

# Carbon Storage Modeling in EPDs

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## Climate change and carbon storage

Man-made climate change is an issue, caused by anthropogenic carbon emissions. One of many approaches to fight climate change is to store carbon, typically removed from the atmosphere or trapped and not released to the atmosphere. A step further are concepts where carbon is bound in a product that is used afterwards; this is typically called carbon capture and utilization (in contrast to a “passive” storage)<sup>1</sup>.

Projects are ongoing to investigate, refine and implement technologies for carbon capture, storage, and utilization. These projects are often publicly funded, due to the great public interest in further developing these technologies and to „combat“ climate change<sup>2, 3, 4</sup>.

A product that stores carbon in this sense fits into this narrative, and is for that reason interesting. Evidently, climate change is only one of the potential impacts of a product, and thus it makes a lot of sense to investigate the overall impacts of this product for the environment, in a holistic, harmonised and standardised assessment as is supposedly provided by an Environmental Product Declaration, EPD.

## Biogenic carbon and EPDs

In order to create an EPD, Product Category Rules (PCRs) for the respective product group need to be followed. These rules are developed under the auspices of EPD program operators, in line with ISO 14025 and other standards and norms, for construction products in Europe for example EN15804.

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<sup>1</sup> <https://www.iea.org/data-and-statistics/data-product/ccus-projects-database>

<sup>2</sup> <https://www.globalccsinstitute.com/wp-content/uploads/2025/10/Global-Status-of-CCS-2025-report-9-October.pdf>

<sup>3</sup> <https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/projects-details/43251567/101146854/CEF2027>

<sup>4</sup>

[https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2025/ENTRANS/EnTrans\\_FACTSHEET\\_INCENTIVE\\_SYSTEMS\\_FOR\\_CARON\\_CAPTURE\\_UTILISATION\\_STORAGE.pdf](https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2025/ENTRANS/EnTrans_FACTSHEET_INCENTIVE_SYSTEMS_FOR_CARON_CAPTURE_UTILISATION_STORAGE.pdf)

For example, for a product with biochar, Clim@Add®, using EPD international as the largest EPD program operator worldwide<sup>5</sup>, the applicable PCR is the construction product PCR in most recent version 2.0.1<sup>6</sup>. This PCR contains also rules for the modeling of carbon and especially of biogenic carbon over the life cycle:

## ANNEX 2: GUIDANCE TO CALCULATING GWP-BIOGENIC

This annex explains and illustrates the basic principles of collecting, reporting, and balancing the mass of biogenic carbon and calculating the GWP-biogenic results. The principles are based on EN 15804:2012+2019:A2/AC:2021.

Generally, the LCI shall separate between fossil and biogenic carbon (typically as biogenic CO<sub>2</sub>, biogenic CH<sub>4</sub>, etc). Furthermore, the LCI shall report GHG emissions that arise from land use or land-use change separately, which are neither included in the GWP-fossil or GWP-biogenic results, but in the GWP-luluc results, to avoid double accounting.

The amount of biogenic carbon is an inherent material property, which sometimes is not included, or correctly accounted for, in secondary datasets available in LCA software.<sup>110</sup> Therefore, the amount of biogenic carbon in the product or the packaging – which is needed to correctly calculate the GWP-biogenic results and account for the content declaration – may have to be checked and added manually.

If there is a biogenic CO<sub>2</sub> emission that is not from the burning or degradation of the product or its packaging, the initial uptake of this biogenic carbon shall be reported in the module where the emission occurs. This means that such emissions and uptakes will be balanced out in each individual module. When calculating the GWP-biogenic results, an emission of biogenic CO<sub>2</sub> and its uptake can therefore be set to zero for all flows that do not end up as content of the product or the packaging. Note that this concerns when the biogenic carbon is emitted as CO<sub>2</sub>; if the biogenic carbon uptake is instead, for example, released as CH<sub>4</sub>, the GWP-biogenic results will not be zero in each individual module, unless a conservative estimate is done (see example in Table 12).

In case the biogenic carbon ends up as product or packaging content, the biogenic CO<sub>2</sub> emissions of incinerating or degrading this carbon will then appear in life-cycle stage C (for product content) or in module A5 (for packaging content)<sup>111</sup>. If the biogenic carbon content of the product is not incinerated at end-of-life, for example because the carbon is permanently stored in the product (for more than 100 years) or because the carbon leaves the product system for reuse or recycling into a new product, a virtual emission of biogenic CO<sub>2</sub> shall be added to the module from which the carbon leaves the studied product system, which most often is life-cycle stage C (similarly an uptake of biogenic CO<sub>2</sub> shall be added in, e.g., module A1 if recycled/reused biogenic carbon is used as an input). Thus EN 15804 and this PCR do not allow credits due to delayed emissions or permanent storage of biogenic carbon (see Section 5.4.2 of EN 15804).<sup>112, 113</sup> In the end, the sum of the sequestered biogenic carbon and the biogenic carbon emitted or leaving the product system in any other way during the product life cycle shall always be zero.<sup>114, 115</sup> Related, note that biogenic carbon that ends up in product or packaging shall be separately declared in the content declaration, unless it is less than 5% of the mass of the product or the packaging, respectively (see Section 6.4.5 of this PCR and Section 6.4.4 of EN 15804).

(PCR 2.0.1, screenshot with highlights by author).

Note that the PCR does not define biogenic carbon, but requests that “generally [...] the LCI (so the inventory) shall separate between fossil and biogenic carbon”. Overall, “the sum of the sequestered biogenic carbon and the biogenic carbon emitted or leaving the product system in any other way during the product life cycle shall always be zero.” Also “sequestered” is not defined in the PCR, unfortunately. “Generally” and “shall” in the same sentence are somewhat contradictory, evidently.

The PCR makes it clear though that also products that store carbon for more than 100 years need to obey this rule. The EN15804+A2 norm contains a similar rule, in section 5.4.3 (not 5.4.2 as the PCR states): “The effect of permanent biogenic carbon storage shall also not be included in the calculation of the GWP”. The question is of course why,

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<sup>5</sup> <https://www.eco-platform.org/the-eco-epd-programs.html>

<sup>6</sup> PCR 2019:14 VERSION 2.0.1 VALID UNTIL: 2030-04-07,

<https://api.environdec.com/api/v2/EPDLibrary/Files/7c2cae37-dcoa-4734-9cd6-o8dda4d191db/Data>

and a further question is how sequestered carbon and how biogenic carbon are to be understood here.

## Biogenic carbon

The EN15804 and the PCR on construction products do not define biogenic carbon. There is an “EN 16449, Wood and wood-based products — Calculation of the biogenic carbon content of wood and conversion” which allows to interpret how biogenic carbon is understood. A clear definition is provided by IPCC<sup>7</sup>:

“Biogenic carbon [is] Carbon derived from biogenic (plant or animal) sources excluding fossil carbon. Note that peat is treated as a fossil carbon in these guidelines as it takes so long to replace harvested peat.”

According to this definition, carbon is biogenic if it once was derived from biogenic sources. Strictly speaking, all carbon has once been derived from biogenic sources, also crude oil or coal, but long time ago<sup>8</sup>. The definition mentions the exception of peat, which grows so slowly that carbon from peat cannot be considered organic. Peat grows about 0.5 to 1 mm per year<sup>9</sup>, meaning that on an (arbitrary) area of 1 m<sup>2</sup>, 1 m<sup>3</sup> takes 1000 years. From that it can be concluded that carbon contained in fossil fuel sources is not considered biogenic as the uptake took place very long time ago.

The PCR contains a strict rule that biogenic carbon aggregated over the life cycle of a product must be zero. A carbon uptake gets a negative sign, a carbon release is associated with a positive sign, the sum must be zero:

“In the end, the sum of the sequestered biogenic carbon and the biogenic carbon emitted or leaving the product system in any other way during the product life cycle shall always be zero.”

The IPCC definition does not address the case where biogenic carbon is stored in a product or reservoir for long time, so the reverse case of peat. It thus does not address carbon capture and storage, or utilization. This allows the conclusion that for the PCR, biogenic carbon that is captured and stored long term (e.g. > 1000 years) or even

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<sup>7</sup> [https://www.ipcc.ch/site/assets/uploads/2019/12/19R\\_V0\\_02\\_Glossary.pdf](https://www.ipcc.ch/site/assets/uploads/2019/12/19R_V0_02_Glossary.pdf); and fossil carbon being defined as “Carbon derived from fossil fuel or other fossil source.”, and fossil not defined in this source.

<sup>8</sup> E.g. <https://science.nasa.gov/earth/earth-observatory/the-carbon-cycle/>

<sup>9</sup> Keddy, P.A. 2010. Wetland Ecology: Principles and Conservation (2nd edition). Cambridge University Press, UK. Cambridge. 497 p. Chapter 7.

utilized is still biogenic carbon. The PCR even contains a sentence that suggests this, explicitly:

“If the biogenic carbon content of the product is [...] permanently stored in the product (for more than 100 years) [...], a virtual emission of biogenic CO<sub>2</sub> shall be added to the module from which the carbon leaves the studied product system, which most often is life-cycle stage C [...]”.

However, here again, the language is not really clear, as it does not address cases in which the biogenic carbon that is contained in the product does not leave the product system. Or, it does not address these cases, and thus there is no need to add a virtual biogenic C emission flow if the carbon does not leave the product system. Admittedly, this is quite a contradiction to the cited general rule, and thus it would be nice or even expected if this “other case” (carbon does not leave the product system) was explicitly mentioned. So it is not entirely clear whether this additional case (carbon does not leave the product system and thus no virtual emission needs to be modeled) is indeed foreseen as an option, or was rather forgotten when formulating the PCR and the standard. Overall, there are four cases. These are illustrated in fig. 1.

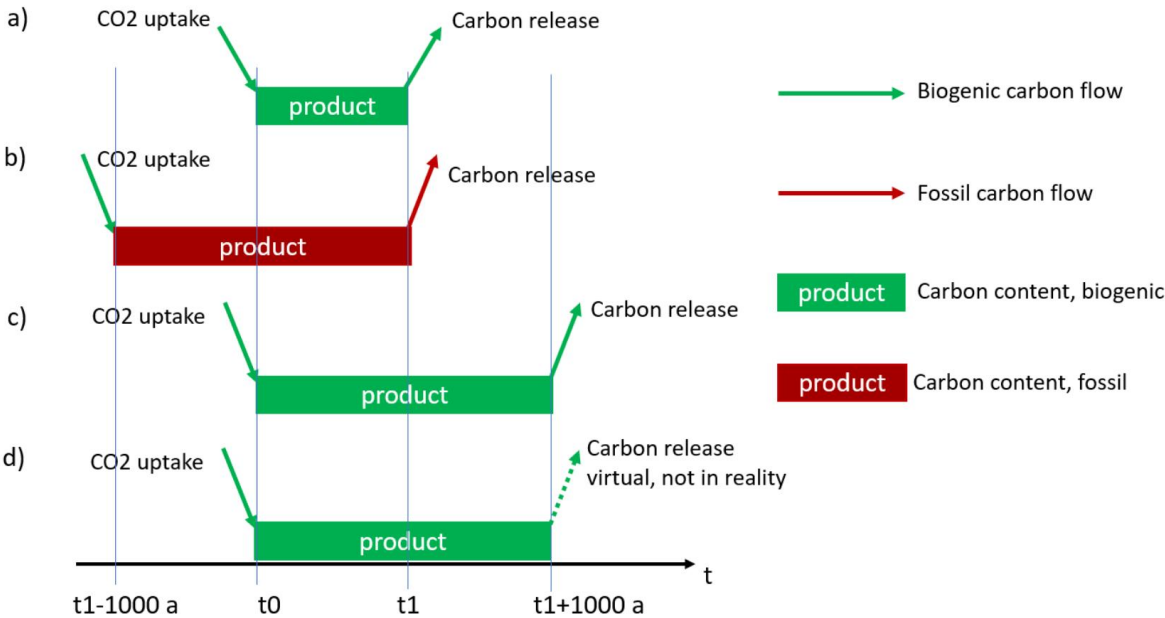


Fig. 1: 4 cases of carbon uptake and release. Further explanation see text.

These cases are:

- a) Biogenic carbon uptake at  $t_0$ , product contains biogenic carbon, releases it at end of life at  $t_1$ ;

- b) Biogenic carbon uptake “long time ago”, leads to carbon content in the product that is considered fossil, carbon release at end of life at  $t_1$  considered as fossil carbon release;
- c) Biogenic carbon uptake at  $t_0$ , leads to biogenic carbon content of the product; carbon is released “much later” (1000 years later), is still considered as biogenic carbon
- d) As c, but no carbon is released even much later, no carbon leaves the product system in any module (i.e. the unclear case described above), assumption that then, a virtual emission flow needs to be added.

So, although case b) and c) are quite symmetrical, they are to be treated in an entirely different and you could say inconsistent way, according to the PCR. Case d) contradicts the carbon utilization upscaling ideas of the European Commission.

A side note: The PCR states that the “amount of biogenic carbon [is] sometimes [...] not correctly accounted for in datasets in LCA software, because of allocation performed, and other reasons, and because of this, the PCR recommends to manually adjust biogenic carbon after the calculation. “

This has been discussed often<sup>10</sup>; it is a bit interesting that biogenic C is requested to be treated differently than any other flow in the life cycle calculation; allocation evidently changes processes and “destroys” mass balance and also the balance of any flow in the inventory, be it water or metals for example. Yet only for biogenic carbon, this effect of the allocation, that is accepted for all other impacts, as allocation is an accepted approach for dealing with multifunctional processes, needs to be manually “corrected” and undone, while other flows remain as they are after the allocation. This leads to inconsistency in the inventory, and it is questionable why the effect of an applied allocation is accepted for any other impact, but for biogenic global warming potential, it is not accepted and tools that calculate all flows alike and do not discriminate one flow (by treating it differently) are classified as calculating incorrectly.

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<sup>10</sup> E.g. in the life cycle initiative’s biogenic carbon project, <https://www.lifecycleinitiative.org/activities/life-cycle-assessment-data-and-methods/biogenic-carbon/#1720622473047-9300930a-b0d4>

## CarstorCon (and similar biochar products)

To better understand the specific case of the product 'Clim@Add®', here a short description. Clim@Add® is developed, produced and promoted by CarStorCon (<https://carstorcon.technology/>). It is used as an additive for building materials such as cement; CarStorCon promises improved material properties when the product is added. Clim@Add® is produced mainly from residual forest wood and other residual biomass via a pyrolysis. In the ECHA chemicals database, it can be classified as charcoal. The product contains biogenic carbon from the residual biomass. In the pyrolysis, this original material is modified<sup>11</sup>. The product is used by mixing it into concrete. In the hardened concrete, the carbon in the material is stabilized and not subject to emission or oxidation#, for literally thousands of years. This is thus a case of carbon capture and utilization.

When creating an EPD for the product according to EN15804 and the PCR cited above, this carbon capture and utilization translates into the rules discussed in the previous section. The product takes up biogenic carbon and stores it “forever”, the carbon does not leave the product system. Thus, either a virtual emission flow needs to be added in the end of life stage to even out biogenic carbon, or this is not done as the carbon does not leave the system, with the effect that the product and system indeed stores biogenic carbon. In addition, any allocation performed in the system needs to be corrected, which is a bit of a challenge if a generic unit process database is used that consists of already allocated processes. The easiest approach is to manually add / remove biogenic carbon so that the balance is even. This is really more tinkering than scientific modeling.

## Conclusions

Biogenic carbon modeling for EPDs according to the PCR for construction products and complicated, tinkerish, and contradicting natural science. The following conclusions are available:

- A manual correction of biogenic carbon after an allocation leads to inconsistent inventories and is for unit process based generic databases not easy; it is questionable why such a correction is required only for one flow, while others remain as they are.

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<sup>11</sup> Hossein Baniasadi, Roozbeh Abidnejad, Ziba Fathi, Kristoffer Meinander, Antti Koistinen, Eero Kontturi, Erlantz Lizundia, Dynamic biogenic carbon accounting and functional properties of wood biochar from five species, Chemical Engineering Journal, 2026, 174573, ISSN 1385-8947, <https://doi.org/10.1016/j.cej.2026.174573>.

- This separate treatment of biogenic carbon in the PCR seemingly (if I understand the PCR correctly and not the “the carbon stays in the system forever” approach is also permitted) contrasts with key European policy to foster and upscale carbon storage and utilization. It seems as if there is a parallel world in the EPD.
- PCR and the standard lack clear definition of key terms such as biogenic carbon, and do not provide goals for required actions. This makes it difficult to understand practical cases, and to practically apply them. Rules without a clear definition of terms used in these rules lead to an ambiguous application of these rules.
- Despite PCR and the EN15804 standard being broadly used, official documents, they contain plain mistakes. This further complicates their use.
- They also contain language that seems purposefully vague and intentionally allowing for several interpretations, such as “generally” [this] “shall be done”. This might be result of a long discussion among stakeholders involved in the creation of these documents, and the ambiguous sentence be a compromise (one group: we made sure that the PCR contains the rule that this shall be done; the other group: we made sure this is not a strict requirement) – but this basically “outsources” the decision to the practitioner and verifier who need to find out if a specific EPD is then in line with the PCR or not. This is not good.
- Finally, why do the rules in the PCR need to be that complicated? Treating one specific flow in a certain way, and (not discussed in this text) treating packaging carbon differently than product carbon, and many more rules, lead to confusing and complicated creation and verification procedures, to mistakes in standard and category rules documents, potentially, to errors in EPDs, and they slow down the entire process of EPD creation.

## What's next

Well, I do not know; hopefully, “document craftsmanship” for EPD standards and PCR documents can be improved, the EPD verification and modeling aligns better with natural science and is not developing into a parallel world, and EPD rules are streamlined to help improve the quality of EPDs, and to upscale their creation and use.

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