Carbon Budgets Working Group Workshop Outcome Report

Background

The Council established a Carbon Budgets Working Group (CBWG) to support the second programme of Carbon Budgets. The second programme will include Council proposals for finalisation of Carbon Budget 3 (CB3: 2031-2035) and a provisional proposal for Carbon Budget 4 (CB4: 2036 – 2040) and shall be submitted to the Minister of Environment Climate and Communications by end of Q4 2024. The term of the Working Group for the second programme of carbon budgets will run from its establishment in early 2023 until the target for the conclusion of the work of the Working Group in Q3 2024.

The Secretariat has made formal requests earlier this year under the Memorandum of Understanding between the Irish Climate Change Advisory Council and all relevant Government Departments and Agencies[1], that modelling capacity will be made available between Q3 2023 and Q3 2024 to support modelling of pathways for Carbon Budget 3 (CB3: 2031-2035) and provisional Carbon Budget 4 (CB4: 2036-2040). The initial modelling will consider a start point in 2030 on a pathway to climate neutrality in 2050. In line with the Carbon Budgets methodology and the agreed workplan for the second programme of Carbon Budgets (See Appendix 3). It is envisioned that modelling will be carried out in three separate iterations of modelling and analysis between Q3 2023 and Q3 2024 to support the evidence base for the Council's proposals for the second programme of Carbon Budgets.

The CBWG convened a workshop for members of the CBWG and those directly involved in the modelling process on the 13th of September 2023. The workshop provided an opportunity for the group to discuss the analytical process for the 2nd Carbon Budgets Programme. The objective of this workshop was to develop a shared understanding of model inputs and expected outputs for the 1st iteration of modelling.

This report is to provide a briefing for Council on the main outcomes from this CBWG Workshop. The workshop agenda is provided in Appendix 1, the list of attendees is provided in Appendix 2, the carbon budgets workplan is outlined in Appendix 3, and links to the presentations are available here. The workshop followed the outline of the section headings below.

Overview of Session 1: Building Blocks for scenarios for CB3 and CB4

The Secretariat introduced the discussion by setting out the building blocks for the development of appropriate baseline scenarios and pathways, as outlined in the Vision for 2050 paper that was presented to the CBWG. This Vision for 2050 working paper was originally presented to the Council at its April 2023 meeting for discussion and was subsequently presented to the CBWG for consideration at its May meeting to inform a discussion on the development of appropriate scenarios and pathways. The Vision for 2050 paper was discussed at the April 2023 CCAC meeting and an overview of the proposed 2030 starting points and 2050 targets for the development of scenarios and pathways for CB3 and CB4, which are outlined in the paper, are summarised in Table 1.

[1] 2022 Signed MoU between Government Departments and CCAC.pdf (climatecouncil.ie)

Table 1: An overview of the proposed building blocks for scenarios for CB3 and CB4

Building blocks for scenarios for CB3 and CB4			
Start point in 2030	(1) staying within carbon budgets 1 and 2	(2) overperformance against carbon budgets 1 and 2 and	(3) underperformance against carbon budgets 1 and 2
Target for 2050		(1) based on an emissions trajectory consistent with specific temperature outcomes	(2) based on an emissions trajectory towards net zero greenhouse gas emissions in 2050.

2030 Starting Points

Scenarios used to determine the starting point in 2030 for the development of CB3 and CB4 should assume achievement of the first and second carbon budgets as a baseline assumption, with alternative scenarios developed based the assumption of overperformance and underperformance of the first and second carbon budgets. Sections 6D (4) and (5) of the Act[2] consider situations where a surplus from a preceding carbon budget may be carried forward where there is overperformance against a budget and where excess emissions are carried forward where there is underperformance against a budget. This therefore results in three scenarios for 2030 starting points for the CBWG to consider at the outset of the workshop, with discussions proceeding from these initial propositions:

1. *Staying within Carbon Budget 1 (2021- 2025) and Carbon Budget 2 (2026 -2030)*
   The achievement of the Sectoral Emissions Ceilings[3] was assumed to be the basis for staying within carbon budgets 1 and 2. It was proposed that there should be two scenarios developed for the treatment of currently unallocated emissions savings for CB2: (a) assigned to the energy sector and (b) assigned on a pro rata basis based on emissions. If and when the Government resolved the allocation of these emissions saving, this information will inform subsequent iterations of the modelling work.

2. *Underperformance against Carbon Budget 1 (2021- 2025) and Carbon Budget 2 (2026 -2030)*
   It was proposed that the 2023 EPA WAM projections[4] would provide the 2030 start point based on underperformance for carbon budgets 1 and 2.

3. Overperformance against Carbon Budget 1 (2021- 2025) and Carbon Budget 2 (2026 -2030)
   It was proposed that emissions reductions that are 5% in exceedance of the carbon budgets would provide the 2030 start point on the basis of overperformance for carbon budgets 1 and 2. It was acknowledged both that the 5% was an arbitrary figure and that overperformance was an unrealistic scenario given emissions reductions to date, however, it was proposed that the scenario would have merit as a sensitivity analysis in line with the provision for overperformance in the Act

[2] Climate Action and Low Carbon Development (Amendment) Act 2021
[3] Sectoral Emissions Ceilings Summary report (September 2022)
[4] Ireland's Greenhouse Gas Emissions Projections 2022-2040 (June 2023)

2050 Targets

The IPCC's AR6 Synthesis report notes that; '*Limiting human-caused global warming to a specific level requires limiting cumulative CO_2 emissions, reaching net zero or net negative CO_2 emissions, along with strong reductions in other GHG emissions'*. Section 3(1) of the Act sets out the national climate objective; '*The State shall, so as to reduce the extent of further global warming, pursue and achieve, by no later than the end of the year 2050, the transition to a climate resilient, biodiversity rich, environmentally sustainable and climate neutral economy'*.

The preparation of baseline scenarios for the development of CB3 and CB4 over the period 2030-2040 should align with climate neutrality in 2050 and account for the role of negative emissions. For the purposes of this carbon budgets process, it may be appropriate for scenarios based on climate neutrality, understood in the context of their temperature impact, to be developed and assessed against the temperature goals of the Paris Agreement. In addition, analysis of the impact of an emissions trajectory towards net zero greenhouse gas emissions in 2050 should also be carried out. This therefore results in at least two targets for 2050 for the CBWG to consider;

1. Target for 2050 based on an emissions trajectory consistent with specific temperature outcomes.

   It was acknowledged that meaningful specific temperature outcomes in 2050 could not necessarily be determined by the individual modelling teams at the outset and that the primary aim of the initial modelling for this first iteration is to provide a baseline for subsequent modelling iterations and analysis.

2. Target for 2050 based on an emissions trajectory towards net zero greenhouse gas emissions in 2050.

   It was acknowledged that net zero emissions in 2050 could not necessarily be determined by the individual modelling teams at the outset and that the primary aim of the initial modelling for this first iteration is to provide a baseline for subsequent modelling iterations and analysis.

Considering the ESAB recommendation for an EU 2040 climate target

The European Scientific Advisory Board on Climate Change (ESAB) recently provided scientific advice for the determination of an EU-wide 2040 climate target and a greenhouse gas budget for 2030–2050[5]. The ESAB recommended keeping the EU's GHG emissions budget for the period 2030 to 2050 within a limit of 11-14 Gt CO_2e, in line with limiting global warming to 1.5 °C (with no or only limited and temporary exceedance of that temperature threshold). To achieve this, the ESAB recommended that the EU must strive for net emissions reductions of 90-95% by 2040, relative to 1990 levels.

It was acknowledged by the Secretariat that the ESAB proposal is a recommendation and that the European Commission has not yet come forward with a climate target for 2040. The European Climate Law mandates the European Commission to propose a 2040 climate target in the first 6-months of 2024, following the first global stock take under the Paris Agreement. It was proposed that a watching brief would be kept on this issue by the Secretariat over the coming months and CBWG discussion of the ESAB recommendation and global stock take would be scheduled for later in 2023 or early in 2024.

[5] ESAB Scientific advice for the determination of an EU-wide 2040 climate target and a greenhouse gas budget for 2030-2050 (June 2023)

Summary of CBWG Discussion

In terms of staying within CB1 and CB2 it was queried whether it would be more sensible to look at the period to 2030 as a whole, taking the combined carbon budget for the decade rather than the two individual carbon budgets, given the insufficient emissions reduction achieved to date for CB1. CBWG members indicated that it was possible to produce scenarios consistent with CB1, although there are broader questions around feasibility. It was suggested that for the 1st round of modelling it would be useful to look at compliance with CB1 and CB2 separately and that a scenario for CB1 and CB2 combined together could be potentially explored in a subsequent iteration of modelling and analysis.

The proposal to use the 2023 EPA WAM scenario[6] as the basis for underperformance was considered overly optimistic by CBWG members, given the growing gap between the WEM and WAM scenarios. It was suggested that the EPA WEM scenario would be a more realistic acknowledgement of the impact of actions implemented to reduce emissions in the period to 2030. There was a broad consensus among CBWG members on this issue. The assessment of underperformance based on both the WEM and WAM scenarios was raised as a potential option, although it was acknowledged that this may pose an additional burden on the modelling teams through increased scenario generation. CBWG members recognized that the 2023 EPA WAM scenario does already capture a significant portion of the 2023 Climate Action Plan[7] measures, with the exception of the agriculture sector. It was acknowledged that the 2023 EPA WEM scenario as the basis for underperformance would potentially provide a more valid assessment of the emissions profile in 2030 however there was an openness to using either scenario as long as it was made explicit in the outputs.

The proposal to develop two scenarios for the treatment of unallocated emissions savings for CB2 (2026-2030) was discussed. Allocation of the unallocated emissions savings pro rata to the existing sectoral emission ceilings for CB2 was proposed as a more sensible option, given that electricity is the sector that has used the largest portion of its Sectoral Emissions Ceiling to date and that there is very little potential to achieve further emissions savings for the sector. It was suggested that the principal for allocation based on a pro rata basis would be the most equitable and fair, however, there may be political or efficiency justifications for assigning it to the energy sector. It was recommended that there should be flexibility in terms of assigning the unallocated emissions among the energy sectors, but that the approach taken for the assignment of the additional emissions savings should be made explicit in the results.

The proposal to explore a 5% overperformance for CB1 and CB2 was largely deemed a misuse of resource by CBWG members due to it being an unrealistic outcome based on current emission trajectories. It was suggested that it would be better to explore the potential for additional emissions savings in the period 2030-2040 and that a 10-20% overperformance would have more use as a pure mathematical sensitivity analysis. The provision under the Act for situations where a surplus from a preceding carbon budget may be carried forward where there is overperformance was acknowledged as the basis for including this scenario and that the exploration of such a scenario was potentially a useful exercise. The proposed 5% overperformance was clarified as an overperformance against CB1 (295 Mt CO_2 eq) and CB2 (200 Mt CO_2 eq) rather than a 56% reduction in emissions by 2030. In addition, the use of the terminology 'sensitivity analysis' was cautioned due to the potential for confusion with risk scenarios as part of the EPA inventories and projections process. In conclusion, it was agreed not to pursue the 5% overperformance scenario

[6] Ireland's Greenhouse Gas Emissions Projections 2022-2040 (June 2023)
[7] Climate Action Plan 2023

analysis at this time for the first iteration of modelling, with the potential to revisit it in subsequent modelling iterations.

Overview of Session 2: Scenario development for 2nd Carbon Budget Programme

Presentations from UCC (TIM), SEAI (NEMF), Teagasc (FAPRI) and NUIG (GOBLIN) outlined shared understandings to inform scenario development and included the following:

- The proposed set of scenarios to be developed, taking into account the building blocks outlined under the first agenda item.
- An outline of input assumptions that will have to be made, noting the potential for commonality or discrepancies with other models.
- An example set of model outputs for the purpose of demonstrating the kinds of outputs that the models will produce.

Hannah Daly (UCC) presented on the carbon budget scenario development with TIMES-Ireland Model. In terms of the proposed scenario dimensions an energy system carbon budget of 344 $MtCO_2$ (2021-2050) is assumed, inclusive of all fossil fuels and industrial process emissions and excluding international aviation and shipping. Regarding the potential overshoot of CB1 and CB2, scenarios assuming both WEM and WAM level of carbon budget overshoot which must be brought forward will be developed. Other dimensions that will be considered will be technology cost, the social discount rate (which is considered being revised downwards from 4% to 0.5%), the level of future energy demand in terms of both a business-as-usual scenario and a low energy demand scenario, the level of bioenergy available and the availability of negative emissions technologies including both Bioenergy with Carbon Capture and Storage (BECCS) and Direct Air Capture and Storage (DACS). In progress analysis of a series of overshoot scenarios were presented to the group, with a link[8] provided to further sample outputs. The priorities for model development were outlined and included calibration to the 2021 and 2022 energy balances, improvements in the range of mitigation options for industry, aviation and shipping, reflecting bioenergy availability and land use consequences and the development of more resolution on the energy system at close-to-zero carbon (e.g., hydrogen, storage, DAC).

Emma Lynch (SEAI) presented on the carbon budget scenario development with the NEMF tool. An overview of the NSMF modelling tool on a 2050 horizon was presented to the group, highlighting the importance of detailed policy assumptions such as the continuation of subsidies and supports post 2030. The objective of the NEMF tool in terms of assessing against a target rather than solving for a target was discussed. In terms of scenario development for carbon budgets, a proposal to use the WEM and WAM as an input and make tweaks was presented. It was noted that the I3E projections are accounted for under the WAM scenario. Sensitivities on data centre demand and transport were highlighted. An example set of results were presented to the working group, which included primary energy, final energy and emissions.

Kevin Hanrahan (Teagasc) presented on carbon budget scenario development with FAPRI-Ireland. The central data sets and inputs, both exogenous and endogenous to the model, were outlined along with the potential for synergies and complementarities with the TIM, I3E and Goblin models. Example outputs in terms of detailed agricultural activity level projections out to 2030, which included fertilizer use and land use, were presented to the group.

[8] https://epmg.netlify.app/tim-carbon-budgets-2022

Extending the projections to 2050 was flagged as one of the key challenges for the model along with developing long term assumptions on agricultural policy, reflecting the impact of new emissions mitigation technologies and price changes, and developing coherent global macroeconomic and international commodity price projections.

David Styles (University of Galway) presented on GOBLIN scenarios for carbon budgets towards 2050. The modelling approach for sequential model runs and aggregation was set out, noting that the CBM-CFS3 Forest model (also funded by DECC) would be utilised for the updated forestry GHG balance and productivity out to 2050 for existing and new forest in alignment with the National Inventory Report along with utilising the LCAD EcoScreen model for anaerobic digestion. The range of input assumptions for agriculture included dairy and beef cow numbers, production, grass utilisation and crop production, and for land use change included the assignment of spared land to rewetting, anaerobic digestion and forestry. It was proposed that a wide range of scenarios would be explored for the first model run and an example csv. file of results was shared with the working group. The example outputs included milk, beef and lamb production in kg, MJ LHV biomethane and m^3 wood harvest along with emissions in terms of GHGs split gas, GWP100 and NH_3, N & P losses to water.

Summary of Discussion

In terms of cement production, it was suggested to assume a separate CBAM would be applied to the UK and calibrated appropriately to deal with differences in ETS prices, which would not affect the incentives to import cement from Northern Ireland. Otherwise, no cement would be produced in Ireland, reducing domestic emissions significantly.

With respect to Social Discount Rate, it was noted that there are good reasons to revise this down from 4%, evidence was discussed that a figures of 2% is more justifiable than 0.5%. Recent publications were noted as supporting figures like 2%[9][10].

The current lack of energy demand reduction measures was noted as a significant gap for the energy sectors and the capacity to model energy demand reduction with NEMF. Furthermore, it was noted that the current NEMF scenarios have a gap in terms of meeting the Sectoral Emissions Ceilings.

The availability of macroeconomic projections out to 2050 was queried and it was noted that Central Bank is currently working on a baseline for Ireland out to 2050 with COSMO and there are international scenarios out to 2050 available for NiGEM.

It was suggested that the projections on Carbon price for the EU Reference Scenario 2020[11] should be used for the modelling.

The issue of reconciling/aligning energy process across the different models was raised and it was suggested that where possible the energy price assumptions for the Inventory and Projections process would be used. Although it was noted that this was not always necessarily clear cut. In terms of the potential for aligning TIM and NEMF on prices, it was noted that TIM is cost sensitive rather than price sensitive i.e., not sensitive to uptake or subsidies etc. for example.

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[9] Drupp, Moritz A., Mark C. Freeman, Ben Groom, and Frikk Nesje. 2018. "Discounting Disentangled." American Economic Journal: Economic Policy, 10 (4):109-34. DOI: 10.1257/pol.2016024

[10] Nesje, F., Drupp, M.A., Freeman, M.C. et al. Philosophers and economists agree on climate policy paths but for different reasons. Nat. Clim. Chang. 13, 515–522 (2023). https://doi.org/10.1038/s41558-023-01681-w

[11] EU Reference Scenario 2020 (europa.eu)

Finally, the importance of providing all modelling results in a csv. spreadsheet format was raised.

Overview of Session 3: Competing Land Use Requirements

Working group members discussed land use and model representations of biodiversity constraints, noting the potential to introduce a land constraint on the basis of the Nature restoration law. The competing requirements for afforestation, biomethane and nitrogen demand (water quality/air quality) were discussed. The question of forestry vs. biomethane and which is more valuable was raised and there was a broad discussion on the value of different types of land use and the need for natural capital accounting. As an example, afforestation with Sitka spruce would likely be the most valuable land use from a strictly monetary perspective, however, the use of a broader set of values would account for its detrimental effect on water and biodiversity. Work in the Netherlands and the UK was pointed to for consistently estimating the value of peatland and woodlands as having more value than the extracted peat and wood. It was noted that NESC is currently working on report on natural capital accounting that is expected to be available in late 2023 or early 2024. In terms of afforestation, planting for the future climate and the risks associated with single species were also discussed.

Overview of Session 4: Timeline for Modelling/Analysis Iteration 1

It was agreed that scenario results from UCC (TIM), SEAI (NEMF), Teagasc (FAPRI) and NUIG (GOBLIN) would be made available for circulated to the CBWG on the 8th of December, for presentation and discussion the following week at the CBWG meeting on 15th December 2023.

It was proposed that the Paris Test Assessment would be conducted during December 2023– January 2024, following receipt of the initial modelling results, and presented at the January CBWG meeting on Thursday the 18th of January 2024, 13:30 – 16:30 (Date and Time TBC).

It was acknowledged that while the workshop had focused on the core scenarios and pathways development for the 2nd Carbon Budget Programme, work on the macroeconomic and economic analysis was progressing in parallel and would also be targeted for presentation to the working group at the January 2024 CBWG meeting (TBC). In addition, additional modelling and testing of results in the context of biodiversity and just transition would be scoped further in the coming months.

The agreed workplan for the second programme of Carbon Budgets was presented and the timeline for the first iteration of modelling analysis from September 2023 to January 2024 was discussed (See Appendix 3). While the Paris test assessment and additional modelling and testing of results are likely to take place slightly latter than had been previously envisioned, the 1st iteration of modelling and analysis is still due to conclude within the agreed timeframe.

Summary of Main Outcomes

- *2030 Start Points*

  1. *Staying within Carbon Budget 1 (2021- 2025) and Carbon Budget 2 (2026 -2030)*

  The achievement of the Sectoral Emissions Ceilings was assumed to be the basis for staying within CB1 and CB2, with two sub scenarios developed for the treatment of unallocated emissions savings for CB2: (a) assigned to the energy sector and (b) assigned on a pro rata basis based on emissions.

  2. *Underperformance against Carbon Budget 1 (2021- 2025) and Carbon Budget 2 (2026 -2030)*

  The 2023 WEM scenario was proposed as a more realistic 2030 starting point. Modelling teams were requested to use both if possible and there was an openness to using either scenario as long as it was made explicit in the results.

  3. Overperformance against Carbon Budget 1 (2021- 2025) and Carbon Budget 2 (2026 -2030)

  As this scenario was considered highly unlikely, it was agreed not to pursue the 5% overperformance scenario analysis at this time for the first iteration of modelling, with the potential to revisit it in subsequent modelling iterations.

- *2050 Targets*

The primary aim of the initial modelling for this first iteration is to provide a baseline for subsequent analysis and modelling iterations. The initial scenarios would be compiled and assessed against targets for specific temperature outcomes in 2050 and net zero emissions in 2050 once results were available.

- *Scenario development for 2nd Carbon Budget Programme*

The points raised in discussion will be revisited once initial results are available and used to refine parameters for subsequent modelling iterations. It was agreed that scenario results from TIM, NEMF, FAPRI and GOBLIN would be made available for the December CBWG meeting and it was proposed that the Paris Test Assessment would be conducted during December 2023 – January 2024, following receipt of the initial modelling results, and presented at the January CBWG meeting.

- *Competing Land Use Requirements*

The points raised in discussion will be revisited at the October CBWG meeting and again once the initial modelling results are available in December.

Appendix 1: Workshop Agenda

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

Appendix 2: Carbon Budgets Working Group Workshop Attendees

Date: 13th September 2023

Start time: 13:30

Venue: Hybrid - EPA officers, Clonskeagh and MS Teams Video Conference Meeting

Present: **In person:** Hannah Daly (UCC), Emma Lynch (SEAI), Trevor Donnellan (Teagasc), Kevin Hanrahan (Teagasc), David Styles (University of Galway), Yvonne Buckley (TCD), Niall McInerney (Central Bank), James Murphy (EPA)

On MS Teams: Brian Ó Gallachóir (UCC), Stephen Treacy (EPA), Kian Mintz-Woo (UCC), Oliver Gedden (SWP Berlin), Colm Duffy (University of Galway), Mert Yakut (ESRI)

Apologies: Jim Scheer (SEAI), Kelly de Bruin (ESRI), Jeanne Moore (NESC), Niamh Garvey (NESC)

Observers: John Fitzgerald (in person)

Secretariat: In person: George Hussey, Meabh Gallagher, Phillip O'Brien, Ciara Hillard. Online: Claire Camilleri

External attendees: Online: Gemma O'Reilly (NESC), Vahid Aryanpur (UCC), Andrew Smith (UCC), Daniel Henn (UL)

Appendix 3: Carbon Budgets Workplan

Item	Description	2023									2024											
		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	**Modelling / Analysis Iteration 1**																					
1.1	Agree inputs, paramaters and assumptions																					
1.2	Core pathways development and modelling																					
1.3	Paris Test Assessment																					
1.4	Additional modelling and testing of results																					
1.5	Post-hoc analysis																					
2	**Modelling / Analysis Iteration 2**																					
2.1	Agree inputs, paramaters 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																					
3	**Modelling / Analysis Iteration 3**																					
3.1	Agree inputs, paramaters and assumptions																					
3.2	Core pathways development and modelling																					
3.3	Paris Test Assessment																					
3.4	Additional modelling and testing of results																					
3.5	Post-hoc analysis																					