Joint Committee on Environment and Climate Action
Leinster House
Dublin 2
D02 XR20

7 January 2021

Ref: CCA-I-2021-258

In the invitation received on 16 December 2021 to a meeting of the Joint Committee to inform consideration of the carbon budgets, it is noted that *'The Committee would specifically like to discuss the process that led to the formation of the budgets, any alternative pathways considered, the information taken into account when composing the budgets and the approach taken in achieving the obligations under the Act.'*

This document provides a written overview of the matters highlighted for discussion to assist the Joint Committee in its considerations prior to the meeting on 11 January 2022.

Carbon Budgets Committee

The Climate Action and Low Carbon Development (Amendment) Act 2021 requires that the Council propose all of economy carbon budgets to the Minister of Environment Climate and Communications "as soon as may be" after the commencement of Section 9 of the Act. The Act was commenced in its entirety on 7th September and the Regulation foreseen in Section 6A of the Act as amended, was signed on 12th October 2021. The Council immediately thereafter concluded its work and made proposals to the Minister on October 25th 2021.

The proposed carbon budgets for each of the periods 2021-2025, 2026-2030 and 2031-2035 (provisional) must provide for a reduction of 51%[1] of greenhouse gas emissions using the GWP_{100} metric by 2030 relative to 2018[2] and set Ireland on a pathway towards a sustainable economy and society where greenhouse gas emissions are balanced or exceeded by the removal of greenhouse gases by 2050.

The Climate Change Advisory Council agreed at its meeting on Friday 5th March to establish a Committee on Carbon Budgets. The Council agreed a Terms of Reference for the new Committee at its meeting on the 15th April 2021. The Committee was tasked with drawing up draft carbon budgets for the periods 2021-25, 2026-30 and 2031-35 (*CB1, CB2 and CB3 respectively*) to be considered by the Council. As part of this task, the Committee was mandated to include the criteria set out in the Climate Action and Low Carbon Development (Amendment) Act 2021 in its consideration of carbon budgets. In drawing up the draft carbon budgets as above, the Committee was tasked by the Council to use the following methodological approach;

[1] As per S.I. No 531/2021, this target does not include emissions from international aviation or shipping.
[2] As per S.I. No 531/2021 Climate Action and Low Carbon Development Act 2015 (Greenhouse Gas Emissions) Regulations 2021, signed on 12th October 2021.

- Top-down: Estimate an appropriate carbon budget for Ireland for the period 2021 – 2050 based on consideration of the global carbon budget (addressing legislated criteria: national climate objective, UN, Paris Agreement, science, climate justice).
    a. The global carbon budget
    b. The role of different gases
    c. The potential for negative emissions
- Bottom-up: Consider what legislative requirements at national and EU level mean for emissions up to 2030, covering the first two carbon budgets (addressing legislated criteria: national climate objective, 51%, EU, inventories and projections, science, reporting, economy, and climate justice).
    a. The implication of required compliance with EU and National Targets (e.g. 51%) incl. treatment/inclusion of LULUCF
    b. Feasibility, competitiveness impacts, implications for investment
    c. Distributional impacts, jobs

It was agreed by the Council that the starting point for addressing the bottom-up part of the mandate would be to undertake scenario modelling using the UCC TIMES Ireland Model, and other sectoral models such as the Teagasc FAPRI Ireland model.

Annex 2 of this document includes the dates of each meeting of the Carbon Budgets Committee and Climate Change Advisory Council between March and October 2021 and minutes of these meetings are published on the Climate Change Advisory Council website[3].

Modelling and Development of Proposed Carbon Budgets

There is no single model in Ireland that captures in sufficient detail the technical information on mitigation options across all sectors. Modelling of carbon budget scenarios by three groups; University College Cork (UCC) TIMES Ireland Model (TIM), Teagasc Food and Agriculture Policy Research Institute (FAPRI) Ireland model and University of Limerick (UL) Goblin model was carried out. Analysis of carbon budget scenarios was sought to inform considerations of feasibility, competitiveness impacts, implications for investment, distributional impacts, impacts on employment and climate justice. The results of the modelling do not imply an endorsement or recommendation of the Council for particular mitigation strategies but rather illustrate the scale of the challenge and also establish appropriate mitigation pathways consistent with the legislated level of ambition including a 51% reduction in greenhouse gas emissions by 2030 relative to 2018.

Modelling of scenarios and analysis of the results allowed consideration of different mitigation options that may be applied to reduce emissions in line with carbon budgets, their potential, their costs, their interactions and their possible implications. The aim was to inform society

[3] https://www.climatecouncil.ie/aboutus/governance/
https://www.climatecouncil.ie/carbonbudgets/carbonbudgetscommittee/minutesofmeetings/

wide carbon budgets that are achievable, consistent with international climate commitments and also to develop an evidence base to address the mandated criteria in the legislation.

The carbon budget scenarios considered represented different mitigation efforts across sectors that could be consistent with meeting the overall national 51% emission reduction target in line with the Council's legislative mandate. The Council considered a number of core scenarios which explore a range of different mitigation reductions across sectors. Different levels of mitigation in the broader energy sector (electricity, heat, transport and industry) were modelled by TIM. Different levels of mitigation effort were modelled in the agriculture and land use sector by both the Teagasc FAPRI-Ireland model and the Goblin model. Appropriate combinations of scenarios from each model gave an overall economy wide[4] scenario for meeting the 51% reduction target by 2030. Each scenario represents different sharing of effort across sectors with Exx-Ayy representing a scenario where the Energy sector (heat, transport, electricity) reduces emissions by xx% while the Agriculture sector reduces by yy% and the LULUCF sector reduces by 51%, adding up to an overall reduction of 51% from 2018 levels.

In addition to the core scenarios a set of scenarios was developed to explore the speed and scale of change required across the energy sector to meet the 51% mitigation target, and to discover the potential costs associated with delivering the 51% target at different speeds of reduction. Early action scenarios were modelled as a linear pathway from 2020 to 2030 while late action or 'no constraint' scenarios were only constrained to meet the 51% target by 2030. These scenarios are illustrated in Figure 1 below.

The model was unable to find a technological option within the State to meet 51% reductions in the context of late action scenarios. Further, it was considered that the early action scenarios created an unachievable task for the first budget period due to;

- the time already elapsed, and;
- the lead in time required for deployment of technologies or changes in behaviour at scale.

Notably, the electricity sector requires large scale deployment of enabling infrastructure including offshore wind and grid upgrades to deliver ambitious mitigation. Decarbonisation of the electricity sectors is the foundation for the decarbonisation of other sectors such as heat and transport. The necessary legislation that enables planning and licensing for this kind of development, especially for offshore wind, has only recently progressed through the Oireachtas. As such within a two-year time frame it is not appropriate to assume significant and immediate reductions in energy emissions.

[4] Excluding International Aviation and Maritime emissions

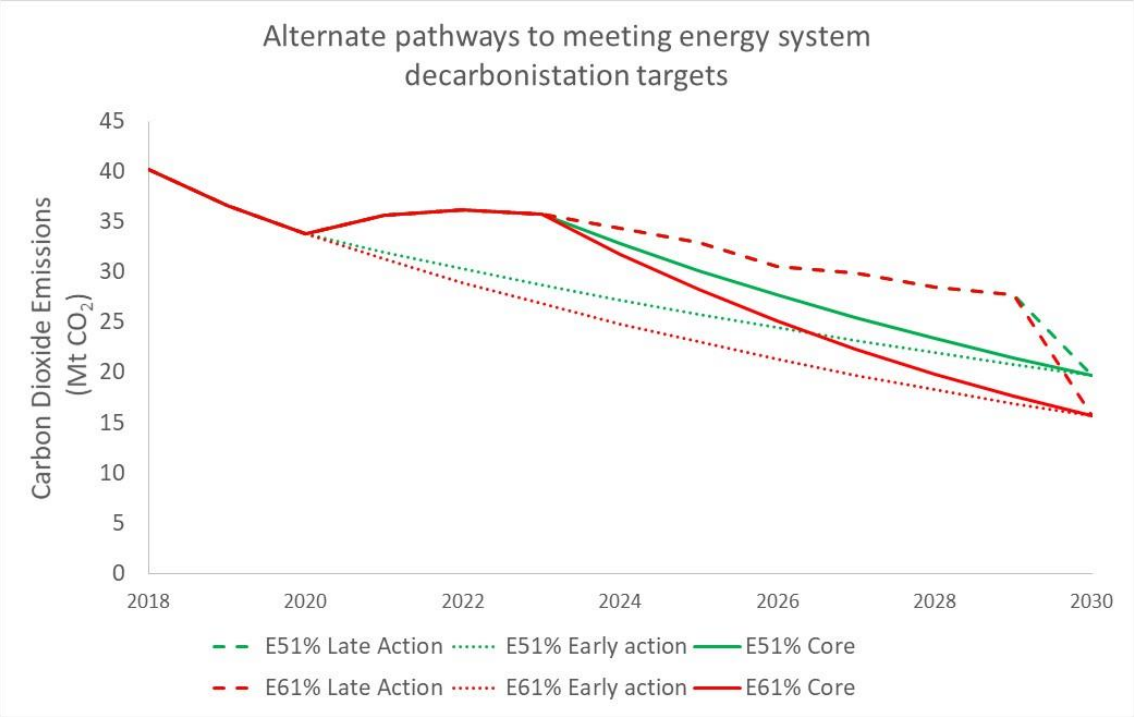

Figure 1 Comparison between TIM model outputs for selected core, early action, and no constraint scenarios (Carbon Budget Technical Report Figure 2-5)

This further analysis therefore demonstrated that the core scenarios represent the more feasible, cost-effective approaches, taking account of recent emissions projections, obligations under EU legislation and the long-term competitiveness of the economy. Delivering further mitigation in CB1 is not feasible due to technology constraints, while delivering less mitigation in CB1 makes the task of complying with the 51% emission reduction target by 2030 infeasible.

Within the legislation each carbon budget is a five-year cumulative limit to all covered emissions in that period.[5] This allows for interannual variations which can arise for non-policy reasons e.g. a cold winter which may lead to increased emissions from heat demand. Such variations are transient and not indicative of long-term trends and will tend to average out. The 2021 Act has a specific target for a reduction of 51% in emissions in 2030 compared to 2018, however it is important to note that it does not determine the pathway to reach this target. The energy modelling shown in the technical report highlights that a linear pathway is technically unrealistic and is an economically inefficient way to meet this. The proposed 5-year budgets therefore are designed to and would enable the emissions target in 2030 to be met in a manner that is technically feasible and has less impact on society as a whole. However, given that action slowly ramps up across the decade and given the time-lag between policy implementation and actual emissions reductions this requires substantial interventions to start immediately.

[5] The Regulation specifies that we include all sectors except international aviation and maritime.

In its 2021 Annual Review[6], the Council highlighted a number of critical gaps in implementation of policy, including for example a failure to meet Ireland's 2020 target under the EU Effort Sharing Decision and delays in implementation of many of the measures in the 2019 Climate Action Plan. Rapid and sustained economic, social and technological transformation will be required across all sectors of the economy and increased investment must start now.

The modelling showed that there are numerous possible pathways consistent with meeting the 51% emission reduction target. A number of sensitivity scenarios were tested to explore the role of technologies and energy sources such as the timing of carbon capture and storage availability, the extent of availability of renewables such as offshore wind, the levels of bioenergy and green hydrogen and the level of energy service demand. Greater availability of energy sources and carbon capture and storage is important but the greatest impact on overall costs of transition was the level of energy service demand (i.e. heat, light, transport) with lower costs seen in a scenario of low energy service demand. Furthermore, greater reliance on electricity as the energy vector for transport and heating, along with growing electricity demand from population growth and data centres illustrates the importance of continuing to push energy efficiency alongside technological (e.g. demand response, system services) and behaviour change as a means to reduce the cost of transition. Continued support for research, demonstration and deployment of key zero emission technologies will also be important.

Inputs to the Carbon Budgets

The Carbon Budget Technical Report[7], which was adopted by the Council at its meeting on 25 October 2021, provides an overview of the inputs to the proposed carbon budgets and describes the deliberations, reasoning and evidence behind the Council's carbon budget proposals.

A complete list of the background papers prepared for the meetings of the Carbon Budgets Committee can be found here. A list of presentations given to the Carbon Budgets Committee can be found here.

The inputs to the carbon budget proposals against the methodology described above included;

1. *Estimation of an appropriate carbon budget for Ireland based on the global carbon budget and the role of different gases:* The Committee received and considered a literature review addressing the global carbon budget and the role of different greenhouse gases from each of two CCAC Carbon Budget fellows[8]. An expert meeting was also held on 22 June 2021 on the science of national mitigation efforts. International speakers included Dr Andy Reisinger (New Zealand IPCC), Dr Joeri Rogelj (Imperial College London), Professor Myles Allen (University of Oxford) and Mr Florin Vladu (UNFCCC).

2. *The potential for negative emissions:* A literature review on the potential for negative emissions was prepared by Research Fellow Paul Price (Dublin City University) and

[6]https://www.climatecouncil.ie/media/climatechangeadvisorycouncil/Climate%20Change%20Advisory%20Council%20Annual%20Review%202021.pdf
[7] https://www.climatecouncil.ie/carbonbudgets/technicalreport/
[8] Price, 2021; Smith, 2021

the physical potential of LULUCF was discussed at a meeting of LULUCF experts convened by the Secretariat on 3 June 2021.

3. *The implication of required compliance with EU and national targets (e.g. 51%), including treatment and inclusion of LULUCF:* Professor Brian Ó Gallachóir provided the Committee with an analysis of the existing and future EU targets and pathways to reach the 51% emission reduction target. Teagasc provided an analysis of scenarios of an agricultural sector contribution to meeting the 51% target, while Dr Hannah Daly provided an analysis of complementary scenarios of varying energy sector contributions to meeting the target.

4. *Feasibility, competitiveness impacts and implications for investment:* The Committee requested modelling of carbon budget scenarios by three groups (those using UCC TIM, Teagasc FAPRI-Ireland and the UL Goblin model), with scenarios and runs informed by the EPA inventory and projections. The Committee requested ESRI to use scenario outputs from TIM to inform further economic analysis.

5. *Distributional impacts, jobs:* Input was provided by Teagasc on the economic implications of different levels of mitigation, by UCD on investment and jobs impacts of TIM energy modelling outputs and by McKinsey on employment, investment and long-term competitiveness. Presentations were also provided on 28 June 2021 on skills, training and higher education requirements by the Department of Further and Higher Education, Research, Innovation and Science (DFHERIS) and SOLAS.

In addition to the papers and presentations noted above, the Carbon Budgets Committee conducted a process of sectoral engagement with relevant government departments and agencies. Meetings about the agriculture, residential, transport, electricity and industrial sectors were held with the relevant bodies over the course of June and July 2021.

The work of the Carbon Budgets Committee, which met between 27 April and 9 September 2021, supported the calculation by the Council of the carbon budget proposals. At its meeting on 14 October 2021, the Council discussed potential carbon budget proposals and noted that the Climate Action and Low Carbon Development Act 2015 (Greenhouse Gas Emissions) Regulations 2021 were made on 12 October 2021. On 25 October 2021, the Council formally agreed the carbon budgets, as set out in the final version of the technical report.

Criteria under the Act

The Council is required to carry out its functions under Section 9 of the Act in a manner that is consistent with the ultimate objective specified in Article 2 of the United Nations Framework Convention on Climate Change. It is also required to have regard to a number of factors including the most recent greenhouse gas emissions inventory and projections, relevant scientific advice including with regard to the distinct characteristics of biogenic methane, international best practice in reporting greenhouse gas emissions and removals, the need to maximise employment and competitiveness and climate justice. The following sections set out the approach taken to achieve these obligations under the Act.

National Climate objective

The proposed carbon budgets set Ireland on a pathway consistent with the achievement of climate neutrality by 2050 with opportunities to achieve improvements in climate resilience and environmental sustainability and protect and enhance biodiversity. Analysis was carried out that showed that the proposed carbon budgets are consistent with achieving net zero emissions of long-lived greenhouse gases (carbon dioxide (CO_2) and nitrous oxide (N_2O)) and a significant reduction in methane (CH_4) emissions by 2050, thus establishing a climate-neutral economy.

Consistency with the Regulation

The proposed carbon budgets are consistent with Statutory Instrument S.I. No. 531 of 2021, Climate Action and Low Carbon Development Act 2015 (Greenhouse Gas Emissions) Regulations 2021, adopted on 12 October 2021. This requires the use of the GWP_{100} metric for calculating and accounting for emissions and specifies the greenhouse gases to be taken into account in the carbon budgets, mandating a gross-net accounting approach for such emissions for carbon budgets.

A 51% reduction by 2030

The proposed budgets have been calculated, in line with S.I. No. 531 of 2021, to allow compliance with the 51% emission reduction by 2030 target. The Regulation requires the Council propose carbon budgets for all greenhouse gases reported by the EPA under the UNFCCC on the basis of Global Warming Potential values evaluated over 100 years, GWP_{100}, published in the IPCC Fifth assessment report (AR5). This ensures consistency with the EU who have adopted these values for reporting going forward from 2021 and is also consistent with UNFCCC reporting practices.

Objectives of the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement

Section 4.2 of the Technical Report on Carbon Budgets[9] sets out how the Committee assessed the proposed carbon budgets in terms of an appropriate contribution for Ireland to the achievement of the ultimate objective of the UNFCCC (as per Article 2[10]) and the mitigation goals of the Paris Agreement[11]. The Committee considered the question of the appropriate contribution for Ireland to the global effort to reduce greenhouse gas emissions and concluded

[9] Published here; https://www.climatecouncil.ie/carbonbudgets/technicalreport/

[10] https://unfccc.int/resource/docs/convkp/conveng.pdf

[11] https://unfccc.int/sites/default/files/english_paris_agreement.pdf Article 2 (1) aims to strengthen the global response to the threat of climate change, by '(a) Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;'.

that the carbon budgets must be at least consistent with the 1.5°C temperature target of the Paris Agreement. The consistency of the proposed carbon budgets scenarios modelled for the Committee with this target was assessed by calculating;

1. The temperature impact of the carbon budgets under different scenarios.

2. The gap between current global temperature levels and the 1.5°C target.

3. A comparison of the estimated temperature impact scaled up on a per capita basis to the global target.

Figure 2 shows the estimate of the potential impact on global temperature of Ireland's emissions and removals of greenhouse gases based on the illustrative scenarios, and the "with additional measures" projection for comparison. It is important to reiterate that all the scenarios achieve the mandated target of a 51% emissions reduction by 2030. Beyond 2030, the scenarios assume a gradual increase in removals so as to achieve a balance of emissions which assures climate neutrality in 2050. It is clear that the scenarios differ in terms of the ultimate impact on warming. Table 1 shows the estimated temperature impact scaled up on a per capita basis to the global scale.

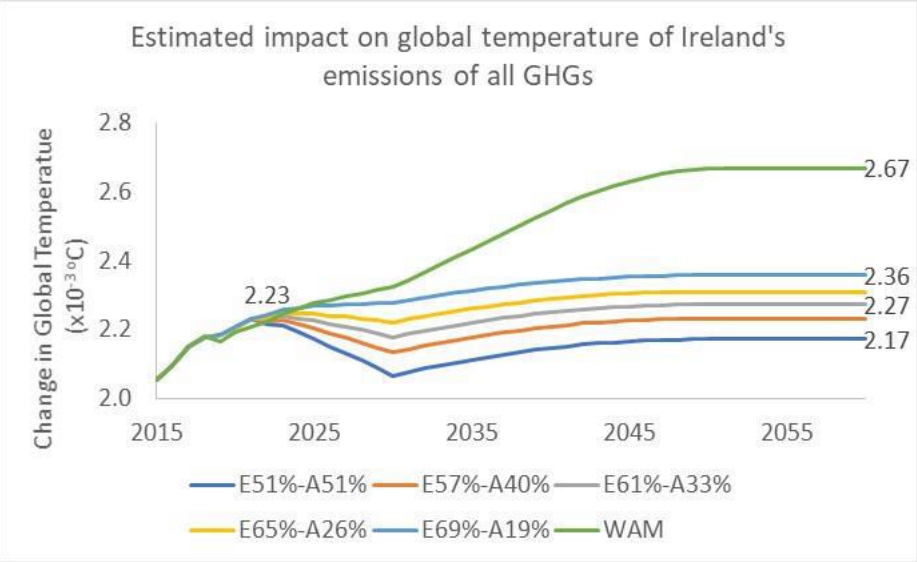

Figure 2 Estimated temperature response to emission of the main greenhouse gases based on the illustrative scenarios. The temperature impact of the proposed carbon budgets is at the scale of one-thousandths of a degree Celsius. (Carbon Budget Technical Report Figure 4-3)

The recently published IPCC AR6 Working Group 1 report provided an up to date assessment of the current attributable human-caused global surface temperature; the extent to which current global temperatures already exceed pre-industrial levels. This is estimated at 1.07ºC, within a likely range of 0.8ºC and 1.3ºC.

In addition to the currently observed warming, based on the pathways by which global actions can achieve the 1.5ºC goal, further warming is expected due to interactions with other gases. This is estimated as 0.2ºC based on the analysis of the IPCC AR6 WG1 report. This leaves a

remaining temperature gap of 0.23ºC expected to be taken up by global emissions of carbon dioxide.

Table 1 below summarises the results of the analysis for the five illustrative scenarios of carbon budgets modelled for the Committee. All scenarios pass the test comfortably, with the exception of E69-A19 scenario which marginally exceeds the estimate of the remaining temperature gap to the Global 1.5ºC goal. The Council concluded that the proposed carbon budgets are broadly consistent with the legislated criteria regarding the UNFCCC and the Paris Agreement.

Summary Table: Additional Impact of Ireland's emissions from 2020 on Global Temperature in 2050						
	Unit	E51%-A51%	E57%-A40%	E61%-A33%	E65%-A25%	E69%-A19%
Net Change in Global Temperature in 2050 relative to 2020	$x10^{-3}$ °C	-0.04	0.03	0.07	0.11	0.15
Upscaled to Global level Temperature change to 2050	°C	-0.05	0.04	0.11	0.16	0.24
Remaining gap to global 1.5 degree goal (with confidence range)	°C	0.23 (0.14- 0.32)	0.23 (0.14- 0.32)	0.23 (0.14- 0.32)	0.23 (0.14- 0.32)	0.23 (0.14- 0.32)

Table 1 (Carbon Budget Technical Report Table 4-4)

Ireland's obligations under EU legislation

The proposed budgets will enable full compliance with the State's current Effort Sharing Regulation target of a 30% reduction by 2030 relative to 2005, and are evaluated as being consistent with existing obligations and the proposed targets for Ireland under the EU's 'European Climate Law' (Regulation (EU) 2021/1119) and its constituent parts, including the Effort Sharing Regulation (ESR). There may be a requirement to make use of the existing flexibilities to remain in compliance (such as banking and borrowing), as the timing of implementation may see a misalignment between national and EU targets.

Biodiversity

The Council's review of the analysis suggests that it is possible to implement carbon budgets while protecting and enhancing biodiversity. However, it is critical that further pressure on biodiversity from all aspects of climate mitigation measures is avoided, in particular from poor siting of renewable energy infrastructure and inappropriate land use change such as over-reliance on, or poor siting of, mono-species afforestation. Care must be taken to identify and implement measures that deliver "synergistic gains" for climate mitigation, biodiversity protection and restoration, and catchment resilience.

Use of latest inventories, projections and best practice reporting of emissions and removals

The proposed carbon budgets were calculated using data from the latest EPA inventories and projections. The modelling of carbon budget scenarios requested by the Committee was calibrated to and informed by data from the EPA inventory and projections[12].

Scientific advice including in relation to biogenic methane

The proposed carbon budgets are consistent with the latest science, including from the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) Working Group 1, while abiding by the legislated mandate and regulation (S.I. No. 531 of 2021). The IPCC AR6 updated our understanding of the global carbon budget and the need for net zero emissions of long-lived gases (e.g. CO_2 and N_2O) and for a strong, rapid and sustained reduction in CH4 emissions. Recent analysis from the United Nations Environment Programme (UNEP) highlights the need for CH_4 emission reductions globally and emphasises the role of mitigation options for CH_4 emissions within the fossil fuel sector as a cost-effective option. Emission reductions in agriculture are seen as necessary but challenging. Additional research is required to enhance the mitigation options available.

Maximising employment, the attractiveness of the State for investment and long-term competitiveness of the economy

The proposed carbon budgets will have an impact on the economy, but failing to act on climate change would have greater consequences. The negative impacts can be mitigated by appropriate policies and supportive infrastructures, e.g. for training, while opportunities arising from a green reputation should be seized and innovation in products and services to support the low carbon economy should be made.

Climate Justice

It is the Council's view that the Paris Agreement represents the only international agreement on a fair approach to common but differentiated responsibilities and respective capabilities. An appropriate contribution to the Paris Agreement is an appropriate response to international climate justice.

People, nature and infrastructure in Ireland are already vulnerable to a range of climate impacts and these will only increase in the coming years as the climate continues to change. As identified by the Council in its Annual Review in 2020 and 2021, increasing adaptation efforts will be required to ensure that societal, economic and environmental goals remain achievable in the face of climate change. The 2021 Annual Review found that despite some progress at sectoral and local level, adaptation is still not adequately considered in a range of policies and initiatives. Policy continues to be concerned with decarbonisation with minimal

[12] EPA (2021). Ireland's Greenhouse Gas Emissions Projections 2020-2040. Available online: https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/Ireland_2021_GHG_Emission_Projections_2020-2040.xlsx

consideration of the potential economic, as well as social and environmental, costs of climate change.

Annex 1 – List of invited members to the Carbon Budgets Committee

Name	Organisation
Marie Donnelly (chair)	CCAC
Alan Matthews	TCD (Emeritus)
Lisa Ryan	UCD
Brian Ó Gallachóir	UCC
Aoife Ahern	UCD
Stephen Treacy	EPA
Jim Scheer	SEAI
Keith Lambkin	Met Éireann
George Hussey	DHLGH
Aoife Parker Hedderman	DECC
Trevor Donnellan	Teagasc
Bill Callanan	DAFM
Hannah Daly	UCC
Kevin Hanrahan	Teagasc
David Styles	UL
Frank O'Mara	Teagasc

Annex 2 – List of Climate Change Advisory Council and Carbon Budgets Committee meetings between March and October 2021

Date	CBC	Climate Change Advisory Council	Other Meetings
05-Mar-21		Climate Change Advisory Council	
23-Mar-21			Preparatory Meeting
06-April-21			Preparatory Meeting
14-Apr-21		Climate Change Advisory Council	
27-Apr-21	Carbon Budget Committee		
30-Apr-21	Carbon Budget Committee		
13-May-21		Climate Change Advisory Council	
17-May-21	Carbon Budget Committee		
24-May-21	Carbon Budget Committee		
03-Jun-21			Meeting on LULUCF
14-Jun-21	Carbon Budget Committee		
18-Jun-21		Climate Change Advisory Council	
21-Jun-21	Carbon Budget Committee		
22-Jun-21			Expert Meeting on the Science of National Mitigation Efforts
28-Jun-21	Carbon Budget Committee		
05-Jul-21	Carbon Budget Committee		
12-Jul-21		Climate Change Advisory Council	
22-Jul-21		Climate Change Advisory Council	
02-Sep-21		Climate Change Advisory Council	
09-Sep-21	Carbon Budget Committee		
15-Sep-21			Meeting on LULUCF
16-Sep-21	Carbon Budget Committee		

22-Sep-21		Climate Change Advisory Council*	
14-Oct-21		Climate Change Advisory Council	
25-Oct-21		Climate Change Advisory Council	

*The Carbon Budget Committee were invited to attend this meeting to discuss the draft Carbon Budget Technical Report.