GreenDelta
sustainability consulting + software

Biogenic Carbon Modeling in LCA: A Temporal Perspective

SETAC Europe 27th LCA Symposium
Oct 19, 2026

Dr. Andreas Ciroth
GreenDelta GmbH

Topics for the talk: Carbon Storage Modeling in EPDs

- Climate change and carbon storage
- Biogenic carbon and EPDs
- Biochar products
- Conclusions

Climate change and carbon storage

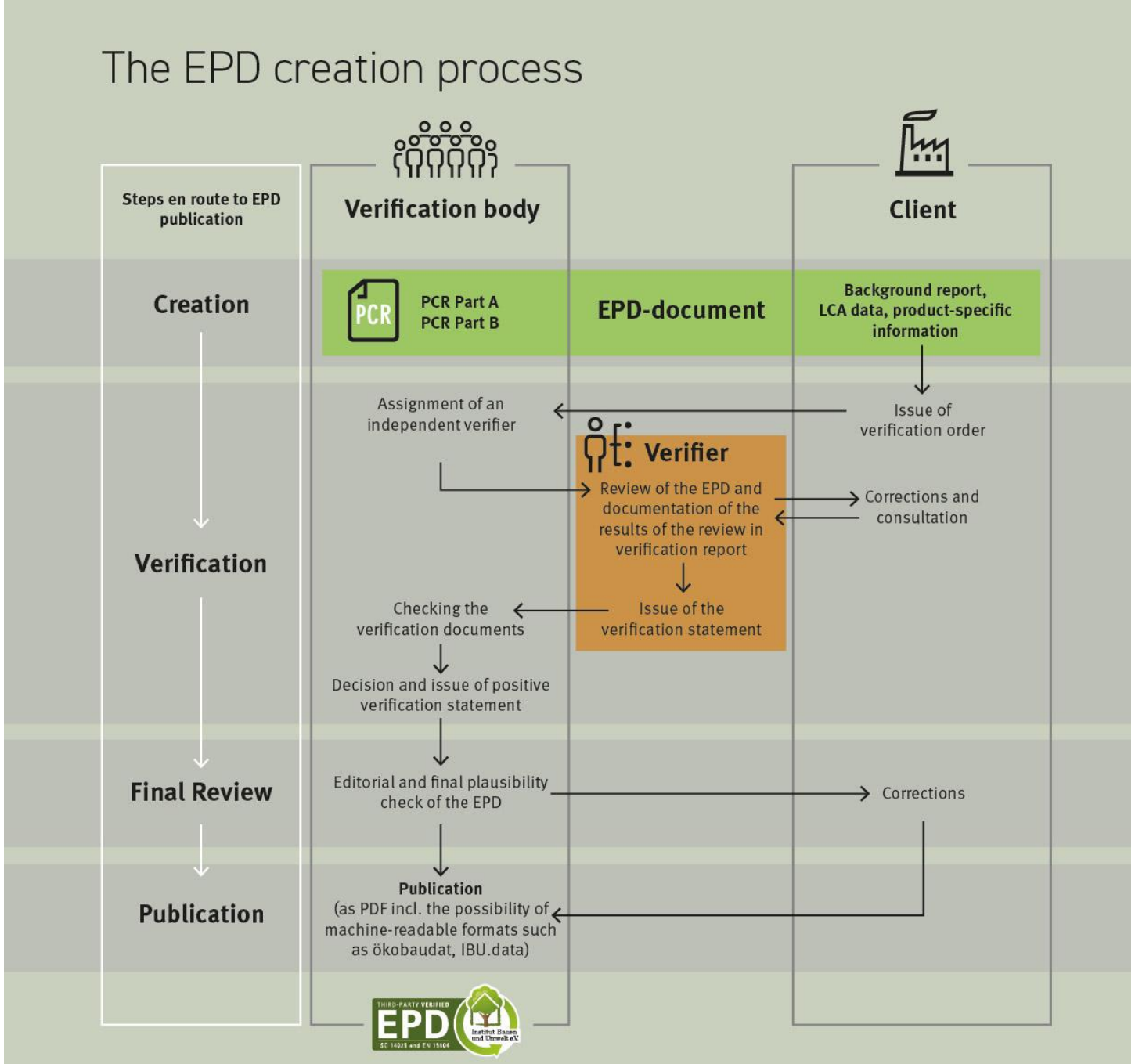
Climate change and carbon storage

- 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).
- 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.
- https://www.iea.org/data-and-statistics/data-product/ccus-projects-database
  https://www.globalccsinstitute.com/wp-content/uploads/2025/10/Global-Status-of-CCS-2025-report-9-October.pdf
  https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/projects-details/43251567/101146854/CEF2027
  https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2025/ENTRANS/EnTrans_FACTSHEET_INCENTIVE_SYSTEMS_FOR_CARBON_CAPTURE_UTILISATION_STORAGE.pdf

Biogenic carbon and EPDs

EPDs (=Environmental Product Declarations)

- LCAs (ISO 14040): goal and scope determine the modeling rules and indicators
  → “anything goes”, results across different LCAs not necessarily comparable
- EPDs (ISO 14025 etc.): prescribe common rules for product categories that must be followed, and have this “verified”
  → idea: consistent models and results, even across different actors
- This is a booming field and a business on its own, with program operators, verifiers, tool providers, data providers (not a bad thing necessarily!)



PCRs („product category rules“) are developed for and provided by the program operators, for product groups; they are the basis for the verification

https://ibu-epd.com/en/epd-creation/

GreenDelta

Biogenic carbon

- (plants incorporate carbon from carbon dioxide via photosynthesis to grow and build e.g. cellulose, wood etc.; when the plants decompose or burn, carbon is released again)

- The climate change effect of this „again-released“ carbon is the same as of any other carbon

- IPCC:
  “Biogenic carbon [is] Carbon derived from biogenic (plant or animal) sources excluding fossil carbon. Note that peat is treated as a fossil carbon [...] as it takes so long to replace harvested peat.”
  https://www.ipcc.ch/site/assets/uploads/2019/12/19R_V0_02_Glossary.pdf

Biogenic carbon & EPDs

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_2, biogenic CH_4, 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.[110] 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_2 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_2 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_2; if the biogenic carbon uptake is instead, for example, released as CH_4, 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_2 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)[111]. 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_2 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_2 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).[112, 113] 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.[114, 115] 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).

Quite a topic, e.g. EPD International's construction product PCR in most recent version 2.0.1

PCR 2019:14 VERSION 2.0.1 VALID UNTIL: 2030-04-07, https://api.environdec.com/api/v2/EPDLibrary/Files/7c2cae37-dc0a-4734-9cd6-08dda4d191db/Data

Biogenic carbon & EPDs

- Quite a topic, e.g. EPD International‘s construction product PCR in most recent version 2.0.1:
- “generally [...] the LCI shall separate between fossil and biogenic carbon”
- “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.”

A remark on „text craftmanship“

- Although a lot of experts work on the PCR documents, there are quite some technical issues
- Key terms are not defined:

  - biogenic carbon (environdec PCR)
  - sequestered carbon (environdec PCR)
  - fossil carbon (IPCC)

Biochar products

Biochar products

Biochar products are high-carbon, charcoal-like materials made by heating organic waste—such as wood chips, crop residues, or manure—without oxygen in a process called pyrolysis. Utah State University +1

How Biochar Is Made

- **Pyrolysis:** Biomass is heated to high temperatures (usually 300°C to 700°C) with little to no oxygen so it does not burn into ash. FORLIANCE +1
- **Structure:** The resulting material is lightweight, black, and filled with microscopic pores. Regeneration Internati... +2
- **Carbon Stability:** Up to half or more of the original carbon locks into a stable form that resists decay and sequesters carbon for centuries. UK Biochar Research C... +1

Biochar products

People are against biochar due to **mixed scientific results, environmental risks, and concerns about large-scale industrial practices**. Reddit · r/Permaculture +2

Soil and Ecological Risks

- **Inconsistent performance:** Studies, such as a review from Mendel University featured on Modern Ag Media, show that biochar can reduce soil fertility, increase salinity, or worsen erosion depending on the soil type. Modern Ag Media
- **Harm to soil life:** Some research points to negative impacts on earthworm reproduction, growth, and DNA integrity, alongside shifts in the balance of soil fungi and bacteria. Modern Ag Media
- **Potential toxicity:** Unregulated or poor-quality biochar can leach heavy metals, polycyclic aromatic hydrocarbons (PAHs), and dioxins into soil and water. Springer Nature Link
- **Nutrient tie-up:** Raw, uncharged biochar is porous and can initially absorb and lock away vital plant nutrients and moisture rather than releasing them. YouTube · Sunnyside Soil

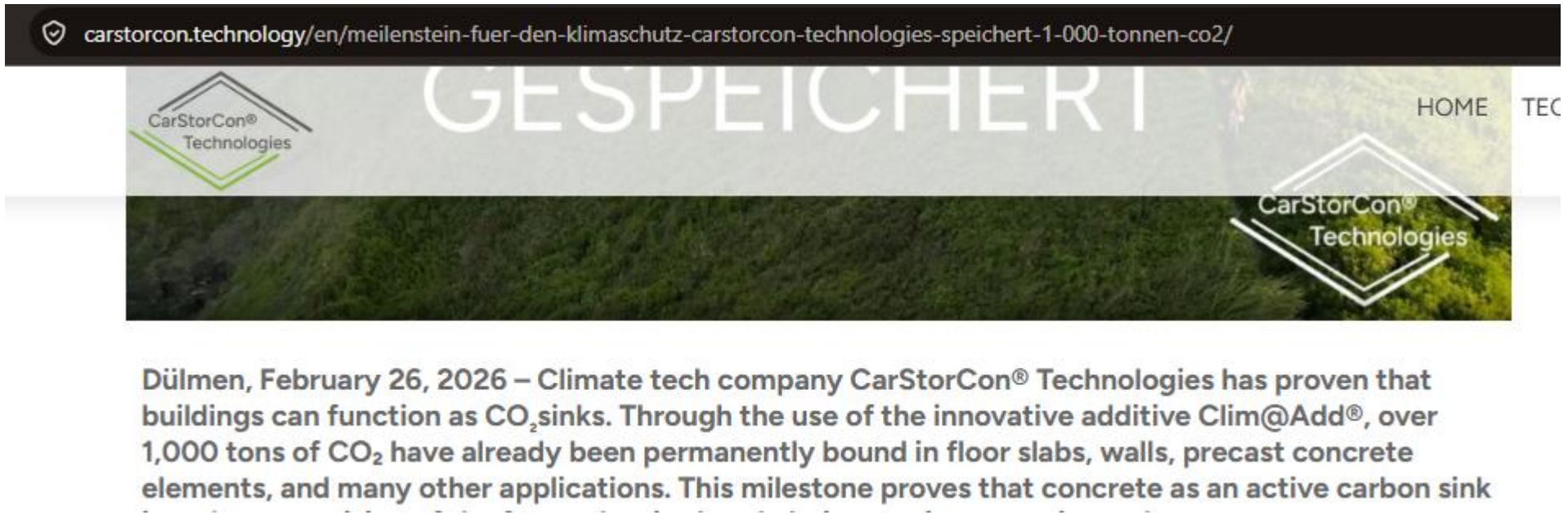
Agricultural and Evidence Concerns

- **Overstated claims:** Recent scientific analyses argue that agricultural trial data is often flawed or lacks long-term controls, and real-world crop productivity gains are frequently smaller than promised. EurekAlert! Science News ...
- **High variability:** Because feedstocks and pyrolysis temperatures vary widely, the physical and chemical properties of biochar change from batch to batch, making consistent results hard to predict. YouTube · Modern Grow... +1
- **High cost:** Commercial or "designer" biochar products can be expensive, limiting their economic viability for large-scale farming. YouTube · Modern Grower

Industrial and Climate Concerns

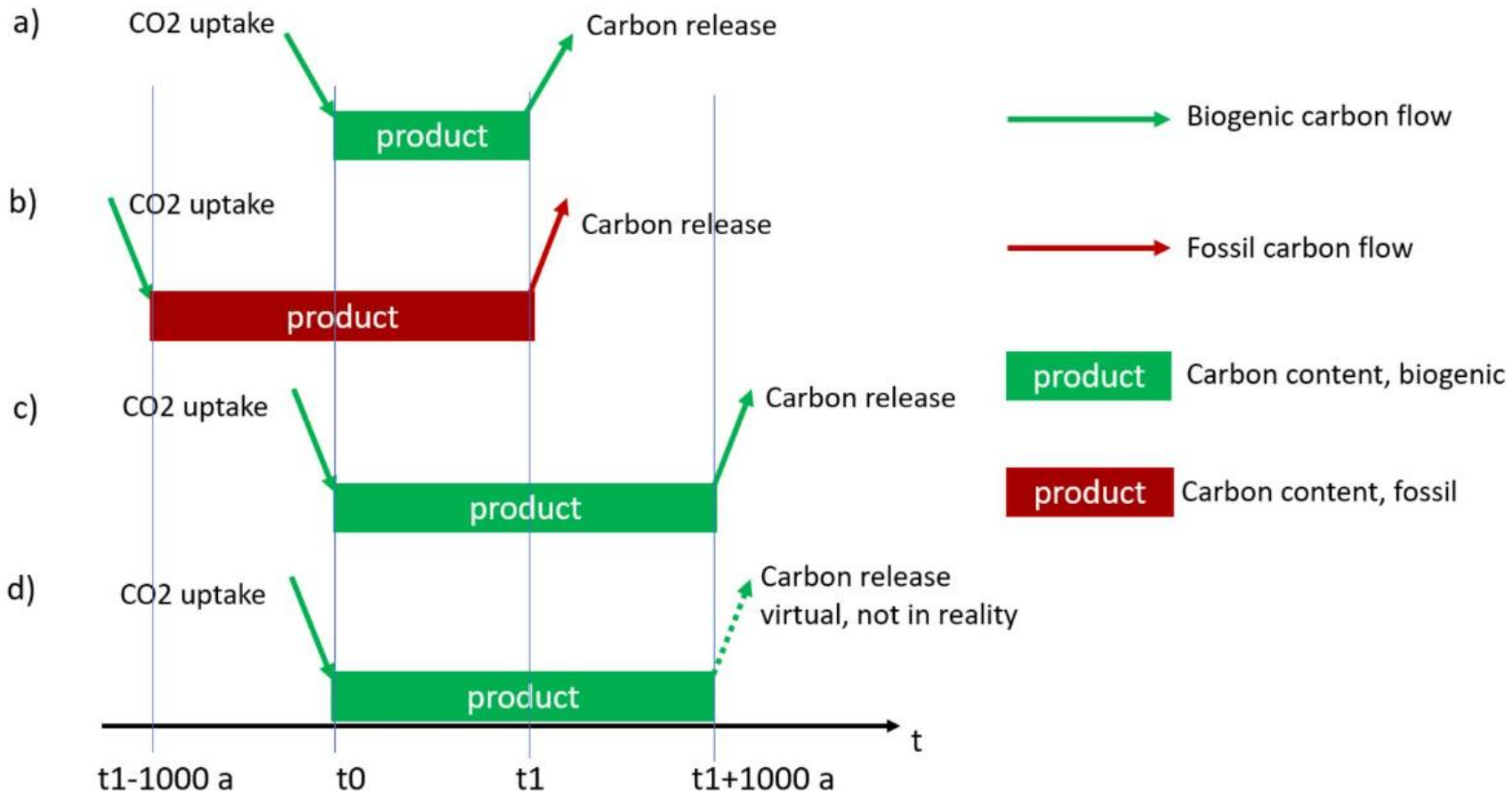
- **Resource exploitation:** Large-scale manufacturing risks driving unsustainable forestry, land clearing, or the diversion of crop residues that should remain on fields. su-re.co +1
- **Production emissions:** Processing biomass via pyrolysis requires energy and can generate air pollution, particulates, or toxic emissions if not strictly controlled. Earth Island Institute +1
- **Land competition:** Scaling biochar globally would require massive amounts of biomass and land area, potentially competing with food production. Climate Change Committee

Biochar products and climate change calculation in EPDs



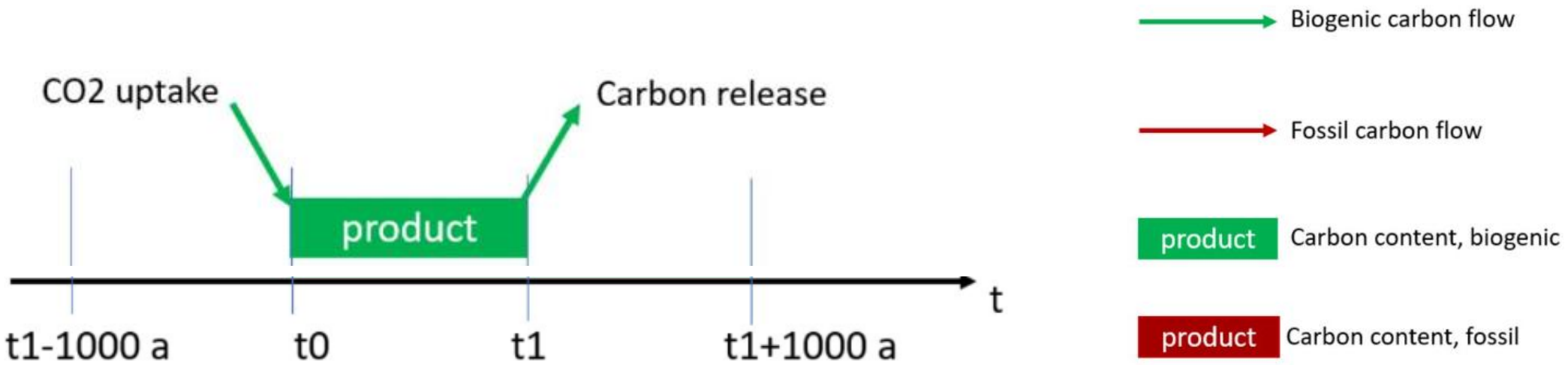
- “the sum of the sequestered biogenic carbon and the biogenic carbon emitted or leaving the product system in any other way during the product life cycle shall always be zero.”

Biochar products and climate change calculation in EPDs, four cases



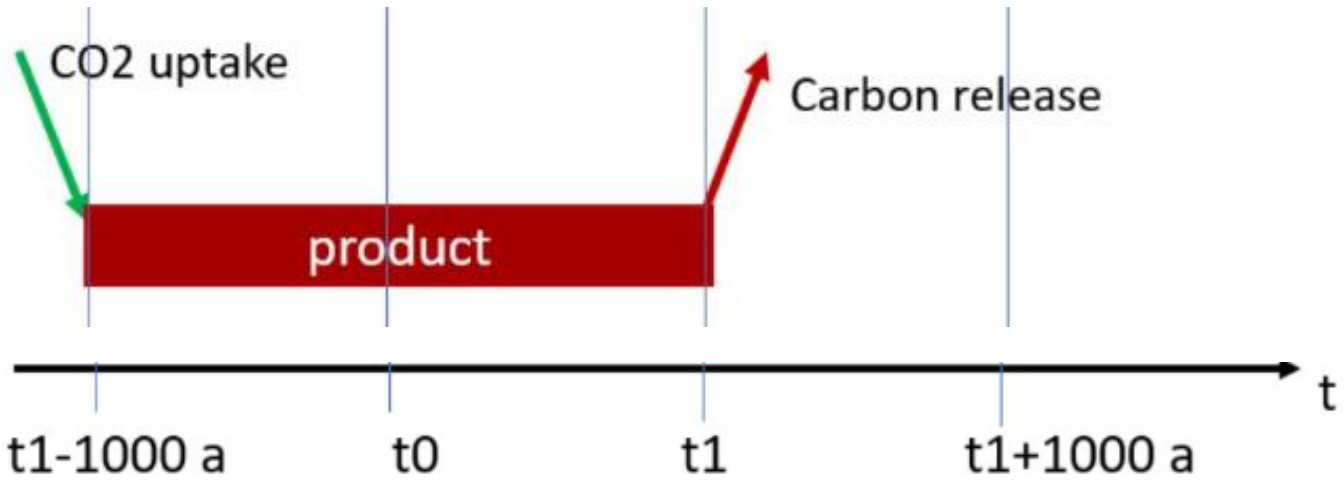
Biochar products and climate change calculation in EPDs

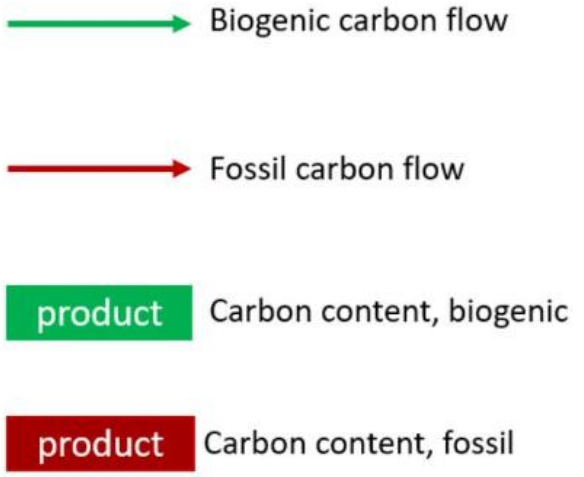
a) A wooden pencil that is incinerated



Biochar products and climate change calculation in EPDs

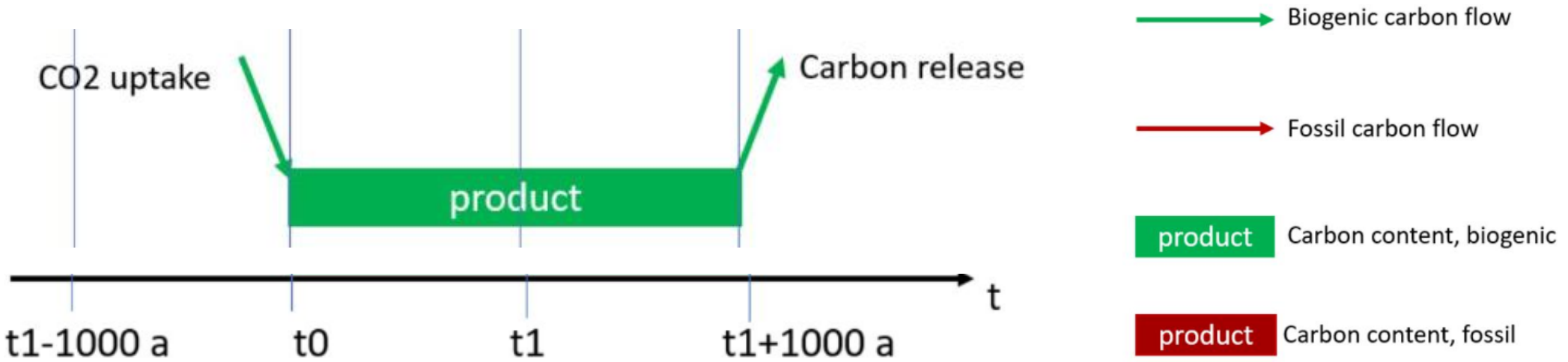
b) Natural gas or peat used as fuel





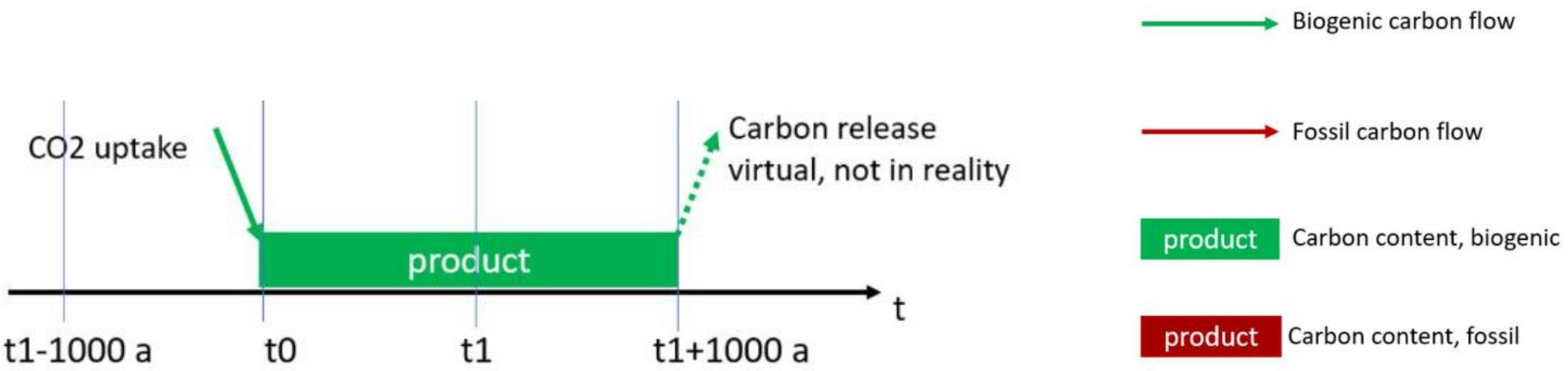
Biochar products and climate change calculation in EPDs

c) Construction wood for underground mining (?)



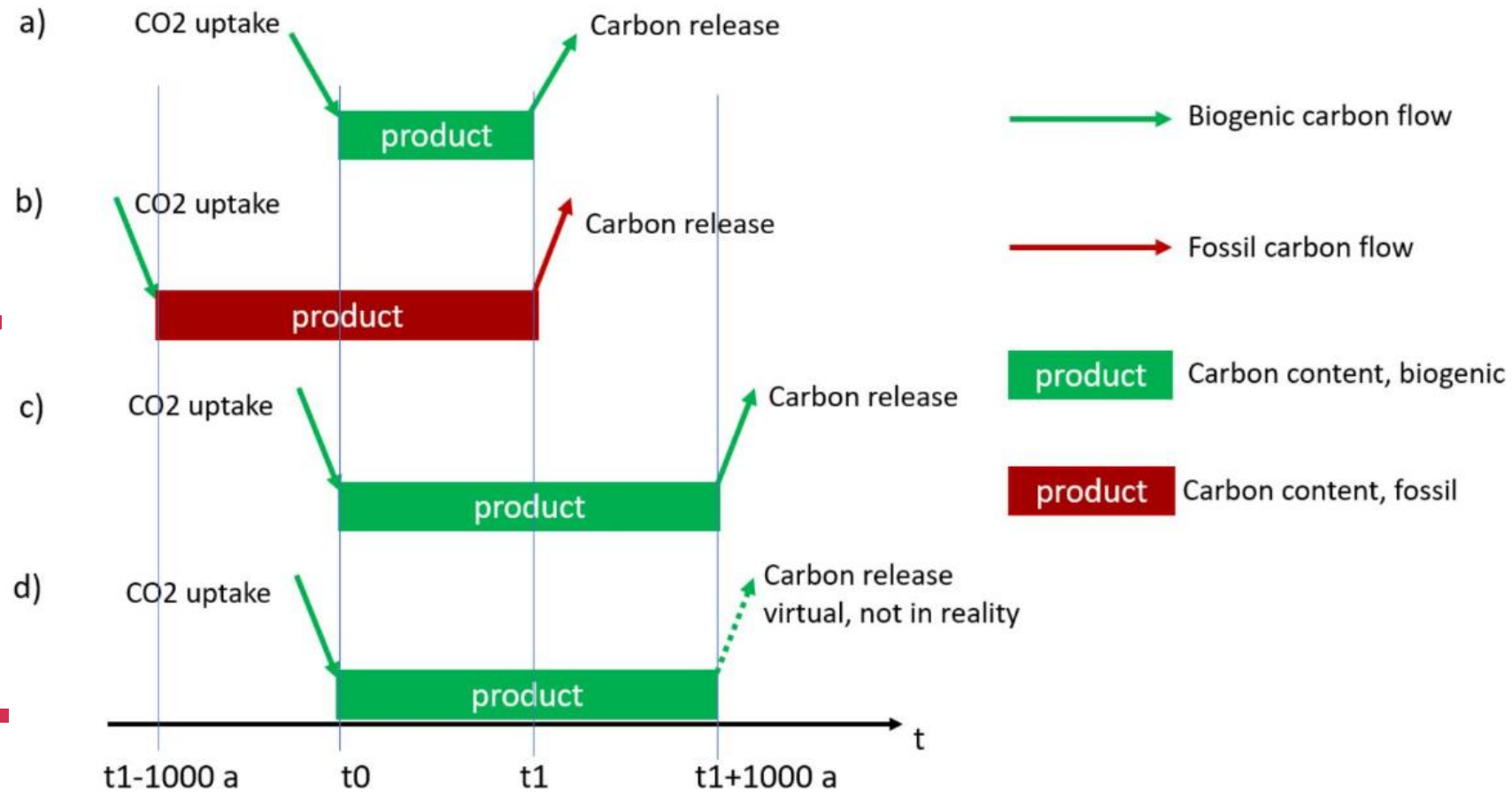
Biochar products and climate change calculation in EPDs

d) Biochar products that bind in cement



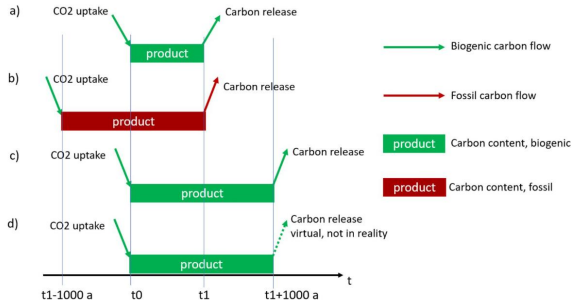
Conclusions and discussion

Conclusions and discussion



Conclusions and discussion

- Isn’t this inconsistent?



- Cautionary, conservative modelling rules are good but they should not “discriminate” products
- Rules should lead to an LCA model that reflects reality (I think)
- “text craftmanship” in EPD rules and regulations needs to be improved.

GreenDelta
sustainability consulting + software

Thank you very much!

Dr. Andreas Ciroth, ciroth@greendelta.com

GreenDelta GmbH, Alt-Moabit 130/131, 10557 Berlin, Germany