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# Refining a “Paris Test” of National Contribution to Global Climate Mitigation

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## Introduction: Framing “Consistency” with the Paris Agreement

The Paris Agreement (UNFCCC 2015; hereafter PA) created a framework for global action commensurate (in so far as still possible) with the original UNFCCC objective of *preventing dangerous anthropogenic* climate change (UNFCCC 1992; Mace 2016). PA Article 2(1) specified, for the first time, a globally agreed quantitative mitigation objective in the form of a global temperature rise limit: ‘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’. Crucially, PA Article 2(2) committed the Parties to implementation that reflects ‘... equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances’ (CBDR-RC). PA Article 3 then prescribed a bottom-up architecture, placing the onus on the Parties *themselves* – nation states and regional blocs such as the European Union (EU) – to ensure that their mitigation plans, presented in statements of *voluntary* Nationally Determined Contributions (NDCs), adequately reflect these objectives and obligations.

As a corollary we suggest that any good faith Party to the Agreement, in developing its mitigation objectives, should itself explicitly and transparently *test* these for consistency with the Agreement; and continue to do so on an ongoing basis as circumstances (both global and local) evolve.

However: while it is commonplace to see political *assertions* that this or that national plan is “aligned” with the Paris Agreement, it is much less common to see this supported by transparent quantitative analysis, grounded in explicit provision for CBDR-RC. One potentially interesting exception is the case of *Ireland*. In this Perspective, we briefly describe, and critique, this exemplar case of a transparent national “Paris Test” of domestic mitigation ambition. Finally, we comment on the opportunity for generalisation to other PA Parties and consider what follows from such a Test.

## The Irish Exemplar

The Irish parliament (Oireachtas) recently passed climate legislation (Oireachtas 2021) which mandated the adoption of successive 5-year “carbon budgets” (constraints on total domestic GHG emissions), structured into a rolling 15-year programme. Recommendations for the quantitative budget amounts in each period are first formulated by an independent statutory body, the Irish Climate Change Advisory Council (CCAC), and submitted for legal adoption (potentially with revision) by the full parliament. Once adopted, successive Governments are required to bring forward and implement policies and measures to ensure “in so far as practicable” that total emissions over each

period are held within the required budget limit. An excess of emissions in a given period must be carried forward and subtracted from the budget for the immediately following period.

Most critically, the Act requires that the actors involved (CCAC, Government, Ministers) must discharge their prescribed functions “... in a manner ... *that is consistent with* ... the steps specified in Articles 2 and 4(1)” of the Paris Agreement (Oireachtas 2021, s. 3(3)(a)(ii) as amended; emphasis added). This PA consistency requirement therefore encompasses the (rolling) process of adopting the quantitative budgets.

Accordingly, in formulating its recommendations for the first 15-year budget programme (covering 2021-2035, in three 5-year periods) the CCAC considered explicitly how to assess these for PA consistency. This is not specified in detail in the Act; so the CCAC itself formulated an explicit, quantitative *Paris Test*. The methodology of this Test, and the outcome of applying it to their budget recommendations, were summarised in their published *Technical Report on Carbon Budgets* (CCAC 2021), and elaborated in a further advisory note (CCAC Secretariat 2021). A supporting spreadsheet was shared with the authors on request, and is publicly archived (CCAC 2022). The outcome of the Test is shown in Figure 1(a). The methodology is somewhat cumbersome, but can be summarised as follows:

- Five bottom-up annual national GHG emissions scenarios (disaggregated by gas) were first developed, covering the period from 2021 to 2050. These were constrained to meet specific guidance in the Act, namely “to provide for” total 2030 emissions, aggregated in  $\text{CO}_{2\text{eq}}$  terms (via  $\text{GWP}_{100}$ ), being 51% below the 2018 level, and that emissions beyond 2050 should be “climate neutral”. The Act defines “climate neutral” as a situation where “... greenhouse gas emissions are balanced or exceeded by the removal of greenhouse gases”. This was interpreted as requiring that total emissions and removals should net to zero *when aggregated in  $\text{CO}_{2\text{we}}$  terms*, via (a version of) the  $\text{GWP}^*$  aggregation method (Lynch et al. 2020). The scenarios *differed* in the distribution of emissions between  $\text{CO}_2$ ,  $\text{CH}_4$  and  $\text{N}_2\text{O}$ , while representing similar aggregate emissions in  $\text{CO}_{2\text{eq}}$ .
- It is important to note that two different GHG aggregation methods are used,  $\text{CO}_{2\text{eq}}$  (via  $\text{GWP}_{100}$ ) and  $\text{CO}_{2\text{we}}$  (via  $\text{GWP}^*$ ), each with distinct use-context and motivation.  $\text{CO}_{2\text{eq}}/\text{GWP}_{100}$  is the standard method in UNFCCC inventory reporting, and is stipulated as the basis for expressing the Irish *statutory budgets*. However, cumulative  $\text{CO}_{2\text{eq}}$  provides a poor proxy for temperature impact, especially if, as is the case for Ireland, the emissions inventory contains a significant component of  $\text{CH}_4$  (Allen et al. 2018; Smith et al. 2021). The CCAC took the view that the “climate neutral” requirement of the Act should be interpreted in the sense of Irish emissions contributing no *additional* warming beyond 2050. Zero aggregate  $\text{CO}_{2\text{we}}$  (via  $\text{GWP}^*$ ) beyond 2050 is then a defensible proxy for this.
- The motivation for developing bottom-up scenarios that differ primarily in  $\text{CO}_2$  vs non- $\text{CO}_2$  mitigation is that Irish non- $\text{CO}_2$  emissions are dominated by  $\text{N}_2\text{O}$  and  $\text{CH}_4$  from agricultural activities. Thus, the scenarios map closely onto potential trade-offs, within fixed  $\text{CO}_{2\text{eq}}$  budgets, between levels of mitigation in agriculture as compared to other activities (primarily energy related but also including significant net emissions from LULUCF). However, even though the scenarios are characterised by similar cumulative  $\text{CO}_{2\text{eq}}$  over the full 2021- 2050 period, they differ significantly in  $\text{CO}_{2\text{we}}$  terms, which is to say warming impact. Accordingly, they require separate assessment for consistency with the PA 2(1) temperature rise objective.
- The CCAC “Paris Test” for any given national GHG scenario then consists in making an estimate of the steady-state (post-2050) warming contribution associated with the scenario,

“upscaling” this to the global level (on some “equity” basis), and comparing that to an estimate of “available” warming, based on the PA 2(1) global temperature objective. If the upscaled warming is less than the “available” warming threshold the Test is passed and the scenario is deemed “consistent” with the Paris temperature objective.

- The steady-state warming contribution from each national scenario is calculated as the cumulative CO<sub>2we</sub> from the scenario start date (start 2021) until it reaches steady-state (end 2050, by design), scaled by a (central estimate of) the Transient Climate Response to Cumulative CO<sub>2</sub> Emissions (TCRE) per IPCC AR6 WGI (IPCC 2021).
- The “upscaling” basis is the ratio of the Irish population to the global population as of the scenario start year. This is motivated via Kant’s “categorical imperative” (Johnson and Cureton 2022). It is evidently intended to reflect the PA CBDR-RC provisions, via a form of equal-per-capita (EPC) mitigation effort sharing, applied from the scenario start date onward.
- The “available” global warming threshold is estimated by taking the difference between 1.5°C and the estimated global temperature rise already experienced at a stated reference date, and then further subtracting an estimate of peak *non*-CO<sub>2</sub> warming, based on a 50% probability of not exceeding 1.5°C total rise. It is thus an estimate of warming specifically attributable to CO<sub>2</sub> available from the stated date onward, based on a 50% probability of not exceeding 1.5°C total rise over pre-industrial. The CCAC used the start of 2020 as the reference date, and calculated the corresponding available warming threshold as 0.23°C.

This procedure yields projected global (upscaled) warming impacts for each of the scenarios, as shown in Figure 1(a). Despite all scenarios corresponding to similar cumulative CO<sub>2eq</sub> emissions, they show significantly different warming impacts, according to each scenario-specific distribution of gases. All but one of the scenarios is shown as projecting a short-term *reduction* in warming impact (up to 2030), and as unequivocally passing the Test when warming impact stabilises (in 2050). The one remaining scenario<sup>1</sup> lacks any short-term reduction in warming, and marginally exceeds the PA available warming limit by 2050. On the basis of this scenario ensemble, and acknowledging that the methodology tests only “a minimum level of consistency with the Paris temperature goals”, the CCAC concluded that “the proposed carbon budgets are broadly consistent with the legislated criteria regarding the UNFCCC and the Paris Agreement” (CCAC 2021, p. 75).

It is important to recognise and commend the achievement here. Firstly, that the Irish parliament voluntarily adopted a statutory domestic emissions budget framework that was bound to expert assessment of consistency with the (collective) PA temperature objective. Secondly, that the CCAC, in discharging this assessment obligation, provided clear and transparent access to their methodology, including articulation of some relevant (necessarily value-laden) equity judgements (specifically the EPC principle for upscaling from national to global level). Thirdly, that even with the complexity of a multi-gas budget system, legally stipulated to use CO<sub>2eq</sub> aggregation, the CCAC identified a pragmatic mechanism to still assess temperature impact via a scenario exploration of the distribution of emissions across gases, coupled with the (relatively novel) GWP\*/CO<sub>2we</sub> aggregation approach. Finally, this work was conceived and executed within an extremely tight timeframe: the Act was passed by parliament in May 2021, and the CCAC recommended the first budget programme in October 2021.

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<sup>1</sup> Labelled “E69%-A17%”, and representing the minimum assessed level of reductions in agriculture relative to energy-related GHGs.

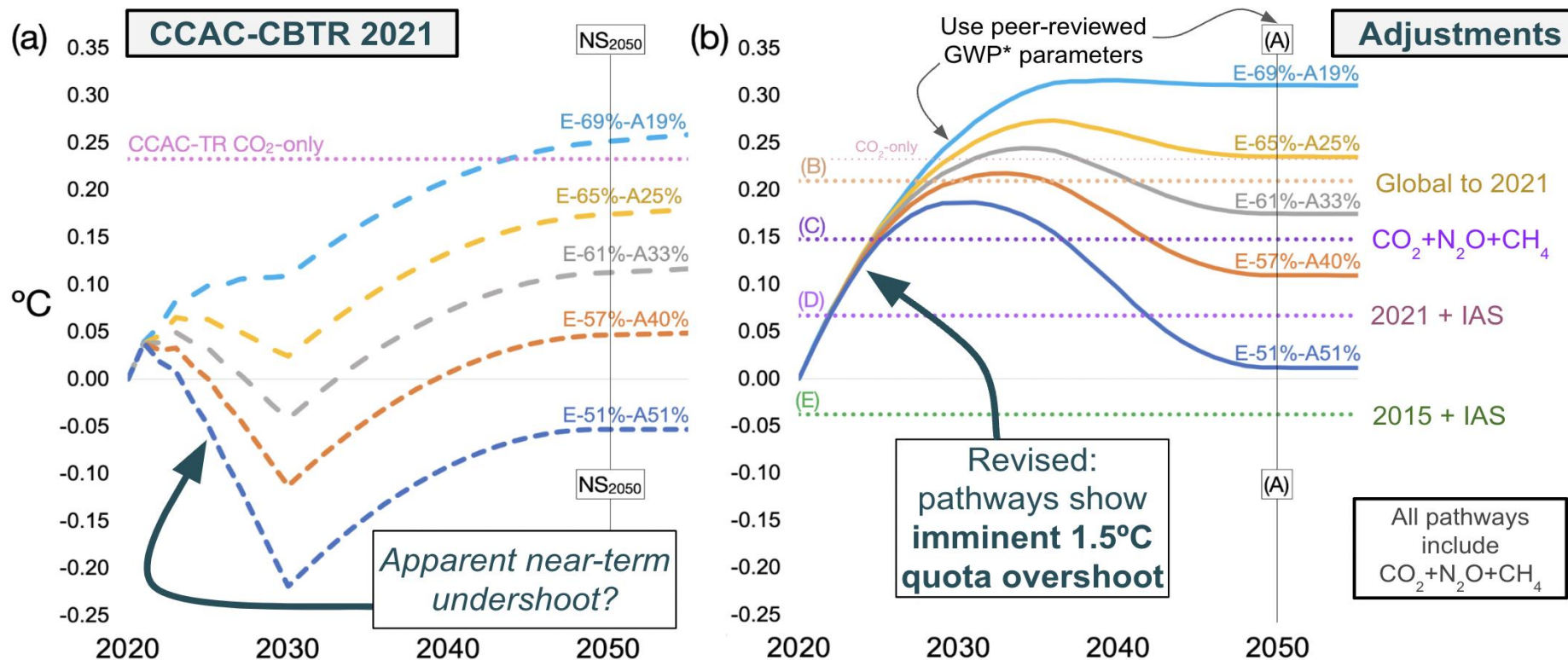


Figure 1: Projected warming impacts of Irish GHG emissions scenarios. The scenario labels indicate the approximate reductions in annual “E” or energy-related emissions (mainly CO<sub>2</sub>) versus “A” or agriculture-related emissions (mainly N<sub>2</sub>O and CH<sub>4</sub>, expressed in mass/CO<sub>2eq</sub> terms), as of 2030 relative to 2018. Panel (a) is derived from (CCAC 2021), Figure 4-3, upscaled to global level and with temperature changes referred to the end of the chosen reference year (2020). Panel (b) shows the effects of applying the refinements proposed in the main text.

## Critical Review

Of course, it is important to consider whether there are aspects of this exemplar that should be improved: both within the specific Irish context (reassessment is required on a 5-year cycle as the budget program is rolled forward), and in considering any generalisation to other PA Parties. Below, we suggest six specific points (A-F) for potential improvement. Point A affects the overall temporal dynamics and stabilisation levels of all scenarios. Points B-E all affect the assessed *warming threshold* for PA consistency, with each one suggesting a progressively lower threshold. Points A-E are quantitative and estimates of their potential effects are illustrated in Figure 1(b).

- A. As noted, the CCAC adopted the GWP\* methodology to translate the by-gas emissions scenarios into estimated warming effects. However: based on review of the supporting spreadsheet, it appears that the calculations adopted a time averaging period ( $\Delta t$ ) of 1 year rather than the standard 20 years recommended for GWP\*; further, they did not use the most recently recommended values for other parameters of this methodology (Smith et al. 2021). Figure 1(b) shows the result of applying updated/corrected GWP\* parameters. The temporal dynamic is dramatically different in all cases, now showing very significant near-term overshoot, and subsequent decline to the 2050 steady-state levels. This correction in projected temporal dynamics is primarily due to the correction in  $\Delta t$ , and strongly emphasises the prudential role of early mitigation action (Geden and Löschel 2017). But separately, the overall updating of parameters also leads to significantly higher steady-state impacts, which are critical for the ultimate Test outcomes.
- B. The CCAC estimate of available warming at the global level is derived from IPCC AR6; but that is referenced to the *start* of 2020. Whereas the estimated warming contributions from the (upscaled) Irish emissions scenarios are referenced to the *end* of 2020 (start of 2021). This is a clear discrepancy. Accordingly, the available warming threshold should be reduced by an amount corresponding to global GHG emissions in 2021.
- C. The CCAC estimate of available warming at the global level is based on the contribution of CO<sub>2</sub> *only*; whereas, the Irish emissions scenarios include *all* GHGs. Accordingly, the warming threshold should reflect global emissions of all GHGs (but should indeed exclude non-GHG effects, especially aerosols).
- D. The Irish legislation stipulates that the *budgets* should be expressed exclusive of emissions from international aviation and shipping (IAS). However, legal analysis indicates that IAS emissions *do* fall within the mitigation responsibilities of the PA Parties (Dehon 2021). Accordingly, the assessment of PA consistency should still allow for them: that is, either an Irish contribution to IAS emissions should be included in the national scenarios, or (equivalently) the warming threshold should be reduced by the estimated, upscaled, total cumulative effect of those Irish IAS emissions. In Figure 1(b) we use the latter method, upscaling the temperature effect of cumulative emissions from Irish IAS emissions bunker fuels, as projected up to 2040 (EPA 2022), followed by linear reduction to zero by 2050.
- E. The CCAC effectively adopt the start year of their scenarios (2021) as an overall historical reference year for their Paris Test, but without any explicit motivation for this choice. The choice is, in fact, highly value laden, reflecting tacit CBDR-RC positions, with potentially very significant effect on the outcomes. It essentially separates global anthropogenic contributions to climate change between a *strictly common* phase without differentiated mitigation responsibility among the PA Parties (mitigation responsibility is effectively “globalised” up to that point), and a *differentiated* phase with different Parties carrying “common but differentiated” mitigation responsibilities only from then onward. In general, Parties with relatively higher historical

emissions benefit from delayed differentiation (a later reference year) and vice versa for Parties with lower relative historical emissions. Given the UNFCCC and PA commitments to CBDR-RC, the choice of reference year in a PA Test therefore merits clear and explicit motivation. The CCAC choice of 2021 seems problematic, tacitly finessing all differentiation of historical responsibility prior to that year. A case can be made for much earlier years, such as the adoption of the Paris Agreement itself (2015), or of the UNFCCC (1992), or the year of the IPCC First Assessment Report (IPCC 1990). For illustrative purposes, Figure 1(b) shows the potential for a significant effect on the Test outcomes, with an adjustment of the warming threshold that would reflect a *minimal* shift of the reference year back to just 2015 (incorporating upscaled Irish GHG emissions, including IAS, over the period 2015-2020 inclusive).

- F. Finally, we note that, quite aside from the issues of differentiating historical responsibility via the choice of reference year, the choice of EPC upscaling for effort sharing in ongoing mitigation is itself also highly value laden (Dooley et al. 2021). While the CCAC does offer *some* motivation in this case (the Kantian “categorical imperative”), it is at least questionable whether this represents an adequate reflection of CBDR-RC. In particular, EPC does not reflect any differentiation among the Parties in relation to relative severity of (per capita) climate *impacts* or (per capita) *capacity to act* (either in mitigation or adaptation).

In summary, Figure 1(b) shows that, as each of the quantitative adjustments A-E are applied, fewer of the CCAC scenarios meet the Test threshold. If all were applied, then the conclusion would be that Ireland was *already* in overshoot relative to its cumulative warming share even before the first budget programme formally started in 2021. Taken together, these points clearly suggest a need for improved Test design, the consequence of which is likely to be the need for a radically stronger (“emergency” scale?) national mitigation response in the upcoming second cycle of the Irish budget programme.

## Conclusion

Declarations of a climate “emergency” have become relatively commonplace at diverse governance levels in recent years: but in general, they neither present quantitative analysis of the scale of response that is actually required, nor offer an equitable basis for sharing that effort. That is, they are infused with *implicatory denial*, where:

... What is denied or minimized are the psychological, political, and moral implications of the facts for us. People fail to accept responsibility for responding; they fail to act when the information says they should ... (Campbell 2023)

Notwithstanding the relatively weak force of the Paris Agreement, *pro tem* it is the only existing framework for collective global climate action. It is therefore incumbent on good faith Parties to the Agreement to move beyond implicatory denial, and to use the PA framework to bring forward, on a collective global basis, *near term* action that is both commensurate with the PA temperature objective and genuine in its commitment to CBDR-RC. Ireland has provided a strong example of at least *testing* its voluntary domestic commitments for quantitative consistency with the PA objectives. Its Paris Test (with the refinements proposed above) provides a strong starting point for such assessment: other PA Parties could usefully adopt and tailor this Test according to individual circumstances.

As we have seen in the recent examples of the global financial crisis and the Covid-19 pandemic, the hallmark of a *real* emergency is the triggering of responses of a scale and nature that would be politically unthinkable in “normal” times. However: the reality is that even in Ireland, over half-way

through its first formal 5-year carbon budget period (at the time of writing), there is already a rapidly widening gap between actual emissions and even the *minimally* Paris-consistent budgets that have been adopted (An Taisce 2023). A robust Paris Test is important in providing a bottom-up articulation of an equitable and commensurate Party-level contribution to meeting the PA goals: but the critical next step is for governments to communicate and act upon the *implications* of that knowledge. We urge all good faith parties to the Paris Agreement to adopt the genuinely *emergency scale* responses that are now so manifestly required.



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