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3rd Meeting of the Carbon Removals Expert Group

Methodologies for Industrial Carbon Removals

25 - 26 October 2023

Christian HOLZLEITNER, Head of Unit,
European Commission, DG CLIMA, Unit C3

Housekeeping Rules

1. IN-PERSON PARTICIPANTS: WEAR YOUR BADGE
Keep your badge (V-Pass) visible.

2. ONLINE PARTICIPANTS: TURN ON YOUR VIDEO & MUTE YOURSELF
We encourage you to turn on your video. Please leave your microphone on mute, unless you take the floor.

3. ASK QUESTIONS & INTERACT (in the room + Webex & Slido)
We want to hear from you! Please ask questions & share comments! We will try to take at least one question from each Webex and Slido in the Q&A.

4. CONSENT FOR THE WEBSTREAM RECORDING & PICTURES
Be informed that the meeting will be web-streamed, recorded and pictures will be taken.

5. SOCIAL MEDIA: #EUCarbonRemovals
Your posts and comments can help others learn more about the topic and connect with like-minded professionals in the industry.

NB - change of room tomorrow: 1D

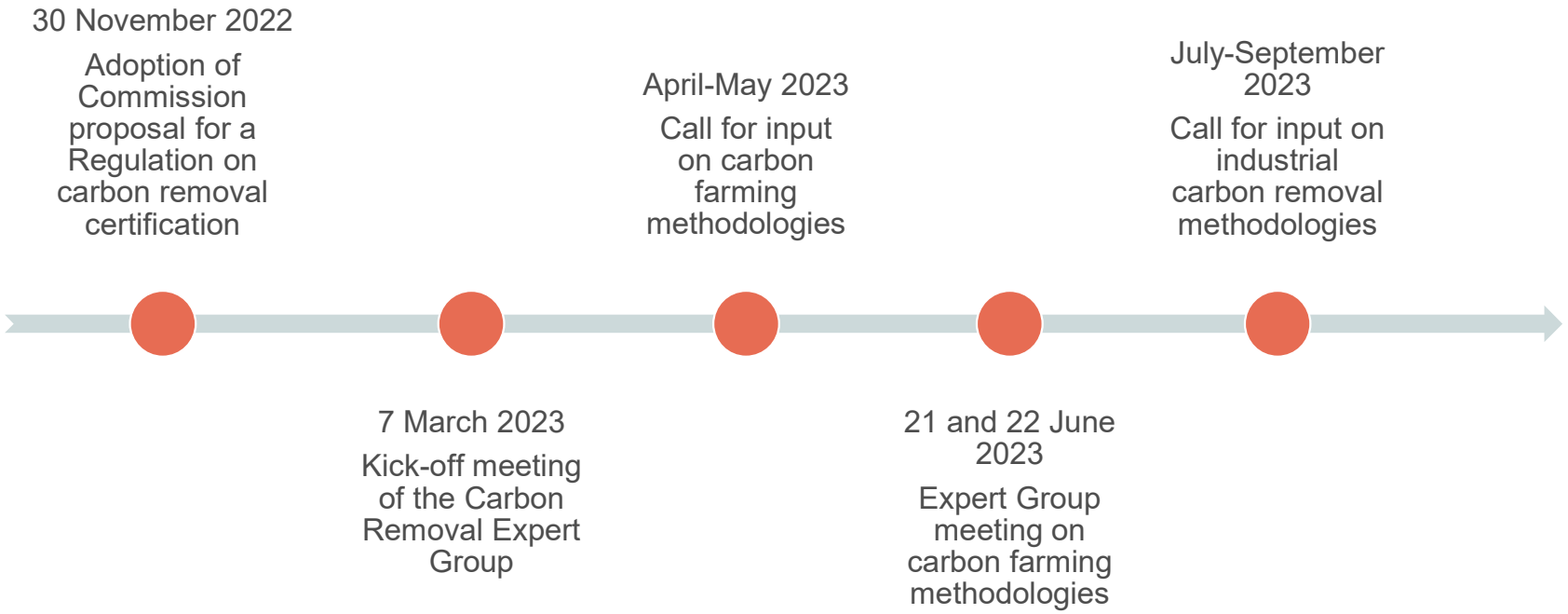
Agenda: DAY 1

10:00	Opening remarks and update on activities *with Q&A*
10:30	Keynote: Importance of robust methodologies for carbon removal purchases
10:45	Presentation of the paper on methodologies for permanent CDR
11:00	*Discussion session*: DAC methodologies
12:30	Lunch break
13:30	*Discussion session*: BECCS methodologies
15:00	Coffee break
15:15	*Discussion session*: Transport & geological storage
16:45	*Discussion session*: Modular framework for industrial CDR
From 17:30	Networking drinks at Grand Central, Rue Belliard 190

Agenda: DAY 2

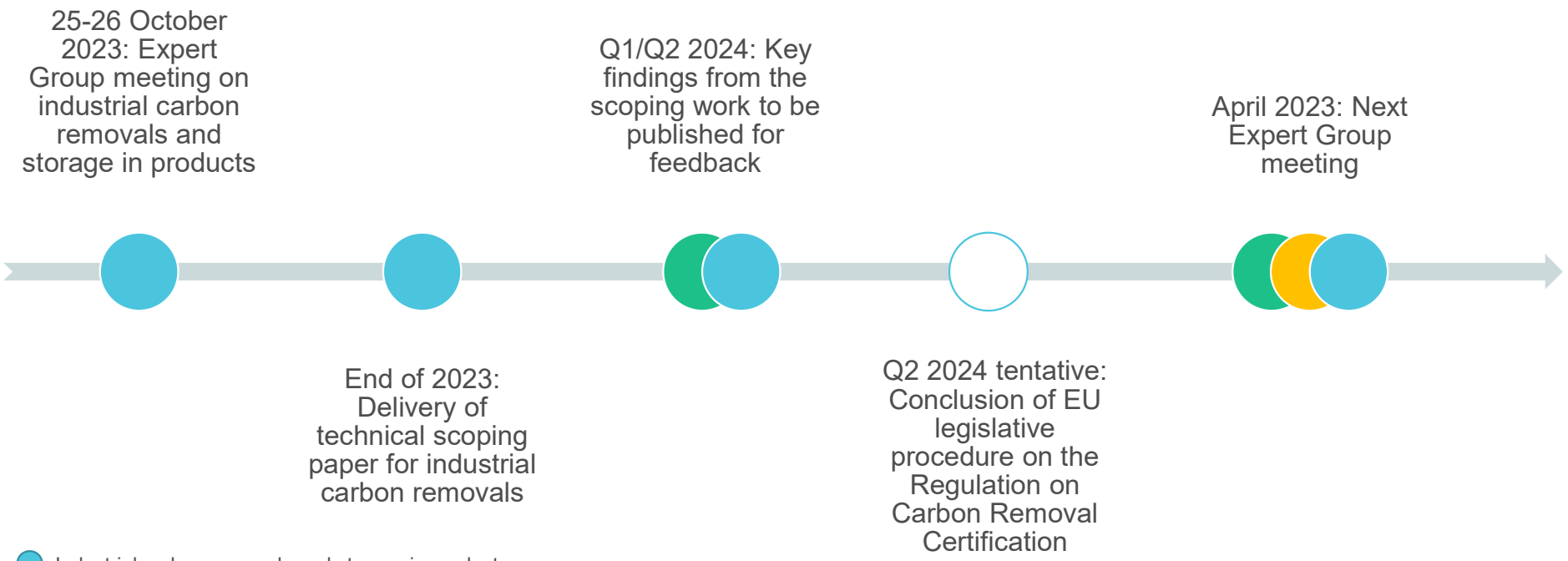
9:00	*Discussion session*: Storing carbon in biochar
10:30	Coffee break
10:45	*Discussion session*: Mineralisation - permanent storage in concrete
12:15	Lunch break
13:15	*Discussion session*: Biogenic carbon storage in buildings
14:45	Coffee break
15:00	*Discussion session*: Improving MRV of emerging methodologies: enhanced weathering
16:00	Concluding remarks from DG CLIMA

What's the state of play?



European Commission

Expert Group in the months ahead



European Commission

Looking towards the April 2023 meeting

- Carbon Farming
- Industrial removals & storage in products
- Verification & registries rules

Tentative agenda:

- Presentation of the Carbon Removal Certification Framework
- Discussion of the work plan
- Discussion of the key findings from the scoping work
- Presentation of the verification & registries rules workstream

KEYNOTE

Importance of robust methodologies for CDR purchases

By Rafael Broze, Senior Programme Manager,
Carbon Removal, Microsoft

PRESENTATION

Technical scoping paper on methodologies for permanent removals

By Chris Malins, Cerulogy

Support to the development of methodologies for the certification of industrial carbon removals with permanent storage – Technical Scoping Paper

25 October 2023

Expert group on carbon removals, 25-26 October 2023

ICF in collaboration with Cerulogy and Fraunhofer ISI

Background

- In order to deliver high quality carbon removals, the Commission has conceived the "QU.A.L.ITY" framework, which stands for Quantification, Additionality, Long-term storage and Sustainability
- Our consortium has been chosen to support the Commission in the development of certification methodologies for industrial carbon removals
- **Our first task was to produce a technical scoping paper identifying relevant elements of existing policies and standards**
  - The draft of this document was shared with the expert group a week ago
  - Following this meeting, this document will be finalised; it will then inform our ongoing work
- The project is scheduled to run for 18 months from June 2023

Objectives of the TSP

- Identify existing approaches that the methodologies for certification of industrial carbon removals can build on
- Look at regulatory approaches and at other standards
- This exercise was extensive, but not comprehensive
  - Discusses relevant aspects of 6 EU regulations and 13 other standards
  - Informed by feedback received on written survey circulated to the expert group
  - Identifies additional potentially relevant resources that are not reviewed in the TSP but may be considered in the ongoing work
  - The consortium will continue to engage with the expert group and others to identify relevant material, but reviews of other frameworks or new methodologies will not be added to the TSP document
- Survey
  - 74 submissions received, including developers of methodologies/standards, economic operators, parties involved in the certification process
  - Survey responses have been used in finalising the TSP draft, and will also be considered in the ongoing work

Assessment of relevant methodologies from EU regulatory framework

1. ETS Directive

- Quantification – accounting for on-site sources
- Additionality and baselining – potential relevance of ETS benchmarks in baselining
- Long-term storage – forthcoming delegated act on 'permanently chemically bound' carbon
- Liability – leakage from transport and storage of CO_2 is regulated by ETS

2. Monitoring and Reporting Regulation

- Quantification - emissions monitoring rules for on-site emissions, uncertainty assessment, site boundary setting

3. CCS Directive

- Quantification – rules for storage site and transport network management
- Long-term storage – rules for site management and monitoring, CO2 stream composition, counter measures for leakage
- Liability – provision for transfer of liability from storage operator to state

4. Renewable Energy Directive

- Quantification – lifecycle analysis framework for bioenergy, RFNBOs, RCFs, indicative ILUC values
- Additionality and baselining – rules for identifying renewable energy as additional (RFNBOs) and agricultural production as additional (low ILUC-risk)
- Sustainability – criteria for biomass used as bioenergy feedstock

5. Sustainable Finance Taxonomy

- Sustainability – technical screening criteria for sustainability for CO_2 transport and storage, DAC and other potentially relevant activities, as well as generic criteria 'do no significant harm' criteria

6. Innovation Fund

- Quantification – GHG calculation rules for IF projects, including identification of net carbon removals, monitoring rules for operational phase

Assessment of relevant methodologies from private standards and non-EU public frameworks

Standards/frameworks reviewed

1. Clean development mechanism
2. ISO 14064-2
3. Puro.earth
4. Verified Carbon Standard
5. CCS+
6. American Carbon Registry
7. Climeworks/Carbfix DACCS methodology
8. GHG Protocol Land Sector and Removals Guidance
9. Global Carbon Council
10. Drax-Stockholm Exergi BECCS methodology
11. JOGMEC CCS guideline
12. Gold Standard
13. Isometric

Assessment of relevant methodologies from private standards and non-EU public frameworks

Areas of difference between standards

Quantification

- Emissions from 'capital goods' (buildings, equipment)
- GHG intensity of consumed electricity
- Indirect emissions*
- Assessment and handling of uncertainty
- Certification periods and project renewal
- Double counting and double claiming

Long-term storage and liability

- Minimum period of expected carbon storage treated as a removal
- Issuance of credits based on modelling
- Assessment of reversal risk
- Use of buffer pools
- End of liability for reversals

Additionality and baselining

- Use of 'direct' additionality assessment versus performance standards/positive lists
- Elements of additionality testing required (financial, barrier analysis, regulatory surplus, common practice)
- Specification of financial additionality tests

Monitoring, reporting and verification

- Relative consensus on requiring reasonable assurance verification statements

Sustainability

- Approach to biomass sustainability
- Recognition of positive co-benefits

**Noting that the term 'indirect' is used differently between inventory-focused and LCA-focused approaches – the CRCF uses it in the sense normally used in LCA contexts.*

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INDUSTRIAL CAPTURE OF CARBON

Direct Air Capture

1. **Presentation** of a DAC methodology, Louis Uzor, Climate Policy Manager, Climeworks
2. **Comments**
    - Eadbhard Pernot, Policy Manager, Clean Air Task Force
    - Selene Cobo Gutiérrez, ETH Zurich and NEGEM
3. **Q&A session**

climeworks

DAC Methodology presentation

Input to 3rd Expert Group Meeting on industrial carbon removals

Context | CDR via DAC and Climeworks

Climeworks: Operating the world's **only** operating direct air capture & storage facility.

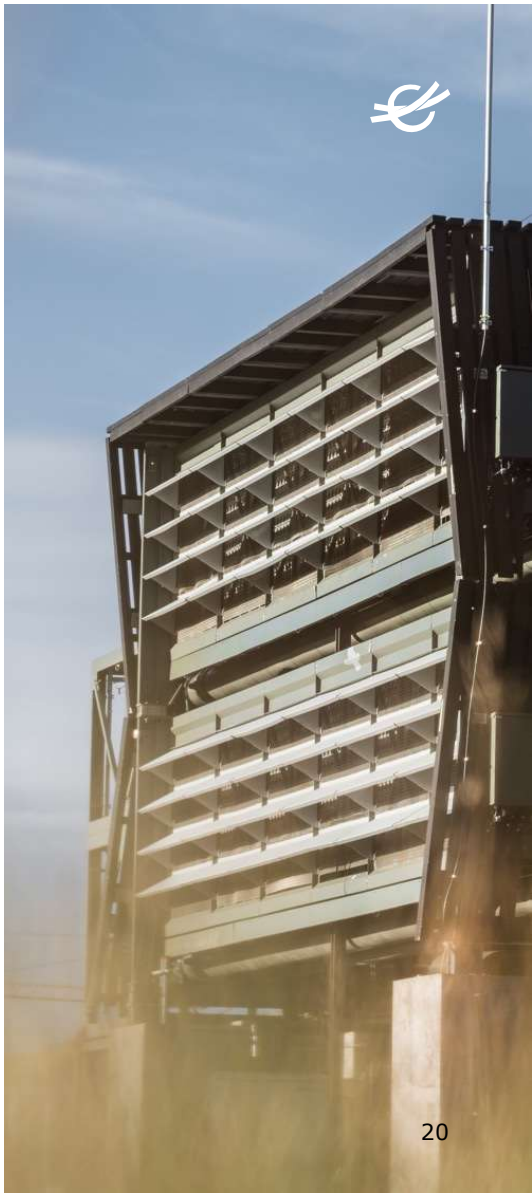
Project Orca: Started operation in September **2021**

Climeworks: Developed the worlds first methodology specifically for DAC+S at Orca, in collaboration with **Carbfix** and involving **DNV** as VVB.

Project Orca: Powered 100% by **geothermal energy**

Carbfix: CO_2 permanently stored underground through **mineralization**

Goals today:
i) **WHAT** the methodology requires,
ii) **HOW** it is implemented and practical challenges
iii) **WHY** we made certain choices for context.



WHAT - DACS | Methodological basis

Methodology for direct air capture

Read more

Methodology for underground mineralization storage

Read more

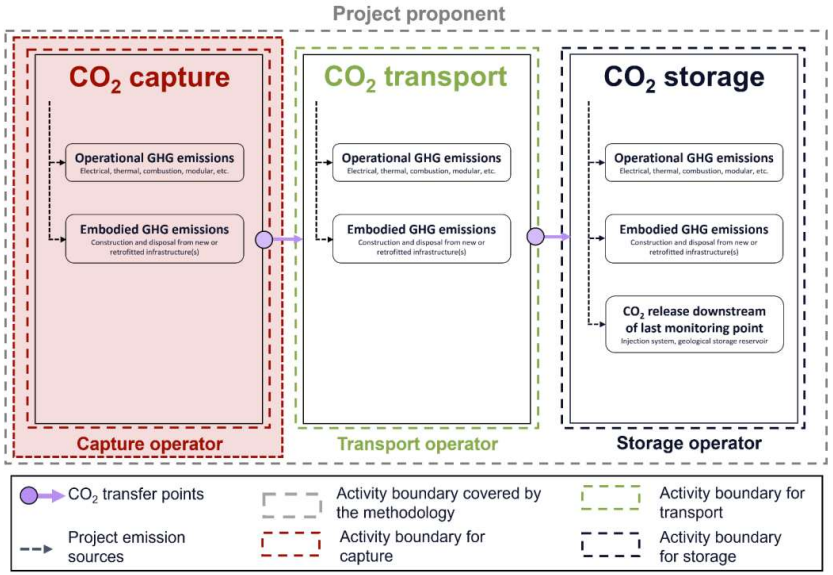


Figure 1 - Project activity boundaries and full chain processes.

DACS informed by modular methodologies that have been validated against ISO 14064-2 by DNV*

Project proponents have to cover full-chain processes from capture to storage, following primarily an LCA approach.**

* Non-accredited validation; 2019 version

** Input is concerning the capture methodology, but final CDR quantification requires full chain quantification

WHAT | Applicability conditions

- **Overall project**:
  - Single capture projects (Importance of „last monitoring point" – i.e. no hubs)
  - Informed by LCA approach: Going beyond geographical boundaries (e.g. including relevant embodied emissions) and crossing temporal boundaries (e.g. amortization of construction emissions over time)
  - Measure where possible
- **Capture related**:
  - Restricted to TVS a**d**sorption processes
  - Capturing for the sole purpose of subsequent in-situ storage
- **Transport related**:
  - Transport via **pipeline** only

WHAT | Boundaries and Quantification

- Baseline scenario - no other activity

- Boundaries - The methodology follows an LCA approach
  - Main DAC emission sources (informed by operational experience and scientific assessments)
    - Energy (thermal and electrical)
    - Other process inputs (e.g. materials)
    - Construction and disposal (highly sensitive to expected plant lifetime)

- Additionality - Baseline choice resolves additionality questions (methodology nevertheless refers to CDM tool).

- Last monitoring point – Injection based quantification allows to simplify upstream capture monitoring, but requires
  - i) single capture source projects and
  - ii) additional reflection of losses happening beyond this point

Table 1: Sources and GHGs

	Emission Source	Gas	Included	Justification / Explanation
Baseline	No other activity in the absence of the project and operation activity	n/a	n/a	n/a
Project activity	Electricity usage (DAC facility)	CO_2	Yes	CO_2 is major emission from source
		CH_4	Yes	Included for completeness
		N_2O	Yes	Included for completeness
	Thermal energy usage (DAC facility)	CO_2	Yes	CO_2 is major emission from source
		CH_4	Yes	Included for completeness
		N_2O	Yes	Included for completeness
	Other process inputs incl. disposal	CO_2	Yes	Major emission from source
		CH_4	Yes	Included for completeness
		N_2O	Yes	Included for completeness
	Vented and fugitive emissions (DAC facility)	CO_2	Yes	Major emission from source
		CH_4	No	Assumed negligible
		N_2O	No	Assumed negligible
	Embedded GHGs in construction and disposal	CO_2	Yes	Major emission from source
		CH_4	No	Assumed negligible
		N_2O	No	Assumed negligible

$$mCO_{2,credited,y} = mCO_{2,injected,y} - mCO_{2,released,y} - mCO_{2eq,project,operation,y} - mCO_{2eq,project,embodied,y}$$

Calculation of CO_2 credited during monitoring period (y): Equation. 1

where			
$mCO_{2,credited,y}$	=	total amount of CO_2 credited in own accounting or sold/transacted to third parties in period *y*.	tonne (tCO_2)
$mCO_{2,injected,y}$	=	total amount of CO_2 injected in the geological storage in period y, determined at the last monitoring point.	tonne (tCO_2)
$mCO_{2,released,y}$	=	total amount of CO_2 released downstream of the last monitoring point at the storage site in period *y*. **(determined according to Storage Methodology)**	tonne (tCO_2)
$mCO_{2eq,project,operation,y}$	=	total GHG emissions due to project operations of the CDR value chain (DAC, Transport, and Storage) in period *y*.	tonne (tCO_2)
$mCO_{2eq,project,embodied,y}$	=	total GHG emissions due to construction and disposal of the CDR value chain (DAC, Transport, and Storage) scheduled for monitoring period *y*.	tonne (tCO_2)
y	=	monitoring period during which credits are produced	days

HOW | Real and science-based

- Inputs shall be metered wherever reasonably possible and/or quantified by their supplier.
- Emission factors for process inputs shall be derived from relevant literature following international standards.
- Trust vs. control: Default values for DACS are scarce. Some consumption values (e.g., for process inputs or overall plant lifetimes) and/or emission factors are unknown (given DACS is a novelty) or need to be initially assumed. The methodology requests ex-post controls and requires safeguards against shortfalls. This is done either via:
  - third party control (e.g., supplier's data or input specific LCA requests by trusted labs),
  - verification and/or
  - periodic revisions.

➔ E.g., for filter material consumption, the methodology foresees that:
Over the life of the project, all actual emissions must agree with the total emissions determined during the monitoring period either through adjusting the emission factor(s) and replacement rate fixed values, or by reconciling the difference between reported and actual emissions in the monitoring report. The project must show that all sorbent emissions have been accounted for at the end of the project life.

How | Flexibility caters to the novelty of DACS

- Embodied emissions are to be totalled across project phases as shown in Equation 5 and shall be scheduled to be deducted from injected CO_2 quantities during the project life. The project may decide the schedule and division of the emissions as long as a minimum of 50% of the embodied emissions are scheduled within the first 50% of the project lifespan and all embodied emissions are scheduled for within the project lifespan.

→ Outlines Climeworks‘ ambition to reflect the true impact of operations. Ultimately only works with trustworthy actors as hard to safeguard without buffer requirements

- Figure 2 identifies the operational inputs and output parameters of the DAC component in a capture-transport-storage process. The input parameters will vary slightly between different projects, but should include:
  - Energy requirements (heat, electricity, etc.)
  - Sorbent material
  - Other process inputs (water, etc.)

→ Should include vs. shall include…

- Depending on the project, the quality (weight fraction) of the CO_2 stream may be measured in the capture or transport component of the project.

→ Reflecting the realities of project Orca

Why | Climeworks' methodology history

2018

Commissioned first DACS demonstration prototype

2019a

CDR service available to individuals

2019b

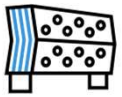
Searching for externally approved standard

2020

Initiating methodology development with plural external GHG-Programs

2021

Commissioning Orca



2022

Publishing the ISO based methodology validated by DNV

2022

Auditing and first verified deliveries based on ISO

2023

Ongoing learnings for further standardizations

Ongoing collaborations with various actors in CDR certification.

Why | Methodology development via plural projects

- Climeworks remains uniquely positioned to inform methodology development and establishment based on real world examples
- This approach requires further standardization and collaborations,
  - In terms of methodological clarity (e.g. other DAC/storage approaches and Climeworks‘processes)
  - In terms of governance (i.e. Climeworks acting as a GHG-Program or not)
  - GHG-Programs‘ willingness and ability to cater to the specific needs of the emerging CDR sector (CDR economics, CDR business sensitiv data, subcategories of CDR).

➔ **We are offering a unique blueprint based and linked to our expertise via the Orca project.**

➔ **We are continuously improving our expertise by understanding real-world implications.**

3 key points for future methodology developments

- Energy sourcing:
  - Market-based vs. location-based assessment of DACS

  ➔ DACS will not scale without flexibility in siting, but the energy transition is not (yet) seen in all grids.

- Plural capture sources:
  - Hub projects with plural CO2 capture sources storing at the same site are seen benefitial for additional cost reductions.

  ➔ Resulting in additional methodological complexities that can be overcome via (more complex) modular frameworks.

- Additionality assessment:
  - For DAC to become climate relevant, substantial investment is necessary. Additionality assessments will become more and more complex for public/private partnerships.

  ➔ Place DAC on a positive list but install periodic reassessments at the activity level.

INDUSTRIAL CAPTURE OF CARBON

Bioenergy with Carbon Capture

1. **Presentation** of a BECCS methodology by Johan Börje, Business Development, Stockholm Exergi
2. **Comments**
    - Fabio Poretti, Technical & Scientific Officer, CEWEP
    - Samantha Eleanor Tanzer, Delft University of Technology
3. **Q&A session**

Methodology for measuring net carbon dioxide removal through bioenergy with carbon capture and storage (BECCS)

v0.9, October 2023

Contributors

Stockholm Exergi	Drax	Eco Engineers
Erik Rylander	Angela Hepworth	David la Greca
Ulf Wikström	Lewis Rodger	Michael Welch
Johan Börje	Michael Goldsworthy	
	Matt Borghi	

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Why, Approach and Next steps

Why

- Lack of clear, consolidated methodology for BECCS with comprehensive view on sustainable sourcing of forest biomass
- Overdue need to describe ”product” in order to close BECCS CRU off-take agreements
- Contribute to the CRC-F process
- Contribute to convergence of the definition of sustainable BECCS

Approach

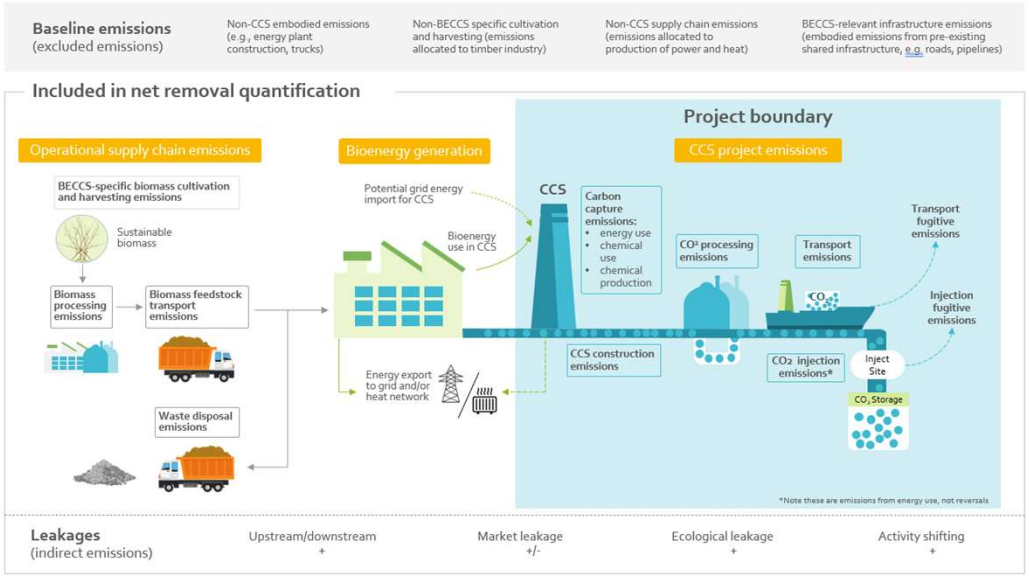
- ISO compatible (14064-2/3:2019, 27914:2017, 14065:2020, 14033:2019 plus 9001:2015)
- IC-VCM Core Carbon Principles
- EU legislation, Implementing decisions and Guidance documents, as well as proposals (CRC-F)
- Early customer requirements, e.g. Carbon Direct’s collection of biomass criteria
- Workable for BECCS / high-capex projects
- Conservative quantification

Next steps

- Informal consultation with interested parties
- Formal Consultation organized by DNV
- Extension from forest biomass only to agricultural biomass and plantation biomass feed-stock and other applications
- Consultation with SBP, SURE etc. to ensure manageable MRV of biomass criteria
- Negotiations with Standard bodies with a view of possible adoption as basis for Certification scheme
- Consultation with major potential off-takers to confirm acceptance

Baseline, Boundary and Net removal quantification

- Geographical scope: EU/EEA, UK, US
- Feed-stock: Forest biomass in first release, to be extended
- Storage: Only geological storage; Combination with Enhanced Hydrocarbon Recovery excluded
- Baseline: Existing embodied emissions and share of Operational Supply chain emissions. Biomass zero-rated
- Net removal quantification > Project boundary
  - Operational Supply chain emissions, with allocation factor
    - Up-stream emissions for biomass handling
    - Up-stream for energy emissions, energy plant (CH_4, N_20)
    - Down-stream for waste disposal
  - Leakage depending on Retrofit or New-build



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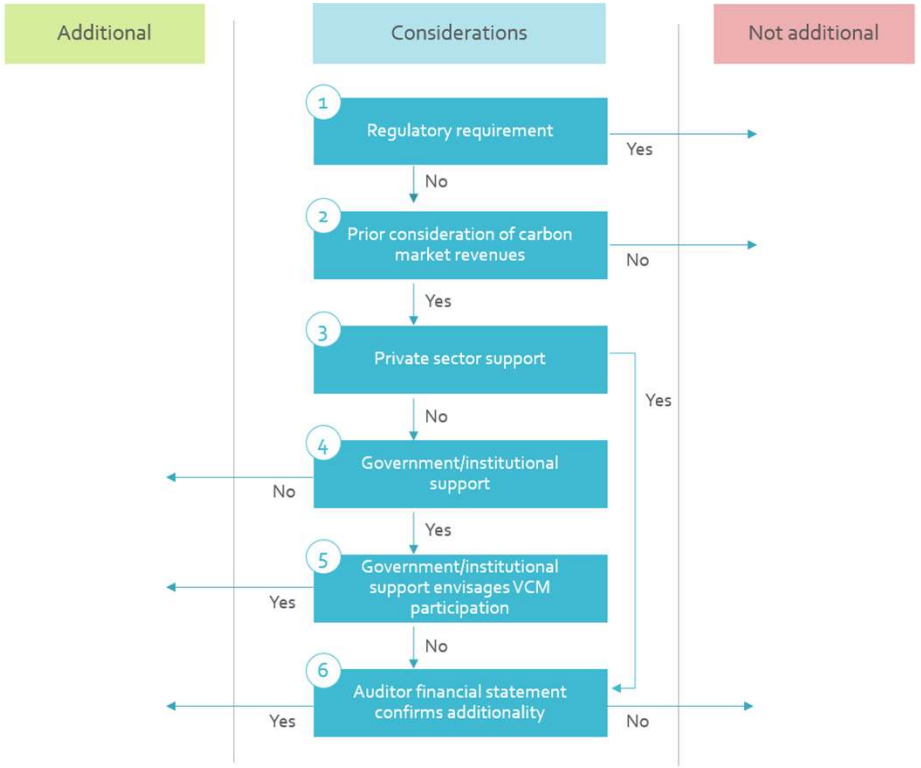
Additionality

- CRUs only produced if there is a buyer, i.e. they are by default additional
- Two checks necessary:
  - No regulatory requirement to do BECCS
  - Project not entirely funded by government
- Additional if Government/Institutional support envisages VCM participation
- If necessary, final assessment by financial auditor to determine Additionality



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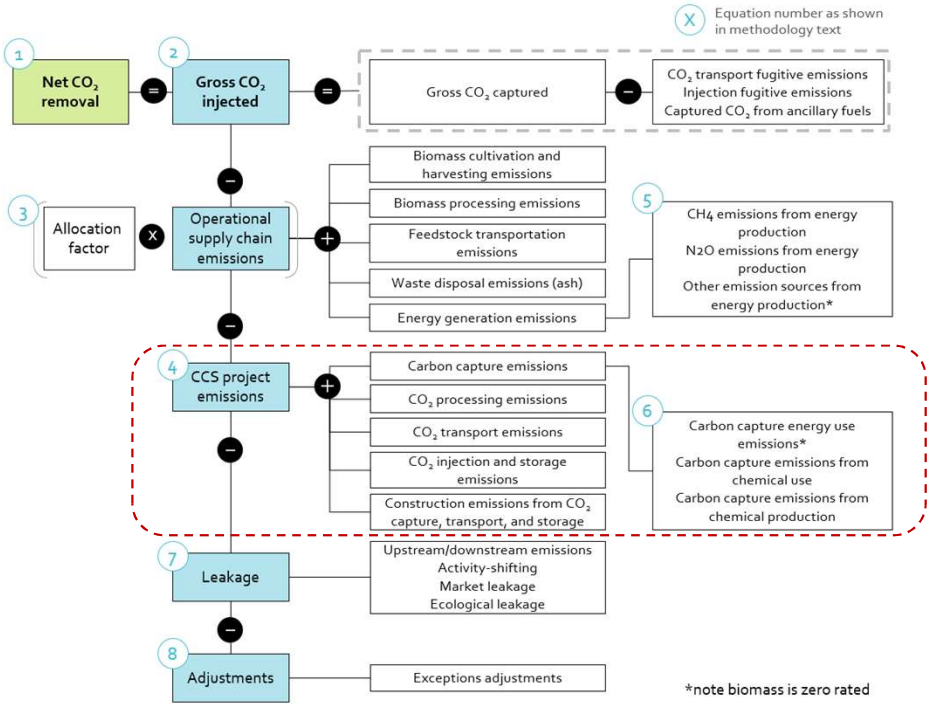
Project Emissions

- Energy emissions for Carbon Capture including Liquefaction and Intermediate storage – Power/Heat/Steam from bioenergy plant is zero-rated
- In case of other energy input (CC and Storage):
  - Regional grid emission factor
  - Directly connected generation facility
  - PPA with temporal and geographical constraints as those in EU Commission delegated act on hydrogen
  - Energy Attribute Certificates not applicable
- Emissions from chemical production and chemical use
- Embodied emissions of new infrastructure, amortized over 15 years



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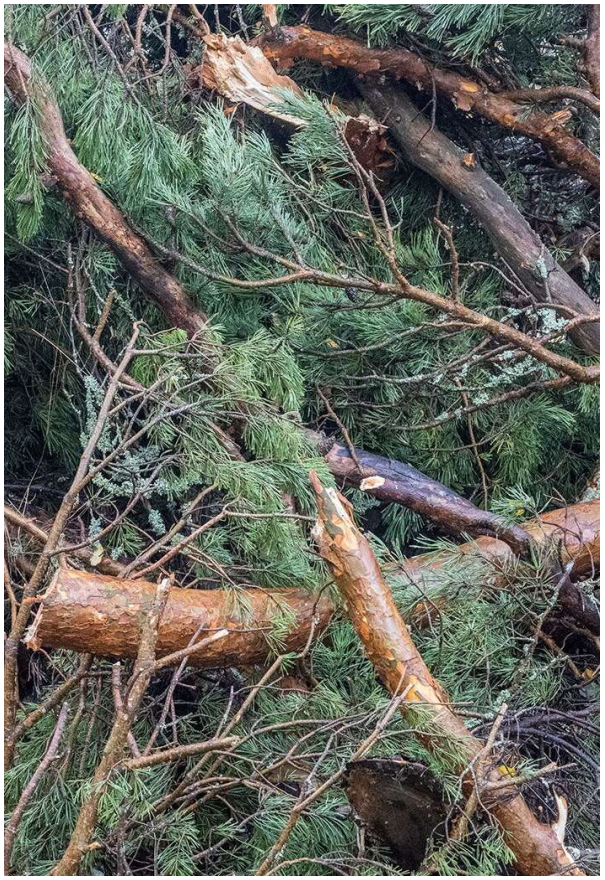
Sustainable biomass

- Inspired by Article 29 RED III, but greater clarity
- Sourcing must only be from areas where the carbon stock is maintained or increasing. Rolling 5 years -> 10 years [?]
- No sourcing from:
  - Primary forests
  - Old growth forests
  - Highly biodiverse forests
- No sourcing of roundwood that could otherwise be used for long-lived wood products
- Corruption Perception Index > 50
- MRV through Certification, Regulatory compliance and/or Independent assurance



Storage, Permanence and Reversals

- Buffer pool deemed unnecessary, unproportional and inappropriate
- Conclusion based on five principles
  - Scientific evidence that risk of reversal is negligible
  - State-of-the-art Regulatory framework
  - Boundary structure compatible with ETS/CCS directives
  - Incentive structure to deliver world class installation
    - ETS EUA requirement if CO_2 emitted from storage
    - 45Q repayment obligation
  - Compatible with IC-VCM

Store Type (Permit Awarded)	Description	Estimated worst-case amount as % of store capacity (125Mt CO_2)
Depleted Field Store	Leakage from all wells	0.070%
	Leakage from all geological features	0.002%
	Total leakage from storage complex	0.072%
	Total estimated contained mass at storage complex	99.928%
Fully or Partially Confined Saline Aquifer Storage Site	Leakage from all wells	0.064%
	Leakage from all geological features	0.024%
	Total leakage from storage complex	0.088%
	Total estimated contained mass at storage complex	99.912%

Deep Geological Storage of CO2 on the UK Continental Shelf, Containment Certainty, February 2023

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Leakage – Indirect emission impacts outside Project boundary and Operational Supply Chain emissions

- Based on ICVCM's structure for Leakage
  - Upstream/downstream emissions – e.g. Knock on infrastructure effects
  - Activity shifting – e.g. LUC
  - Market leakage – e.g. Energy leakage
  - Ecological leakage – e.g. Impacts from water use for biomass cultivation
- Energy leakage
  - No energy leakage if project part of Cap and Trade system
  - Energy leakage deemed immaterial if emission factor below 18g CO_2e/MJ (Hydrogen criteria)
  - Due to heat component, can be negative
    - Number of credits not allowed to increase, however
  - Conversion from Coal – no leakage
    - No separate crediting of conversion, however

Scenario	Non-CCS bioenergy plant construction in net removals quantification	Energy leakage from capture
Scenario A – retrofit BECCS The project enables the installing and operating of CCS equipment on a biomass power plant which would otherwise continue operations as is	✗	✓
Scenario B – new-build BECCS The project enables the development and operating of a new BECCS plant	✓	✗

New build: Energy plant operational <= 48 months before installation of Carbon Capture

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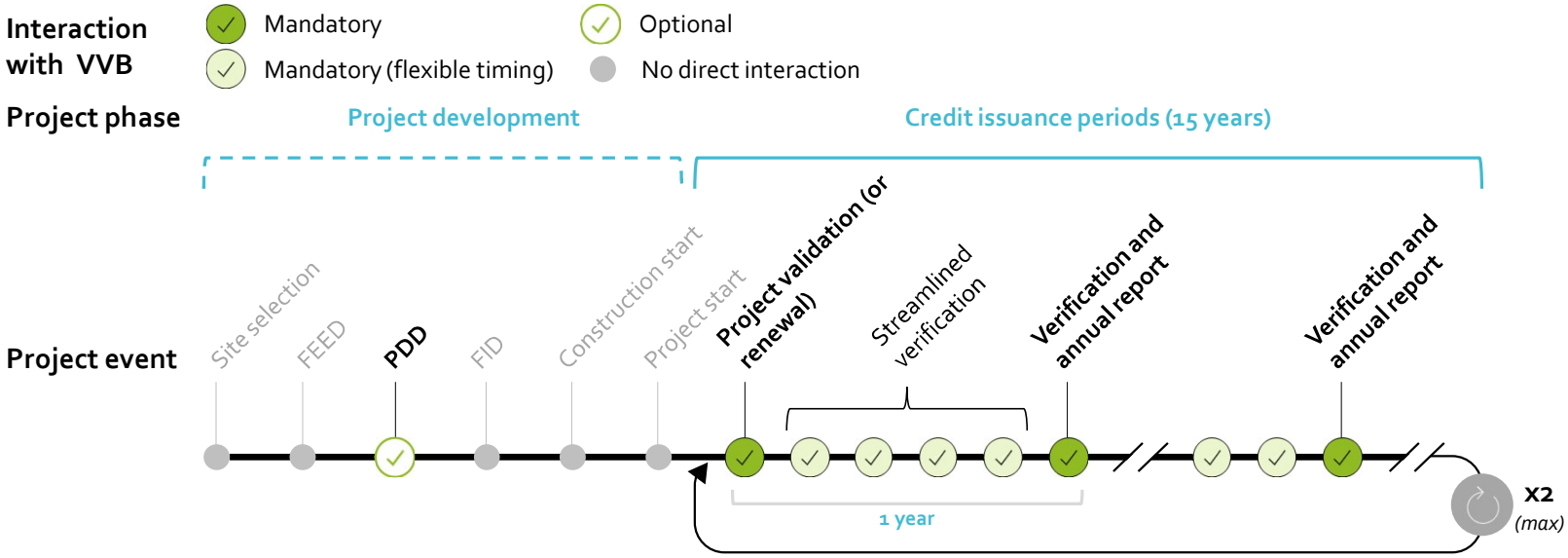
MRV – Typical Validation and Verification Cycle with independent third-party approvals



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Back-up

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The Registry requirements

- Serial number
- Issuing organization
- Issue date
- Last cancellation date
- Technology and feed-stock
- Capture company
- Capture plant
- Capture method
- Transportation method
- Storage location
- Storage method
- Reversal mechanism

- Transaction chain (price, date of sale, seller and purchaser)
- Cancellation date
- Cancelling party (holding corporation at the time of cancellation)
- Volume (standardized to 1 tonne or appropriate multiple thereof)
- Amount of CO_2 subtracted from gross tonne injected to arrive at net tonne (for issuance as CDR credits)

Under discussion:

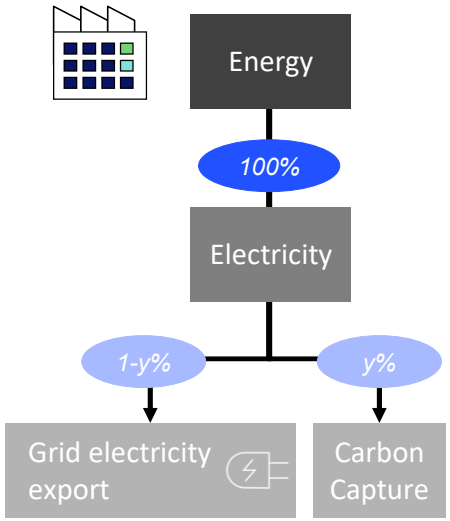
- Tag for Voluntary Carbon Market or Compliance Market
- Host country
- Chain of national adjustments (c.f. CA)

Purpose:

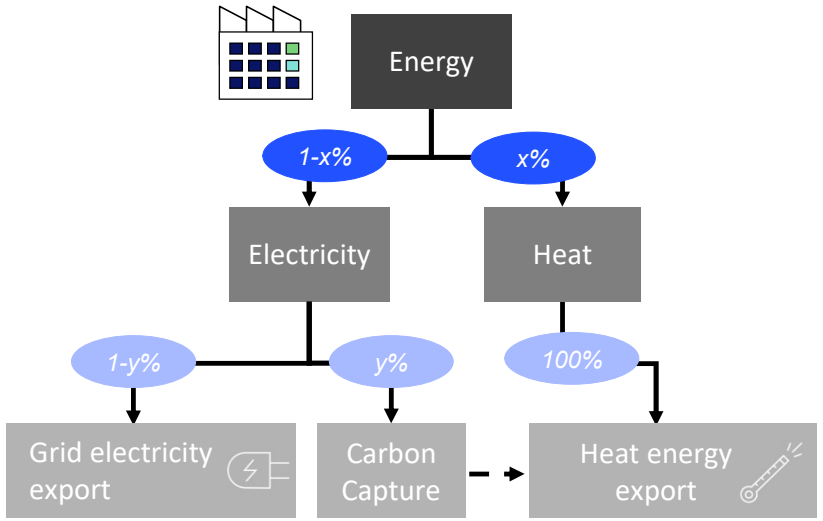
A BECCS plant must be able to issue CRUs applicable both towards voluntary purposes (CRU-V) as well as compliance purposes (CRU-C). Possibly a CRU should be able to transition from voluntary application to compliance application. For a CRU-C, the set-up must be able to keep track of transactions such that the mitigation outcome is only counted by one Nation/NDC.

Supply chain emission allocation factor by BECCS plant type

Type A: Power only



Type B: Combined heat and power (CHP)



Share of operational supply chain emissions allocated to CCS project (AF_y) =

Share of plant's energy output allocated to CC

AF_y =

100 % * y%

AF_y =

(1-x%) * y%

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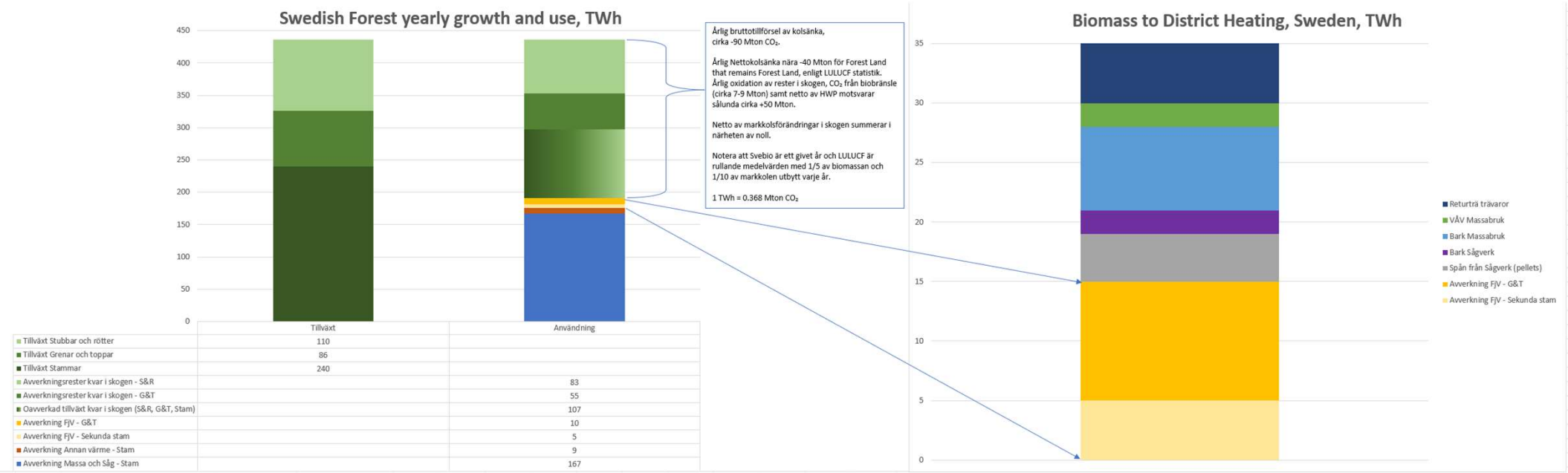
Examples of Conservativeness

- Retrofit – Include portion of existing supply chain emissions
  - Transport
  - CH_4 and N_20
  - Ash management
- Supply chain emissions will not be allocated to heat from heat recovery
- New build – Embodied emissions in energy plant
- No credits for replacement of fossil emissions
- Energy Attribute Certificates not allowed
- Leakage can never contribute credits, even though negative leakage (i.e. positive climate impact) could occur due to heat component

Swedish Foresty Growth and Usage. 2015



	Tillväxt	Användning
Tillväxt Stubbar och rötter	110	
Tillväxt Grenar och toppar	86	
Tillväxt Stammar	240	
Avverkningsrester kvar i skogen - S&R		83
Avverkningsrester kvar i skogen - G&T		55
Oavverkad tillväxt kvar i skogen (S&R, G&T, Stam)		107
Avverkning FjV - G&T		10
Avverkning FjV - Sekunda stam		5
Avverkning Annan värme - Stam		9
Avverkning Massa och Såg - Stam		167

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TRANSPORT AND STORAGE OF CAPTURED CARBON

Transport & Geological Storage

1. Presentation of the Monitoring and Reporting Regulation (MRR) by Christian Heller, Technical Expert, Umweltbundesamt GmbH

2. Comments

- Thomas Ratouis, Head of Reservoir Engineering, Carbfix
- Morten Skovgaard Olsen, Adviser, Danish Energy Agency

3. Q&A session

European Commission

umweltbundesamt
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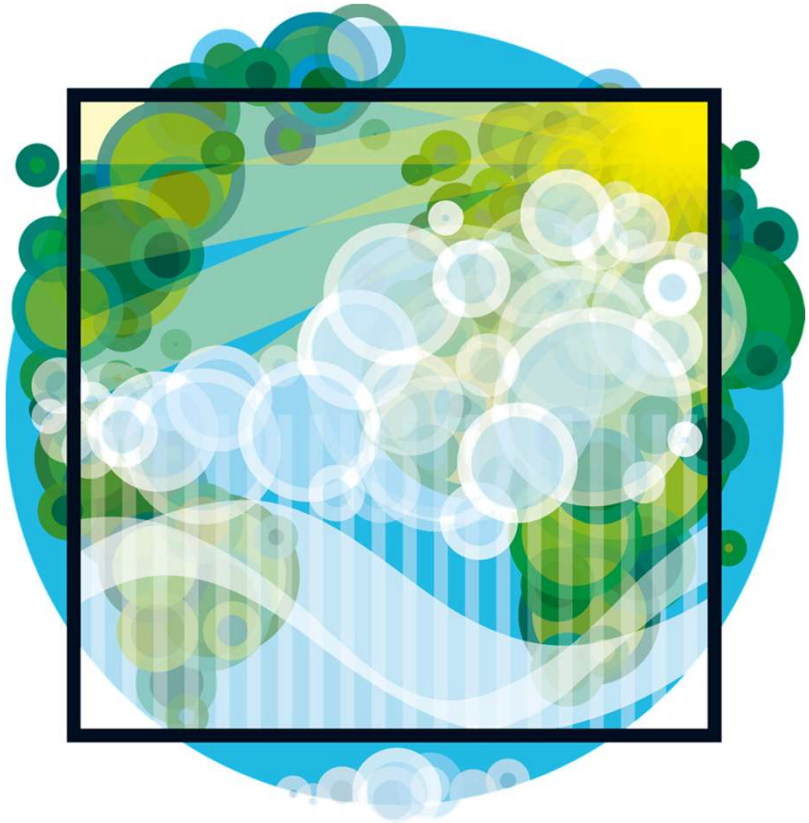

Expert Group Meeting on Industrial Removals

Monitoring rules for CCS in the EU ETS

Christian Heller

umweltbundesamt
ENVIRONMENT AGENCY AUSTRIA

CCS IN THE EU ETS

- May 2023: **Revision of the EU ETS Directive** as part of the Fit-for-55 package
- General principles of the EU ETS:
  - Each covered installation reports **only direct emissions!** (Scope 1 within installation boundary) → No indirect emissions (i.e. no Scope 2 and 3, no application of LCA)
  - Operators of an installation needs to obtain a **GHG permit** including an approved **Monitoring Plan**
  - Art. 14 EU ETS-D: Monitoring & Reporting Regulation (2018/2066/EU) contains **detailed monitoring rules**
- CCS relevant scope of the EU ETS Directive (Annex I activities):
  - **Capture** of greenhouse gases from installations covered by this Directive for the purpose of transport and geological storage in a storage site permitted under Directive 2009/31/EC
  - **Transport** of greenhouse gases ~~by pipelines~~ for geological storage in a storage site permitted under Directive 2009/31/EC, with the exclusion of those emissions covered by another activity under this Directive
  - **Geological storage** of greenhouse gases in a storage site permitted under Directive 2009/31/EC
    - *Permanence* assurance managed under the separate regime for geological storage (Directive 2009/31/EC; CCS-D)
    - *Reversal risk* covered by inclusion of permitted geological storage sites as installations in the EU ETS

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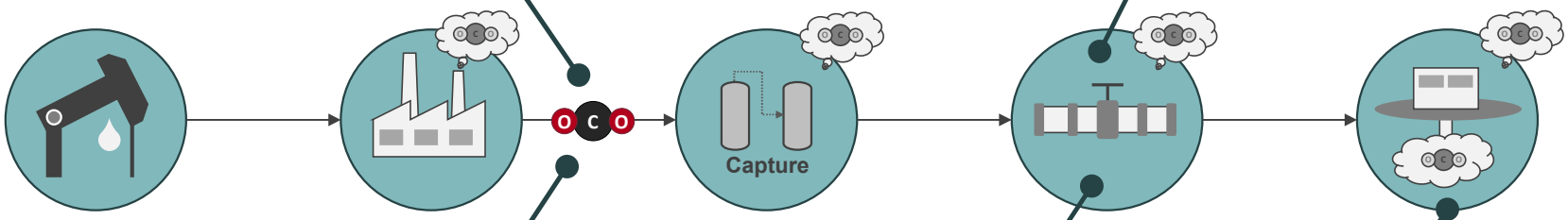
EU ETS: CURRENT CCS RULES IN THE MRR

Precondition for considering **CO_2 non-emitted**: storage site has **CCS-D permit**
Transferred CO_2 monitored via continuous monitoring systems (CMS)

CO_2 transport emissions:
Method A: Mass balance ($CO_{2,in}$ – $CO_{2,out}$) (CMS)
Method B: Direct monitoring of vented/leaked/fugitive emissions



Closed CCS 'chain-of-custody':
continuous ownership and liability for the CO2 molecule

Activity emissions: booster stations, etc.

Monitoring of any emissions from combustion, venting (CMS), leakage (max. uncertainty of 7.5%),...

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MRR QUALITY REQUIREMENTS

Reasons for derogation:
technical infeasibility or unreasonable costs

Type	General requirements	Required uncertainty (>50.000 t CO_2/year)	Required uncertainty (<50.000 t CO_2/year)
Combustion emissions	Calculation-based approach: Fuel quantity x NCV x EF	Fuel quantity: ±1.5% NCV, EF: Sampling & Analysis*	Fuel quantity: ±5% NCV, EF: Default values
Mass balance, venting	Continuous measurement systems (CMS)** Industry best practice guidelines	±2.5%	±7.5%
Fugitive emissions	Industry best practice guidelines Sampling & Analysis*	±2.5%	±7.5%
Leakage (into water column)	Sampling & Analysis*	±7.5%	

NCV = Net Calorific Value, EF = Emission Factor

*MRR Art. 32 to 35 = Application of relevant standards, sampling plan, use of accredited laboratories

**Relevant standards: EN 14181, EN ISO 16911-2, etc.

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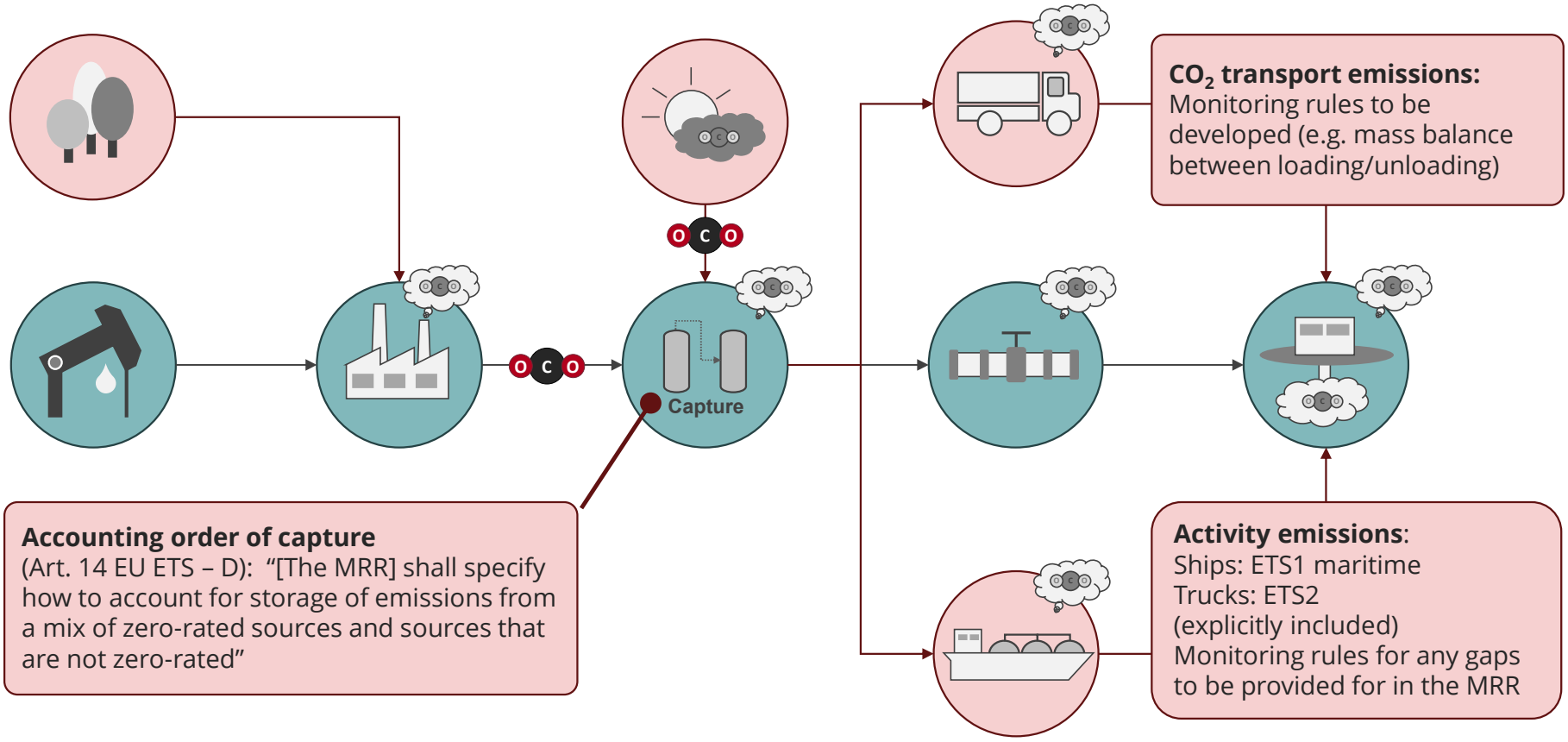
EU ETS: CCS RULES IN THE MRR UNDER DEVELOPMENT



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FURTHER (LEGAL) ASPECTS

- Art. 14 EU ETS Directive:
  - "[The MRR] shall provide for the application of the **sustainability and greenhouse gas emission-saving criteria** for the use of biomass established by [the Renewable Energy Directive]"
  - "[The MRR] shall specify how to **account for storage of emissions from a mix** of zero-rated sources and sources that are not zero-rated" → Accounting order of capture
- 2006 IPCC Guidelines (Vol 2, Ch 2, p 2.37) regarding the **treatment of captured biogenic CO_2** in national GHG inventories:

  "any subsequent emissions from CO_2 transport, CO_2 injection, and the storage itself should be counted in national total emissions, irrespective of whether the carbon originates from fossil sources or recent biomass production."
- Recital 30 of the CCS Directive "…**Liability for climate damage** as a result of leakages is covered by the **inclusion of storage sites** in Directive 2003/87/EC, which requires surrender of emissions trading allowances for **any leaked emissions**… "
- **Tentative planning** of MRR update: Adoption in Q2/2024

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Christian Heller
Senior EU ETS Expert

Christian.Heller@umweltbundesamt.at

Carbon Removal
Expert Group Meeting
25.10.2023

METHODOLOGY ARCHITECTURE

Modular Framework for Industrial Carbon Removals

1. **Presentation** by Christiaan Gevers Deynoot, Secretary General, CCS+ Initiative
2. **Comment**
    - Eli Mitchell Larson, Chief Science Officer, Carbon Gap
3. **Q&A session**

Building the market for industrial carbon management

How to design a resilient carbon accounting methodology architecture

CCS+ initiative

Christiaan Gevers Deynoot, Secretary General

Presentation to the EU Carbon Removal Expert Group
25 October, 2023

www.ccsplus.org | info@ccsplus.org

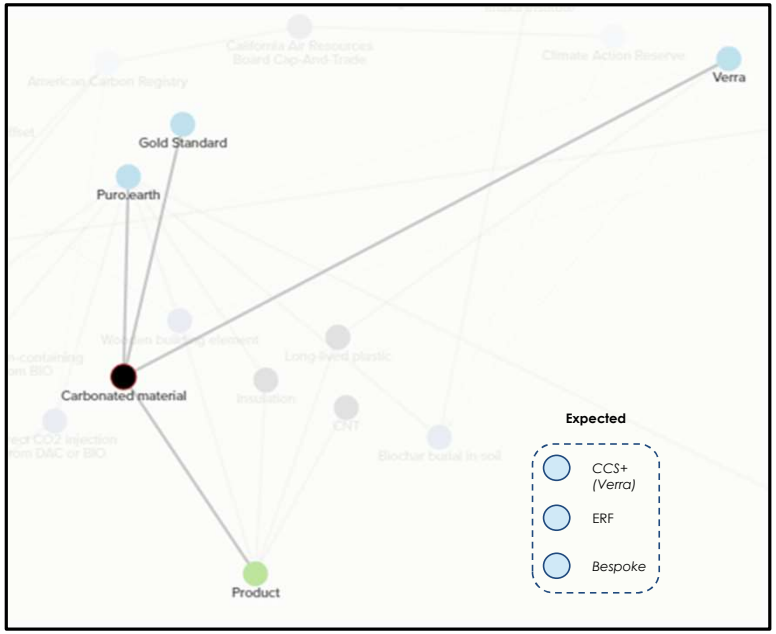
Our mission

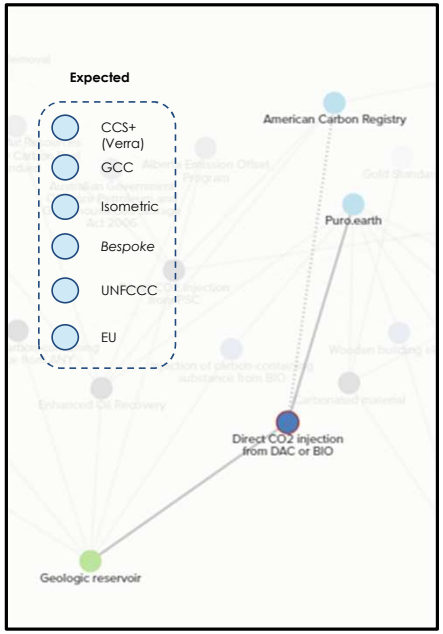
The CCS+ Initiative aims to scale cutting edge climate technologies by developing a robust carbon accounting infrastructure that promotes environmental integrity. The CCS+ Initiative separately accounts for emissions reduction and carbon dioxide removal solutions.

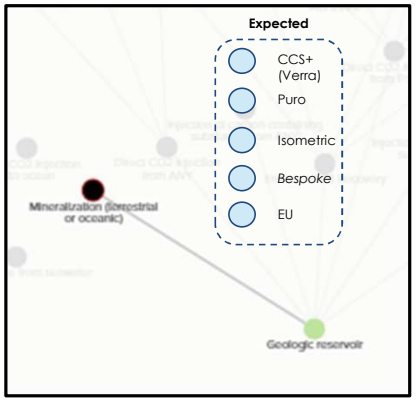
CCS+ Initiative

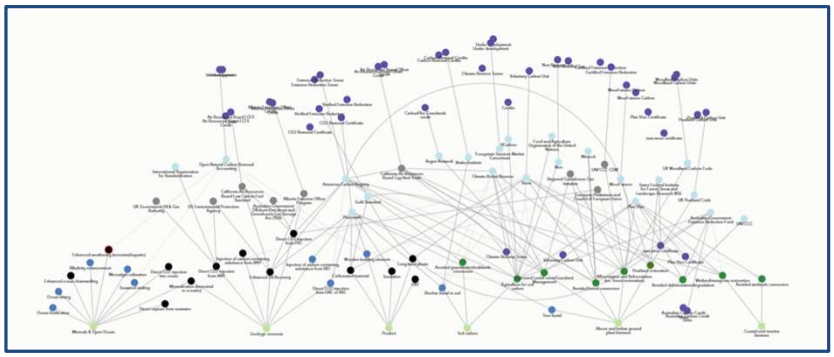
Reality check

Prevent methodology proliferation









Source: *Based on 'Snapshot of the Carbon Dioxide Removal Certification and Standards Ecosystem (2021-2022)' by Dr. Stephanie Arcusa, Center for Negative Carbon Emissions at Arizona State University, and Dr. Starry Sprenkle-Hyppolite, Moore Center for Science at Conservation International (available here)*

CCS+ Initiative

Purpose-led design

Keep the end-goal in mind

DIRECT EFFECTS

Enable the transparent and accurate quantification of climate change mitigation outcomes

+

INDIRECT EFFECTS

Unlock the responsible deployment of high-integrity emissions reduction and carbon removal projects at scale

Implementing methodologies

- Iteration
- Standardisation
- Verification
- Certification
- Monetization

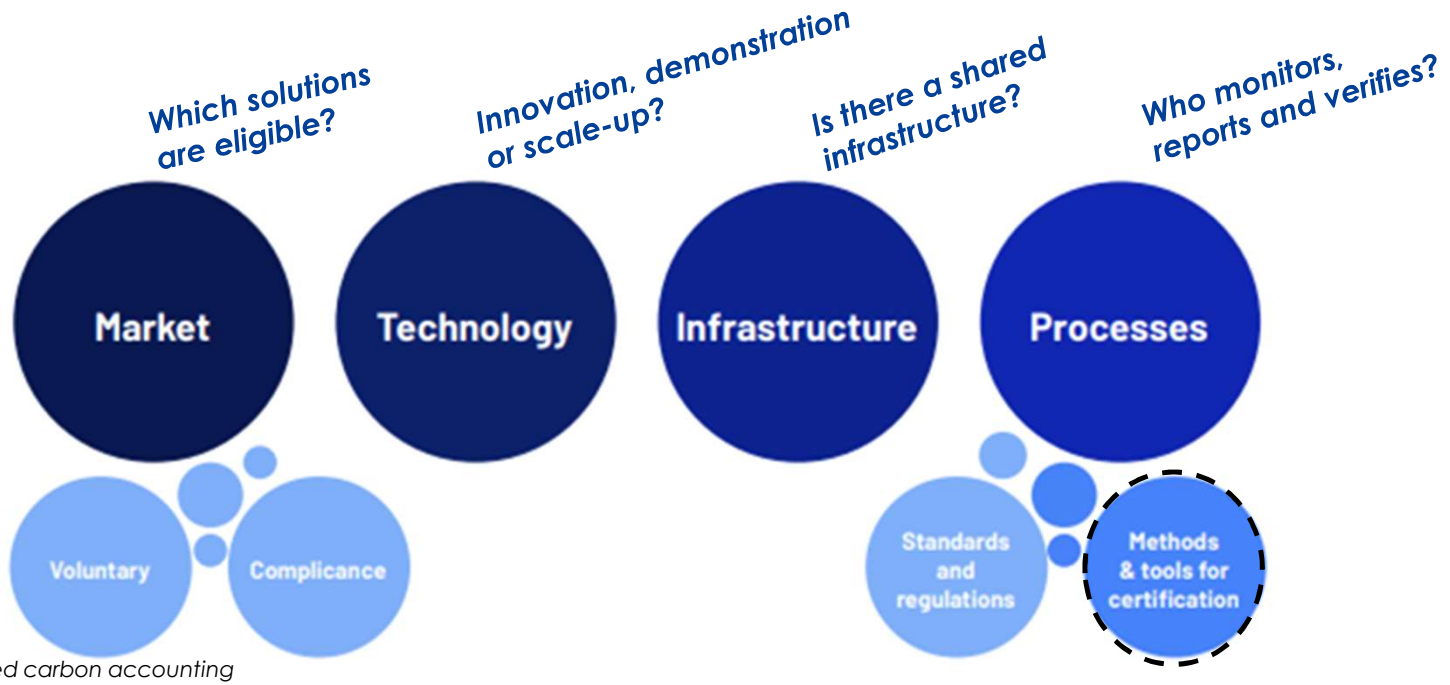
=

OUTCOME

TRUST

System needs

Cater to the 'value chain'



Source: *'EU guide to an integrated carbon accounting infrastructure for the industrial carbon management market', CCS+ Initiative (available here)*

CCS+ Initiative

Embedding in rules

Don't build in a vacuum

Rules, criteria, procedures to assess a project's

- Eligibility
- Additionality
- Baseline
- Sustainability
- Durability
- Boundaries
- Embodied carbon
- Leakage
- Impact

Methodology operating and application 'widgets'

- Modules
- Tools
- Reductions/ removals
- VCS/non-VCS emissions

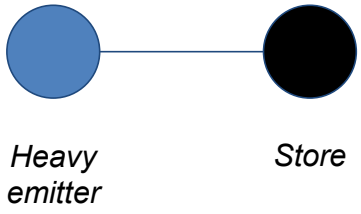
Requirements to interface with a given rules environment

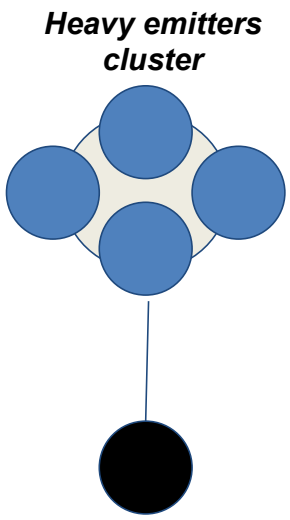
- Storage requirements
- Non-permanence risk mitigation
- Liability arrangements

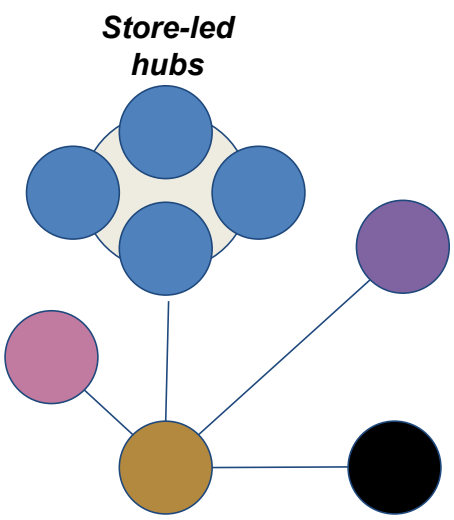
Project type evolution

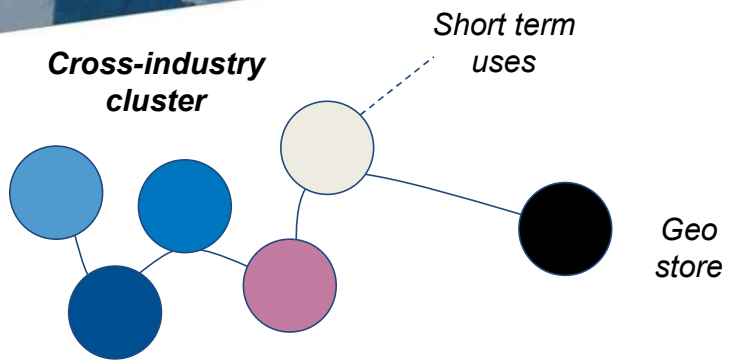
Design for complexity

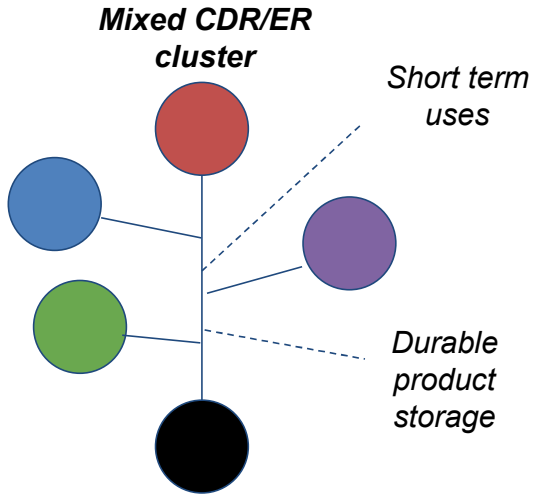
Point-to-point → **Hubs and clusters**











Source: *Inspired by 'The world needs to capture, use, and store gigatons of CO2: Where and how?', McKinsey (2023) (available here)*

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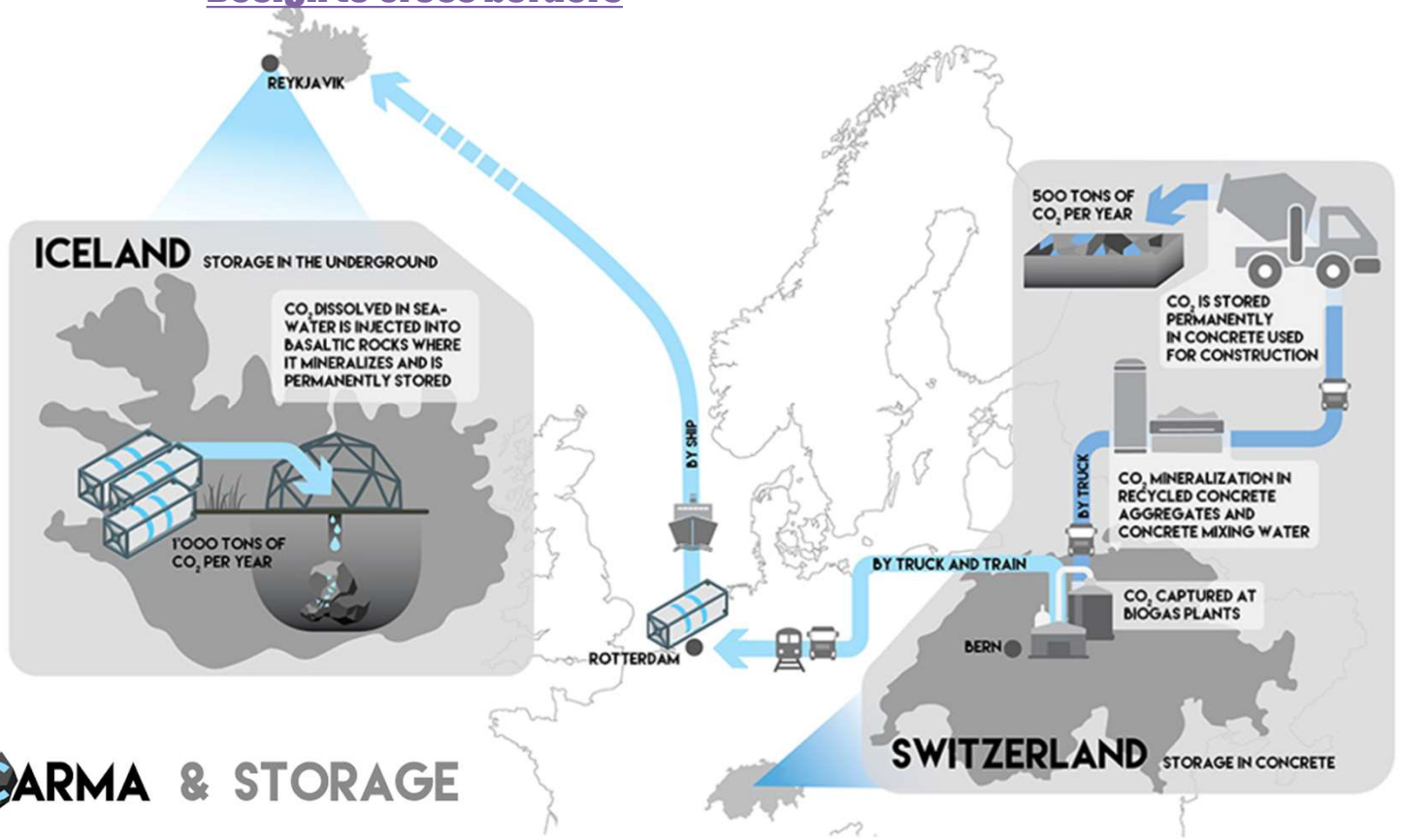
Accounting in action

Design to cross borders

Characteristics:

- ❑ Several capture sources
- ❑ Em. reductions & removals
- ❑ Transportation modes
- ❑ Transboundary transport
- ❑ Permanent storage
- ❑ Diverse utilization options
- ❑ Carbon market interactions, e.g., voluntary & compliance

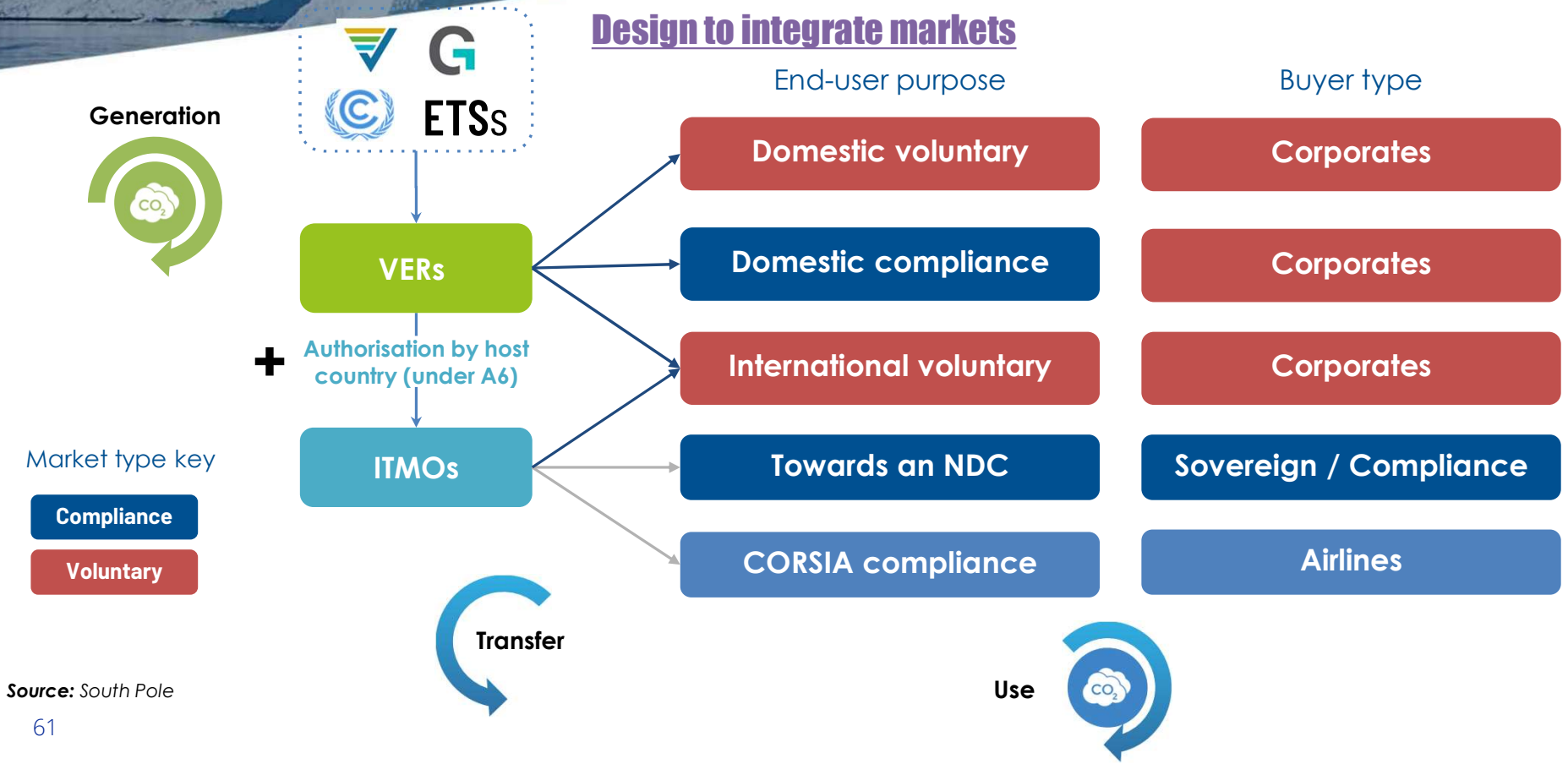


Source: *DemoUpCarma*

DEMO UP CARMA & STORAGE

CCS+ Initiative

Multiplication of markets



Source: *South Pole*

CCS+ Initiative

Methodology architecture

From

Project type specific methodology

Rules and procedures VCM standard

To

Design to scale

CCS+ Methodology framework

CCS+ Methodology

CCS+ Storage modules
- Saline aquifer
- Depleted oil/gas fields
- Mineralization in igneous rock

CCS+ Tools
- Additionality (standardized approach)

CCS+ & CCUS+ Capture modules
- DACC
- Power & Heat (post-combustion)
- Industrial processes
- Oil & Gas
- BECCS
- Pre-combustion / Oxyfuel

CCS+ & CCUS+ Transport modules
- Pipelines, Ships, Road/trucks and Rail

CCS+/CCUS+ Tools
- Non-VCS-CO2
- Reductions vs. Removals

CCU modules
- CO2 utilisation and storage in short lifetime products (fuels)
- CO2 utilisation and storage in medium lifetime products (plastics)

CCUS+ Methodology framework

CCUS+ Methodology

CCUS+ Product storage modules
- Aggregates
- Cement admixtures
- Concrete
- Ceramics

CCUS+ Tools
- Additionality (standardized approach)

Verra GCS Standard update

Verra NPR Tool

Verra registry updates

Source: *CCS+ Initiative*

Thank you

Feel free to contact us at the Secretariat via mail:

info@ccsplus.org

CCS+ initiative