# Aligning carbon budget considerations for agriculture, land use & forestry with climate neutrality

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## 1. Purpose

The focus of the CCAC CBC is on cumulative carbon budgets for the 2020 to 2035 accounting period, in line with international climate action required for climate stabilisation and a national target to reduce GHG emissions by 51% between 2018 and 2030. It is not the objective of the CBC to recommend sector-specific targets. Nonetheless, meaningful deliberation of implications of compliance with national and EU legislative requirements, vis-à-vis LULUCF accounting, feasibility, competitiveness, investment, employment, etc, does implicitly require consideration of how different sectors will contribute to the national target. In this context, there remains considerable debate around emissions and emission removals by agriculture, LULUCF and the combined AFOLU sectors.

Teagasc have provided a briefing note to the CBC illustrating how a selection of AFOLU scenarios may or may not comply with potential carbon budget requirements under different LULUCF accounting rules. That briefing note was focussed on the period up to 2030, and was based on a number of assumptions:

- Business-as-usual agricultural activities
- Highly ambitious scale-out of technical mitigation measures in the agricultural sector
- Low levels of ambition in the LULUCF sector
- Any (net-net) LULUCF credits count towards emission reductions for the agriculture sector
- Reduced output from livestock farming is not replaced by other low-carbon (or carbon-positive) activities

The purpose of this briefing note is to share information derived from AFOLU modelling in the *SeQUEsTER* project that is pertinent to determining combinations of AFOLU emissions and removals compatible with 2050 climate neutrality. Specifically, some possible forward-looking "landing zones" for AFOLU climate neutrality are presented. These relate to the remit of the CCAC CBC insofar as: (i) consideration of feasibility, competiveness, employment, etc, requires some view of both short- and long-term inter-sectoral effort sharing; (ii) AFOLU is subject to unique factors requiring long-term (land use) planning, in particular the long-time lag in GHG flux responses to some activity changes, and the likelihood for separate consideration of biogenic methane emissions in *future* climate regulations. Therefore, it will be important to ensure that messaging around carbon budget proposals is at least cognisant of implications for achieving climate neutrality by 2050.

## 2. Scope & Methods

This briefing note takes a back-casting approach to present broad-brush scenarios that comply with a plausible definition of climate neutrality in 2050. The intention is not to make forecasts, but to show the combinations of activities and emissions over the carbon budgeting period that could be broadly compatible with achieving climate neutrality post 2050. The definition of climate neutrality is confined to the AFOLU sector only, based on a balance of emissions and removals across $CO_2$ & $N_2O$ only in the year 2050, using AR5 $GWP_{100}$ equivalence and assuming linear activity changes out to 2050, starting in 2022 for organic soil rewetting and in 2025 for afforestation. This is a conservative

approach that does not account for additional removals that could be required from the AFOLU sector in order to compensate for residual emissions & emissions overshoot from other sectors. It also assumes that $CH_4$ emissions are reduced to an internationally-acceptable "fair share" of the 2050 global $CH_4$ emission envelope compatible with climate stabilisation – for Ireland, this fair share could equate to a 30-80% reduction in annual emissions relative to a 2010 reference year (Prudhomme et al., 2021).

The baseline for emission reductions is 2018, accounting for broad categories of non-$CH_4$ emission from: agricultural activities, organic soils under grassland and exploited wetlands. Soil carbon accumulation under mineral soils (c.2 Mt $CO_2$ in 2018) is a function of grassland improvement, and is assumed to be exhausted by 2050 based on the default 20-year transition period for land use changes and the assumption that further grassland improvement will be constrained. Forestry dynamics are modelled in GOBLIN using the Irish forest carbon model developed by (Duffy et al., 2020), representing: (i) existing forestry managed under long-term economically-optimised rotations; (ii) new forestry planted on mineral soils at a constant rate from 2025-20250, with a commercial or conservation bias (70:30 or 30:70 conifer:broadleaf split, respectively). Proposed new $CO_2$ emission factors for organic soil under forestry (Jovani-Sancho et al., 2021) have been incorporated, increasing the flux from existing (baseline) forestry by circa 1.8 Mt $CO_2$e annually.

## 3. Results

Figure 1 displays the simple balance of emissions and removals (excluding $CH_4$) across agriculture, organic soils under grassland, wetlands and forestry associated with climate neutrality in AFOLU in 2050. Indicative scenarios are based on forestry removals needed to exactly balance residual emissions from AFOLU sources. Agriculture emissions are reduced by 25% (Ag-25) to 75% (Ag-75), whilst all exploited wetlands are rewetted and 25-75% (R-25 to R-75) of organic soils under grassland are rewetted to illustrate interactions and trade-offs across activities. Total removals required range from 3.8 to 11.4 Mt $CO_2$ eq. annually, for Ag-75,R-75 to Ag-25, R-25 respectively.

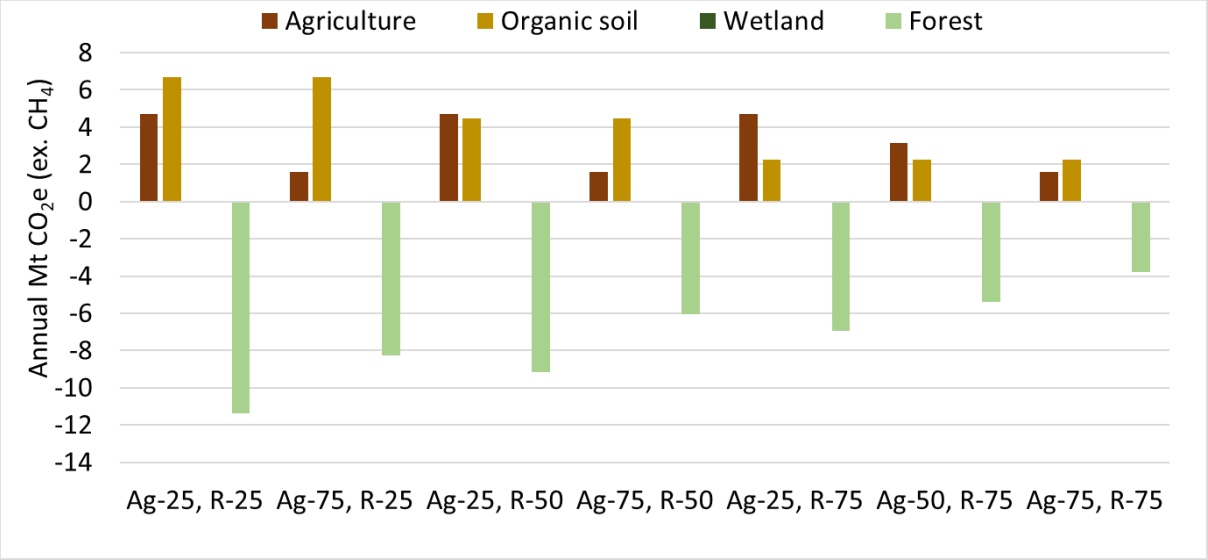


**Figure 1. Combinations of $CO_2$ equivalent (excluding $CH_4$) emissions and removals in 2050 across agriculture, organic soils under grass, wetlands and forestry compatible with climate neutrality in the AFOLU sector**

Table 1 indicates levels of LULUCF activity needed to achieve the GHG reductions or removals indicated in Figure 1 across the indicative scenarios. From 2022 onwards, between 2,888 and 8,664 ha of organic soil under grassland need to be rewetted annually in order to achieve 25-75% rewetting across the circa 350 kha of drained organic soils under grass.

Meanwhile, between 13 kha and 32 kha of commercial-oriented forestry, or 16 kha to 40 kha of conservation-oriented forestry, would need to be planted annually between 2025 and 2050 in order to balance residual emissions of $CO_2$ & $N_2O$ from agriculture and organic soils by 2050. Although high by historical comparison, these afforestation rates would leave gross national forest cover at between 16% and 24% of Ireland's land area – still considerably below the European average of 45%.

The time series of net $CO_2e$ flux from forests is shown in Figure 2. Note that the "carbon cliff" in the baseline is a function of forest harvest cycles, and arises later in GOBLIN than in some EPA projections because GOBLIN is predicated on economically optimised (longer) rotations in line with historic trends. The timing of the "carbon cliff" will depend on future forest management, but is not likely to substantially influence the 2050 balance calculations because the baseline forest trajectory post 2040 represents only a gradual improvement in balance. Meanwhile, it is clear that even at high planting rates of 32 kha/yr for the Ag-25 R-25 scenario (Table 1, Figure 2), net removals are only ca. 1 Mt $CO_2e$ larger than for the baseline (5kha/yr planting rate) by 2030. Nonetheless, this sustained rate of planting goes on to deliver an additional 11 Mt $CO_2e$ annually by 2050 – emphasising the important contribution of timely afforestation to climate neutrality targets (but not necessarily the carbon budget).

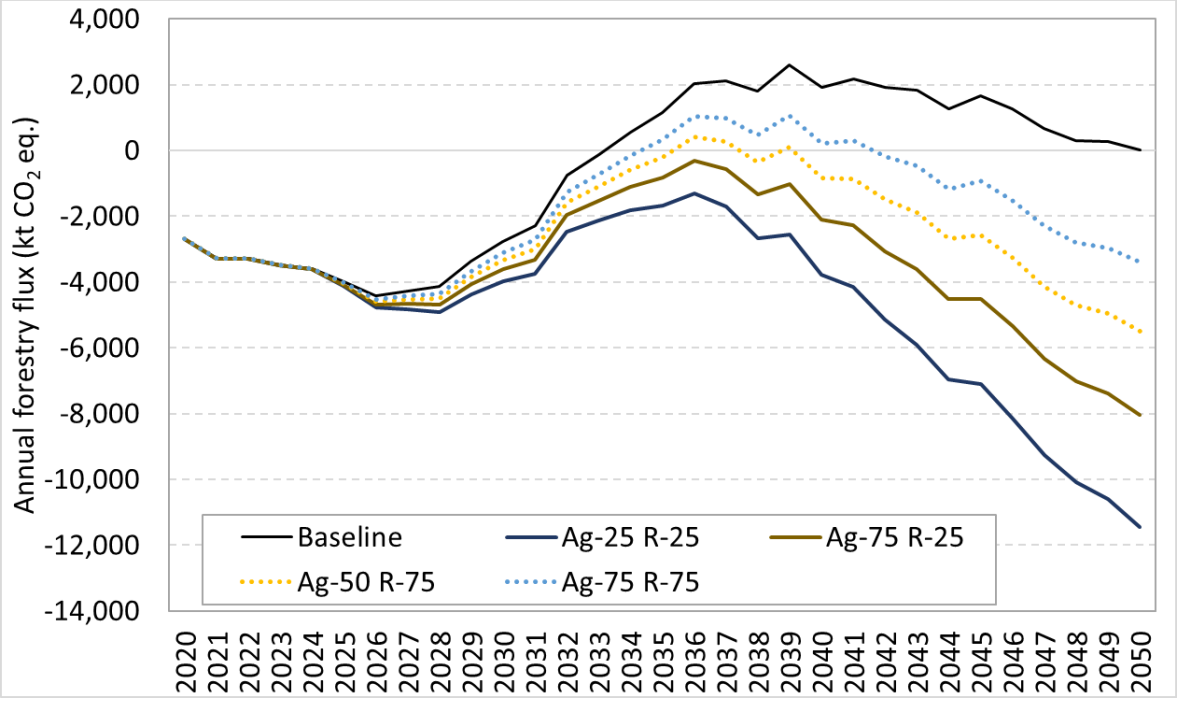


**Figure 2. Trend in commercial-mix forestry net $CO_2e$ flux between 2020 and 2050 for planting rates (Table 1) needed to offset agricultural and organic soil emissions under the indicative scenarios. A baseline planting rate of 5 kha/yr from 2018 through to 2050 is also displayed for context.**

**Table 1. Annual (bold), and aggregate to 2030 or 2050, levels of activity across organic soil rewetting and afforestation (70:30 or 30:70 conifer:broadleaf "commercial" or "conservation" mixes) needed to achieve climate neutrality in the AFOLU sector by 2050 in terms of GWP100 balance for $CO_2$ & $N_2O$. Afforestation rates rounded to the nearest 1000 ha.**

| | Organic soil rewetting | | | Commercial-mix afforestation | | | | Conservation-mix afforestation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario | Annual (ha/yr) | Aggregate 2030 (ha) | Aggregate 2050 (ha) | Annual (ha/yr) | Aggregate 2030 (ha) | Aggregate 2050 (ha) | Forest cover 2050 | Annual (ha/yr) | Aggregate 2030 (ha) | Aggregate 2050 (ha) | Forest cover 2050 |
| **Ag-25, R-25** | **2,888** | 23,103 | 83,750 | **32,000** | 160,000 | 800,000 | 22% | **40,000** | 200,000 | 1,000,000 | 24% |
| **Ag-75, R-25** | **2,888** | 23,103 | 83,750 | **24,000** | 120,000 | 600,000 | 19% | **30,000** | 150,000 | 750,000 | 21% |
| **Ag-25, R-50** | **5,776** | 46,207 | 167,500 | **27,000** | 135,000 | 675,000 | 20% | **33,000** | 165,000 | 825,000 | 22% |
| **Ag-75, R-50** | **5,776** | 46,207 | 167,500 | **19,000** | 95,000 | 475,000 | 17% | **24,000** | 120,000 | 600,000 | 19% |
| **Ag-25, R-75** | **8,664** | 69,310 | 251,250 | **21,000** | 105,000 | 525,000 | 18% | **26,000** | 130,000 | 650,000 | 19% |
| **Ag-50, R-75** | **8,664** | 69,310 | 251,250 | **18,000** | 90,000 | 450,000 | 17% | **22,000** | 110,000 | 550,000 | 18% |
| **Ag-75, R-75** | **8,664** | 69,310 | 251,250 | **13,000** | 65,000 | 325,000 | 15% | **16,000** | 80,000 | 400,000 | 16% |

## 4. Discussion & conclusions

The simple indicative scenarios presented here illustrate some important principles pertinent to carbon budget considerations:

- Climate neutrality is a zero-sum game based on gross-net accounting that will require simultaneous high levels of ambition across agriculture, organic soil rewetting and afforestation.
- Forestry is the primary, scalable $CO_2$ removal measure in the near term for Ireland – and will therefore be required to offset any residual AFOLU emissions in order to achieve climate neutrality.
- AFOLU climate neutrality is likely to require sustained average rewetting rates for organic soils under grassland of over 8 kha per year, and sustained average afforestation rates somewhere between 13 and 33 kha per year, depending on the level of ambition in mitigation of AFOLU emission sources (considerably higher than the AgClimatise target of 8 kha/yr).
- There is a considerable time-lag between forest planting and increased rates of $CO_2$ removal. Timely forest planting will be imperative to provide "headroom" for agricultural activities and residual organic soil emissions within the envelope of AFOLU climate neutrality by 2050.
- Harvested wood product (HWP) C storage, future bioenergy carbon capture & storage (BECCS) and product substitution from cascading wood value chains have been excluded from the current analysis. Recent work has shown these processes to more than double net GHG mitigation compared with terrestrial C storage alone over a 100-yr period of two commercial forest rotations (Forster et al., 2021). The indicative commercial forestry scenarios explored here could therefore support long-term climate neutrality across the wider Irish economy, generating significant new (bio)economic activities & employment.
- Excluding $CH_4$ from offset calculations is predicated on ambitious $CH_4$ reduction in line global climate stabilisation (Huppmann et al., 2018). Applying "fair share" principles to ascertain Ireland's biogenic $CH_4$ quota implies reductions of between 30 and 80% relative to 2010 levels (Prudhomme et al., 2021). Without appropriate reductions in $CH_4$, much larger $CO_2$ removals (and therefore afforestation rates) would be required by 2050 to compensate.
- In aggregate, organic soil rewetting and afforestation will require significant change of use or management on 0.6-1.1 M ha of land across the scenarios looked at here. This will inevitably have implications for livestock production, indicating that business-as-usual trajectories of animal production are not realistic (implying up to 35% increase in average stocking rate, with serious consequences for, *inter alia*, nitrogen loading & leakage).
- Unless governments, companies and other institutions abandon climate neutrality targets, there will be increasing scrutiny of emission-intensive products and activities, and increasing rewards (payments) for $CO_2$ removals.
- GHG mitigation and carbon sequestration activities in the AFOLU sector will be integral to Ireland's transition towards climate neutrality, presenting opportunities for farmers to diversify income via, *inter alia*, carbon farming and commercial forestry.
- Irish farmers are in an excellent position to benefit from emerging carbon markets owing to internationally high rates of tree growth and thus carbon sequestration.
- Focussing on business-as-usual trajectories in livestock production is an unbalanced and high-risk strategy that is likely to undermine the "green" image of Irish agri-food exports

currently used for marketing purposes. This approach is also likely to distract farmers and other stakeholders from diversification opportunities, increasing the risk of major disruptive change over the coming decades (i.e. reducing prospects for a just transition).

**References**


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