Assessing society-wide national climate change mitigation scenarios using a warming-equivalent model to aggregate greenhouse gases including methane

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Global climate action is not currently aligned with staying within remaining global carbon budgets (GCBs) corresponding to the Paris Agreement temperature limits of “well below 2°C” and making efforts to limit to 1.5°C over pre-industrial. Estimated CO2-only GCBs critically depend on achieving reductions in nitrous oxide (N2O) and in short-lived methane (CH4). Therefore, a nation’s “low carbon transition” needs to be completed within its ‘fair share’ quota of the aggregate global greenhouse gas (GHG) budget. For Ireland, assessing climate action including these non-CO2 gases is important because a comparatively large fraction of reported emissions is due to N2O and CH4, arising primarily from ruminant agriculture. However, the warming commitment of mitigation scenarios that include CH4 has been difficult to evaluate as the standard GHG equivalence metric, called GWP100, crucially fails to reflect the physical reality that sustained reductions in CH4 flow can result in a substantial reduction in its total warming-equivalent contribution within 10 to 20 years. A new metric, called GWP*, accurately approximates changes in the warming-equivalent (CO2-we) contribution of short-lived climate pollutants such as CH4. Incorporating the GWP* methodology, we have developed an open source model to project GHG warming-equivalent commitments (by gas and in aggregate) of policy-relevant national mitigation scenarios to 2100, relative to a Paris-aligned national GHG quota. Comparing illustrative scenarios for effective climate change mitigation reveals significant implications for Paris-aligned climate action. Complex but critical trade-offs between GHGs and sectors are clarified. Supplementing the primary requirement for radical CO2 mitigation, substantial and sustained reduction in total national methane emissions appears to be critical to the feasibility of achieving net zero CO2-we by 2050. In addition to radically limiting fossil fuel usage, reducing total usage of reactive nitrogen in agricultural and biogas production is argued to have a key role in overall climate mitigation for Ireland.

Keywords: climate action, Paris Agreement, transition, climate modelling, methane, GWP*.