Chapter 7

Technical Annex

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A7.1 Methods for estimating current CDR

Estimating CDR levels from afforestation, reforestation and forest management

In line with the previous edition of *The State of CDR*, this report uses two largely independent approaches to quantify the amount of conventional CDR from afforestation, reforestation and forest management. The first (primary) approach is aligned with the Global Carbon Budget (GCB) and provides both country-specific and global CDR values through bookkeeping models. The second (complementary) approach is derived from the sum of all national greenhouse gas inventories (NGHGI), combined with modelling of the indirect anthropogenic sinks, which allows us to obtain a global CDR value. Because of the time series available in the NGHGI, in this report we use the average 2014-2023 for both NGHGI and bookkeeping models.

Bookkeeping models

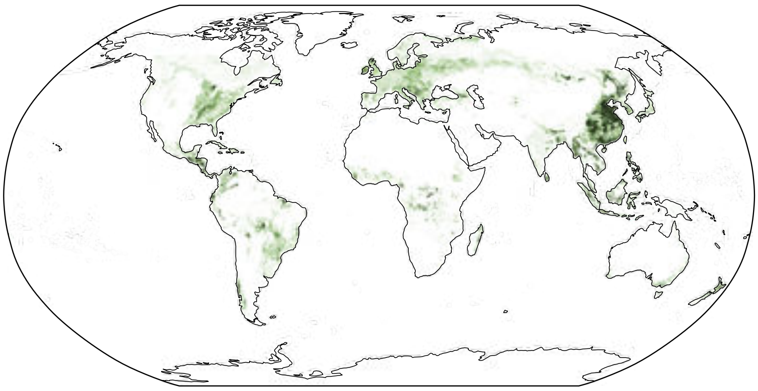
The GCB uses the average of three bookkeeping estimates to quantify CDR: the Bookkeeping of Land Use Emissions model (BLUE[1]), the Land-Use Change Emissions model (LUCE[2]), and the OSCAR reduced-form Earth system model[3]. BLUE and LUCE incorporate information on land use and land-use changes based on the spatially explicit LUH2 dataset[4], updated to 2024 (which therefore limits CDR estimates up to and including 2024). OSCAR provides a best guess estimate by combining data from LUH2 and from the United Nations Food and Agriculture Organization Statistics (FAOSTAT) and Global Forest Resources Assessment (FRA) for changes in agricultural areas and wood harvesting (which are also used by LUH2). These bookkeeping models estimate the gross sources and sinks of CO_2 from direct anthropogenic land use and land-use change, of which one component is the CDR attributable to afforestation & reforestation activities. All bookkeeping estimates take into account the effects of land-use activities since 1700; this means that CO_2 removals occurring today due to afforestation & reforestation several decades ago are accounted for.

In a change to the previous report, all bookkeeping models now consider the effect of changing environmental conditions (e.g., increased atmospheric CO_2 concentrations, climate change, nitrogen deposition) on CO_2 emissions and removals from land use. Forests growing under today's climate typically accumulate more carbon when they are fully grown as compared to the same forests under pre-industrial conditions, due to the elevated atmospheric CO_2 concentrations. In the estimate of CDR from afforestation & reforestation from bookkeeping models, the maximum carbon uptake is determined by the environmental conditions at the beginning of the (re-)growth; any additional carbon uptake due to subsequent changes in environmental conditions is not counted as CDR.

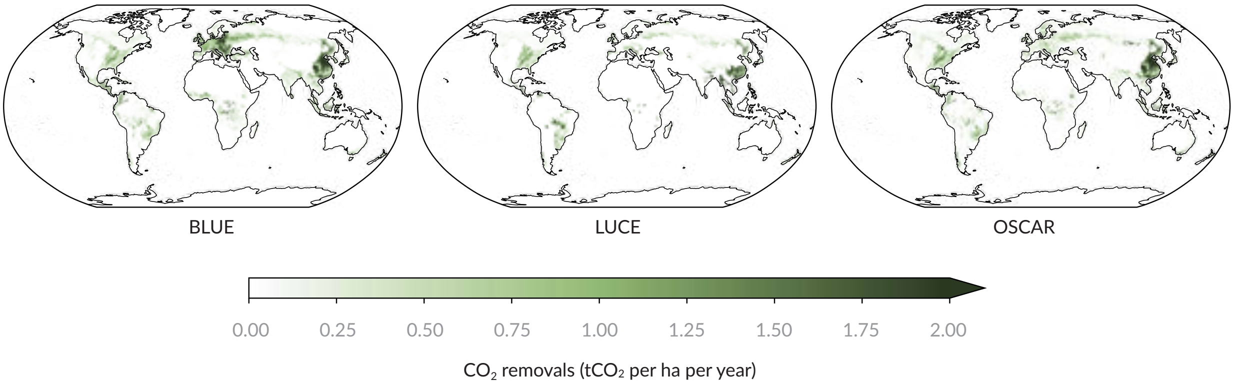
Within the CO_2 fluxes associated with afforestation & reforestation, we include fluxes from expansion of forest area due to active planting and due to (re-)growth after abandonment of agricultural land, but we exclude fluxes from (re-)growth of forest after natural disturbances (because this is not directly attributable to human activity). We also exclude short-term removals from shifting cultivation (non-permanent reforestation as part of rotational agriculture – a cultivation practice found mostly in tropical areas) and from (re-)growth after wood harvesting (because this does not imply a change in forest cover – although the harvested wood can represent a carbon transfer as part of other CDR methods; see “Transfers between durable carbon pools” below).

The map of CDR through afforestation & reforestation shown in Figure 7.1 is based on the average of the three bookkeeping models BLUE, LUCE and OSCAR. Figure A7.1 shows the multi-model mean (as in Figure 7.1) and additionally the individual estimates of BLUE, LUCE and OSCAR.

CDR through afforestation and reforestation



Multi-model mean



BLUE

LUCE

OSCAR

Figure A7.1 *Global maps of CO_2 removals due to afforestation & reforestation. The top map shows the multi-model mean of the three bookkeeping models BLUE, LUCE, and OSCAR, and the bottom maps their individual estimates. BLUE and LUCE provide spatially explicit data, whereas OSCAR provides data at the country level. The OSCAR data have, therefore, been spatially distributed based on the CDR patterns of BLUE: for each country, the spatial pattern of the CDR flux density (i.e. flux per grid cell area) in BLUE is used, and the pattern is scaled such that the countrywide CDR estimate matches the OSCAR CDR estimate in the respective country (see Schwingshackl et al., 2022[5], for details).*

National greenhouse gas inventories (NGHGIs)

NGHGIs submitted by countries to the UNFCCC are typically based on direct observations, which cannot fully distinguish the CO_2 sink attributable to direct human activities from that attributable to indirect effects (occurring as a response to changes in environmental conditions). To address this challenge, the IPCC guidelines for NGHGIs[6,7] proposed the concept of "managed land" as a basis for reporting human-caused emissions and removals. Managed land is land where human interventions and practices have been applied to perform productive, ecological or social functions. In most NGHGI submissions by countries, emissions and removals within managed land include both direct human-induced effects and indirect human-induced effects. Globally, about 80% of the total forest area is reported as managed forest land in NGHGIs[8]. Only a relatively small expansion of managed forest has occurred since the 1990s, mostly in Brazil (expansion of protected indigenous land area) and the Russian Federation (expansion of fire protection activities). According to the IPCC guidelines for NGHGIs, it is good practice to describe the processes that led to re-categorization when moving previously unmanaged land to the managed land category. In other words, countries should not move lands in their NGHGI categories without evidence of an actual change in the status of the land.

Given the above, estimates of CDR that draw on NGHGIs can only be made by applying additional modelling. The estimation method used for this report inverts the approach used in Grassi et al. 2023[9] and subtracts the modelled "natural CO_2 sink" (result of indirectly human-induced environmental changes in managed forest areas, estimated by dynamic global vegetation models, DGVMs) from the CO_2 fluxes reported in NGHGIs under the 'managed forest land' category. In theory, this approach captures CDR not only from afforestation and reforestation (new forest), but also due to improved forest management (already existing forest). The NGHGI data used in this report can be visualized for each country in the JRC LULUCF data hub (https://forest-observatory.ec.europa.eu/carbon/fluxes), and the methodology for the collection and processing is described by Melo et al. 2026[8]. The natural CO_2 sink in managed forest is estimated using data from the ca. 20 DGVMs used in the latest GCB[10], filtered for the area of managed forest, which is estimated based on country information or through proxies[9,11]. In this report, we consider only those countries where the difference between the sink in managed forest land in NGHGIs and the natural sink from DGVMs (filtered for the area of managed forest) is a net removal based on the 2014-2023 average. We exclude countries where this difference results in net CO_2 emissions, which we interpret as processes like forest degradation, incompatible with CDR. From the removals of 6,000 $MtCO_2$ in managed forests, 2,100 $MtCO_2$ are attributed to CDR (Figure A7.2 and Figure A7.3, top panel).

The estimate of CDR in managed forests derived from the NGHGIs depends on assumptions that are made in the process of taking out the natural fluxes on managed land. Given the large uncertainty of these assumptions, in this report we provide only a global value of forest CDR derived from the NGHGIs, but no country-specific values. Furthermore, since NGHGIs use periodic observations (which smooth interannual variability) while DGVMs are climate-sensitive (thus showing a marked interannual variability), also the adjusted NGHGIs show a strong interannual variability (Figure A7.3, bottom panel). Since this variability reflects the calculation methodology rather than a genuine variability of CDR activities, in the main text we consider it more appropriate to show the decadal average rather than the yearly estimates.

We provide an uncertainty estimate for CDR in managed forests based on a combination of the uncertainties for the NGHGIs and the DGVMs. The NGHGI uncertainty is estimated as in Grassi et al. 2017[12]. The DGVM uncertainty is based on the uncertainty value for the natural land sink provided by the GCB 2025[10], scaled to the non-intact forest sink.

As complementary information, we also provide global estimates for the NGHGI category “land converted to forest”, which contains all CO_2 fluxes in the first 20 years after land conversion to forest (note that this category is not available for all countries). Broadly speaking, this category can be fully attributed to direct human activity and thus qualifies as CDR (see figure A7.2) although any removals occurring more than 20 years after land conversion are not tracked. In contrast, only a fraction of the large carbon sink in pre-existing forests could be classified as CDR (e.g., through improved forest management) but cannot be isolated or tracked within NGHGIs. Its identification requires the adjustment with DGVMs as described above.

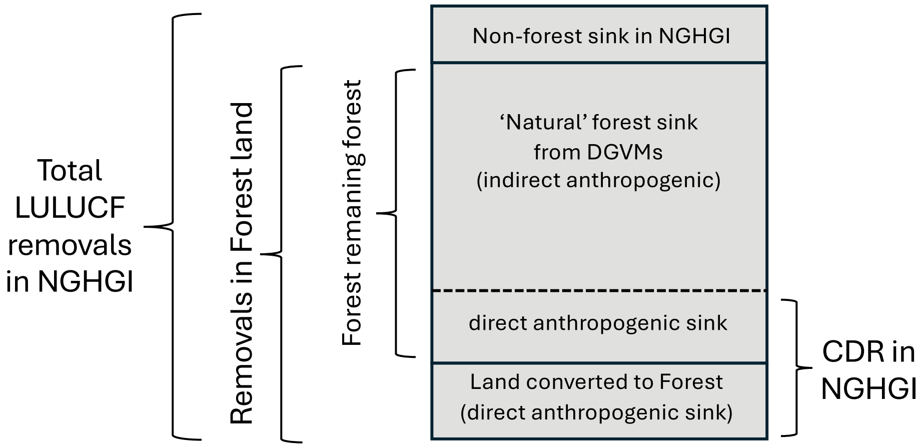
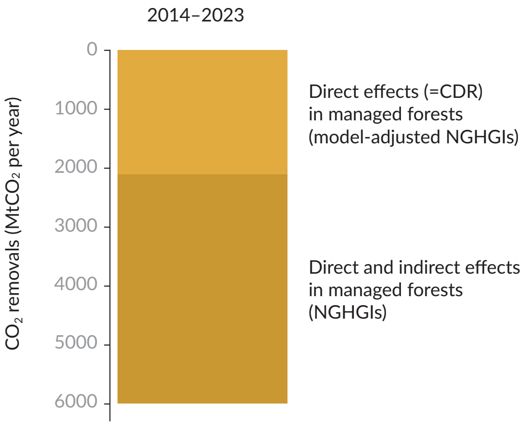


Figure A7.2 *Conceptual illustration of how conventional CDR is estimated from NGHGIs.*



CDR in managed forests according to NGHGIs

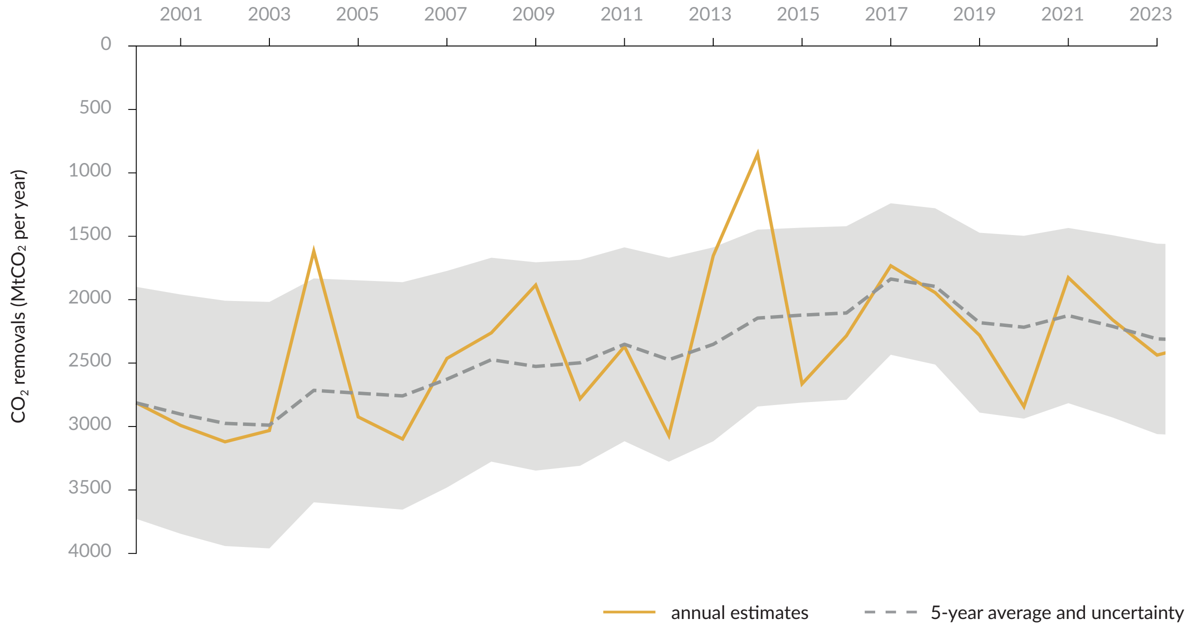


Figure A7.3 *Estimated global net CO_2 sink in managed forests from NGHGIs excluding emissions from organic soils and harvested wood products. Top: global total averaged over 2014-2023. Bottom: time series during 2001-2023 for direct effects only. Following this methodology, the fluxes directly attributable to land-use activities ("direct effects", which is CDR as per the definition used in this report; green-hatched area in top panel) only account for about 35% of the total average NGHGI CO_2 sink in managed forests reported by countries (dark-green area). Countries' reported estimates include natural fluxes in response to environmental changes, as well as fluxes directly attributable to human land-use activities. Data in this graph include only those countries where the difference between the NGHGI forest sink and the DGVM-derived sink in managed forests is negative (which is considered here as CDR; see Chapter 7) for the period 2014-2023.*

Overall, the NGHGI-based estimation of conventional CDR from forest land is likely more uncertain for the past (Chapter 7) than for the future (Chapter 9, in which Nationally Determined Commitments, or NDCs, are discussed). This is because the subtraction of the indirect anthropogenic sink estimated by DGVMs involves high uncertainties. The approach followed to identify land-related CDR in NDCs is different. Specifically, Chapter 9 uses country-specific information on planned activities leading to additional removals – which therefore qualify as CDR. In the absence of such information, Chapter 9 takes the difference between the total projected LULUCF removals indicated in the NDC (or estimated using the net LULUCF flux in the NDC and the average proportion of removals in the net LULUCF flux of the NGHGI) and the total historical LULUCF removals in the NGHGI. This difference is assumed to reflect fully a direct anthropogenic contribution, and thus qualifies as CDR. Therefore, in estimating forest-based CDR from NDCs there is no need to make the rather uncertain subtraction (using DGVM data) that is needed for NGHGIs.

Bookkeeping models and NGHGIs include CO_2 fluxes from indirect effects to varying degrees. Figure A7.4 conceptually summarizes how the evolution of forest carbon density over multiple afforestation–clearing cycles differs between NGHGI and bookkeeping models. All bookkeeping models used in the current report consider transient environmental conditions to estimate CDR through afforestation & reforestation. When a new forest is established, the maximum carbon density of that forest is determined by the environmental conditions prevailing at the beginning of the (re-)growth.[10,13] Any additional carbon uptake due to subsequent changes in environmental conditions which is reflected in NGHGIs, see below) is not considered as CDR in bookkeeping models. Two out of three bookkeeping estimates of CDR through afforestation & reforestation in *The State of CDR* 2nd Edition were based on fixed environmental effects, assuming environmental conditions of the 1980s or 2010s[14,15]. In contrast, NGHGI estimates consider most or all indirect human-induced environmental effects, including also environmental changes after the beginning of the (re-) growth. Thus, forests in NGHGIs typically reach larger carbon densities than in BMs.

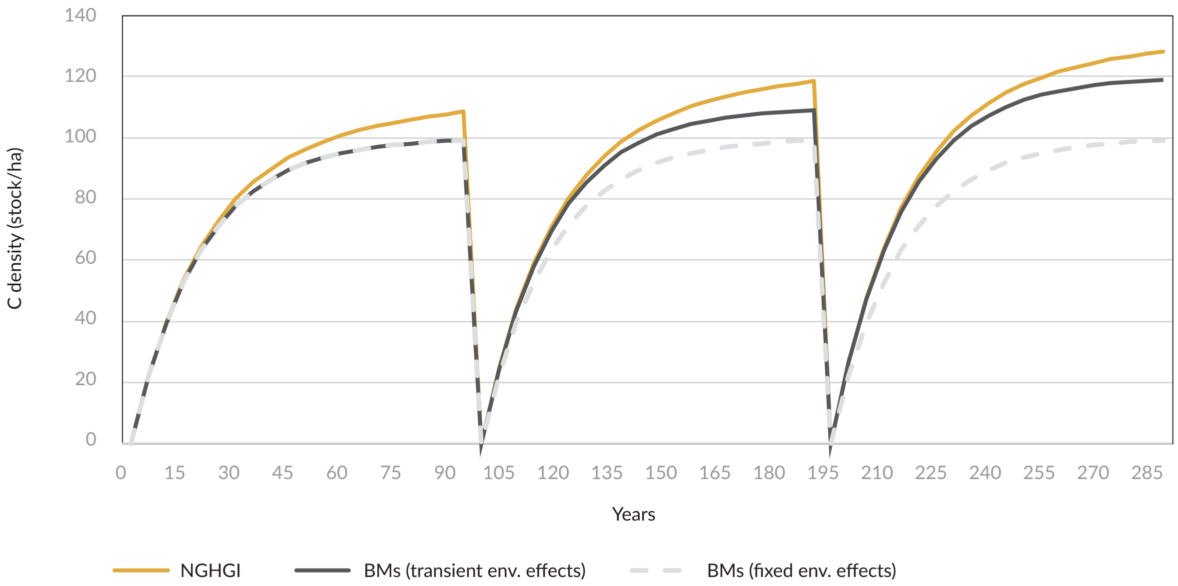


Figure A7.4 *Conceptual illustration of how differences in the consideration of indirect environmental effects changes the carbon density evolution for subsequent afforestation–clearing cycles. NGHGI (not adjusted) includes most or all indirect human-induced environmental effects (red line); two out of three bookkeeping models used in The State of CDR report 2nd Edition assumed fixed environmental conditions of the 1980s or 2010s (dashed light-blue line), and the updated bookkeeping approach used in the current report considers transient environmental effects prevailing at the time the new forests are established (blue line).*

Estimating CDR levels from novel methods

Biochar

A global biochar stakeholder survey was conducted over six weeks (November to December 2025), in collaboration with the International Biochar Initiative and the United States Biochar Initiative and facilitated by CTRS Market Intelligence. An initial email campaign reached approximately 24,000 contacts, yielding 1,237 partial and complete responses. The survey targeted biochar producers, users, equipment manufacturers and researchers, gathering information on biomass cultivation, location, biomass types, pyrolysis technologies, production volumes, application types and planned production and use through 2030 and 2050. We included production values from a late respondent to better reflect overall activity, increasing the total commercial output by 70,000 tonnes.

The campaign aimed to maximise coverage via email distribution through mailing lists and was supplemented by a social media campaign. Nevertheless, survey coverage is inherently incomplete, particularly given the widespread production and use of biochar by smallholder farmers, many of whom are unlikely to be captured through these channels. As a result, production and use are likely to be underreported, and the resulting CDR estimates should be interpreted as conservative. To assess what proportion of the 1.47 $MtCO_2$ from biochar

CDR estimated for 2025 reflects genuine increases in biochar production versus improved survey coverage, we compared key parameters from the 2023 and 2025 surveys. In 2025, producers reported their 2023 production, enabling comparison with the production for 2023 reported in the earlier survey. While a similar number of producers responded in both years, reported 2023 production was lower in the 2025 survey (Table A7.1). Because broader survey coverage would be expected to increase, rather than decrease, the estimated production for a given year, this pattern may suggest that the 1.47 $MtCO_2$ estimate for 2025 primarily reflects real growth in biochar production rather than improved survey coverage.

	Results from 2023 survey	Results from 2025 survey
Quantity of biochar produced in 2023 (t biochar)	352,304 tonnes	179, 749 tonnes
Number of respondents (producers)	309 (1,007 respondents total)	290 (1,256 respondents total)
2023 CDR estimate ($MtCO_2$)	0.79	0.49

Table A7.1 *Respondents to the 2025 Global Biochar Market Survey were asked to report their biochar production in 2023, enabling comparison with 2023 estimates derived from an earlier survey in 2023, and assessment of differences arising from survey coverage and respondent pools. CDR is calculated by splitting into biomass type, assuming producers used same feedstock for biochar in 2023 as they did in 2025.*

Calculating CDR from biochar production

Calculations for annual CDR from biochar are based on the total biochar produced each year, and account for carbon content of biochar, as well as any CO_2 re-release from the decay of biochar produced in previous years. CO_2 stored from newly produced biochar is estimated following Woolf et al. 2021[16] and registry protocols according to:

$$CO_{2\,(stored)}(t) = C_{\text{biochar}} * m_{biochar} * F_{durable}(t) * 44.01/12.01$$

Where $m_{biochar}$ is the amount of biochar produced (tonnes), $F_{durable}$ is the fraction of durable biochar remaining after time t (in years), $C_{biochar}$ is the average biochar carbon content, and 44.01/12.01 converts mass of C into mass of CO_2.

$C_{biochar}$ can be measured directly or estimated based on biomass type and pyrolysis conditions[16]. Here, respondents reported biomass type, allowing biochar produced to be grouped into 13 feedstock categories (Figure A7.5). Reliable information on pyrolysis temperature was unavailable, but Woolf et al., 2021[16] reports that sensitivity of $C_{biochar}$ to temperature is relatively low. Consistent with IPCC guidelines[7], we therefore apply average $C_{biochar}$ values by biomass type. To capture potential variability in $C_{biochar}$, we compiled biochar C content data for each biomass type from multiple sources, including the UC Davis Biochar Database[17], restricting compiled values to those of biochar produced within the typical commercial pyrolysis temperature range of 500-650°C. From these values, we calculated the mean and standard deviation of $C_{biochar}$ for each feedstock type (Table A7.2). The mean values were used to estimate $CO_{2\ (stored)}$ (tonnes), while the standard deviation was propagated as uncertainty.

Biomass type	**Average C content**	**Uncertainty (standard deviation)**
Woody biomass	0.816	0.116
Agricultural processing byproducts (e.g. coconut shells, bagasse, corn cobs, nut shells, etc.)	0.755	0.054
In-field agricultural crop residues (e.g. straw, corn stover, orchard trimmings)	0.642	0.104
Purpose-grown crops (e.g. bamboo, switchgrass, roundwood, etc.)	0.663	0.019
Urban green wastes (e.g, branches, leaves, wastes)	0.730	0.127
Food waste	0.536	0.142
Municipal solid waste (organic fraction)	0.625	0.066
Manure – cow	0.538	0.179
Manure- chicken	0.275	0.088
Manure - pig	0.427	0.082
Biosolids	0.213	0.053
Aquatic biomass (e.g. seaweed, algae)	0.728	0.155

Table A7.2 *Average C contents for each feedstock type as collected from literature survey and the UC Davis Biochar Database*[17]. **For other, we use closest biomass type to details provided by respondent.*

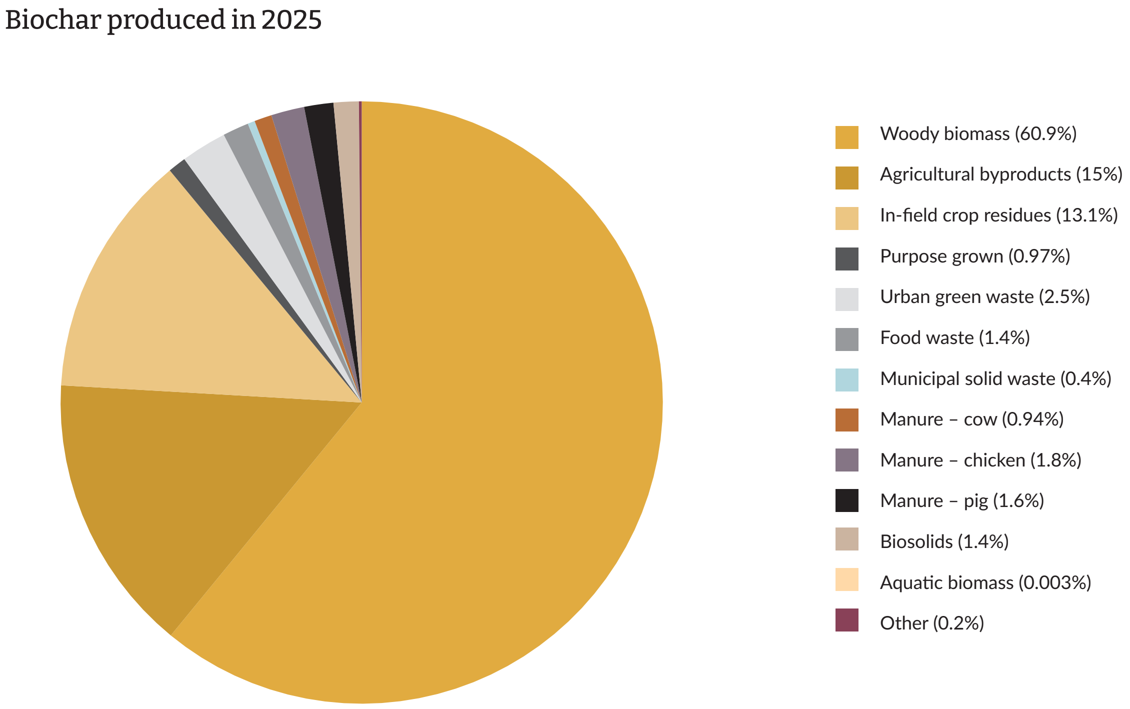


Figure A7.5 *Breakdown of biomass types used for global biochar production (2025). Data collected from biochar producers (commercial and non-commercial) in the 2025 Biochar Stakeholder Survey.*

In the year of biomass production, $F_{durable} = 1$. For subsequent years, $F_{durable}(t)$ is calculated to account for year-on-year C loss through biochar decay. Biochar decay rates depend on the pyrolysis temperature, the temperature of the soil at application and feedstock type and can be derived using calculations given in Woolf et al. 2021[16].

Because pyrolysis temperature was not reported by survey respondents, this introduces uncertainty into the estimation of $F_{durable}(t)$. To address this, we adopt a conservative assumption of low-temperature pyrolysis conditions, which correspond to higher decay rates.

Soil temperature strongly influences biochar decay rates. We used regionally specific mean soil temperatures (0-7 cm depth) and standard deviations from the Copernicus Climate reanalysis dataset ERA5, employing monthly averaged data on single levels from 1940 to present[18]. Country-level values were calculated by spatially averaging grid cells within national boundaries using country shapefiles from the Database of Global Administrative Areas (GADM)[19].

For some countries, full national averages may not reflect temperatures relevant to biochar deployment. In Canada, extensive permafrost lowers the national mean; therefore, we only extracted temperatures from southern Canada (below 60°N) to exclude tundra regions. For the United States, we used contiguous US (CONUS) averages, which excludes Alaska and some non-continental territories. For Russia, land north of 60°N was excluded to remove Arctic and permafrost-dominated regions. These adjustments increase annual mean soil temperatures by approximately 5°C (Canada), 3°C (United States) and 7°C (Russia), which provide values more representative of regions of likely biochar deployment. For each country, the standard deviation of the mean temperature is used to quantify uncertainty in the F_{durable} (t) parameter. Sequential year-on-year C loss for the biochar produced via each survey respondent was then determined by applying each year's decay fraction to the remaining biochar from previous years, accounting for cumulative decay over time.

Uncertainty in cumulative CO_2 loss due to biochar decay is relatively high, with estimated re-release in 2025 of 0.008 Mt CO_2 (+/- 0.0011 Mt CO_2). This uncertainty arises primarily from the variability of soil temperatures across large areas. Nevertheless, this loss is still very small relative to the total CDR achieved through biochar deployment (1.46 MtCO_2, ~0.5% of total CDR), indicating that over short timescales (0-6 years, the maximum age of deployed biochar in our study), decay has a minimal impact on overall CDR. However, as C loss through decay increases with years following deployment, future editions using this analysis should aim to reduce this uncertainty through improved reporting of pyrolysis conditions and more spatially resolved application data.

We include biochar derived from all biomass types in our total estimate for CDR from biochar (i.e. Figure 7.2). However, biochar produced from wood-based feedstocks reflects a transfer of CO_2 between durable reservoirs. We therefore also present the total transfer into biochar in Section 7.4 and Figure 7.3.

BECCS, DACCS and other novel methods

Our estimate of CDR deployment for all other novel methods beyond biochar was derived from a review of databases including the International Energy Agency[20] (IEA), CDR.fyi[21], Mission Innovation[22], and registries like Isometric[23] and Puro.earth[24]. Using these sources, we compiled a list of active companies. Our aim was to then collate project-level CDR estimates with traceable supporting information.

For companies listed on registries, we compiled project-level gross and net CDR from publicly available documentation and applied any reported uncertainty discounts (e.g. for downstream CO_2 losses or measurement uncertainty) by subtracting these from gross values. Where reporting periods spanned multiple calendar years, CDR was apportioned by the ratio of months for each year, under the assumption of uniform removal over the reporting period. Because registry data are sometimes published with a time lag, not all 2025 removals have been uploaded at the time of data collection, which concluded in the first week of February. Therefore, reported 2025 values may be subject to minor subsequent revision.

For active projects not listed on registries, we use the annual delivered CDR reported in CDR.fyi, which represent net values. No adjustment was made to estimate gross CDR, as this would introduce significant uncertainty and reduce traceability. Consequently, CDR compiled from projects not listed within registries is likely to be underestimated.

We subsequently conducted a joint survey with CDR.fyi to (i) identify any active companies not captured in our dataset, (ii) validate our CDR estimates and ask for documentation if possible, and (iii) assess company deployment ambitions for 2030 and 2050 (see Chapter 3). The survey was distributed via email to over 400 suppliers listed on the CDR.fyi portal and supplemented with a social media campaign. We asked respondents to report their CDR for 2025 and to clarify whether these were gross or net values. The BECCS estimate includes three facilities Blue Flint Ethanol Facility, the Illinois Decatur ADM facility, and Gevo (formally Red Trail Energy). The first two rely on data sources outside of registries and CDR.fyi, as they conduct insetting rather than offsetting activity. For the Blue Flint Ethanol facility, monthly CO_2 injection data was obtained from North Dakota Department of Mineral Resources[25]. For the Illinois Decatur ADM facility, the 2024 value includes CO_2 captured prior to October 2024, when injection was paused following detected fluid migration. In the absence of documentation, we estimate total CDR based on the facility's annual rate (0.428 $MtCO_2$ per year), scaled to 9/12 of the year. For 2025, no CDR was assumed from January to September. Following public announcements of resumed injection in September 2024, removals were assumed to resume at capacity and scaled to 3/12 of the year.

Consistent with our aim of compiling project-level CDR estimates with verifiable sources, the values we report include only projects with CDR data published online in registries, CDR.fyi, or government databases. For instance, although many direct air capture facilities operate globally, we include only those where captured CO_2 is demonstrably delivered to durable storage. Facilities in testing phase, using CO_2 for non-durable applications (e.g. EOR, greenhouses), lacking a confirmed storage site, or facilities with estimates based solely on company announcements were excluded, as these typically report capacity rather than realised removals. When only capacity data was available, we describe these projects in the text. Similarly, survey data obtained jointly with CDR.fyi that could not be independently traced to public sources were not included in the estimates but are noted in the discussion.

We feel that this approach prioritises transparency and conservatism. We encourage novel CDR companies to publish project-level data online via registries, CDR.fyi or other open online sources to enable robust long-term tracking of CDR deployment.

Transfers between durable carbon pools

We consider that forest management contributes to CDR when biomass is transferred to durable product pools via harvested wood products (HWP). We take data from the FAOSTAT (2025) Forest Product Statistics database[26], counting only the categories “sawnwood” and “wood-based panels” as being durable enough to count as CDR. We convert the volume of harvested wood into tonnes of CO_2 following the tier 2 methodology in the IPCC Guidelines for NGHGIs[7]. According to the IPCC’s recommended conversion factors, sawnwood has a carbon fraction equal to 0.5 and a density of 0.45 tonnes per cubic metre for coniferous species and 0.56 tonnes per cubic metre for non-coniferous species; wood-based panels have a carbon fraction equal to 0.454 and a density of 0.595 tonnes per cubic metre. Using the FAOSTAT global volume of sawnwood and wood-based panels is more complete than countries’ HWP data in NGHGIs, which do not account fully for international trade (IPCC 2019[7]). Since even durable wood products decay over time, some of the carbon stored in HWPs is returned to the atmosphere each year. We provide year-on-year estimates for (i) the carbon transferred to durable products and (ii) the carbon actually stored in the HWP pool. For (ii), the carbon stock at the beginning of the data series (1900) is assumed to be in steady state. The inflow is defined by the annual production equal to (i), and the outflow is determined through a first order decay function, using the default IPCC half-life coefficients, equal to 35 and 25 years for sawnwood and wood-based panels, respectively[7]. The total HWP net carbon ‘sink’ (i.e. increase in HWP carbon storage) is equal to the sum of the annual carbon stock changes of sawnwood and wood-based panels.

CDR deployment pipeline

Our CDR deployment pipeline estimates aim to provide a cautious assessment of near-term CDR and include only additional removals which are likely to occur. For conventional CDR, no quantitative pipeline estimate is provided. The reason is that pipeline indicators for conventional CDR (mainly afforestation and reforestation) are typically expressed as pledged land area or policy targets rather than amounts of CO_2 removals. Given variability in implementation timing and reporting practices, pledged areas cannot be consistently converted into near-term additional removal estimates. The pipeline assessment therefore does not derive numerical forecasts for conventional CDR and instead discusses reported commitments qualitatively.

For BECCS and DACCS, we count new projects only if they are under construction, while assuming existing facilities scale to expected capacity. Estimates are based on IEA-announced capacities and therefore subject to uncertainty.

For biochar, we assess upscaling plans only for companies reporting removals on registries with publicly available documentation to substantiate their pipeline estimates. This likely excludes several companies, particularly as those registered with Isometric tend to provide these estimates within the documentation, whereas those registered with Puro.earth generally do not disclose comparable figures. Our estimates are therefore conservative but provide a minimum indication of the near-term pipeline.

For enhanced weathering, the time lag between rock application and weathering means that most companies can expect more CDR from deployments where rock was already applied. We estimated the remaining CDR from rock already applied by companies with registry documentation. Where projects reported short-term CDR estimates directly, we used those values. Otherwise, we derived estimates from the information provided in company online documentation, including (1) rock application rates and area covered, (2) expected CO_2 removal per tonne of rock (which varies depending on rock type; e.g. olivine ~0.8 tCO_2/t rock, basalt ~0.2-0.3 t CO_2/t rock[27], or (3) assumed CDR per hectare per year. We then subtracted the CDR already achieved (Section 7.3) to calculate the remaining possible CDR allowance for each project. These estimates assume that weathering will proceed as projected and are therefore subject to uncertainty. Only projects listed in registries were included, and therefore additional undeclared rock application activities likely exist.

Box 7.1 Points of departure from ***The State of CDR 2nd Edition***

Compared to the 2nd Edition, several methodological refinements have been introduced in the estimation of CDR. These include:

- Bookkeeping models now use transient environmental conditions (e.g. better vegetation growth due to higher atmospheric CO_2 concentration) to quantify CO_2 uptake from reforestation and afforestation, replacing the assumptions of fixed environmental conditions used previously. Carbon uptake is estimated based on the environmental conditions at the time of forest establishment, while additional uptake driven by subsequent environmental changes is not attributed to CDR. This improves consistency with the definition of direct anthropogenic removal and aligns the approach with the Global Carbon Budget 2025.[10]

- Bookkeeping estimates use the latest updates in land-use datasets consistent with the Global Carbon Budget 2025.[10]

- The bookkeeping model ensemble has been revised, replacing the H&C2023 model with the LUCE model, which better reflects recent developments in bookkeeping modelling, including the representation of transient environmental conditions and updated data coverage. Estimates based on NGHGI data have been updated using the latest reported data, including the first reporting under the Paris Agreement's Enhanced Transparency Framework, and further refined through improved harmonization with an updated DGVMs ensemble to better separate direct anthropogenic removals from indirect environmental effects at global level.

- This report uses revised data and accounting approaches for harvested wood products (including decay dynamics and conversion factors), as well as a more recent averaging period (2014–2023) to reduce artefacts arising from interannual variability and reporting differences.

- We updated our methodology for biochar accounting in partnership with the International Biochar Initiative and the United States Biochar Initiative through a new global survey. This edition incorporates feedstock carbon content variability and includes uncertainty analysis and potential for CO_2 release from biochar decay.

- We have updated our approach to accounting for novel CDR. Between 2024-2025, more companies have begun registering their projects and certifying CDR through established protocols, such as Isometric's standards for enhanced weathering, DACCS, OAE, etc. For companies reporting under these frameworks, audit documents now allow us the most accurate method of carbon accounting available, despite some remaining methodological assumptions within the protocols (e.g., estimating downstream loses in enhanced weathering). As data becomes more accurate and transparent, we may see an initial shift to lower CDR values, which does not necessarily imply reduction in activity.

- In this edition, we estimate the likely lower-bound pipeline CDR achievable between 2026-2030, based only on projects already operating or under construction. This provides a realistic benchmark for near-term delivery that can be directly compared with the higher stated ambitions outlined in Chapter 3.

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