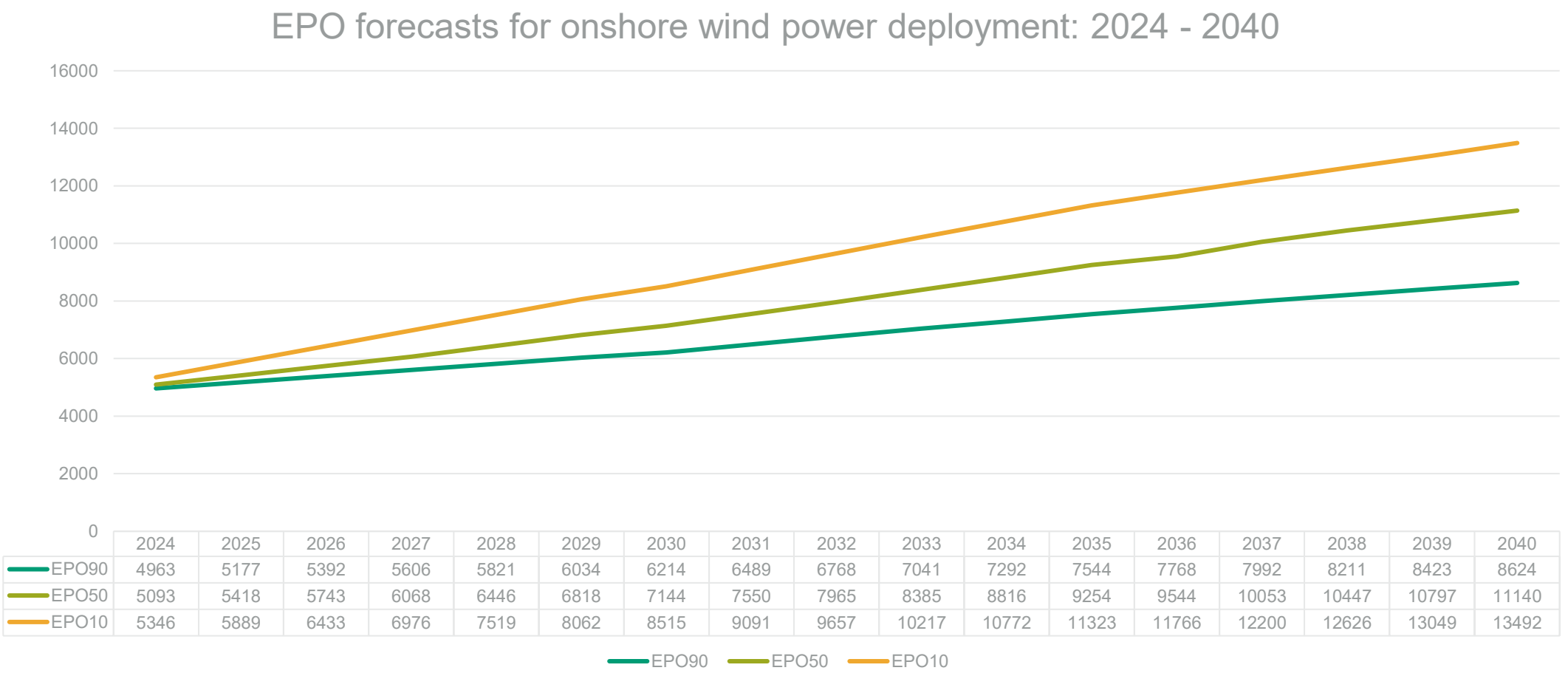
Results: Expert Pooled Opinion 2024 - 2040

Qualitative synthesis of *high deployment* scenario for 2030:

Most Phase 1 projects do not face a combination of two or more types of delay related to planning consent, JR, or supply chain bottlenecks, or such delays are of shorter durations.

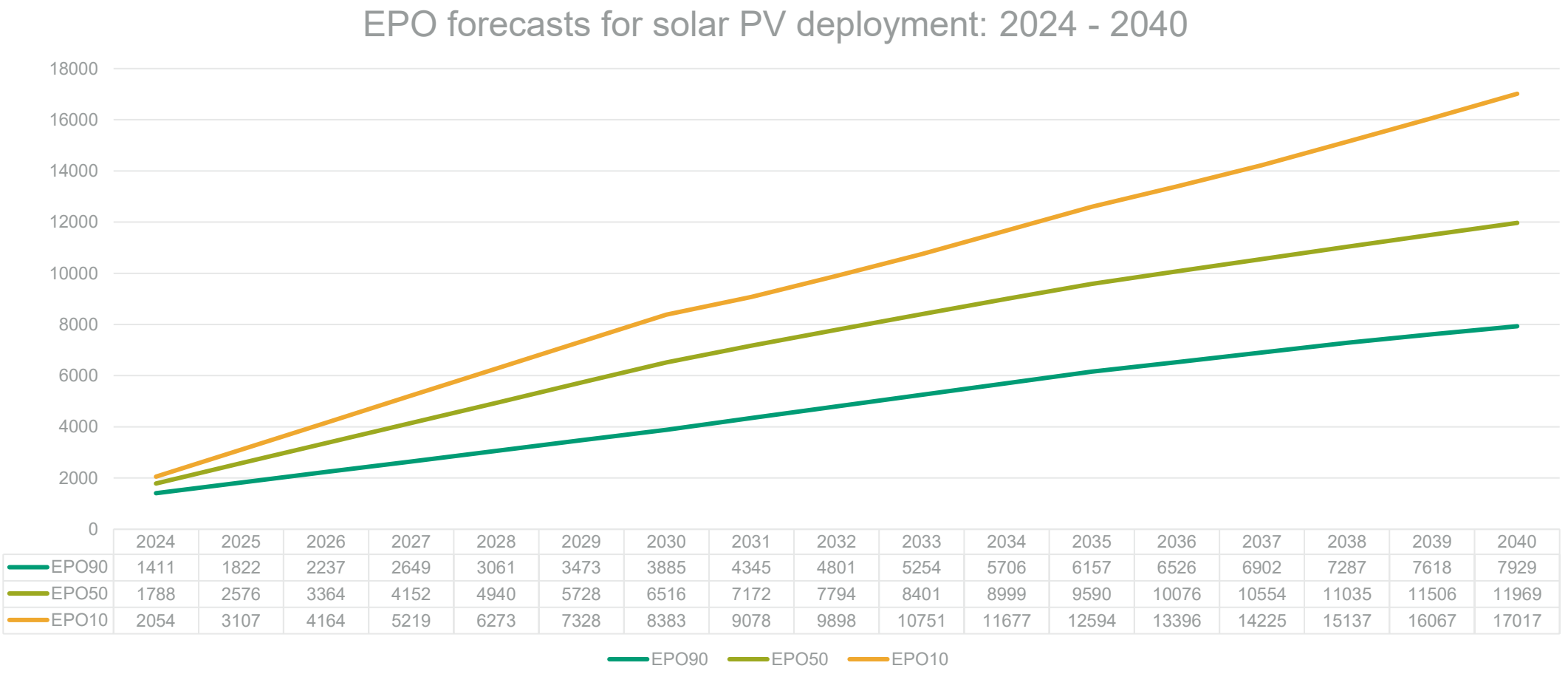
- Most participants think that it is plausible (though unlikely) that all Phase 1 projects receive planning consent within 9 months from application. This assumes that the Oireachtas undertake legislative reform to impose time limits on planning decisions for national strategic infrastructure, and that An Bord Pleanala (ABP) and National Wildlife and Parks Services (NWPS) establishes necessary capacity for processing applications
- Most participants assume that JRs will be brought against most Phase 1 projects. However, almost all participants think it plausible (though unlikely) that these projects could suffer minimal delays of not more than 2 years and that none of the JRs lead to abandoned projects. This assumes that most or all JRs are rejected or that they all run concurrently. Some participants noted that this requires legislative reform to implement time limits on JR decisions and additional capacity for the high court.
- Most participants think it plausible (though unlikely) that supply-chain related bottle necks may not delay some or most Phase 1 projects. This assumes that some developers have already secured specialist installation vessels for their international portfolio which could be deployed to Ireland at shorter notice when consent is received or JR resolved, or that there will be sufficient capacity in Belfast port to commence construction of the earlier projects in 2027.
- All participants agree that offshore wind capacity dedicated to hydrogen production is implausible by 2030.

Results: Expert Pooled Opinion 2024 - 2040



	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
EPO90	4963	5177	5392	5606	5821	6034	6214	6489	6768	7041	7292	7544	7768	7992	8211	8423	8624
EPO50	5093	5418	5743	6068	6446	6818	7144	7550	7965	8385	8816	9254	9544	10053	10447	10797	11140
EPO10	5346	5889	6433	6976	7519	8062	8515	9091	9657	10217	10772	11323	11766	12200	12626	13049	13492

Results: Expert Pooled Opinion 2024 - 2040



	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
EPO90	1411	1822	2237	2649	3061	3473	3885	4345	4801	5254	5706	6157	6526	6902	7287	7618	7929
EPO50	1788	2576	3364	4152	4940	5728	6516	7172	7794	8401	8999	9590	10076	10554	11035	11506	11969
EPO10	2054	3107	4164	5219	6273	7328	8383	9078	9898	10751	11677	12594	13396	14225	15137	16067	17017

Results: Expert Pooled Opinion 2024 - 2040

- Plausible average annual deployment rates over the 2nd, 3rd and 4th carbon budgets

	OFW			ONW			SPV		
	EPO90	EPO50	EPO10	EPO90	EPO50	EPO10	EPO90	EPO50	EPO10
2026 - 2030	0	271	731	205	342	517	406	754	1039
2031 - 2035	202	625	815	282	412	553	320	589	843
2036 - 2040	698	862	1299	226	311	420	339	466	865

Key messages

1. Least-cost, ‘technically feasible’ scenarios may miss critical criteria for decarbonisation success, e.g. planning system, labour market, international supply chains
2. Expert elicitation internalises larger set of risks that may constrain solution space, potentially offering a more accurate account of plausible solutions.
3. If implausible rates of technology deployment (or any other form of optimism bias) are assumed in models, the true requirement to decarbonise other areas is missed.
4. A comparison between current carbon budget solutions and the results of the expert elicitation would offer insights on the plausibility of the current budgets for the power sector.

References

- Anthony O'Hagan, Caitlin E. Buck, Alireza Daneshkhah, J. Richard Eiser, Paul H. Garthwaite, David J. Jenkinson, Jeremy E. Oakley, Tim Rakow. 2006. Uncertain Judgements: Eliciting Experts' Probabilities. Online ISBN:9780470033319. DOI:10.1002/0470033312
- Robert T. Clemen and Robert L. Winkler. 1999. Combining Probability Distributions From Experts in Risk Analysis. Risk Analysis, Vol. 19, No. 2.
- Ian Durbach, Bruno Merven, Bryce McCall. 2017. Expert elicitation of autocorrelated time series with application to e3 (energy-environment-economic) forecasting models. Environmental Modelling & Software. Vol. 88. p. 93 – 105. http://dx.doi.org/10.1016/j.envsoft.2016.11.007

Any questions?

Please email [redacted]

Analysis completed by Jean-Pierre Roux and Arash Alavi

@ seai_ie

Ireland's European Structural and Investment Funds Programmes 2014-2020

Co-funded by the Irish Government and the European Union

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Expert Pooled Opinion compared to other scenarios for 2030

- For offshore wind, the EPO median forecast is much lower than the 2030 target and the WEM and WAM scenarios (SEAI 2024)
- For onshore wind, the EPO median forecast lies between the WEM and WAM scenarios
- For solar PV, the EPO median forecast exceeds the WEM and WAM scenarios, but falls short of the target.
- We have not performed a comparison to TIM preliminary results for 3rd and 4th carbon budgets

Difference between expert pooled opinion (CDF: P = 0.5), 2030 targets and policy scenarios (GW)			
	CAP23 Target	WAM	WEM
ONW	-1.9	-0.1	0.3
OFW	-3.5	-2.5	-1.2
SPV	-1.5	0	0.8

Negative figure indicates expert pooled forecast for P = 0.5 is less than target/scenario. Positive figure indicates forecast is more than target/scenario. WEM = With Existing Measures, WAM = With Additional Measures. These are policy scenarios used by EPA and SEAI for European reporting which broadly align with 70% RES-E and 80% RES-E respectively.

Thank you

@ seai_ie

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Agriculture & LULUCF Research Overview: Emissions and Mitigation

Karl Richards, Gary Lanigan, Laurence Shalloo and Kevin Hanrahan

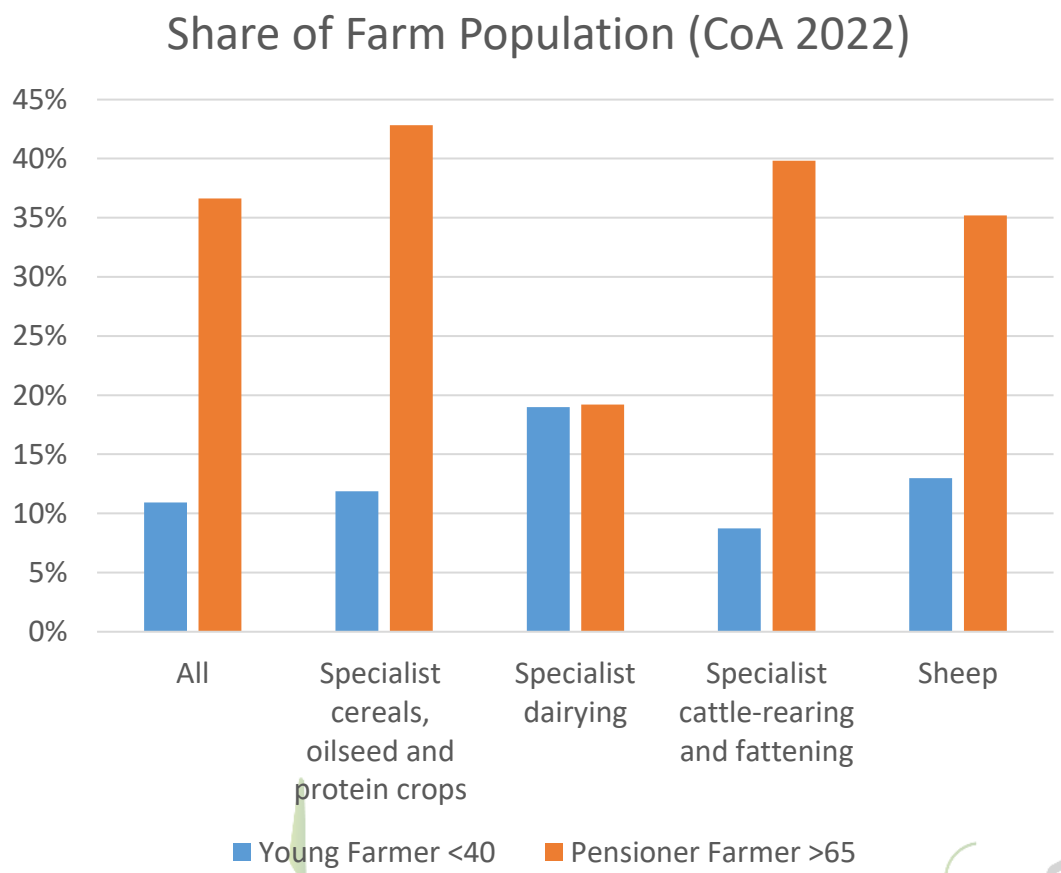
TEAGASC CLIMATE CENTRE

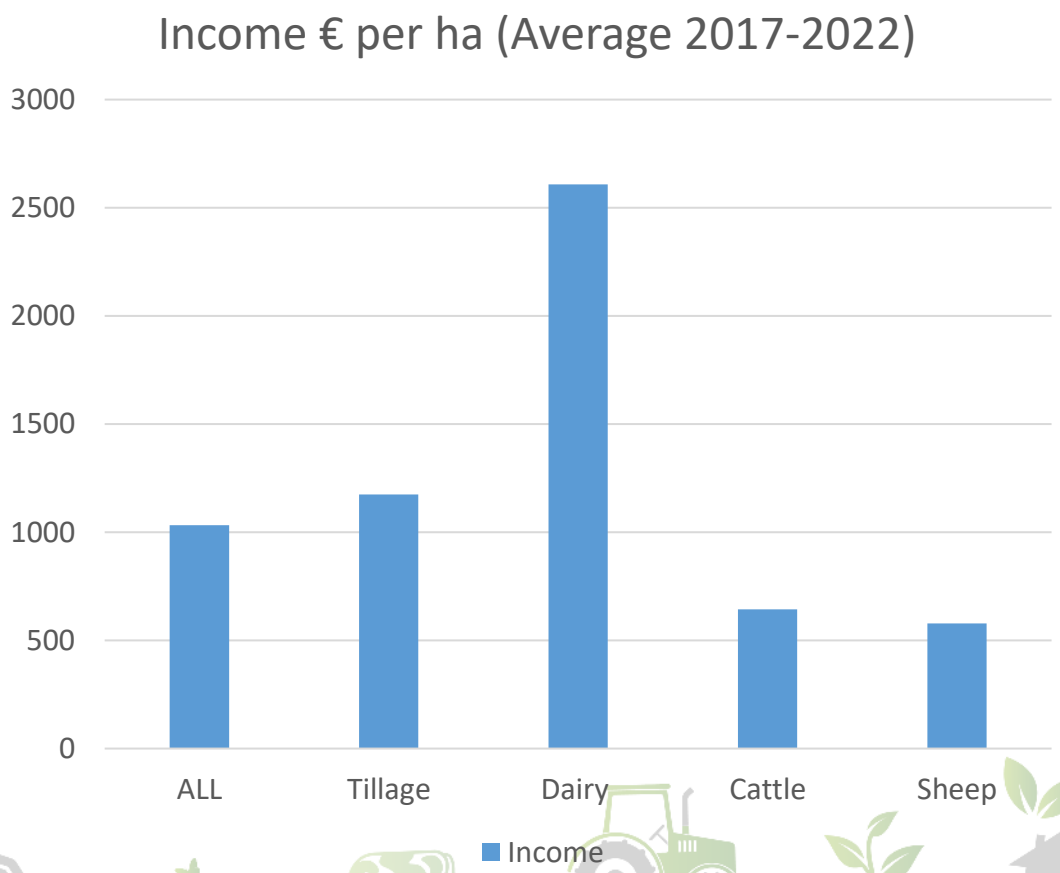
teagasc
Agriculture and Food Development Authority

Presentation Outline

- Outline of farmer demographics/social sciences
- Emissions Overview
- Teagasc Climate Centre
- Teagasc Climate Centre research
- Inventory Refinement Science
- Mitigation Science
- Summary

Farming Demographics & Income Performance





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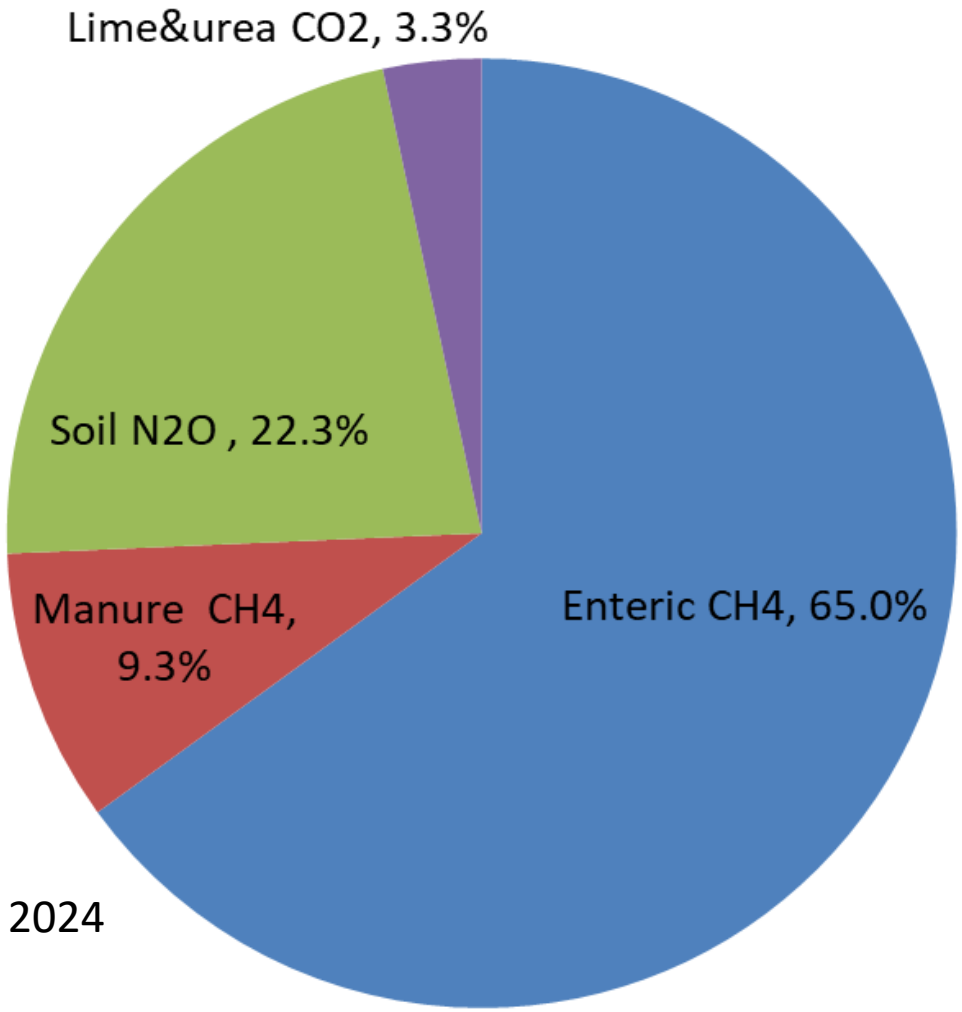
Agricultural Emissions

- Emissions Share
  - Methane (CH_4) c. 74%
  - Nitrous oxide (N_2O) 22%
  - CO_2 emission c. 3% (liming & urea)
- Currently modelling for CCAC
  - Projected emissions 2030-50
  - Potential Mitigation 2030-50



EPA 2024

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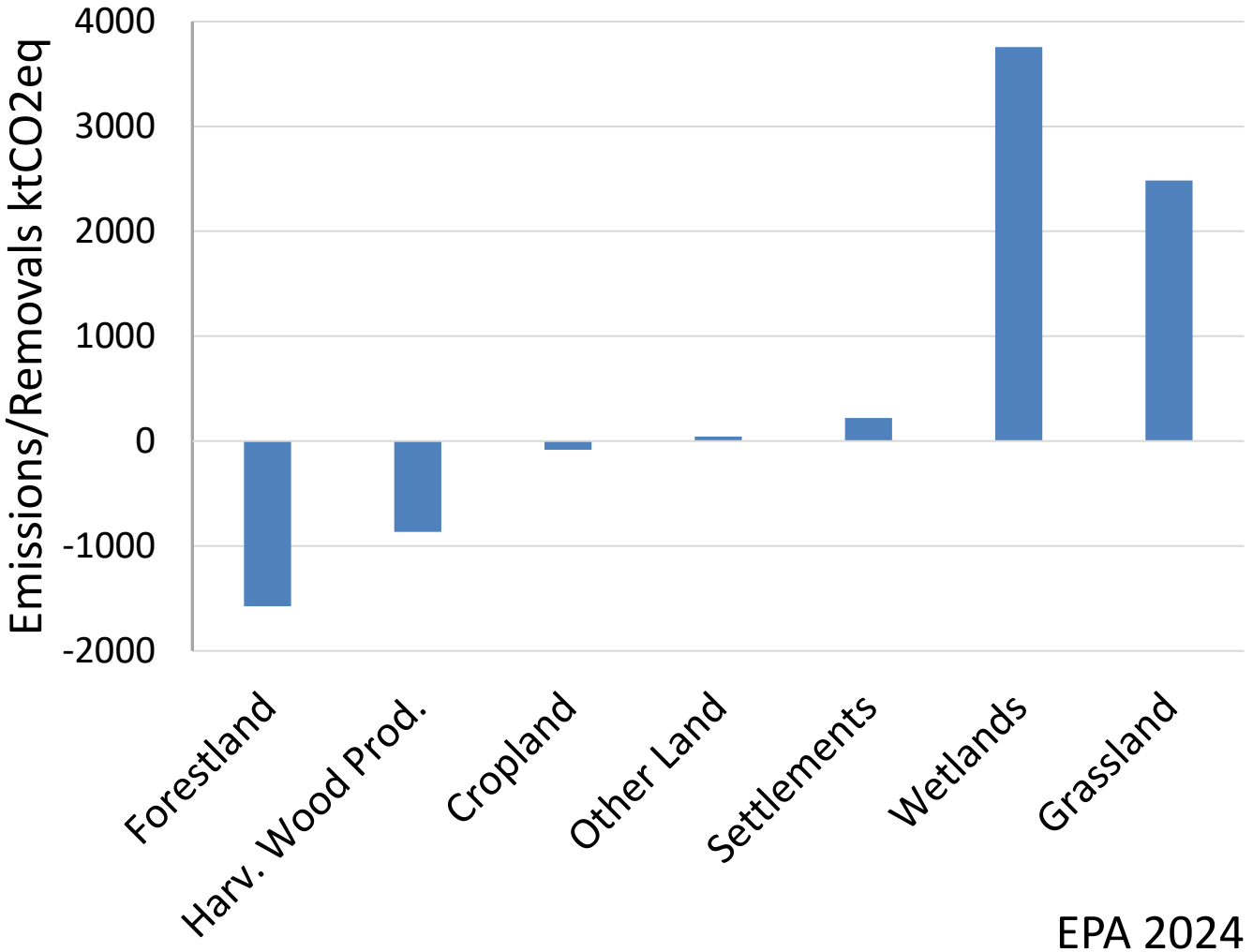
LULUCF Emissions

- Latest EPA inventory (2024)
- Wetlands 3.8 Mt CO_2e
- Grasslands 2.5 Mt CO_2e
- Forestry/wood products -2.4 MT CO_2e
- Sectoral emissions growing since 2018
- Frequent inventory revisions
- Update LULUCF Projections to 2050



EPA 2024

Teagasc Climate Strategy

3 Key Pillars of Climate Action

SIGNPOST ADVISORY PROGRAMME

- Available to all farmers
- Enhanced advisory & training support
- "Know my Number - Make my Plan" *supported by the* Sustainability Digital Platform
- Engage with 50,000 farmers by 2030

AGNAV

- New Secure Online platform
- Facilitating Whole Farm sustainability assessment
- Farmer & Advisor Understand emissions profile

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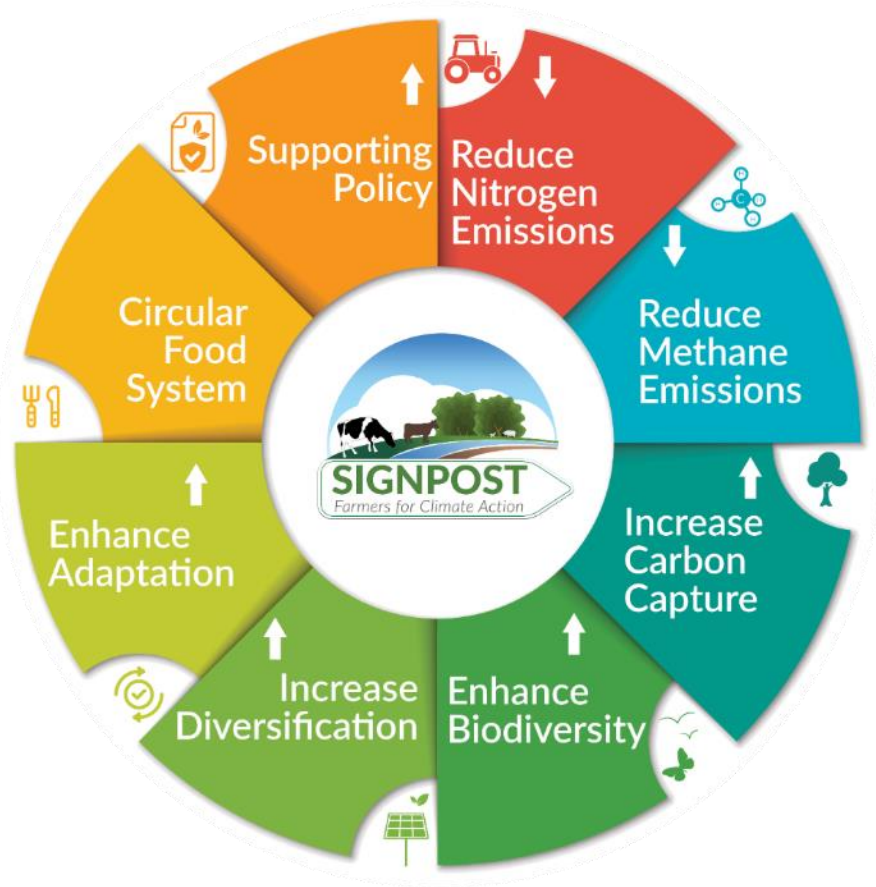
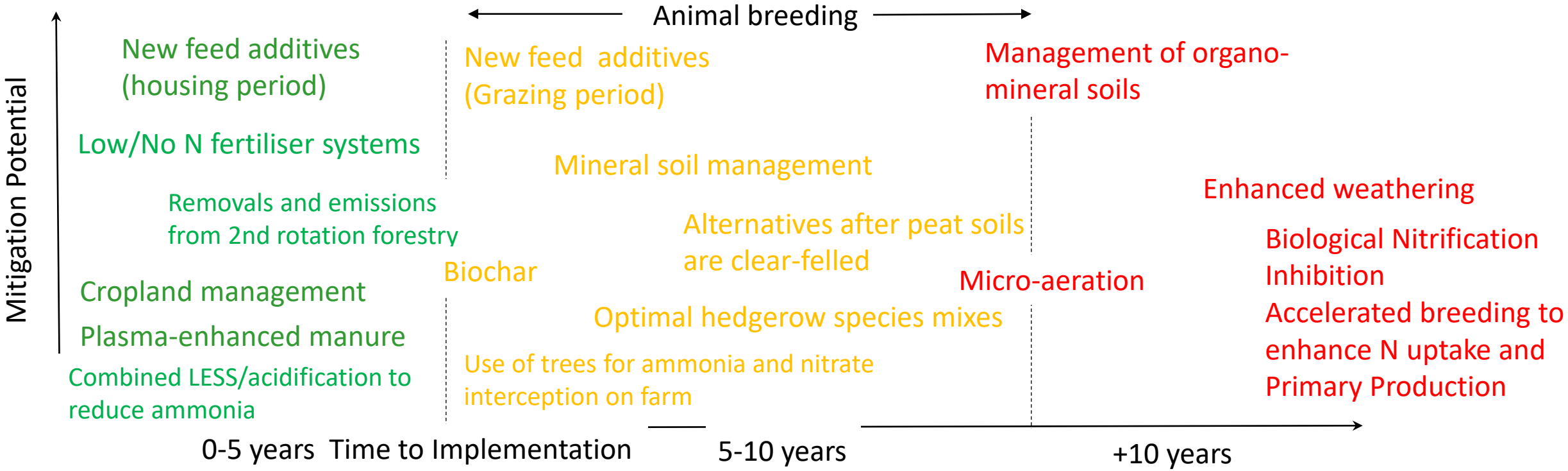
- New Virtual Centre
- Accelerate & co-ordinate Climate Research & Innovation Programmes
- Providing leadership, nationally & internationally

Teagasc Climate Centre



Modelling Pathways towards Net Zero

- Extending FAPRI modelling to project agricultural activity to 2050
- Extend BAU LULUCF emissions using process-based modelling
- Model future agricultural mitigation potential & adoption rates
- Model future LULUCF & land-based mitigation to 2050



Inventory Refinement Research

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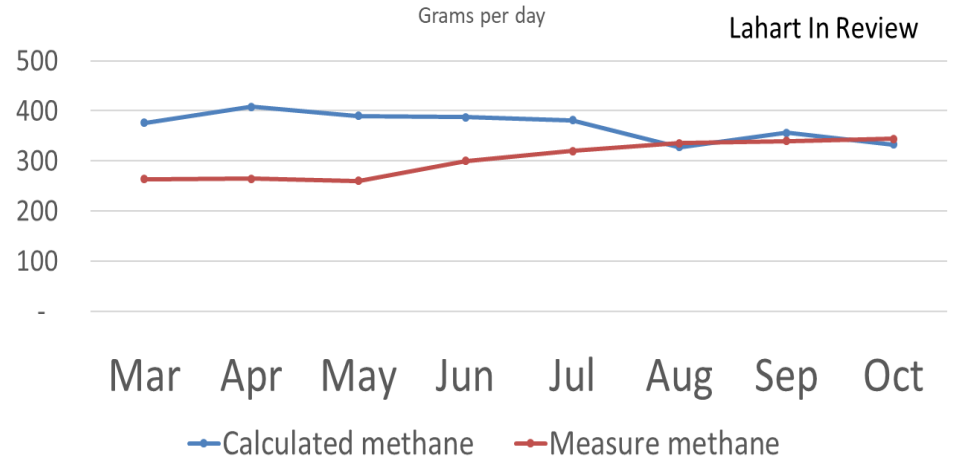
Methane (16.7 $MTCO_2e$ 65%)

- Cattle and Sheep
- Grazing
  - Grassland Management
- Grass silage
- Alternative forages
- Manure: volume/timing, housing/storage EF



J. Dairy Sci. 107:383–397
https://doi.org/10.3168/jds.2022-22646

Evaluating enteric methane emissions within a herd of genetically divergent grazing dairy cows

B. Lahart,[1]* F. Buckley,[1,2] J. Herron,[1] R. Fitzgerald,[1] E. Fitzpatrick,[1] N. Galvin,[1] and L. Shalloo[1]
[1]Animal and Grassland Research and Innovation Centre, Teagasc, Moorepark, Fermoy, Co. Cork, Ireland P61 P302
[2]School of Biological Earth and Environmental Science, University College Cork, Distillery Fields, North Mall, Cork, Ireland T12 K8AF

Inventory Model calculation 285g/day

Item	High quality	Low quality	S.E	Treat
Bodyweight (kg)	630	606	13.66	0.195
BCS (1-5)	3.36	3.35	0.064	0.897
DMI (kg/DM/cow)	12.78	8.93	0.598	0.001
CH_4 (g/day)	254	213	7.123	0.001
CH_4 (g/kg DMI)	21	26	1.217	0.008

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Enteric Methane Emission Factor

Study	Method	Emission factor
Wims et al. 2010	SF6	6.4
O'Neill et al., 2011	SF6	5.7
Ferris et al., 2020	SF6	4.9
Hynes et al., 2016	Chamber	5.6
Lahart et al., 2023	GreenFeed	5.2
Starsmore et al., 2023	GreenFeed	6.1
Jiao et al., 2014	SF6	5.6
Foley et al., 2008	SF6	6.3
Lovett et al 2005	SF6	5.6
Hidalgo et al 2014	SF6	6.8
Mean		**5.75**
IPCC 2019 used in inventory		**6.3**

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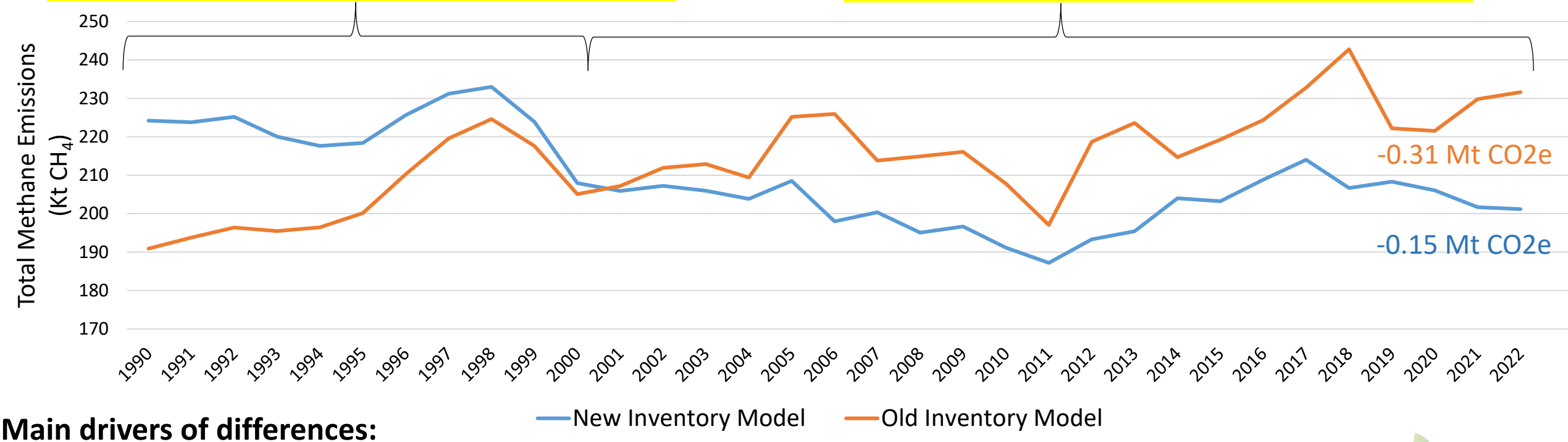
Beef Methane Inventory Refinement

Average increase 1990-2000:
c. 9% [1 – 17%]
= 0.51 Mt CO_2e [0.08 – 0.93 Mt CO_2e]

Average reduction 2001-2022:
c. 8% [1– 15%]
= 0.48 Mt CO_2e [0.04 – 1.01 Mt CO_2e]



Main drivers of differences:

- Better characterisation of lifetime diet/diet changes across systems
- National concentrate consumption captured more effectively via substitution rates
- Update of methane Ym & prediction equations
- More effective capture of animal performance (lifetime growth, carcass, age slaughter)

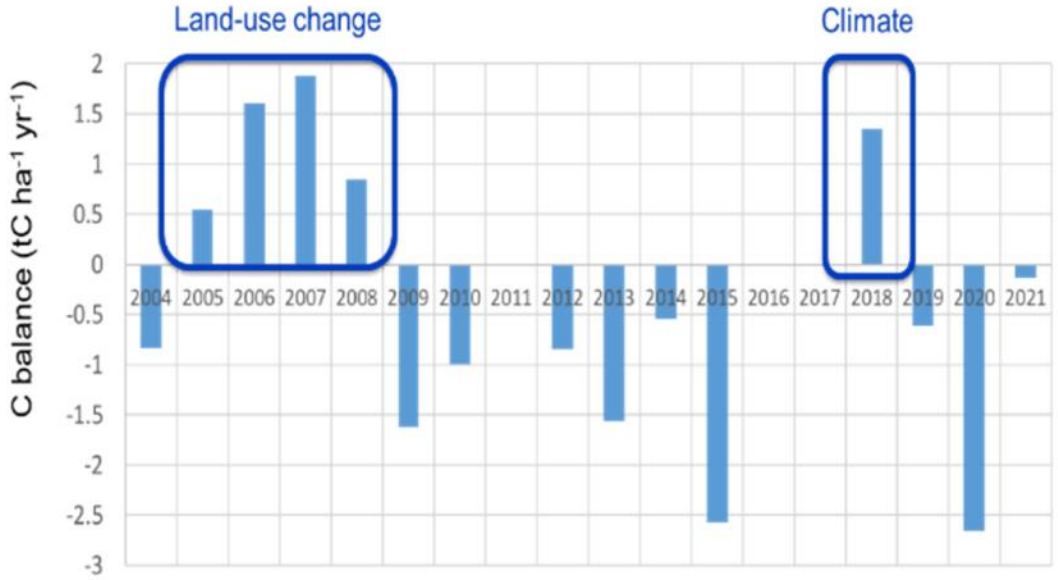
Nitrous Oxide (5 $MTCO_2e$ 22.3%)

- Fertiliser type
- Manure/Digestate
- NH_3/N_2O – Digestate
- Peat drainage
- Soil type (peat/mineral)
- Tier 3 fertiliser model

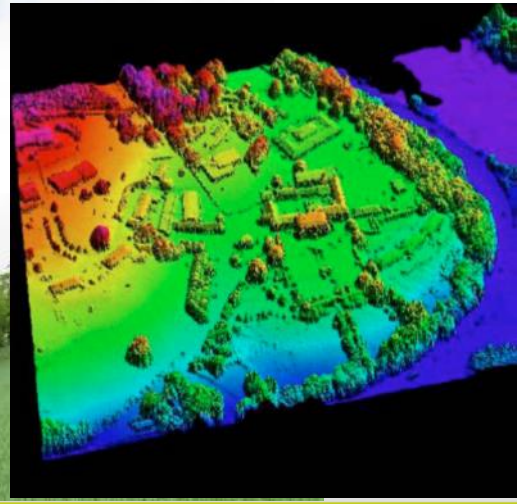
	Default EF%	Irish EF %	EF range %
GRASSLAND FERTILISER			
CAN	1	1.49	2.74 – 0.87
Urea	1	0.25	0.40 – 0.18
Urea+NBPT	1	0.40	0.21 – 0.69
SPRING BARLEY FERTILISER			
CAN	1	0.42	0.35 – 0.49
Urea	1	0.29	0.27 – 0.31
Urea+NBPT	1	0.22	0.20 – 0.23
GRASSLAND ANIMAL DUNG/URINE			
Dung	2	0.31	0.02 – 1.48
Urine	2	1.18	0.31 – 4.81

Carbon Dioxide (Ag. 0.75 & Grass 2.5Mt CO_2eq)

- Liming EF
- Soil Type
  - Emissions factors
  - improved mapping
- Land-use
  - Grassland on Mineral Soils
  - Cropland
  - Hedgerows
- Refine land management factors
  - Grassland: forage type, grazing intensity
  - Tillage: cover crops, Manure & Straw Incorporation
- Tier 3 model development



Murphy et al. In preparation



National Agricultural Soil Carbon Observatory

- Inventory highly uncertain
- Need to produce national emission factors
- Monitor long-term changes in soil carbon stocks
- 28 carbon towers - management, land-use, soil type and climate impacts
- Tier 3 model: measurements, biogeochemical models and satellite data

VistaMilk

Terrain-AI

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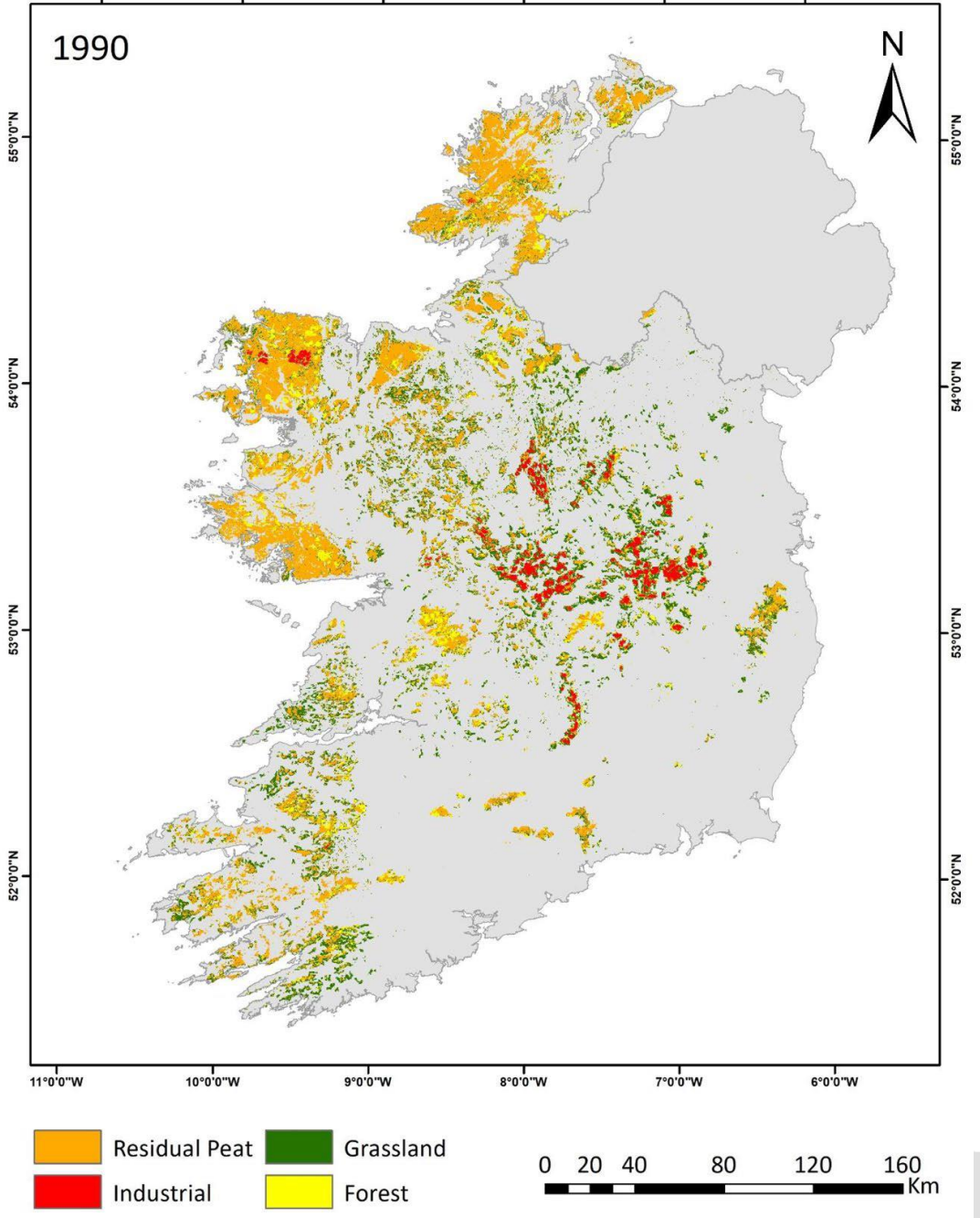
Agricultural Peat Soils

- Peat soils store 15-30% C globally
- Peat covers 21% Ireland
- Grassland peat soils emit ~~7.1~~ **2.5** $MTCO_2eq$
- Research underway to refine:
  - Area of peat soils
  - Drainage and nutrient status of peat soils
  - Emission factor peat types & mitigation
- Raising the water table reduces emissions



Habib & Connolly 2023 Reg. Env. Change 23:124

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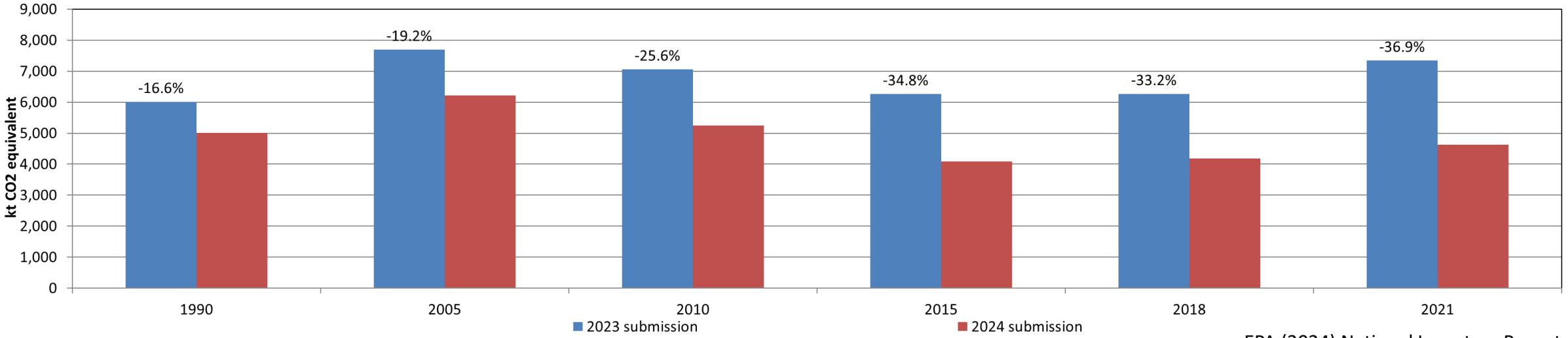
Inventory Refinement Impact LULUCF 1990-2021



EPA (2024) National Inventory Report

- Grasslands -52.8% (2. 5 MTCO_2e)
- Wetlands +87.9% (3.8 MT CO_2e)
- Future research – soil type x land-use x management

Mitigation Research

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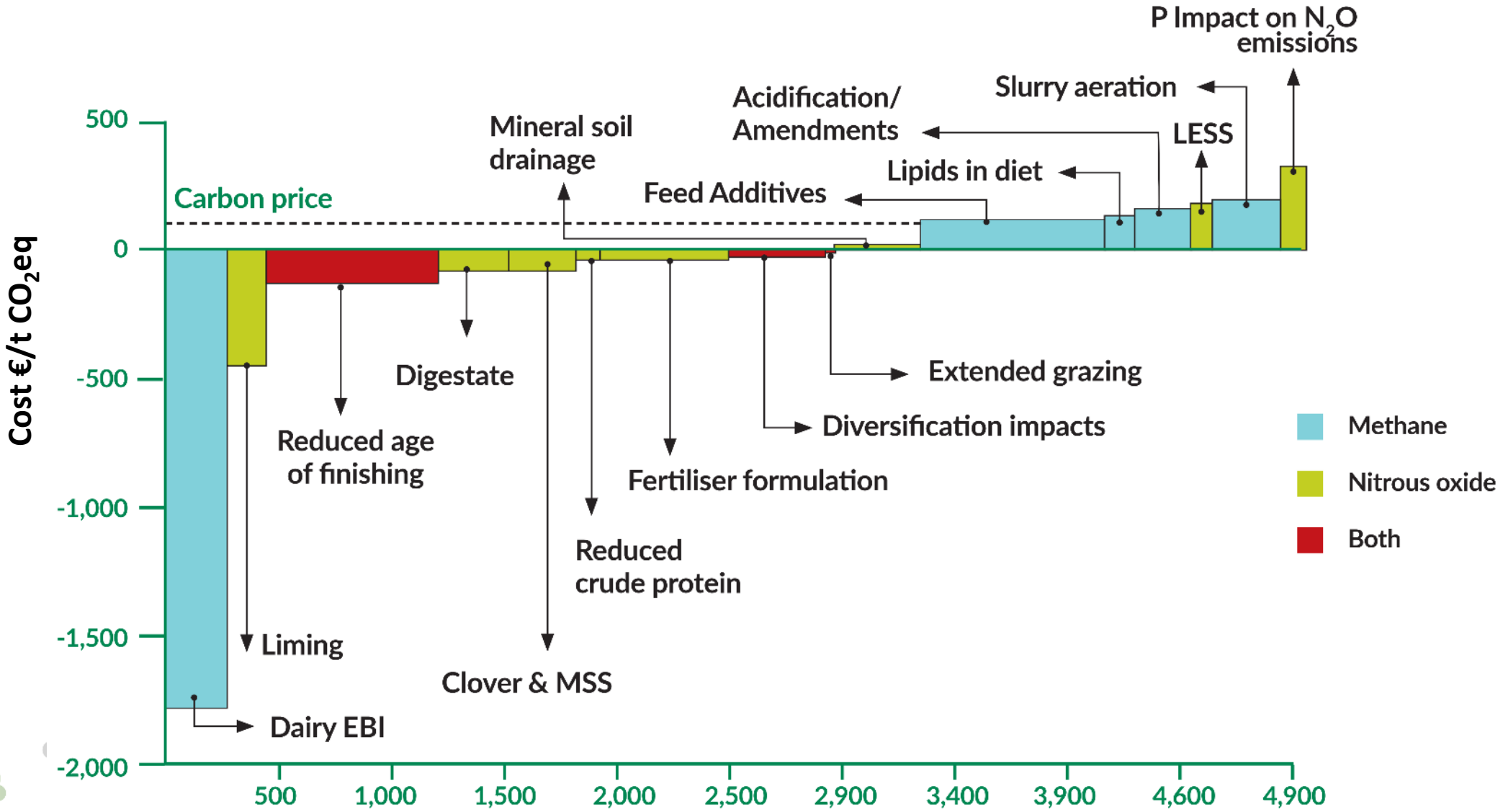
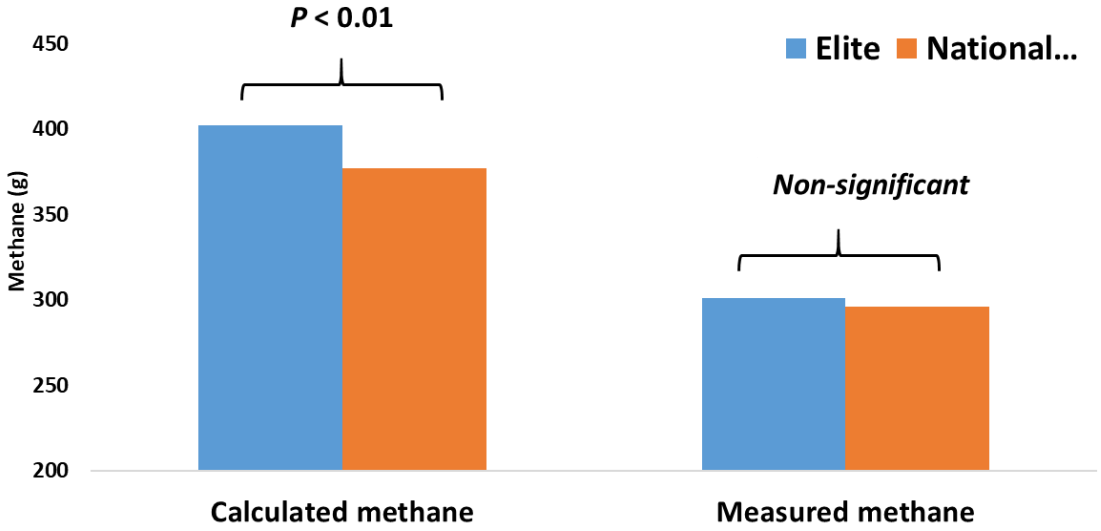
Agricultural Mitigation 2030 -MACC



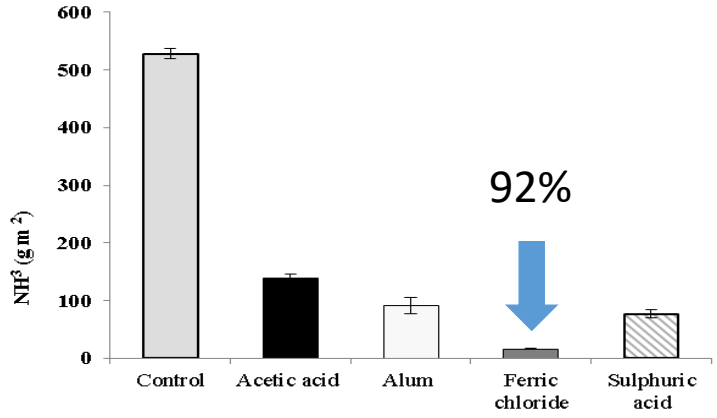
Lanigan et al. 2023

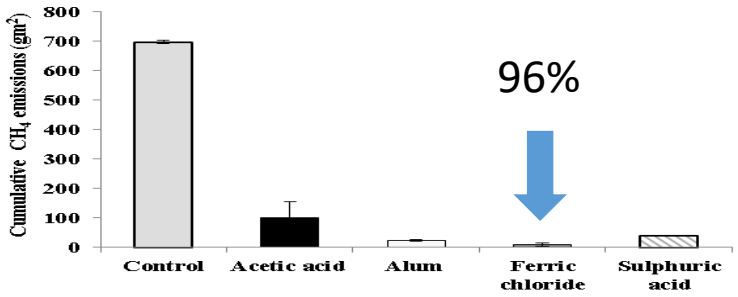
Methane Mitigation

- Genetic selection for low methane/N excretion
- Reduce Age of Finishing
- Feed supplements
  - Red seaweeds CH_4 -80%
  - Linseed oil CH_4 -19%
  - Rapeseed cake/oil CH_4 -8%
  - Brown seaweed extract CH_4 -7to -9%
- Manure additives CH_4 -96%



Lahart et al. 2024. Journal of Dairy Science, 107, 370-384.





Kavanagh et al. 2019 J. Cleaner Production 237, 117822

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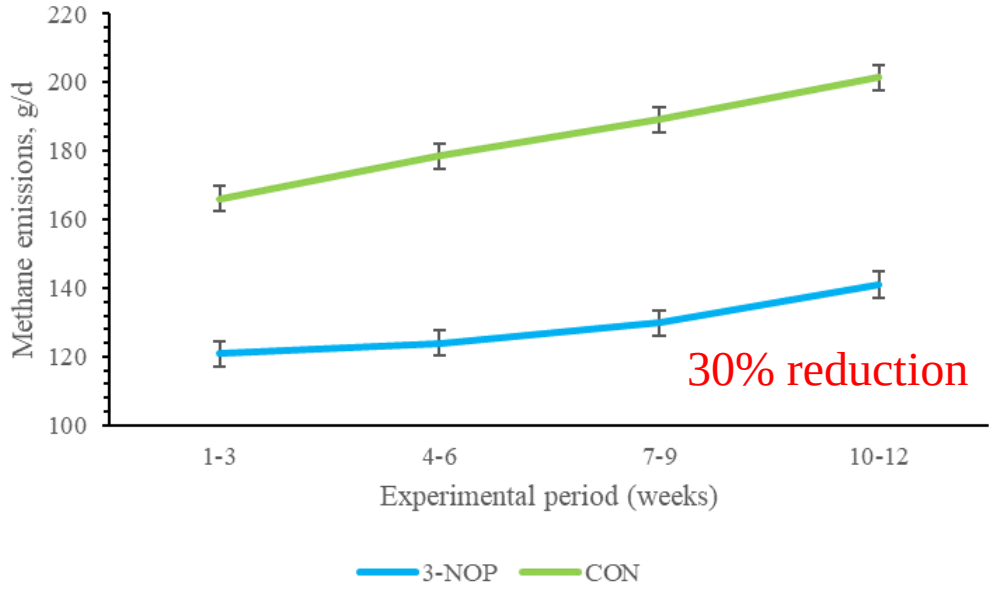
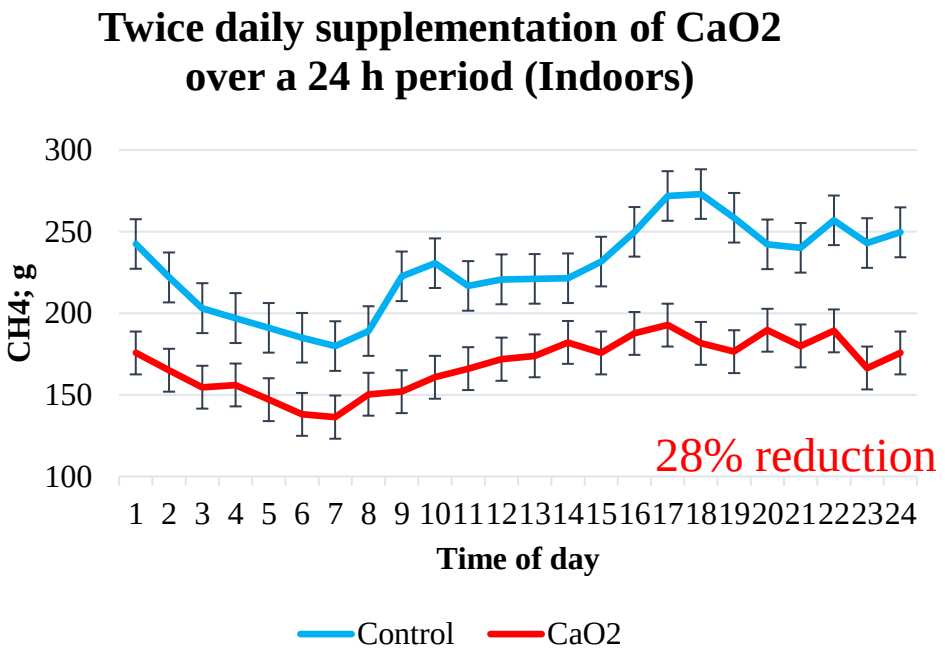
Feed Additives Beef

- **3-NOP**[1]
  - TMR diet (50:50 F:C)
  - 30% ↓ CH_4 g/d
  - No effects on feed intake, digestibility, performance



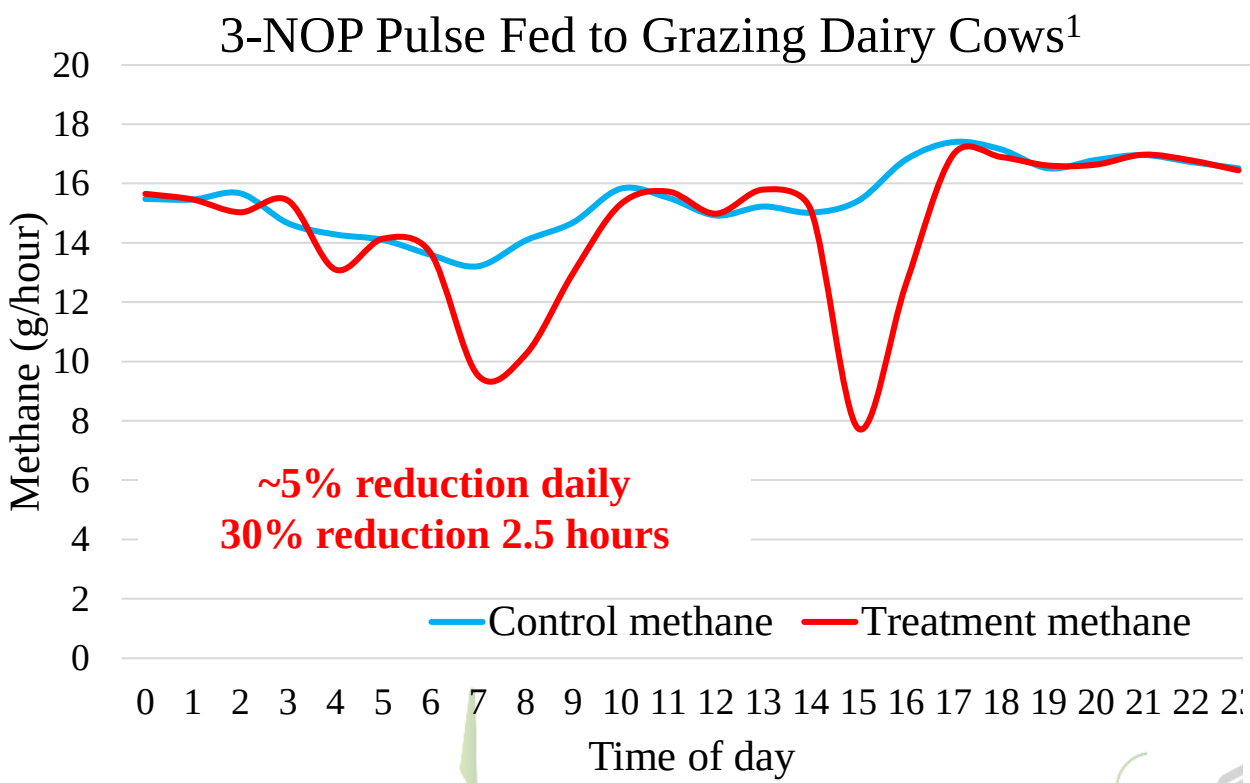
- Calcium peroxide
  - ↓ CH_4 -28% (housed) -20% (grazing)
  - Potential effects on intake/digestability
  - Optimisation: delivery & slow release of O_2



[1]Kirwan *et al.*, 2023; [2]Roskam *et al.*, Submitted to Animal

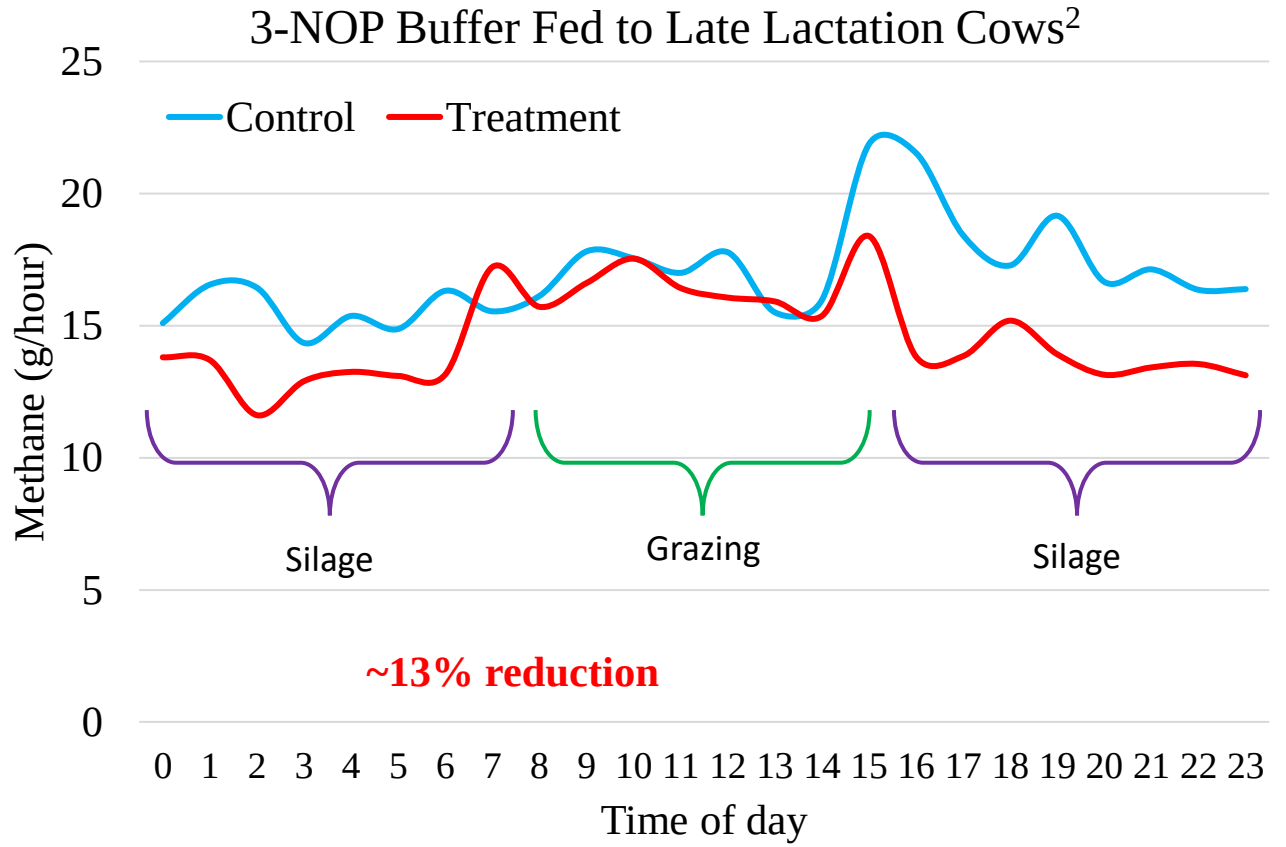
Feed Additives Dairy

3-NOP in Lactating Dairy Cows



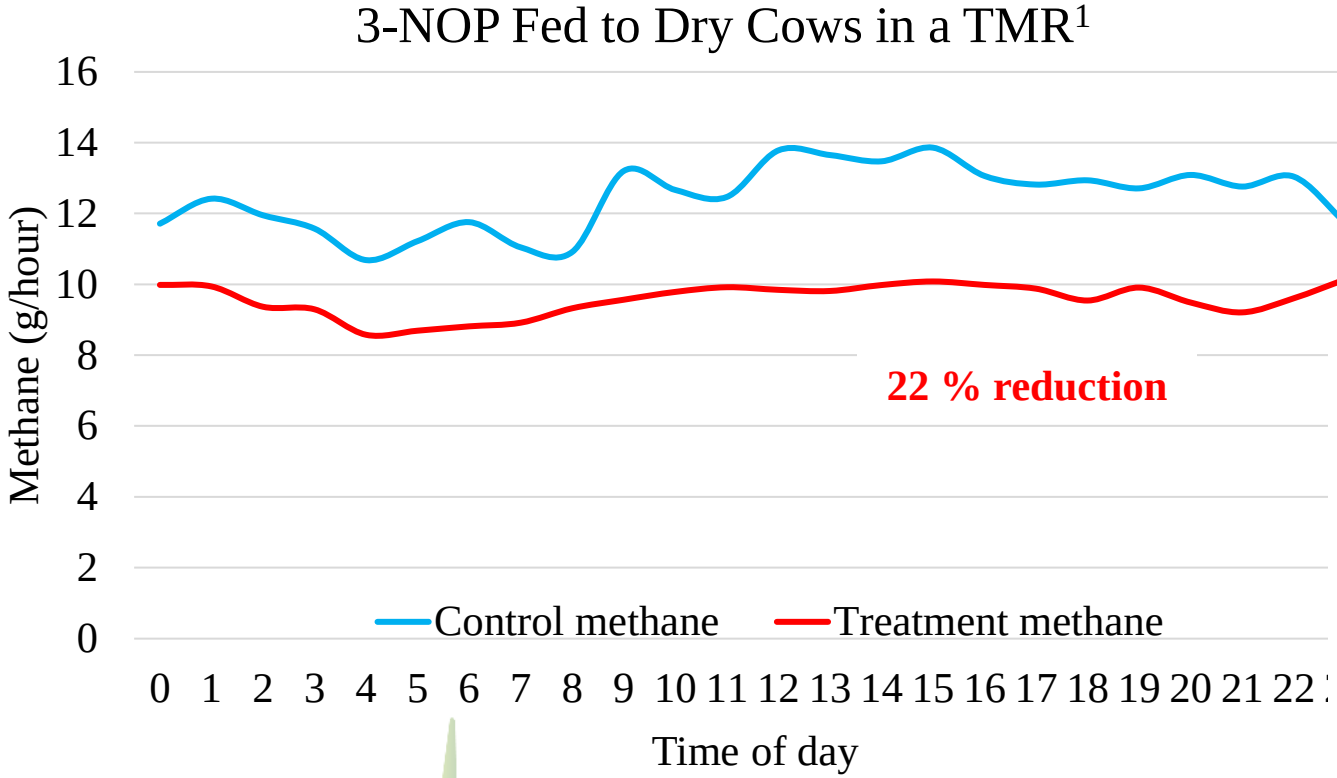
[1]Costigan *et al.* under review; [2]Costigan *et al.*, in preparation

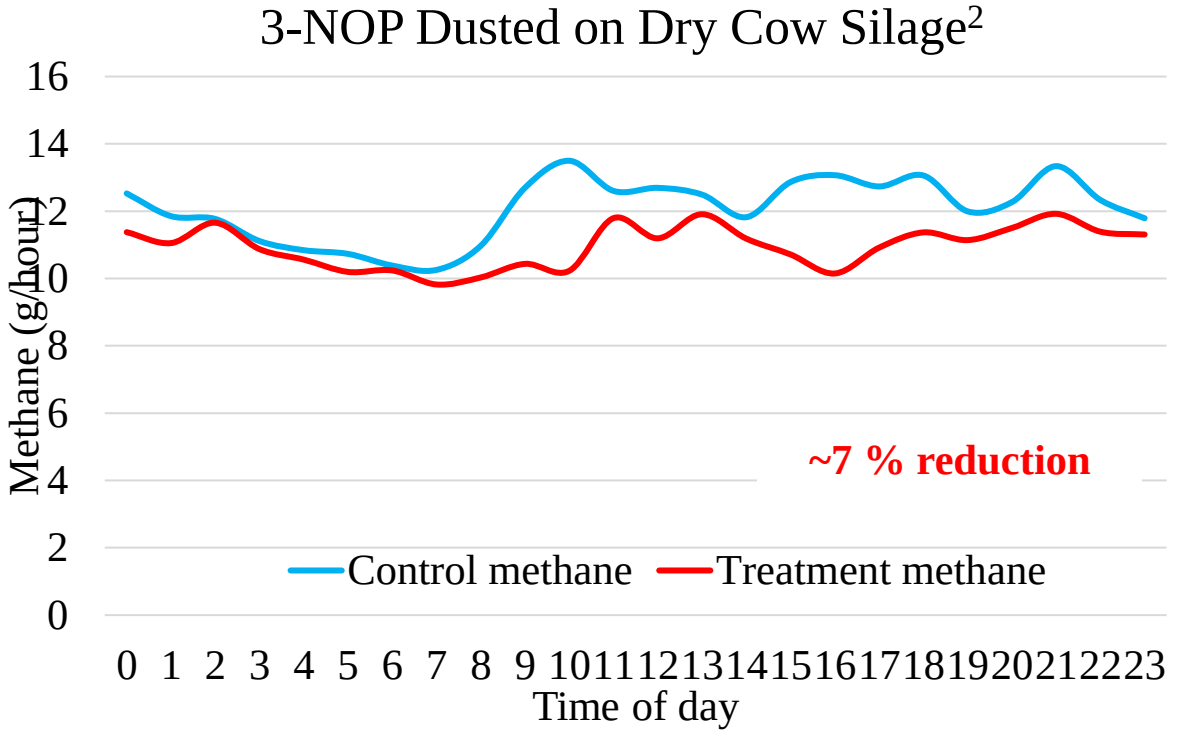
- Practicality
- Slow release mechanisms
- Cost
- Residues
- Life cycle assessment



Feed Additives

3-NOP in Non-lactating Dairy Cows

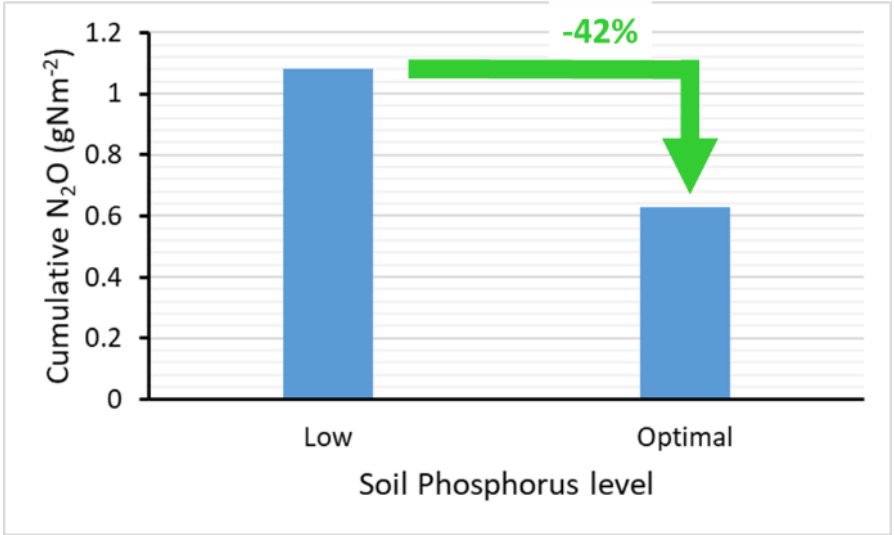




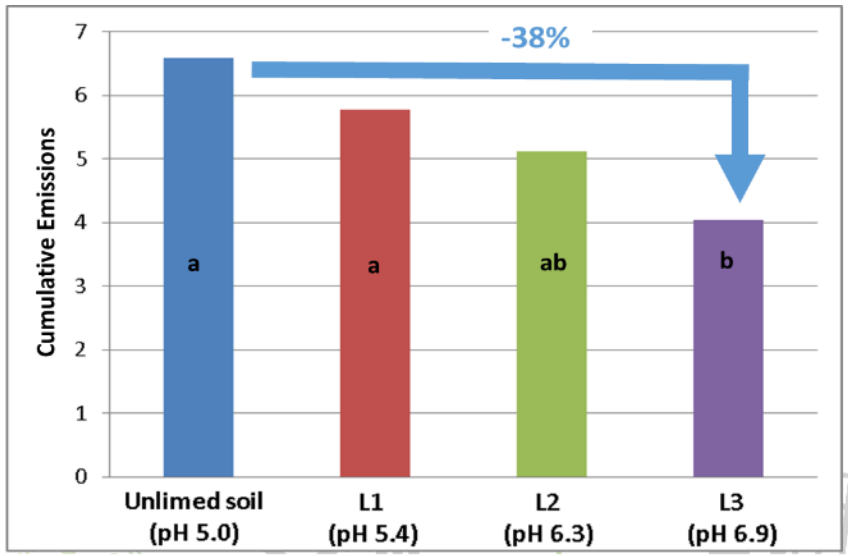
[1]Lahart *et al.*, in preparation; [2]Lahart *et al.*, preliminary results

Nitrous Oxide Mitigation

- Soil Fertility
  - Optimal soil P -42%
  - Optimal soil pH -38%
- Multispecies swards (MSS) – fertiliser reduction
- Nitrification inhibition biological & chemical
- New low emission/organic fertilisers
- Precision grazing
- Low to no nitrogen integrated farming systems



Gebremichael et al. 2022. Scientific Reports, 12, p.2602.



Žurovec et al. 2021. Agriculture, Ecosystems & Environment 311: 107319

Nitrous Oxide Mitigation

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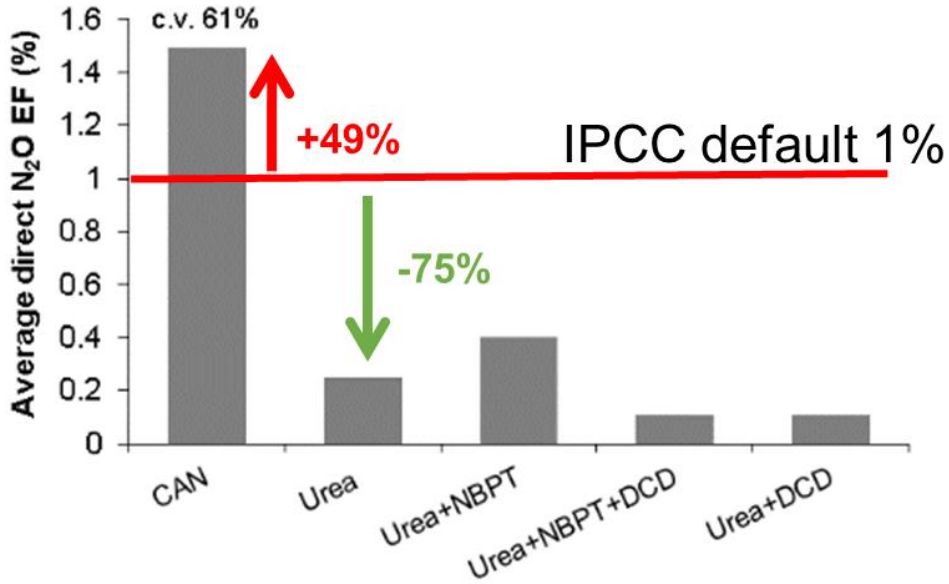
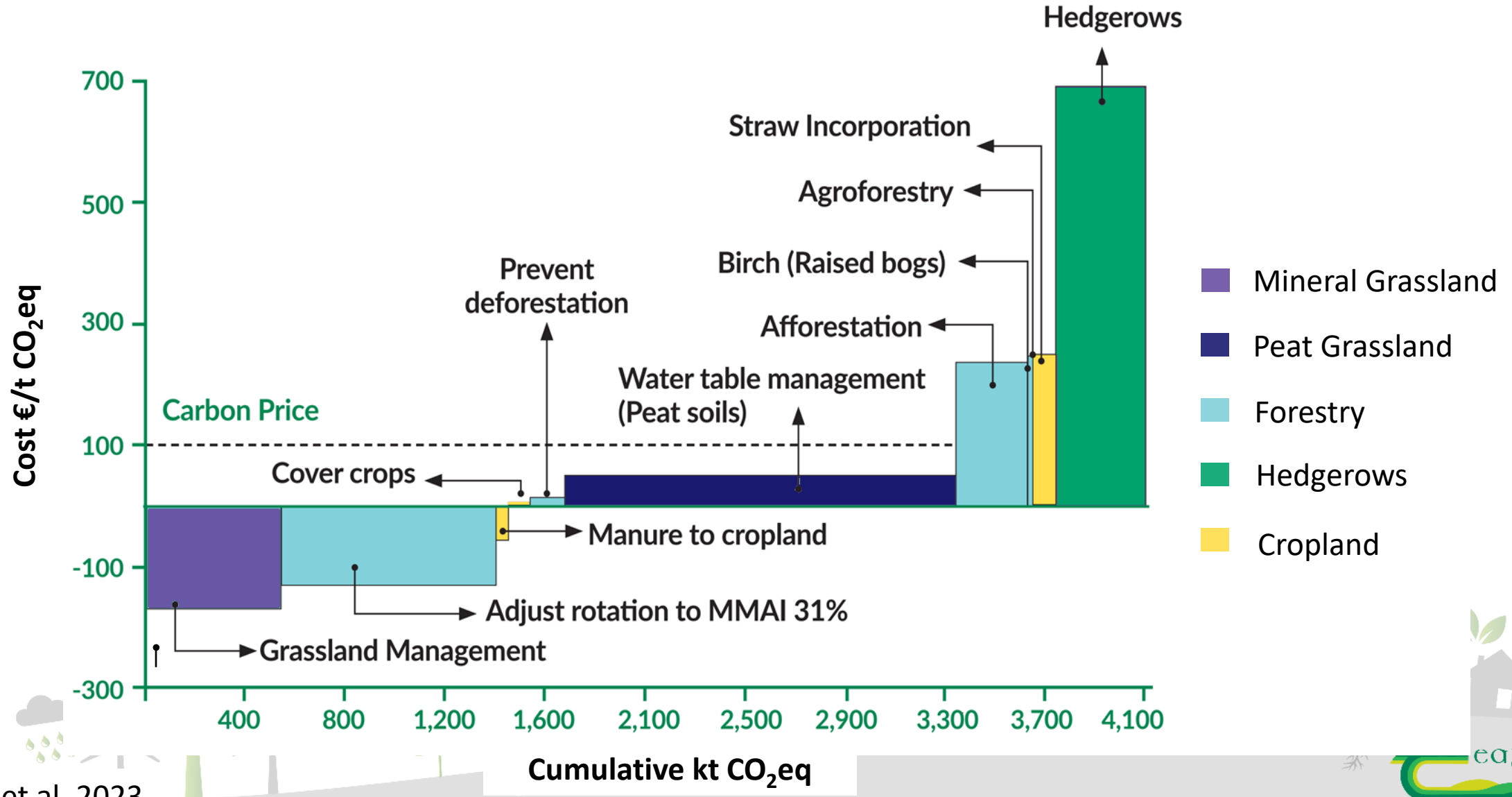


Harty et al. 2016. Sci. Total Env. 563: 576-586.

LULUCF 2030 – MACC



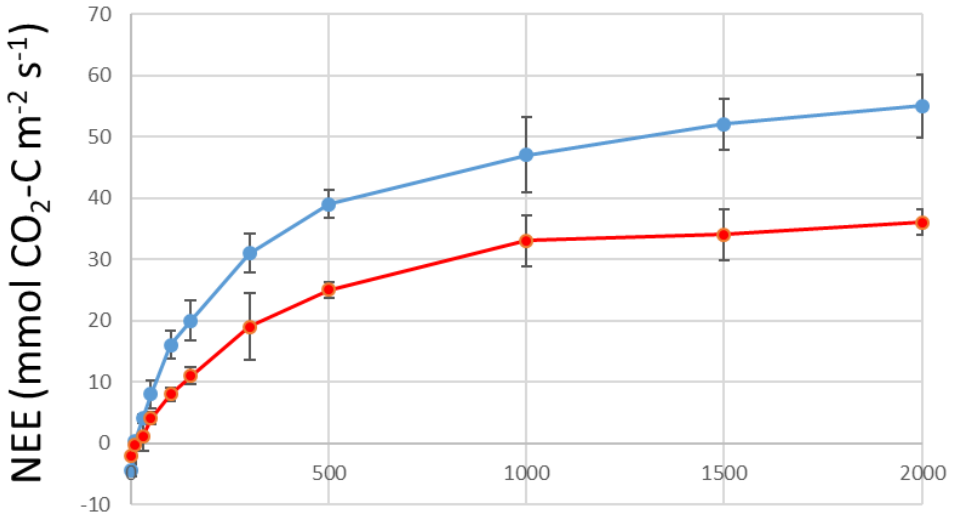
Lanigan et al. 2023

Carbon Dioxide Mitigation

- Multispecies swards/clover
- Improved soil fertility
- Integrated farming systems
- Forestry- type, management, attitudes, peat soils, 2nd rotation, adaptation
- Peat soil water table management
- Low input peat and peaty-mineral soils
- Biochar, Enhanced weathering

Other Research Areas

- Social and behavioral sciences
  - barriers to practice change
  - Socio-Economic consequences of system changes
- Monitoring, reporting and verification
- Impact of climate change
  - Emissions
  - Market opportunities
- Land-use optimization
- Protecting soil C (Land-use change)



Adoption - Knowledge Transfer

- Signpost demonstration farms (125)
  - Demonstration of mitigation practice
  - Farmers share experiences
  - Track progress
  - Signpost farms as “living labs”
- Signpost Advisory programme
  - Free advise to farmers
  - 10,000 farmers per year
- AgNav
  - Decision Support tool: C emissions calc. & GHG reduction plan
- Carbon farming – economic signals to reduce emissions

Summary/Take home Messages

- Considerable ongoing research CH_4, N_2O and CO_2
- New mitigation measures in development
- Barriers - measure cost/acceptability
- Research moving towards Tier 3 inventory modelling
- Importance of Knowledge Transfer
  - Signpost demonstration farms
  - Signpost advisors, AgNav (carbon sequestration)
- Farmer/Landowner Attitudes and Behaviour
  - Address demographic challenges
  - Acceptability of mitigation options

Acknowledgements

- D. Krol, R. Murphy, G. Bondi, T. Donnellan(Teagasc), M. Saunders (T.C.D.), P. Murphy (U.C.D.), R. Fealy & T. McCarthy (Maynooth Uni.), S. Waters, V. O'Flaherty (University of Galway)
- This research was financially supported a wide range of funders and their support is gratefully acknowledged

[redacted]

Taighde, Idirphlé, Comhairle
Research, Dialogue, Advice

Just Transition Reflections for Carbon Budget Process: A Principles-Based Approach

Dr Jeanne Moore and Niamh Garvey, Secretariat
The National Economic and Social Council

Taighde, Idirphlé, Comhairle
Research, Dialogue, Advice

Bringing a Just Transition Lens

- **To provide an opportunity for the WG to discuss and engage with just transition considerations within the carbon budget narrative- using a principles-based approach.**
- **To reflect on the role of the carbon budget process and outputs in support of just transition principles within the overall governance of transition.**

- How should the carbon budget process and outputs reflect just transition principles and enhance just transition delivery?
- How **the outcomes** of the work of the Working Group and the CCAC frame, communicate and provide context to how the budget is discussed?
- How the data and analysis provided supports an integrated, structured and evidence-based approach to identify and plan Ireland's response – including the kinds of evidence that supports thinking around fair and equitable outcomes?
- How does the **process** of the WG do this- in terms of transparency, accessibility and who is involved in the discussion?

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Considering Just Transition Principle 1

Social dialogue to ensure impacted citizens and communities are empowered and are core to the transition process

- Will the carbon budget process and final reporting result in transparent, clear, accessible data and analysis appropriate for support other institutions in effective communication and supporting social dialogue and engagement? Will the benefits as well as costs be communicated?

- To what extent will final reporting by the CCAC convey a narrative that includes framing around just transition: identifying potential costs and impacts, opportunities and benefits in a clear, accessible and constructive way?

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Considering Just Transition Principle 2

An integrated, structured, and evidence-based approach to identify and plan our response to just transition requirements

- Can we specify what the evidence is related to just transition considerations: specifically, equity of impact, effort-sharing, enabling people to benefit from opportunities, that will support evidence-based transition?
- What evidence is known or planned?
- What are the gaps or limitations?
- Can and if so, how will the gaps be addressed?

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Considering Just Transition Principle 3

People are equipped with the right skills to be able to participate in and benefit from the future net-zero economy

- Is there research, modelling and data on both opportunities and costs of transition?
- Will the work consider analysis for both opportunities and protections for vulnerable groups?
- How will the work discuss and attempt to reflect negative externalities, ‘invisibility of nature’ (ecosystem services) in costs and benefits?

Considering Just Transition Principle 4

Costs are shared so that the impact is equitable and existing inequalities are not exacerbated

- Are the models and the evidence for the Working Group considering the full range of distributional impacts –including demographics, geographical location, sectors/sub-sectors, and wider environment (water, air, biodiversity) – to inform mitigating the costs?

- Does the analysis include transparent consideration of effort-sharing between sectors, within sectors, and across regions?