Presentation of Puro.earth's BECCS and Geologically Stored Carbon methodology

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Agenda (session A)

Host: **Elba Horta,** Business Development and Communications, Puro.earth

Definition of Carbon Removal

- **Mark Preston Aragonès**, Policy Advisor, Bellona

Methodology for Geologically Stored Carbon

- **Marianne Tikkanen**, Co-founder, Puro.earth

Q&A Panel with experts

-Waste-to-Energy + CCS: **Jannicke Bjerkas,** CCS Director, Fortum (Norway)
-DACCS: **Brett Cooper**, Southern Green Gas Ltd (Australia)
-BECCS: **Dr. Fabian Levihn**, Head of R&D, Stockholm Exergi (Sweden)
-Storage: **Cristel Lambton**, Technical manager, Northern Lights (Norway)
-EOR+ : **Esther Mertens**, Head of European Projects, South Pole (Netherlands)
-Cluster: **Camilla Brox** , BORG CO2 (Norway)

Agenda (session B)

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Host: **Antti Vihavainen**, Co-Founder, Puro.earth

Definition of Carbon Removal
- **Mark Preston Aragonès**, Policy Advisor, Bellona

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What is Puro.earth?

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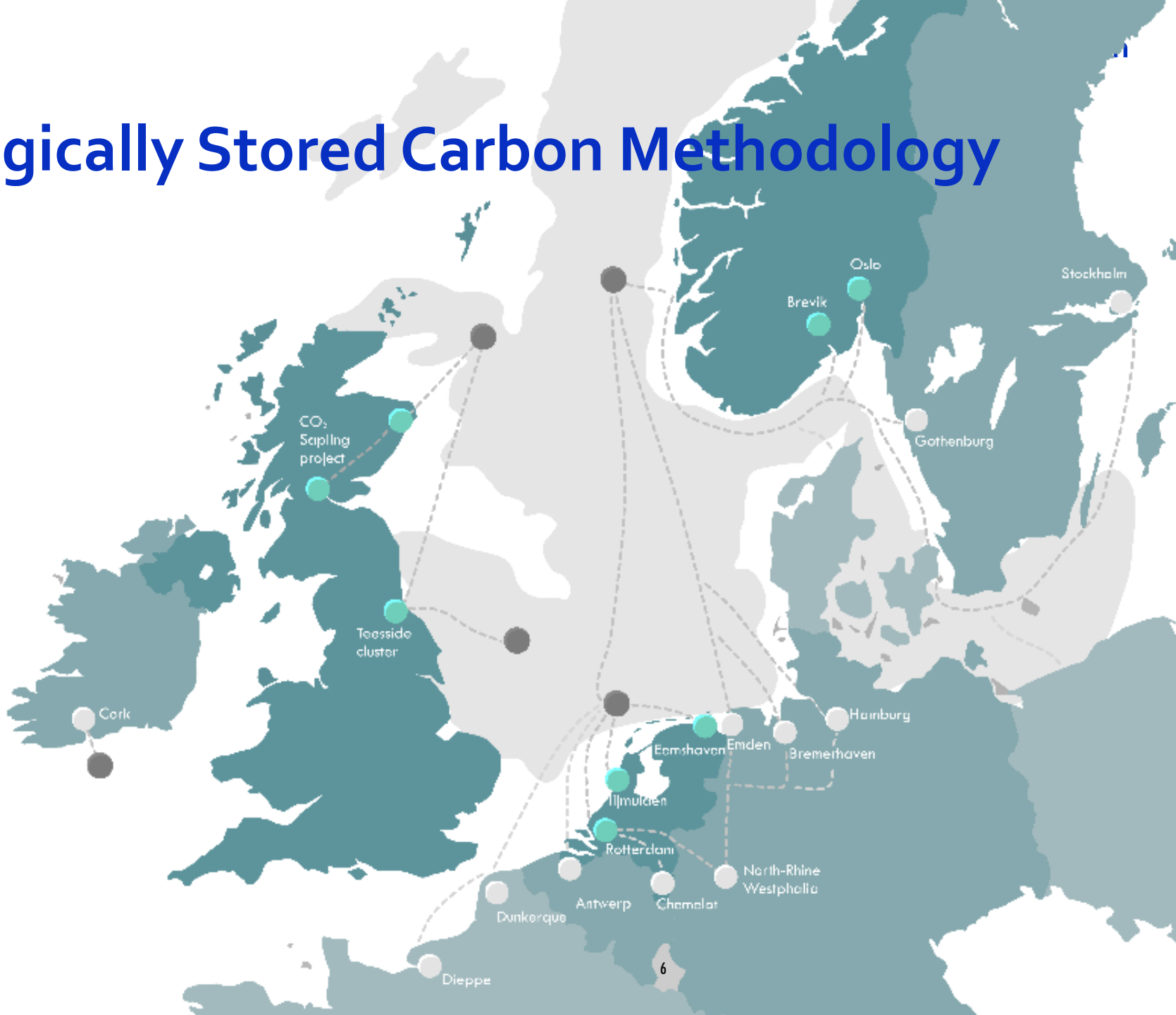
Definition of Carbon Removal

Mark Preston Aragonès, Policy Advisor, Bellona

The Bellona Foundation is an independent non-profit organization and was one of the first NGOs to begin championing CCS and Bio-CCS two decades ago and continues to do so, through collaborative platforms and research projects.

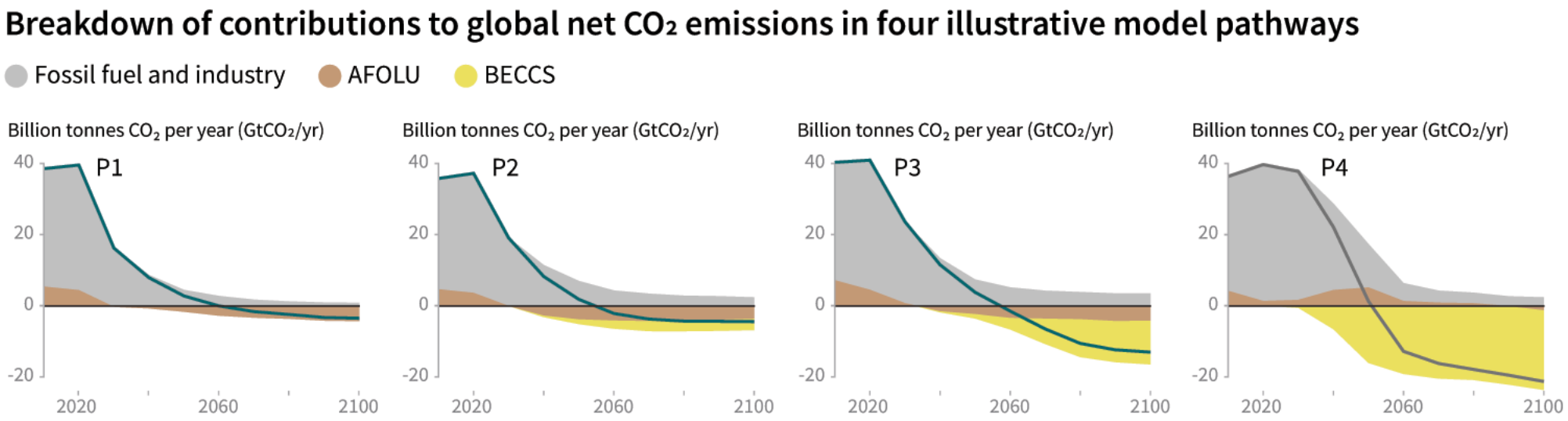
BECCS and Geologically Stored Carbon Methodology



Mark Preston Aragonès
Policy Advisor
mark@bellona.org

February 18th 2021
Webinar organised by Puro.Earth

Why this conversation is important



Large deployment of negative emissions will be needed **in addition** to deep and rapid emission reductions

Defining Carbon Dioxide Removal

Principles to be met when removing CO_2 from the atmosphere (CDR)

1. ***Carbon dioxide is physically removed from the atmosphere***
2. ***The removed carbon dioxide is stored out of the atmosphere in a manner intended to be permanent***
3. ***Upstream and downstream greenhouse gas emissions, associated with the removal and storage process, are comprehensively estimated and included in the emission balance***
4. ***The total quantity of atmospheric carbon dioxide removed and permanently stored is greater than the total quantity of carbon dioxide equivalent emitted to the atmosphere***

Reference: When are negative emissions negative emissions? (Tanzer & Ramírez, 2019)

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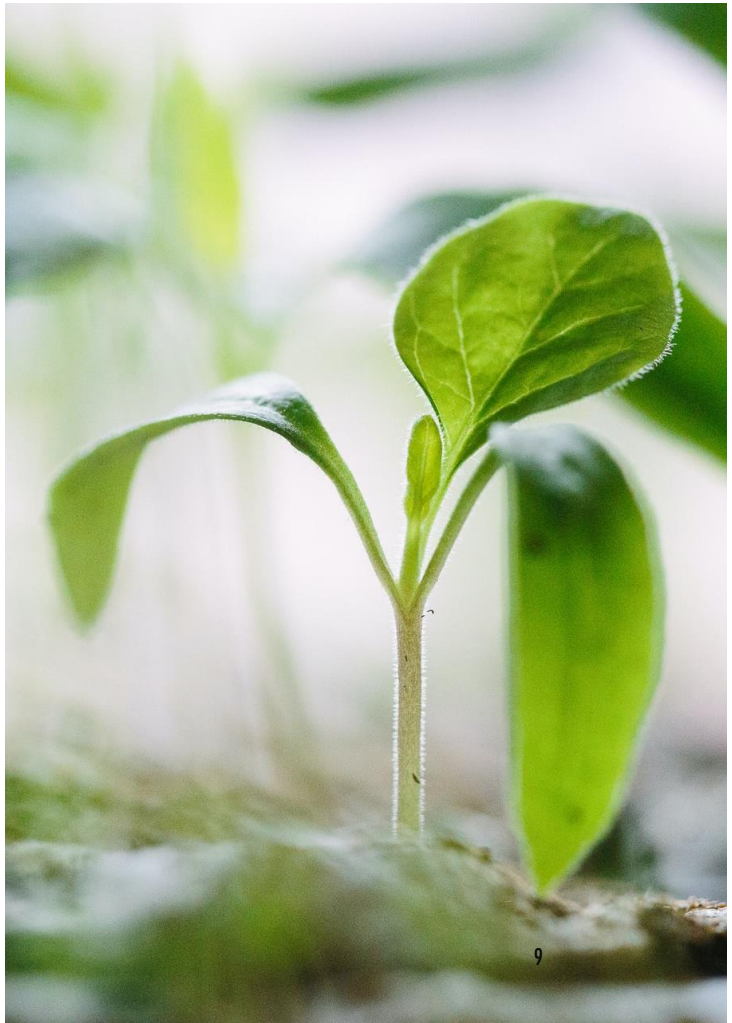
1. Carbon dioxide is physically removed from the atmosphere



2. The removed carbon dioxide is stored out of the atmosphere in a manner intended to be permanent

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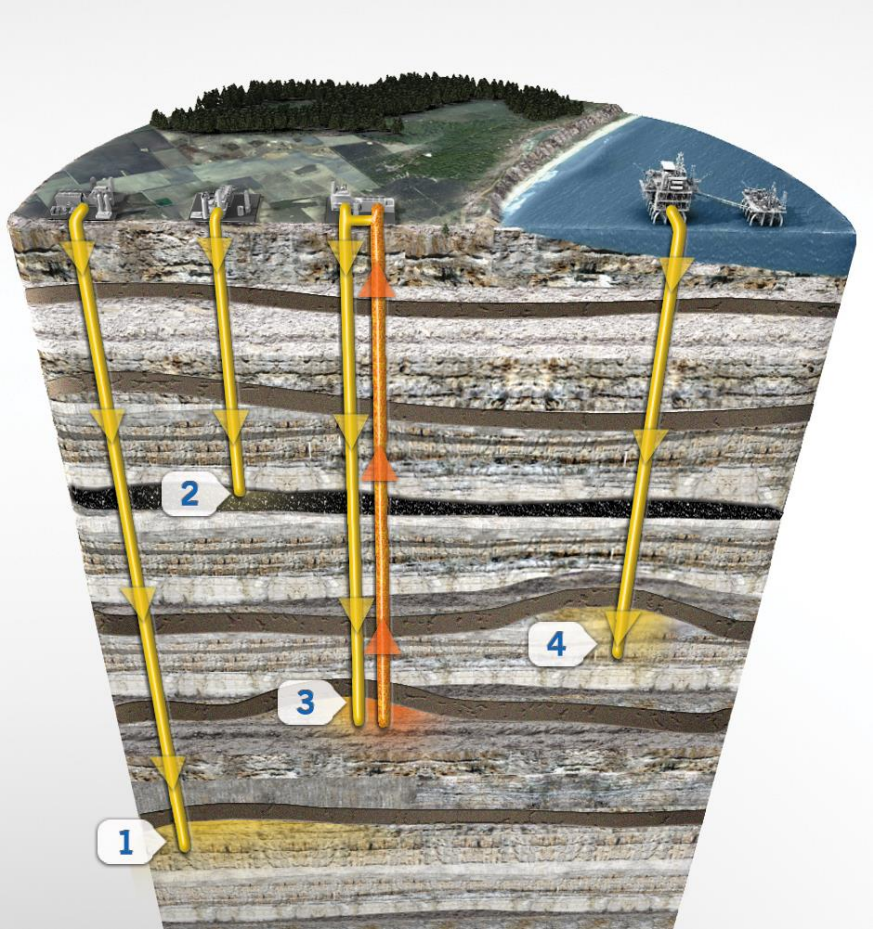
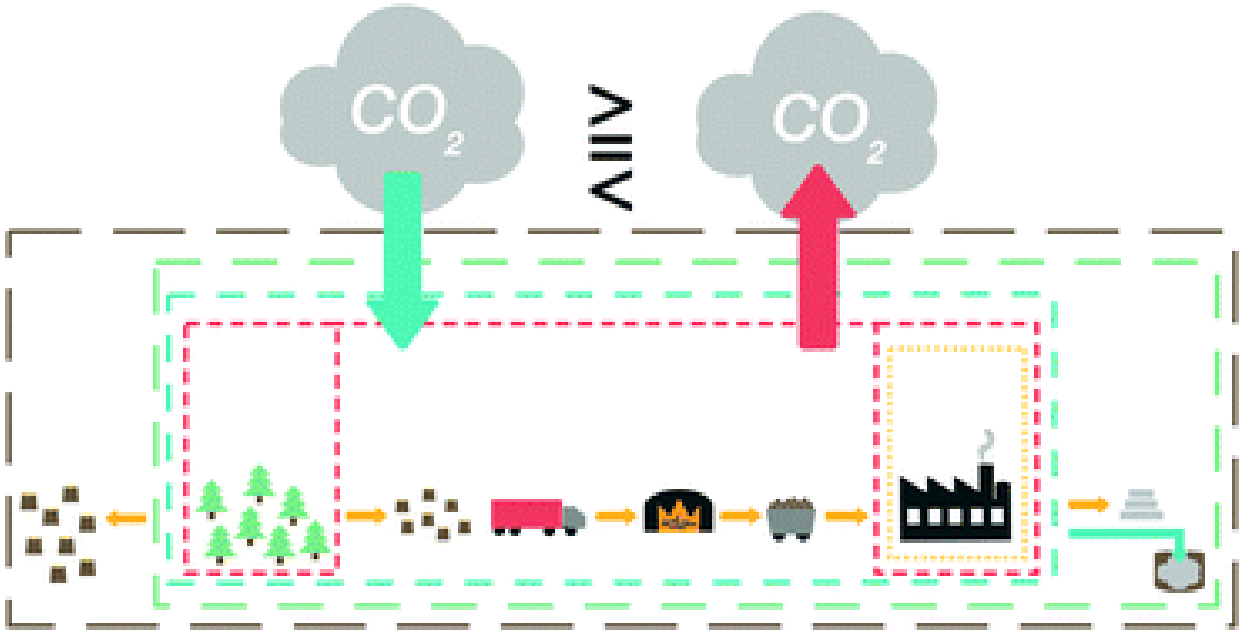
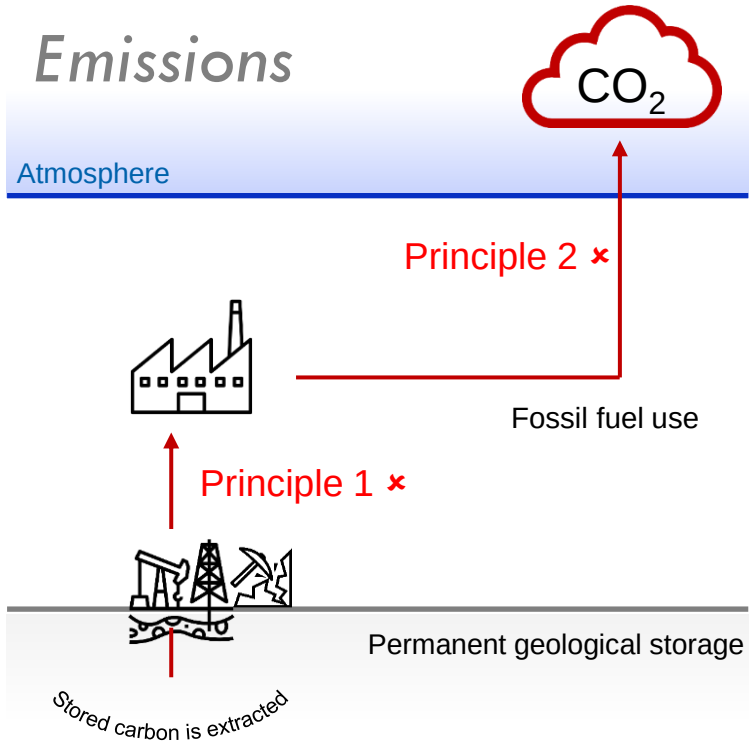


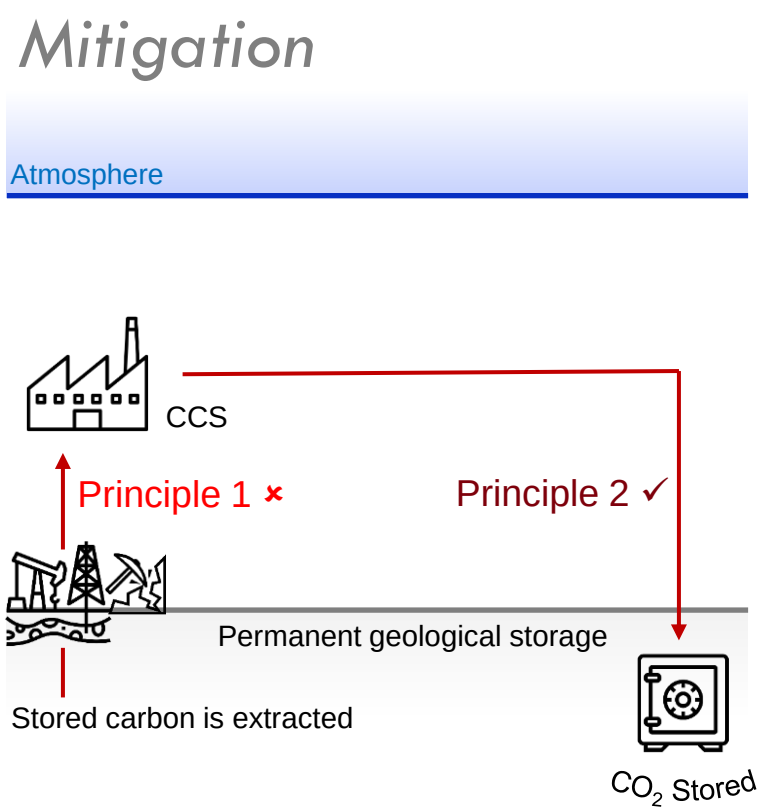
3. Upstream and downstream ghg emissions are included in the balance

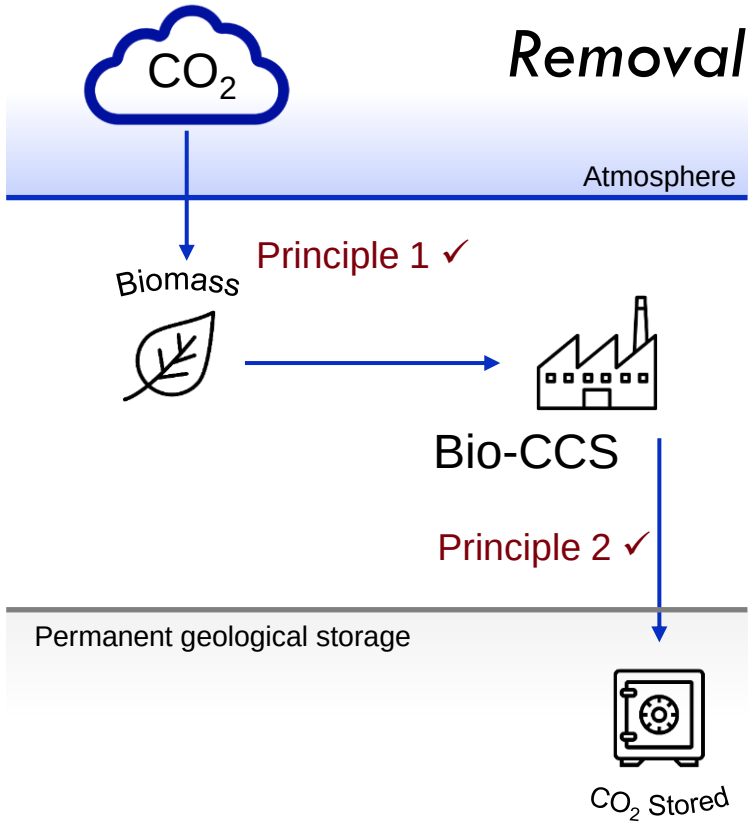


When are negative emissions negative emissions? (Tanzer & Ramírez, 2019)

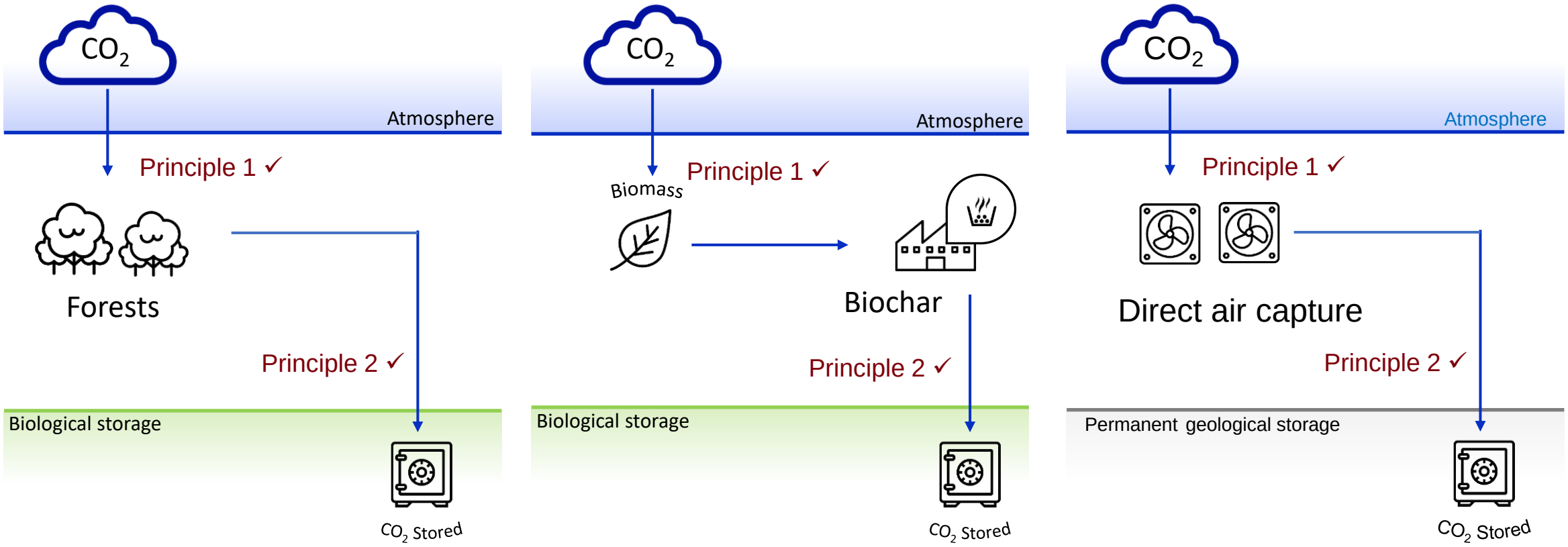
CCS Alone is not CDR







Carbon Dioxide Removal (CDR)



Takeaways

Carbon Dioxide Removal is distinct from Emission Reductions

- Removing CO_2 from the atmosphere and putting it elsewhere for a long long time

Carbon Dioxide Removal is supplementary to mitigation (i.e. not a replacement for it)

- Not making a mess in the first place is easier than cleaning it up after

Carbon Dioxide Removal will be limited by supply rather than demand

- We need to work on this in the lead up to 2030

Geologically stored carbon methodology

Marianne Tikkanen, Co-founder
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Puro.earth company timeline

- **2018** Aha-moment
  "Carbon removal is possible, but not happening. A business model and standard is missing". At the time standards were designed to measure and verify avoided emissions.
- **2019** Market validation and creation of CO2 Removal Certificate, CORC
  "We want to create a science-based, transparent standard for carbon removal. Are you in?"
  → with 22 companies we co-created 3 carbon removal methodologies : biochar, durable building materials (wooden and carbonated)
  → demonstrated verification & sales: Tieto, SEB, SwissRe
- **2020** Growth
  → new customers: Shopify and Microsoft
  → Co-created new methodology: geologically stored carbon
- **2021** Go-to marketplace for verified carbon removals

What is a carbon removal methodology?

- A set of rules and requirements to guarantee **high-quality carbon removal credits**
- Sets a minimum bar for a CO2 removal activity to be **ELIGIBLE** and qualify
- Defines how to **QUANTIFY** climate impact
  - How to calculate carbon balance
  - within the defined system boundaries
  - on a life-cycle basis
- **VERIFICATION** assures that

  1. eligibility requirements are met
  2. quantification can be validated based on the data trail and evidence presented

More methodologies coming ....

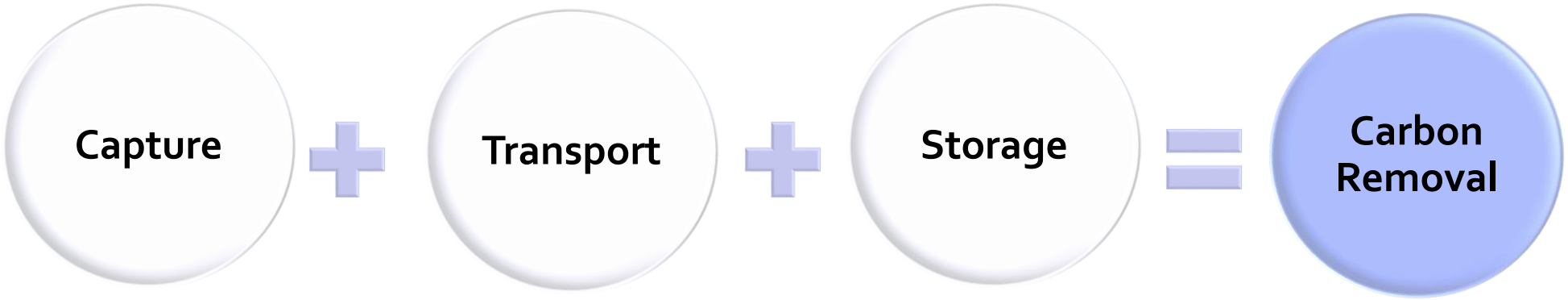
Are you a visionary methodology writer?

recruitment@puro.earth

Eligibility Rules

Geologically stored carbon methodology

Steps in geological carbon removal



- The methodology includes criteria for each step

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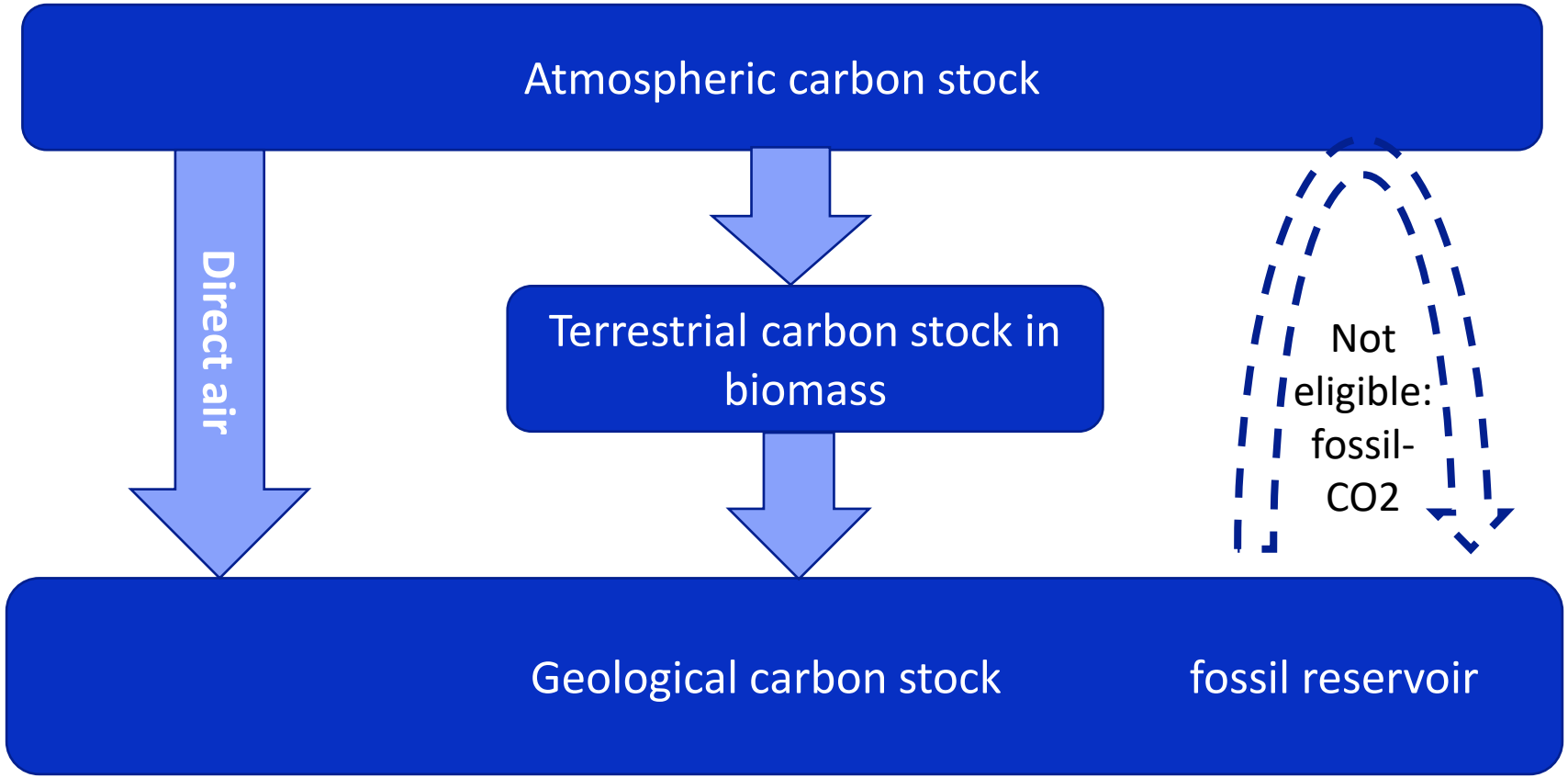
Capture: CO2 physically removed from atmosphere



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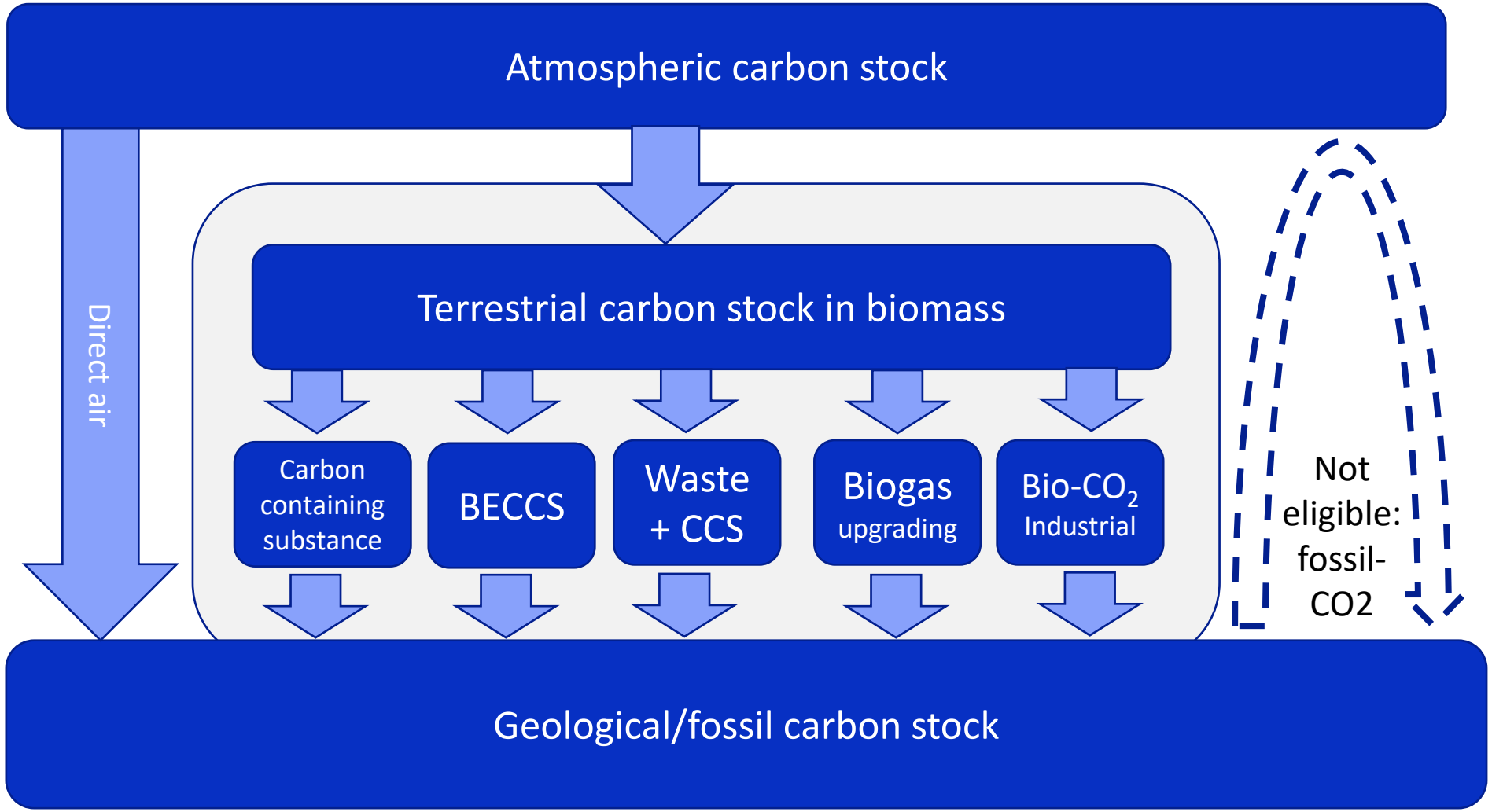
Capture options when using biomass as an intermediate step



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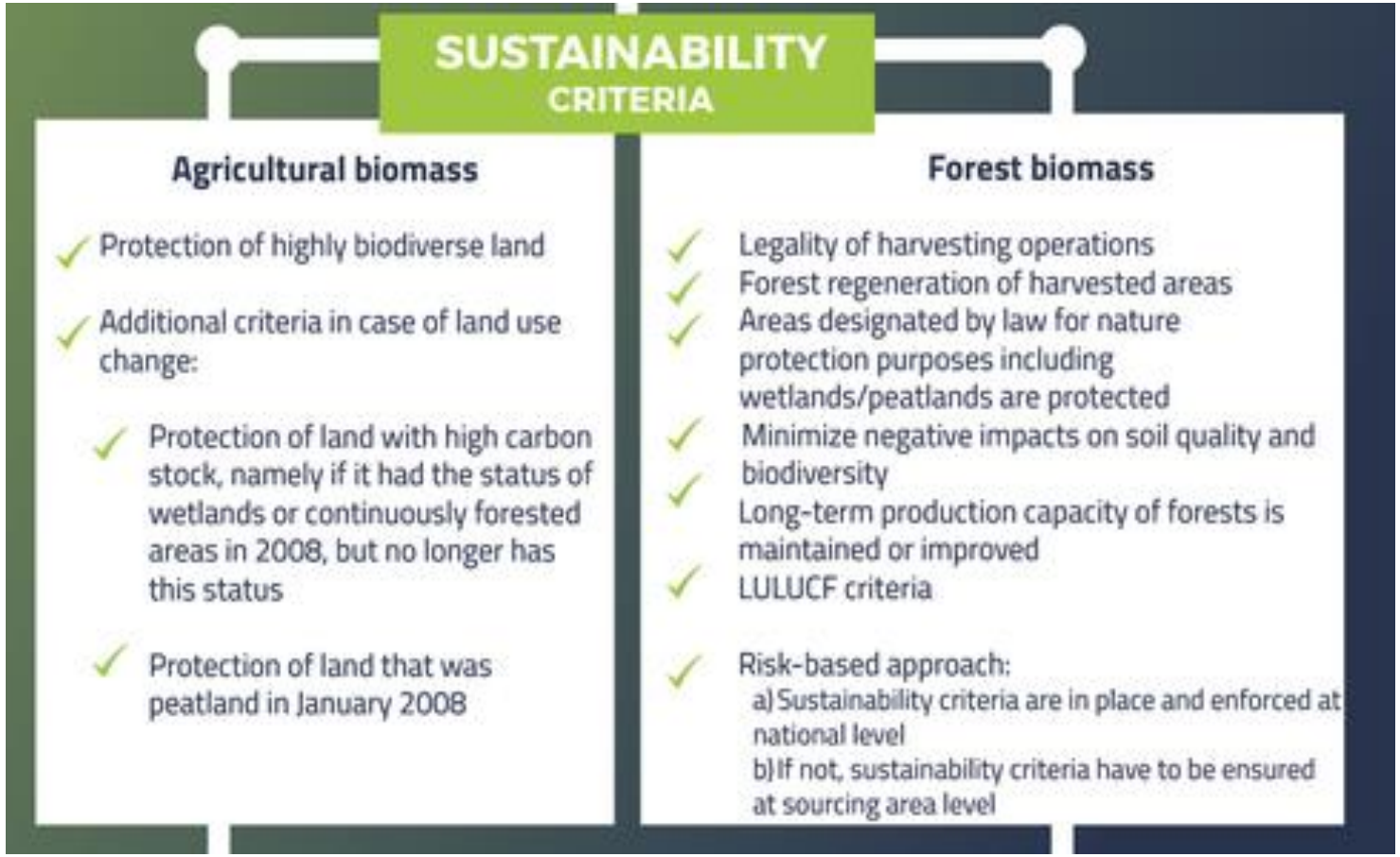
If CO_2 source is biogenic, the biomass used must be sustainable

- **Built on existing sustainability reporting and verification that is already required for biomass-based processes**
- Sustainable biomass criteria as defined in EU directive RED II https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02018L2001-20181221
- All emissions accounted for purpose-grown biomass: cultivation, harvesting and transport of the biomass
- Note: For all activities with biogenic CO_2 capture, the biomass must be sustainable, even if the biomass is not purpose-grown but residues or side streams are used.

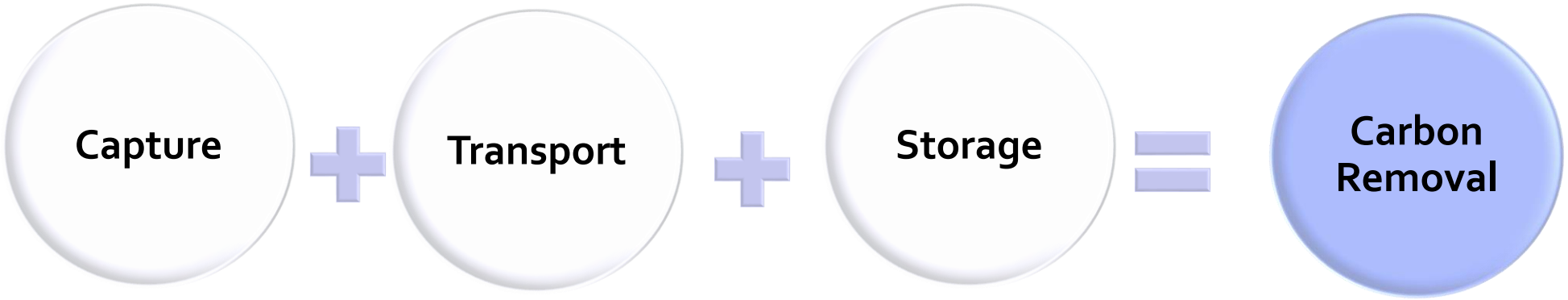


Source: European Biomass Association

Eligible Carbon capture types of the methodology

- Direct air capture (DAC)
- Biogenic CO_2 from combustion of biomass, bioliquids or biogas (BECCS)
- Biogenic CO_2 fraction from incineration of biomass mixed with other substances (Waste + CCS)
- Biogenic CO_2 from biogas upgrading process (Biogas + CCS)
- Biogenic CO_2 Carbon capture from oxidization of biogenic materials in industrial processes
- Biogenic carbon-containing substance (carbonaceous liquids, bio oil, carbon-containing slurry, ethanol, phenol)

Steps in geological carbon removal



- The methodology includes criteria for each step

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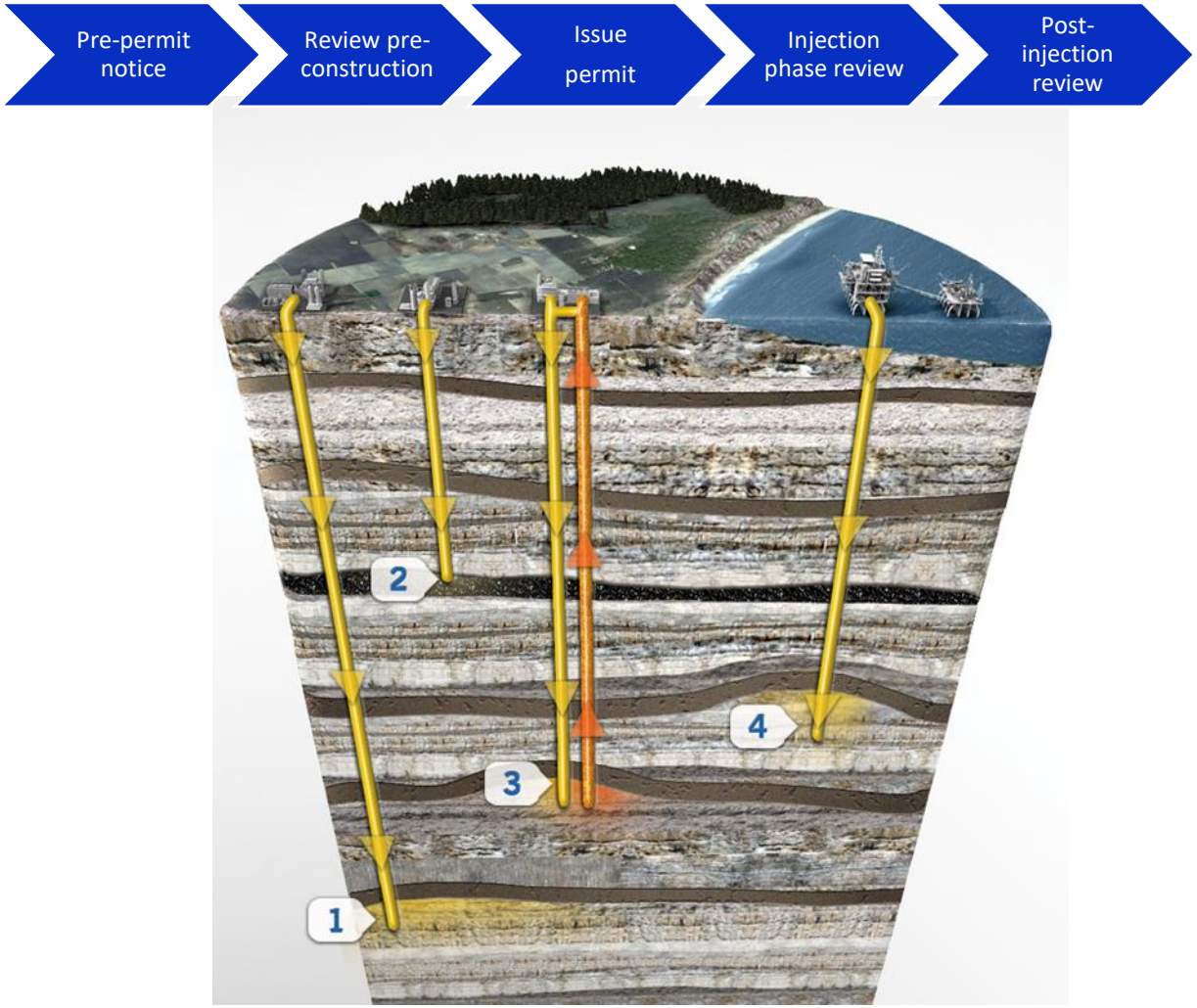
Storage criteria aligned with existing regulation

- Based on existing EU and US regulation or similar
- Permitting and licensing are controlled by the respective authorities
- In the EU, CCS Directive https://ec.europa.eu/clima/policies/innovation-fund/ccs/directive_en
- In the US, EPA criteria for wells used for geologic sequestration https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-co2



Storage: Eligible Geological Storage types [1]

- **Direct injection of CO_2 into deep geological formations (EPA CLASS VI or EU CCS directive)**
- **Injection of carbon containing substance into reservoir (EPA CLASS I, II and V)**
- **Oil and gas reservoirs as part of EOR+ (EPA CLASS II)**

'EOR+' refers to Enhanced Oil Recovery by injecting CO_2 into oil and gas reservoirs so that more CO_2 remains underground than what is contained in the oil extracted by EOR in that reservoir.

1 In EU area, CCS Directive, see https://ec.europa.eu/clima/policies/innovation-fund/ccs/directive_en In the US, EPA criteria for wells used for geologic sequestration, see: https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-co2

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Quantification Rules

Geologically stored carbon methodology

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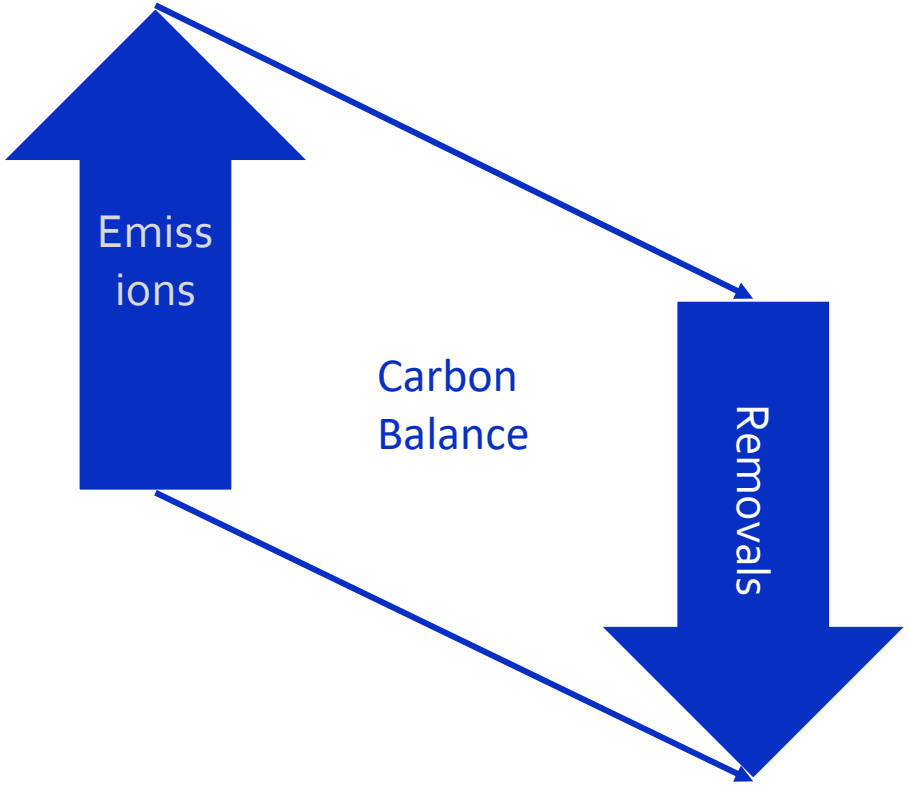
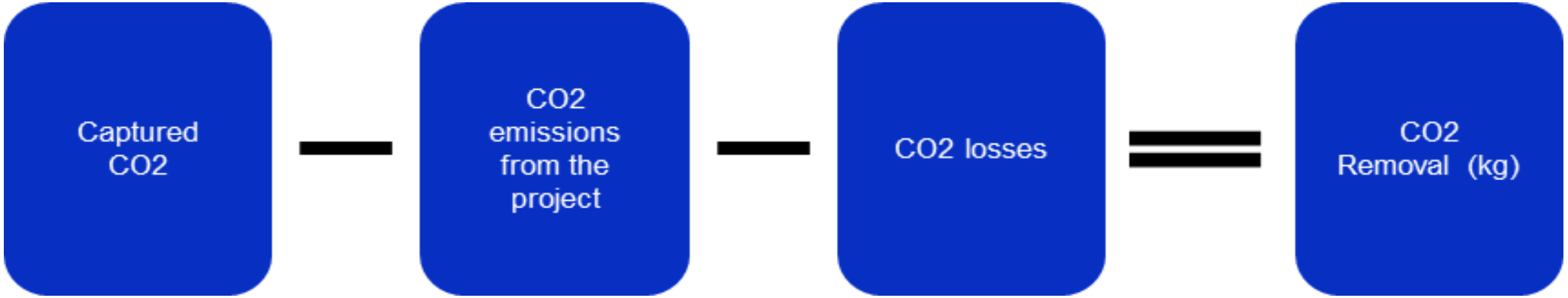
Quantification of CO2 removal is based on carbon footprint life-cycle analysis

- Carbon Balance/footprint = CO2 stored net of any process emissions
- Negative carbon balance/footprint = carbon removals
- Broadly defined system boundary
- On a life-cycle basis
- No emissions avoided or reduced included



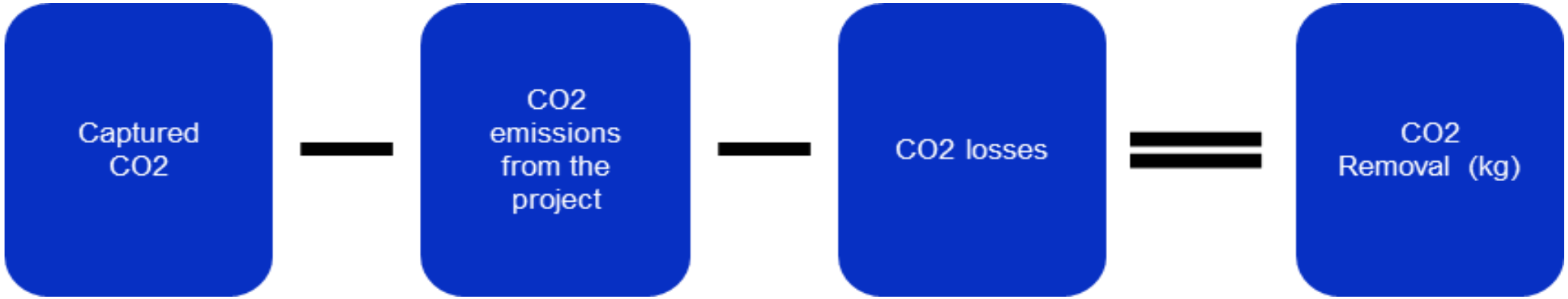
Net-negativity = CO2 removed from the atmosphere, net of any life-cycle process emissions



- Carbon balance is assessed following the LCA calculation principles of ISO standard and GHG Protocol.

Applying the same principles to different scenarios

- For example, differences in how Captured CO_2/Carbon is calculated
  - For Mixed CO_2 sources: the biogenic fraction of the captured CO_2 is measured and only that is counted as Captured CO_2
  - For Carbon containing substance: the quantity of captured CO_2e is determined by the carbon content (%) of the substance (in $kgCO_2e$)
- For EOR+ : the quantity of the oil extracted from the same reservoir is deducted from the quantity of CO_2 injected (in $kgCO_2$)



In Summary

Geologically stored carbon methodology

Puro.earth Geologically Removed Carbon methodology

- This methodology sets the requirements for eligibility and quantification of the **Net CO_2 Removal** impact achieved by activity carbon sequestration and geo-storage, where **CO_2 is captured from the atmosphere** and **stored permanently** into deep geological formations **by a CO_2 Removal Supplier**.

  - **Net CO_2 removal** impact is calculated as net carbon balance of emissions and storages. The gross carbon increase in the geo-storage must be larger than the GHG emissions caused over life-time of the activity.
  - **Capturing CO_2 from the atmosphere** means either 1) **direct air capture,** where CO_2 is captured from the atmosphere through chemical sorption or by membrane separation or 2) **biogenic CO_2** capture, where plants have originally captured CO_2 from the atmosphere through photosynthesis.
  - **Stored permanently** means that CO_2 or carbon-containing substance is stored in **geological storages** in deep, confined rock formations from where the CO_2 cannot escape back to atmosphere.
  - **CO_2 Removal Supplier** is the party **contractually responsible** for the complete activity with the intent of creating permanent carbon storages by capturing carbon from a biogenic source or directly from the atmosphere and storing into geological storages.

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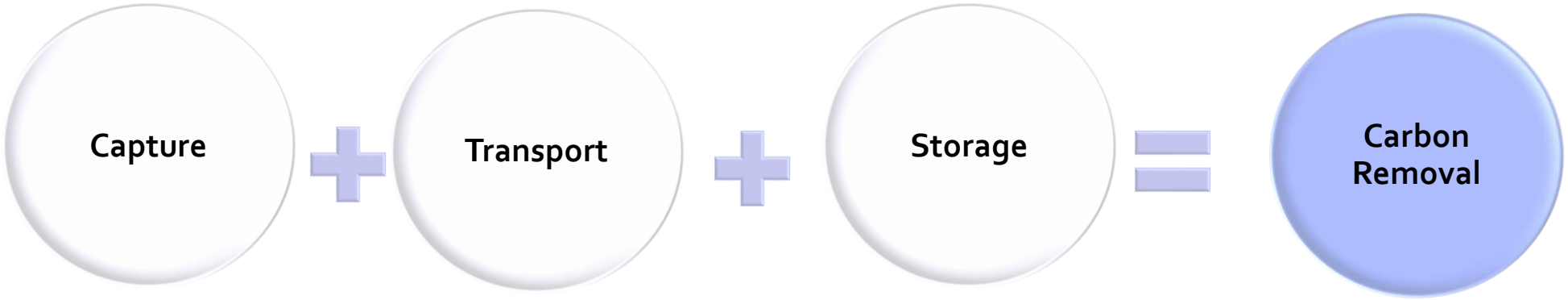
One party responsible for end-to-end process

CO2 Removal Supplier contractually responsible end-to-end



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Key takeaways from the methodology

1) Net-negativity

2) No fossil CO_2 allowed

3) Building on existing regulation

(ISO standard, GHG Protocol, RED II, EU CCS Directive and EPA injection wells legislation)

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Thank you to workgroup members

Bellona - Todd Flach, Mark Aragonès

Borg CO2 - Pål Mikkelsen, Camilla Brox

Charm Industrial - Peter Reinhardt

Climeworks - Louis Uzor

Drax - Karl Smyth

Fortum Oslo Värme - Jannicke Bjerkås

Gaia Consulting- Laura Ylimäki, lead author

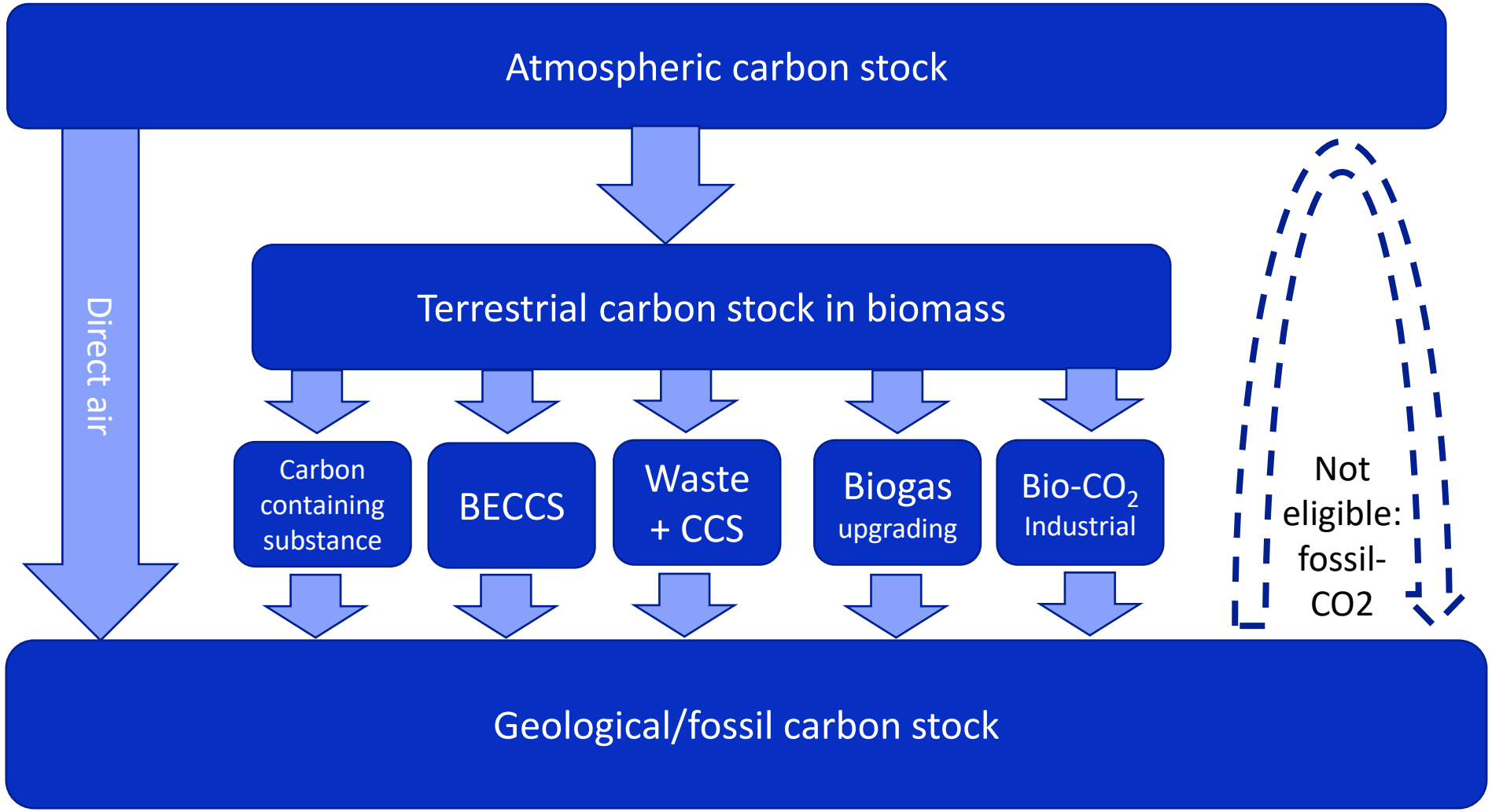
South Pole - Esther Mertens, Christian Ehrat

Stockholm Exergi - Fabian Levihn

Tondu Corporation - Joe Tondu

Members of the work group provided competence in their fields of expertise. The Methodology document does not necessarily reflect the views of individual members or other contributors.

Example of meta-level methodology: harmonizing across technologies



Example of trade-offs that were discussed in workgroup

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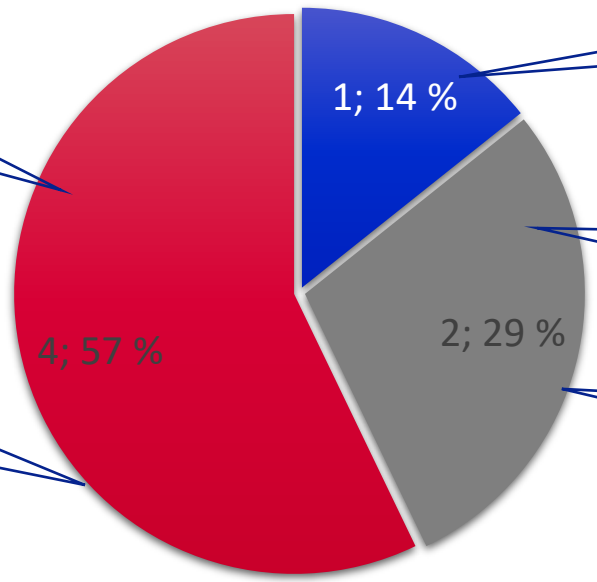
Q1: Are the CCS equipment (materials, construction) included in the activity boundary?

- A) Yes, all CCS related equipment emissions are included (material, construction). Argument: Must be net negative, all emissions are relevant for climate impact.
- B) Yes, partially. For example, transportation equipment should be included if they are pipelines (built solely for CCS) and excluded if used for various purposes (trucks, container ships). Argument: Predefined percentage, for example 3%. if the emissions
- C) No, emissions related to construction of equipment and storage should not be included. Argument: Emissions from installations account for a small share of total emissions. Equipment emissions are very difficult to calculate.

Not significant compared total removed CO2, only 2-3% max.5%

No, Buyers have not requested this



Yes, all emissions are relevant for carbon balance

Yes, but very time-consuming to calculate every nut and bolt. Maybe use a proxy (e.g.CAPEX costs) to estimate the emissions.

If included, equipment fabrication emissions needs a clear amortization schedule.

Geologically removed carbon CO_2 Removal Certificate (CORC):

1 metric ton of CO_2 removed from the atmosphere

net of any life-cycle process emissions

intended to be permanently stored under ground.

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Q & A

Q & A Panelists

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Waste-to-Energy + CCS: **Jannicke Bjerkas,** CCS Director, **Fortum Oslo Varme** (Norway)

Fortum Oslo Varme has developed a CCS project on waste-to-energy which provides a blueprint for cities across Europe on how to best deal with CO_2 emissions from non-recyclable waste.

DACCS: **Brett Cooper, Southern Green Gas** Ltd (Australia)

Southern Green Gas is an Australian renewable energy company pioneering technology for carbon-neutral fuels and generating negative emissions via direct air capture of CO_2 linked to geological storage.

BECCS: **Dr. Fabian Levihn**, Head of R&D, **Stockholm Exergi** (Sweden)

Stockholm Exergi is the city of Stockholm's energy company ensuring that the fast-growing region has access to heating, cooling, electricity, and waste processing services. In 2019, they opened their first research facility for Bio-CCS.

Storage: **Cristel Lambton**, Technical manager, **Northern Lights** (Norway)

Northern Lights project is part of the Norwegian Longship project with the ambition to create a complete carbon capture and storage value chain in Norway and Europe.

EOR+ : **Esther Mertens**, Head of European Projects, **South Pole** (Netherlands)

South Pole is a leading climate solutions provider and project developer with over 400 experts in 18 offices worldwide.

Cluster: **Camilla Brox , BORG CO_2** (Norway)

Borg CO_2 is a Norwegian company established to facilitate and manage studies on Carbon Capture Utilization and Storage (CCUS). Their long-term goal is to build an industrial CCUS cluster.

Q & A Panelists

DACCS: **Louis Uzor**, CDR Specialist, **Climeworks** (Switzerland)
Climeworks is the world's leading direct air capture company. In 2020, it raised 100M USD– the largest ever private investment into direct air capture.

Bio oil: **Shaun Meehan,** Co-founder & Chief Scientist**, Charm Industrial (US)**
Charm Industrial converts waste biomass into fast pyrolysis bio-oil, then injects bio-oil deep underground as negative emissions

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Questions

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DACCS – Louis Uzor: Direct air capture is very energy-intense – it takes very much electricity to capture CO_2 from thin air. How can DACCS be net-negative? How are you able to remove more CO_2 that you emit, when all energy-related emissions are counted in the balance?

Bio oil - Shaun Meehan: Bio-oil acts differently. You inject bio-oil underground instead of CO_2-gas. Does that impact the kind of geological formation you can use? The cavity depth and type?

Storage operator - Cristel Lambton: Can you explain how is it possible that a gas remains underground? Why doesn't it escape? What characteristics does the geological formation have to have for it to be "air-tight"?

EOR+ - Christian Ehrat : There is a contradiction in EOR+. You are pumping out fossil fuel from the well. How do you explain that this is good for the climate?

Transport and Storage - Camilla Brox: Shared transport and storage makes sense, but how can you measure amount of CO_2 stored per Capture operator, when the gases have been mixed?

Waste-to-energy operator - Jannicke Bjerkas: Municipal waste that is incinerated for energy is a mix of different sources. In this methodology only biogenic CO_2 is accepted. How do you know which fraction of your municipal waste is biogenic?

Questions

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Final questions to All panelists:

Marianne explained how the trade-offs and harmonization across technologies were discussed in the workgroup. How did you feel about that way of working?

Very briefly, what is the one thing you want the audience to remember about this geologically stored methodology?

Last question to Mark Preston Aragonès from Bellona: How do you see this methodology in relation to the carbon removal definition that you presented in the beginning?

We invite you to provide your comments on the methodology

Submit your feedback

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