

CCSA Technical Working Group Meeting

Chair: Suzie Ferguson

17th September 2024

Agenda



No.	Time	Item	Speakers
1	10:00 [5 mins]	Introductions and CCSA competition law policy notice <ul style="list-style-type: none"> • Introduction, housekeeping & introductions • Approval of June meeting minutes 	Suzanne Ferguson <i>(TWG Co-Chair)</i>
2	10:05 [30 mins]	Update: CCSA Research and Projects – Cost Reduction Workstream <ul style="list-style-type: none"> • An introduction to the cost reduction workstream, initial questions and discussion points for the Technical Working Group, and opportunities for further engagement 	Samuel Levin & Piers Johnston <i>(KPMG)</i>
3	10:35 [20 mins]	Secretariat Update <ul style="list-style-type: none"> • Task subgroup updates • Open & recently submitted consultations 	Beth Hebditch & Despoina Tsimpridou (CCSA) Subgroup convenors
4	10:55 [25 mins]	External presentation: Strengthening MRV standards for greenhouse gas removals <ul style="list-style-type: none"> • Please note: pre-reads attached 	Leo Mercer Josh Burke <i>(LSE Grantham Research Institute)</i>
5	11:20 [up to 40 mins]	External presentation: MRV in practice; a software solution and a case study of its application by a CCUS project in the US	Mike Rolfe Jonathan Broer <i>(Validere)</i>
6	12.00	Conclusions and AOB	Suzanne Ferguson <i>(TWG Co-Chair)</i>

1. Introductions & House Keeping

- Meeting is being recorded for internal note taking purposes
- Slides & Recording will be available for members after the meeting
- CCSA Competition Law Policy notice is attached to the meeting invite

- If you are not speaking please mute your microphone
- Please **raise your hand** if you wish to comment, you will be invited to come off mute, if you can also turn on your camera
- Please also pose any **comments in the chat** and these will be picked up by the secretariat

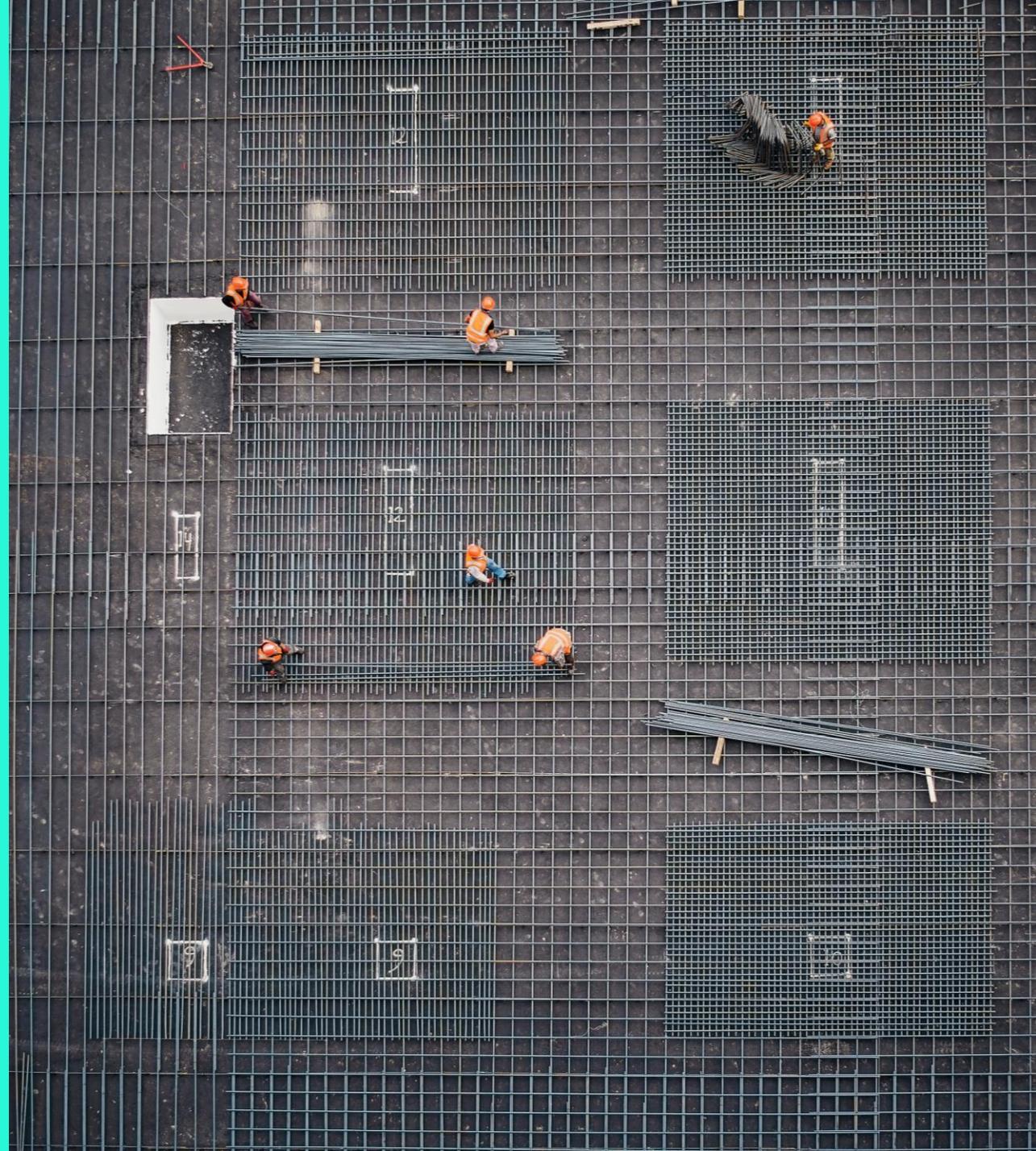
- **Introductions** of any new members joining the call

- Approval of June Minutes

2. CCSA Research and Projects updates

Cost reduction work programme

Samuel Levin & Piers Johnston
(KPMG)



KPMG is supporting the CCSA across three areas of work



Workstream 1

Autumn Budget submission 2024

Aug-Sep 2024 (complete)

The submission includes:

- The immediate sector and policy **priorities for 2025/26**
- A high level narrative that illustrates the **cost reductions** associated with increased and/or accelerated CCUS deployment
- A showcase of the potential additive role of **GB Energy** and the **National Wealth Fund** in deploying the industry at scale

In progress

Workstream 2

Cost reduction analysis

Sep-Nov 2024

This workstream includes:

- **Workshops with CCSA members** to explore the key areas of potential cost reduction for CCUS
- Working with AFRY to **quantify elements of the cost reduction analysis**
- Summarising **findings and policy levers for government** to support a cost-effective and self-sustaining CCUS industry in the UK

In progress

Workstream 3

Spring Budget submission 2025

January 2025

This workstream includes:

- An update of the total **revenue support envelope** using latest cost and project data
- **Quantified ranges for cost reduction potential** associated with CCUS deployment and government levers to deliver cost reductions (including GB Energy and National Wealth Fund)
- Outline of the **growth opportunities and benefit to UK Plc and HMG**, with case studies

The cost reduction analysis framework

An initial high-level overview of the cost reduction analysis was conducted for the Autumn Budget submission. This analysis identified key cost categories and levers that will be quantified ahead of the Spring Budget Submission.

Key cost areas

Creating a sustainable and fully commercialised CCUS market requires a reduction in two key areas:

1

The cost to deploy CCUS

Cost to deploy CCUS is **the £/tCO₂e for capture and T&S projects** and includes the technology costs, financing and insurance, and efficient project delivery.

2

The level of government subsidy

Subsidy is the amount of support government have to provide (via CfD). This gap will close as the cost to deploy comes down, but can also be addressed through increasingly **robust and clear market frameworks** that allow costs to be passed through to consumers to reflect the cost of unabated carbon.

Cost reduction levers

Cost reductions for both areas can be addressed through three main categories:

- **Sector development:** e.g. scaling the supply chain, skills development, and knowledge transfer.
- **Financing:** e.g. early engagement and collaboration with private and public finance, and early investment in projects and enabling infrastructure.
- **Policy:** e.g. clear and robust policy frameworks for carbon markets, low carbon power, hydrogen, and CCUS allocation rounds, and streamlining regulatory compliance processes.

13+ cost reduction levers have already been identified across the different cost areas and categories

Next steps

- This initial cost reduction analysis outlines a qualitative overview of the work that CCSA is currently undertaking.
- Further in-depth analysis and quantification of these cost reduction measures will be completed over the coming months. This will include:
 1. **Engaging with CCSA members** to explore the key areas of potential cost reduction
 2. **Quantification** of cost reduction elements and levers
 3. **A summary of findings and policy levers** for government

Questions for membership

- ? What are the largest cost drivers for you in deploying CCUS?**
- ? What work have you already done to quantify potential cost reductions in these cost drivers?**
- ? What are the policies or market changes that government need to prioritise to support cost reductions?**
- ? How can public finance organisations (e.g. NWF, GB Energy, UKIB) best support the sector in driving cost reductions?**
- ? What are the 'no-regret' policy decisions or sector investments to reduce costs?**

Appendix



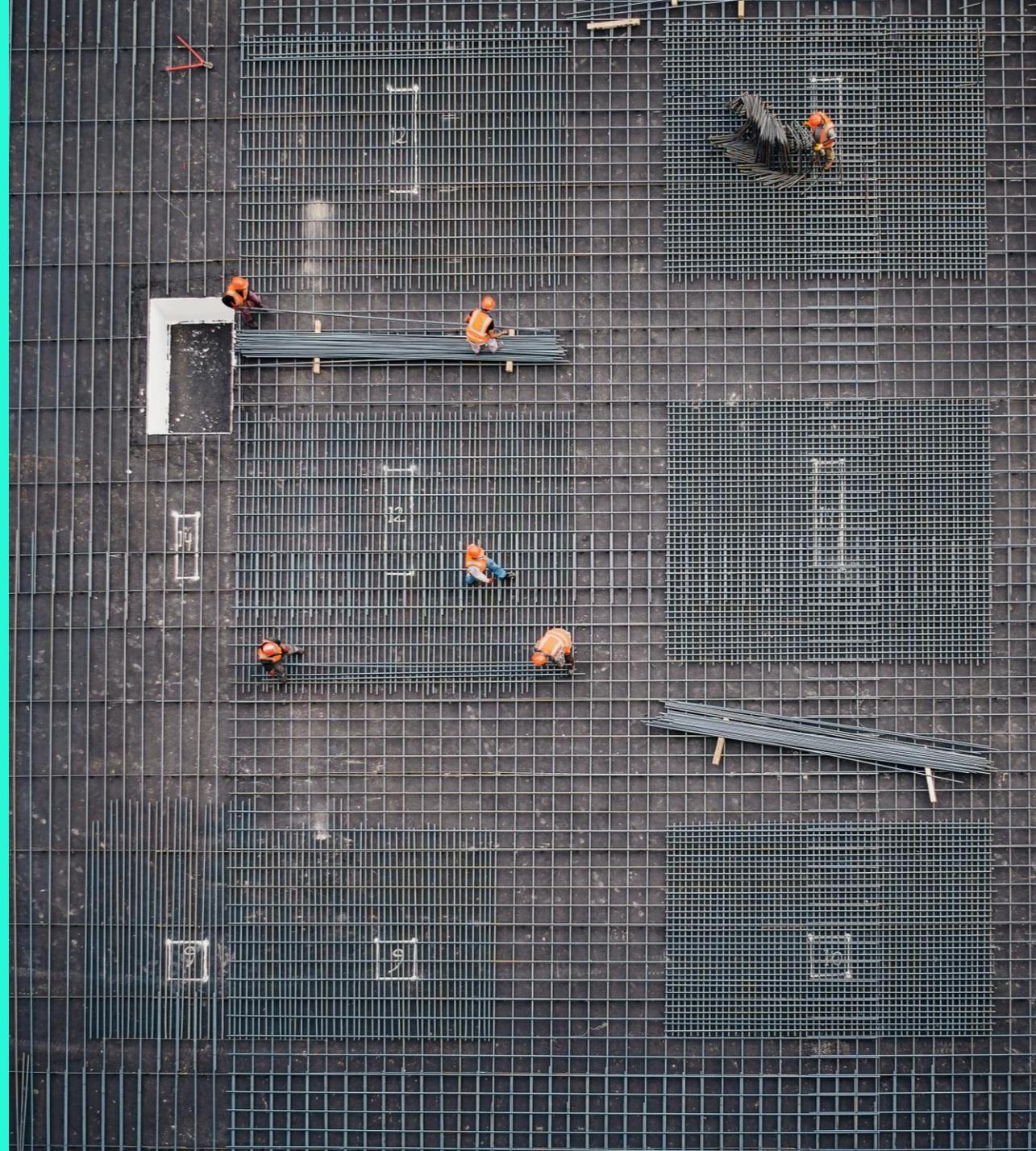
The existing cost reduction work packages will feed into the analysis

Work package	Cost reduction lever category		
	Sector development	Financing	Policy
1 Supply chain and commodity costs	✓		✓
2 Skills	✓		✓
3 Technical components	✓		✓
4 Contracting strategies	✓		✓
5 Legal & regulatory compliance			✓
6 Finance and insurance	✓	✓	✓
7 Allocation frameworks for government funding			✓
8 Cross-border CO2 transport and storage	✓		✓
9 Markets and mandates			✓

3. CCSA subgroup updates

Active workstreams and key updates

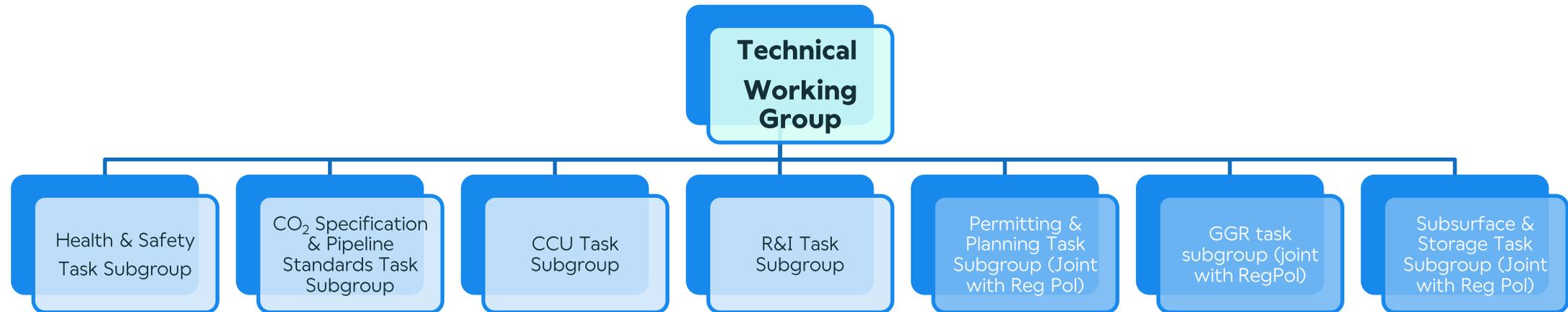
Beth Hebditch & Despoina Tsimprikidou (CCSA) and subgroup convenors



Technical Working Group (TWG)

CCSA Lead: Beth Hebditch

Co-Chairs: Suzie Ferguson - Wood, Andy Brown - Progressive Energy, Alastair Rennie - Yo Energy



External Stakeholders engaged with the Task Subgroups include: Exploration Taskforce, Subsurface Taskforce, IDRIC, UKRI, HSE, EI, BGS, NZTC, The Crown Estate, Crown Estate Scotland, DG RTD, DG ENER

Technical Working Group Updates



Greenhouse Gas Removals (GGRs)

Convenors: Greg Williams (Evero Energy)

CCSA lead: Despoina Tsimpridou

Previous meeting: 12 August 2024

- Purpose: discussed and finalized outstanding positions for the UK ETS consultation submission.

Next meeting: TBC

Next steps for the subgroup

- Awaiting Government response on the Integrating GGRs in the UK ETS consultation.
- Government is still due to consult this year on a cross-sectoral biomass sustainability framework & creating high integrity VCMs.
- In the process of identifying key priority areas and topics of future discussions. If you have any suggestions, please get in touch with the CCSA Secretariat.

Permitting and Planning

Convenors: Matt Brown (RWE), Nicola Smith (SSE), Aleks Dragicevic (Viridor)

CCSA lead: Georgina Katzaros

Previous meeting: 8 July 2024

- Purpose: EA/CCSA permitting teach-in session – 8th July (materials available [here](#))

Next meeting: TBC

Next steps and key priorities for the subgroup

- CCSA Capture Rate efficiency paper – 3rd draft shared with EA, finalising points on monitoring & reporting methods ahead of publication
- Letter issued to SoS/DEFRA/DESNZ new ministers; highlighting solvent confidentiality & EAL consultation delays
- EAL Consultation: Draft EAL for Piperazine shared with members, 7 further EAL dossiers will be shared ahead of public consultation (date tbc)

➔ If you would like to be involved in these task subgroups please reach out to the CCSA Secretariat

Technical Working Group Updates



Carbon Capture and Utilisation (CCU)

Convenors: n/a

CCSA lead: Despoina Tsimpridou

Previous meeting: 15 March 2024

- Purpose: Review and update the CCSA's CCU position paper

Next meeting: November 2024 (TBC)

- Purpose: address member comments on the position paper draft currently in circulation for review, and discuss approach for DESNZ engagement

Next steps for the subgroup

- Comments to be made on position paper draft by 14 October
- Member review of the position paper currently open. Members of this group, please submit your comments to the draft sent to you via email

Subsurface and Storage

Convenors: Mark Weldon and John Ford (Petrostrat)

CCSA lead: Beth Hebditch

Previous meeting: 10 September 2024

- Purpose: Discuss the new CCS directive Guidance Documents and prepare questions and comments for DNV

Next meeting: TBC (c. 5/6 weeks)

- Purpose: workshop to gather industry thoughts, questions and feedback on The Crown Estate's Storage Exploration and Appraisal Agreement (SEAA) to form an industry response to the proposals.

Next steps and key priorities for the subgroup

- Response to the NSTA consultation on the publication of company specific information (decommissioning and enforcement).
- Ensure industry, including external taskforces, are aligning and communicating with the Crown Estate's (TCE).

➔ If you would like to be involved in these task subgroups please reach out to the CCSA Secretariat

Technical Working Group Updates



Health and Safety

Convenors: Toby St Ledger (Harbour Energy), Sebastien Cochet (DNV)

CCSA lead: Despoina Tsimprikidou

Previous meeting: November 2023

- Purpose: gather member feedback on experimental conditions for the HSE/DNV CO₂ Transportation Safety Project (Skylark)

Next meeting: w/c 7 October

- Purpose: workshop to set up health and safety priorities, focusing on operators.

Next steps for the subgroup

- Engaging with the HSE to enable knowledge exchange and enhance collaborative ways of working.
- Establish Venting Task and Finish Group to action CO₂ venting work alongside the HSE - this will be followed up once the Skylark Project has reached its next phase.

CO₂ Specification and Pipeline Standards

Convenors: Andy Brown (Progressive), Tiana Walker (Storegga), Ben Rowton (NPL)

CCSA lead: Beth Hebditch

Previous meeting: 22 February 2024

- Purpose: covering updates across impurities, Northern Lights Project, acoustic monitoring for marine facilities and Forecasting North Sea Infrastructure

Next meeting: TBC

Next steps and key priorities for the subgroup

- Next steps and alignment of standardisation in the UK and across Europe, including CO₂ stream and pipeline composition
- The CCSA has just joined CEN TC/474 as a liaison member
- *Further updates in slides to follow*

➔ If you would like to be involved in these task subgroups please reach out to the CCSA Secretariat

Measurement of CO₂ stream purity



Update from Andy Brown, convenor of CO₂ Specifications and pipeline standards subgroup

- The permissible levels of impurities within a CO₂ stream have been set to minimise possible adverse effects on the thermodynamic and corrosion properties.
- In some cases, where experimental evidence is not available, the limits have been set based on theoretical analyses.
- Measurements could be taken:
 - Real-time on line
 - Periodically (every x minutes)
 - Off-line (gas samples sent for offsite analysis)
 - Not at all, if it has been demonstrated that it is impossible for the impurity to be present in the stream.

Measurement of CO₂ stream purity

- The levels for each impurity is different.
- Some measurement techniques are available for gas phase, a smaller number have been demonstrated for dense phase CO₂ streams.
- Some impurities within a CO₂ stream are relatively easy to measure using “off the shelf” equipment, from diverse suppliers.
- Some impurities can be measured in a laboratory setting, but equipment suitable for an industrial environment is not available.
- Some impurity limits are below measurable values using existing equipment.

Measurement of CO₂ stream purity

- The problem is that store operators, not unreasonably, want to be assured that the CO₂ stream is compliant with their specification, and have asked producers how this assurance can be demonstrated.
- This is a particular problem where suitable equipment is not available.
- There is also a problem when it comes to calibrating the equipment, providing, reference gasses etc. There are no Standards.

What are the other CCS projects worldwide doing about this?

- Porthos: still refining the specification
- Santos: unwilling to provide details at the moment
- Northern Lights: asking the same questions

Measurement of CO₂ stream purity

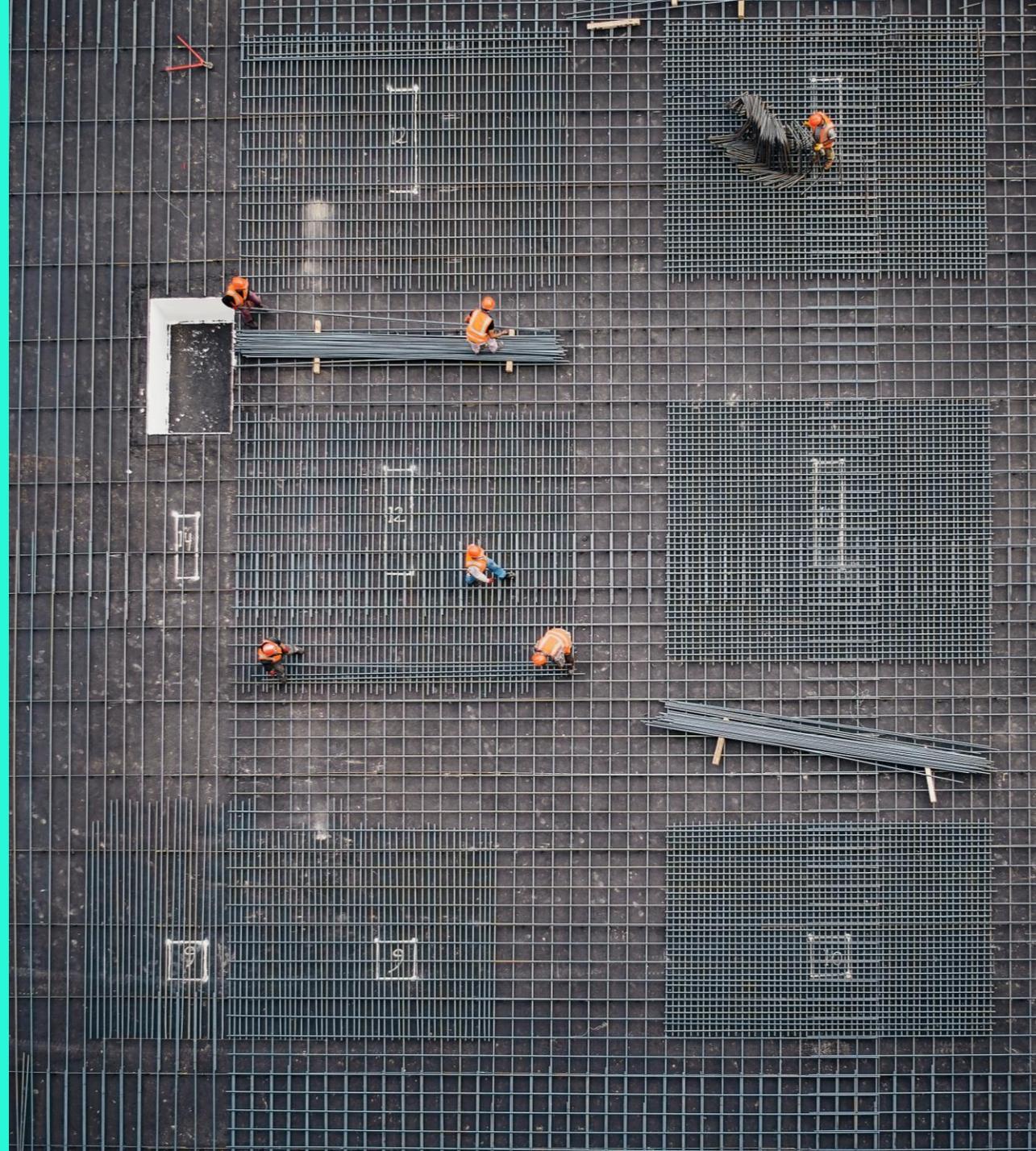
What are we doing about the problem?

- The Energy Institute is to pull together a draft “Good Practise Guide”, collating what information is currently available.
- A Working Group (including TUVSUD/NPL) is being established.
- The “Good Practise Guide” would provide an input to the proposed CEN Standards on CCS (TC 474), which could be upgraded to a new ISO Standard.
- An input from the UK projects would be an important part of this, and allows information exchange between the clusters.
- Nominations for representatives by 20 Sept to Beth Hebditch, please.

4. External presentation

Strengthening MRV standards for greenhouse gas removals

Leo Mercer & Josh Burke
(LSE Grantham Research Institute)



Towards improved cost estimates for Carbon Dioxide Removal MRV

Leo Mercer and Josh Burke

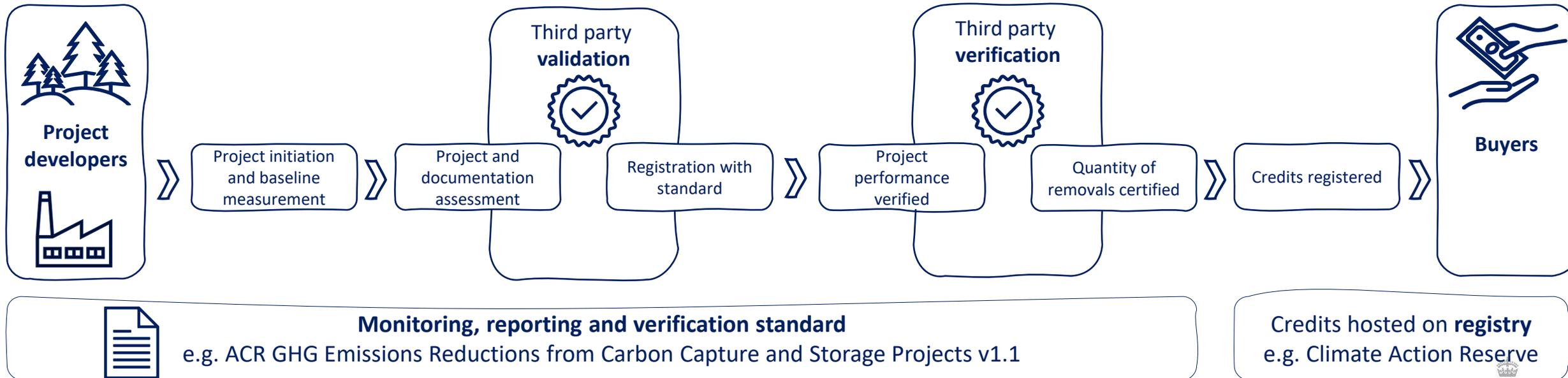
17/9/24

Overview of presentation

1. Share some early network mapping of the MRV ecosystem
2. Updates to this work in the State of CDR report - edition 2
3. Share preliminary findings from a new policy report looking at the cost of MRV

First principles

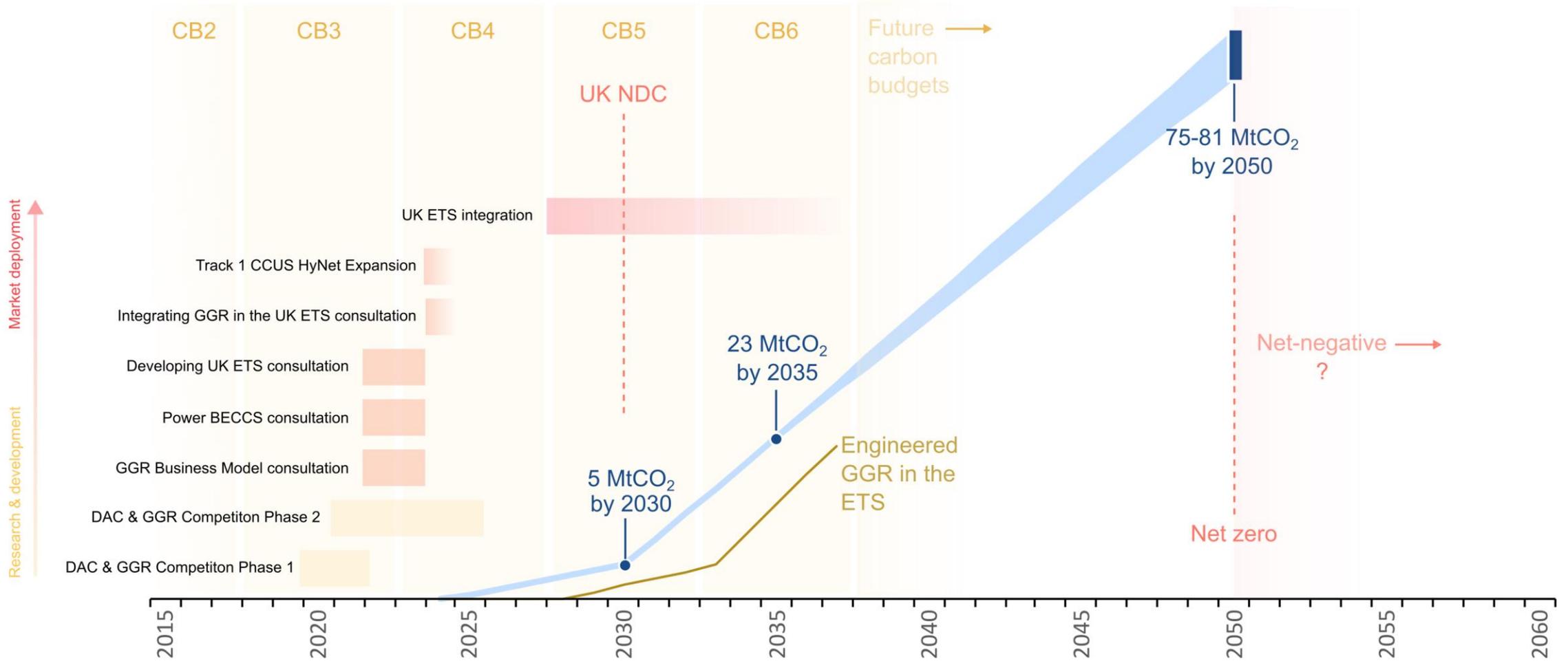
- (1) **Monitoring** or quantifying carbon dioxide (CO₂) removals from a CDR activity and monitoring those CO₂ removals over the course of a CDR activity;
- (2) **Reporting** on those removals, quantified relative to a baseline, to national inventories or project registries;
- (3) **Verifying** through an independent third-party, the veracity of an emissions removal claim by ensuring the relevant CDR standard has been followed. The greenhouse gas programme that certifies and issues carbon credits



So, why is MRV important?

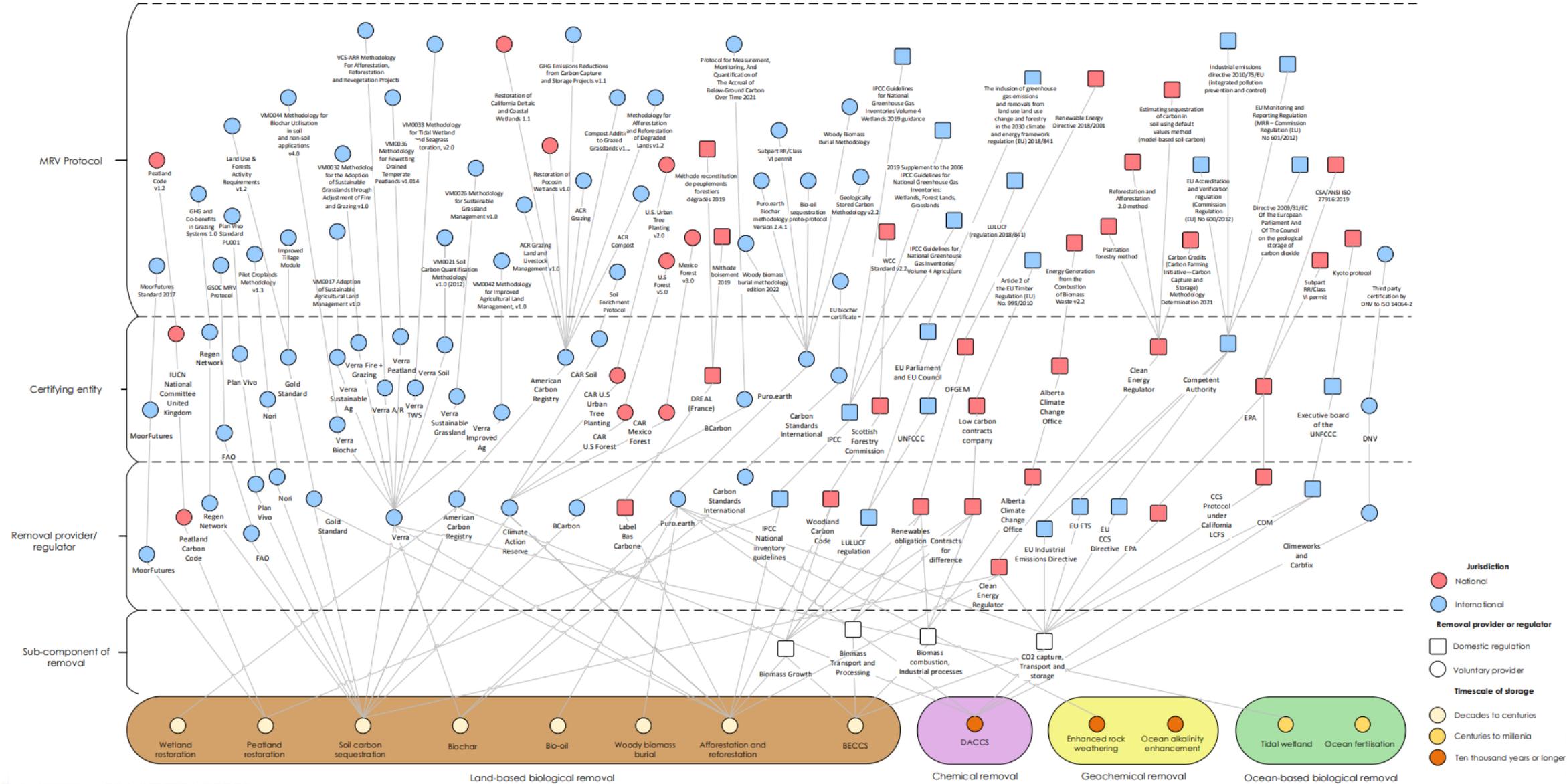
- Any credible industry is built on the development and implementation of standards and certification as an attestation that activities meet those standards; CDRs are no different (Arcusa and Sprengle Hyppolite, 2022)
- Assess whether a CDR project has done what they have claimed in accordance with the relevant CDR methodology.
- Paves the way for CDR **integration into climate policies**, targets and markets.
- **Benefits of CDR vis a vis conventional mitigation** policies can be assessed on a like for like basis.
- Provides an **oversight mechanism** for market participants, governments and the public to hold project developers accountable for externalities and breach of consent conditions etc.
- Develops the pre-conditions to allow **liability transfers** between different actors along the value chain, and ultimately, to jurisdictions after a given amount of time.
- Drives **investment** into early – mid stage CDR companies **through better transparency** and ease of analysis.

UK CDR targets, policies, consultations etc.



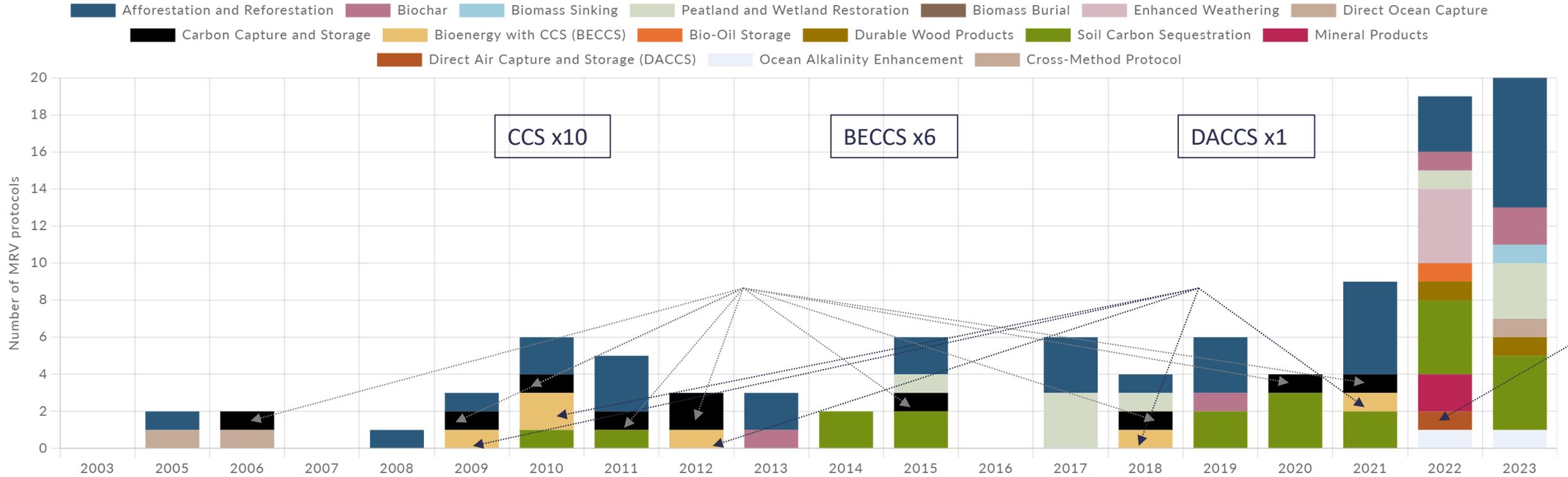
Source: Smith, H (2024). Presentation to GGR Future Leaders Network 20/8/24

Strengthening MRV standards for greenhouse gas removals to improve climate change governance (Mercer and Burke 2023) n = 69



State of CDR report edition 2 – Chapter 10

Number of MRV protocols by CDR method and year



Key takeaways from these projects

- **An inconsistent patchwork of MRV exists. This has created a complex system, making navigation and meaningful comparisons between different CDR pathways difficult - ultimately slowing upscaling of the industry.**
 - Well-designed, flexible MRV regulations are a market enabler and will help drive growth, innovation and credibility in the sector.
- **R&D and demonstration support should be made available to reduce costs for expensive MRV processes.**
 - Greater data-sharing between project developers, MRV providers and selling platforms should be incentivised to increase transparency and identify where effort is needed to reduce MRV costs.
- **Jurisdictional divergence:**
 - The EU and the UK have prioritised development of CDR standards and guidelines while the US has focused on scaling up market-ready CDR.
- **Existing MRV protocols focus predominantly on conventional CDR – novel methods only evidenced from 2022.**
 - Proprietary capture technologies developed for e.g. DACCS which limits oversight and comparisons with publicly available MRV.

MRV costs report

- **Cost of MRV is bundled within overall price – 5% assumed within Mac Dowell et al. (2022).**
 - Anecdotal evidence that MRV constitutes 70% of the total cost of removal for certain methods.
- **Should MRV be an eligible cost under government support schemes?**
 - Is there a sweet spot between MRV cost and accuracy? How should Governments think about this?
- **What are baseline MRV costs in 2024? What is the relationship between absolute and relative MRV costs?**
 - Can we better understand the incremental investment to reduce uncertainties?
- **Some CDRs with high theoretical potential i.e. OAE/ERW that accelerate natural carbon fluxes may be disadvantaged because MRV is costlier than A/R, in situ mineralisation etc.**
 - Need to understand any disparities to make decisions on public support to drive down MRV costs.

Methodology

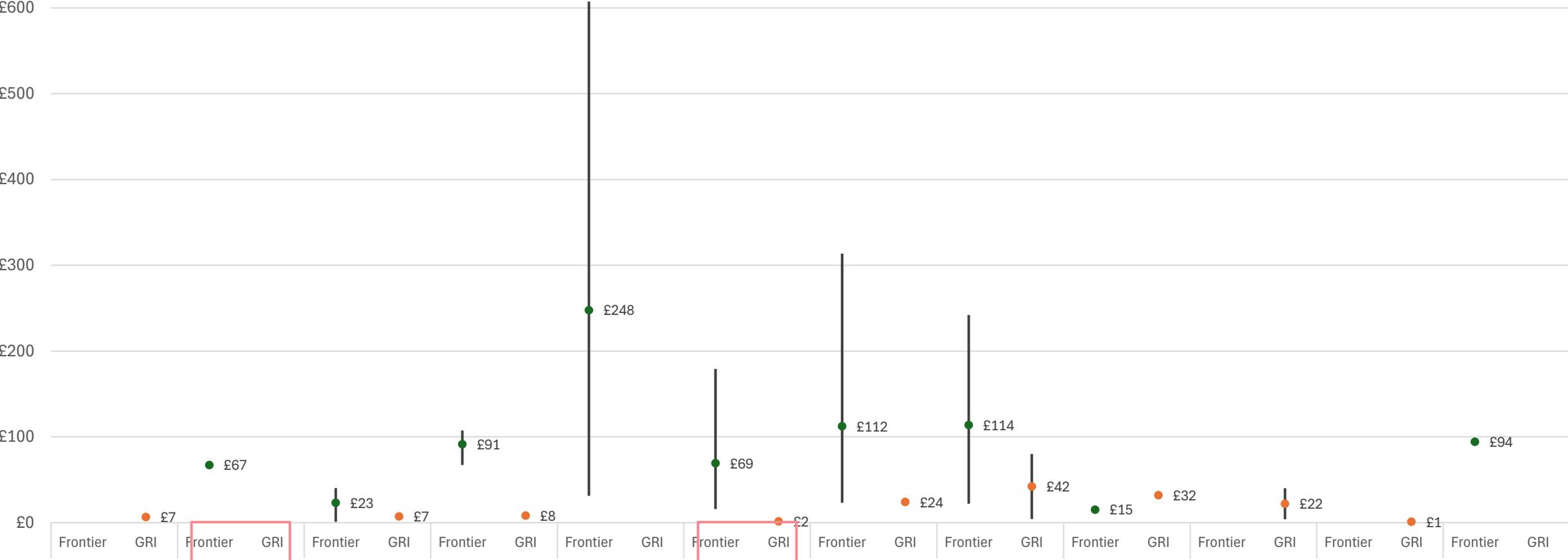
- **Survey live from 11-25 April 2024**
 - Global survey, respondents from: India, Netherlands, United States, Middle East, UK, Canada, Australia, Germany and Indonesia and ‘multiple jurisdictions’
- **58 responses, but only 19 useable responses for the detailed MRV cost questions**

11% TRL 4	16% TRL 5
21% TRL 6	16% TRL 7
5% TRL 8	32% TRL 9

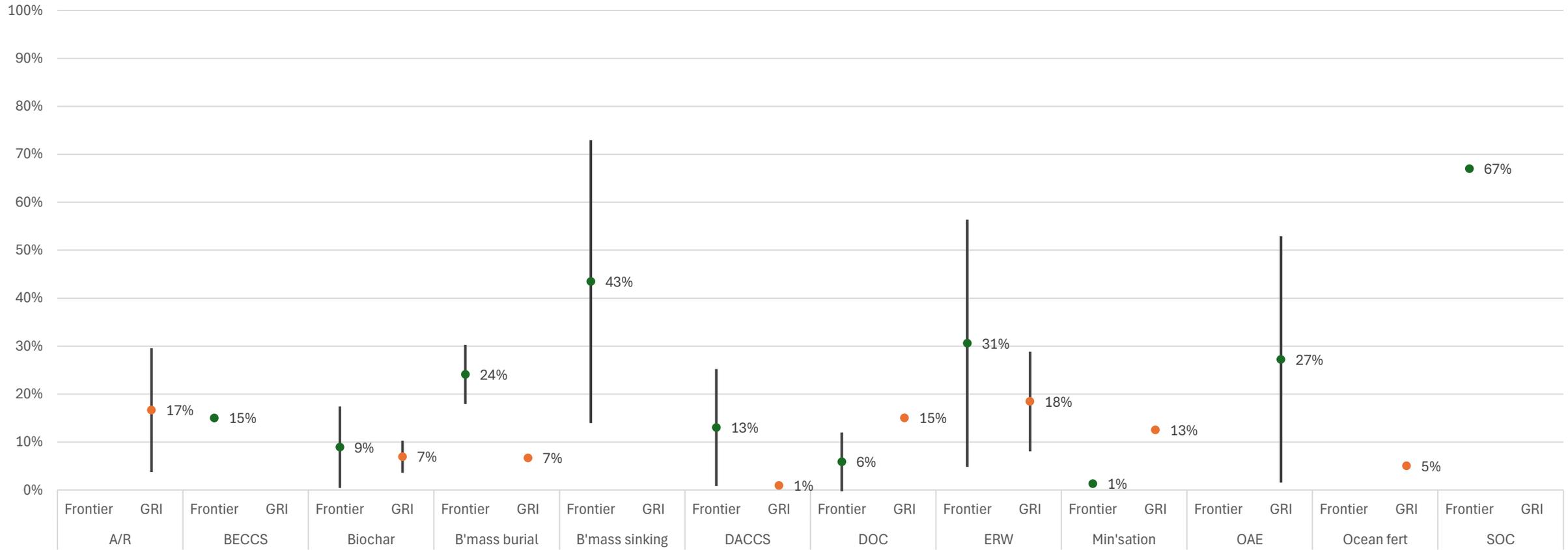
- Frontier (2022, 2023 and 2024*) AMC project applications with detailed MRV cost data have been used to compare with our dataset

CDR method	Count
Marine biomass sinking	1
ERW	2
Direct Ocean Capture	2
DACCS	2
Multiple methods identified	2
Ocean fertilisation	1
Biochar	3
OAE	2
A/R	2
Biomass burial	1
Mineralisation	1

Absolute MRV costs: Frontier = 32 - GRI = 19

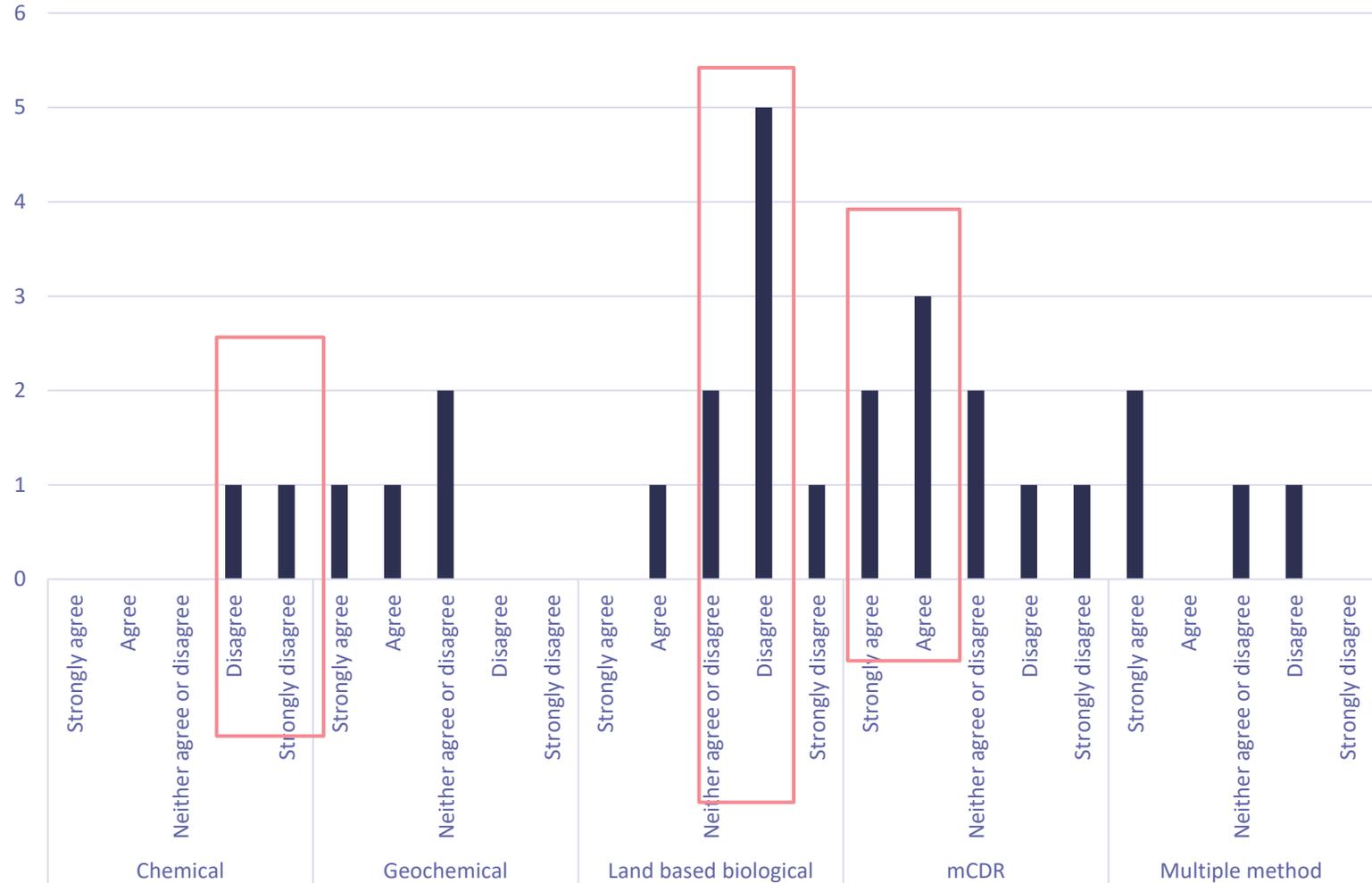


Relative MRV costs: **Frontier = 32** - **GRI = 19**

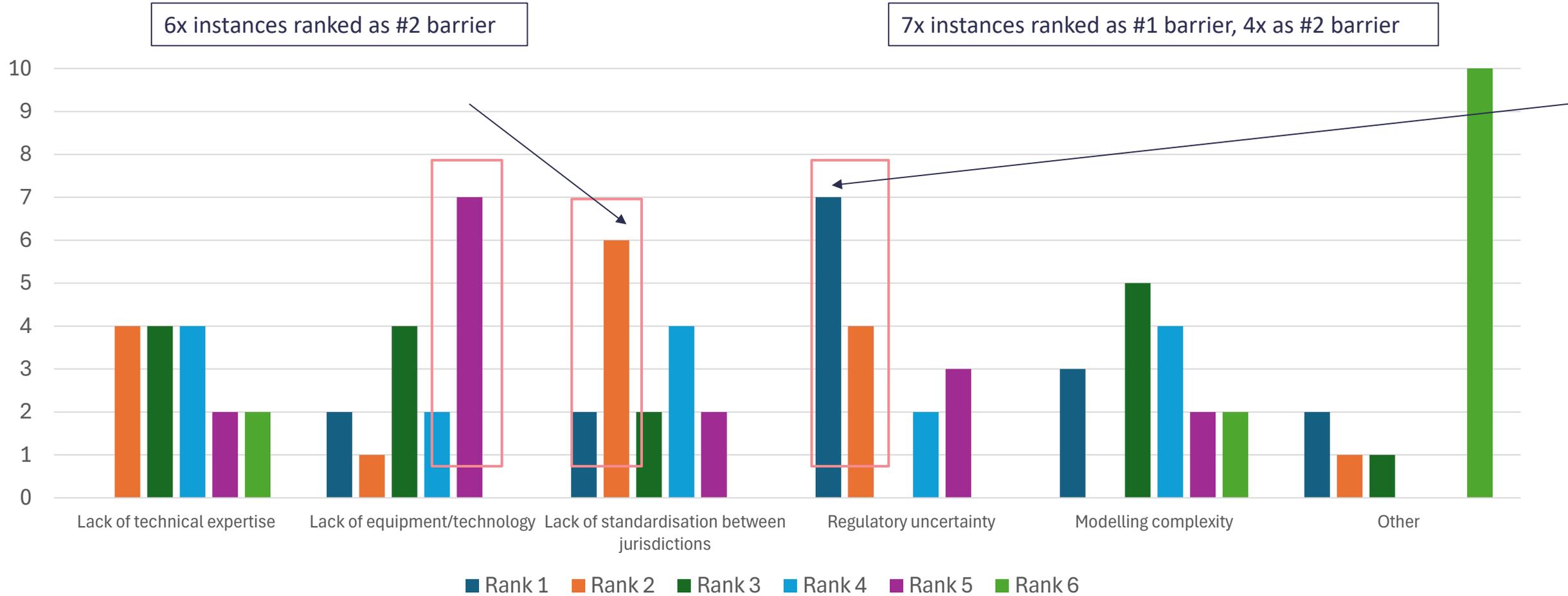


Is the cost of MRV a significant barrier to scaling a CDR company? n = 28

- Mixed perceptions that MRV costs are a barrier to scaling
- Geochemical (e.g. ERW) and marine CDR methods viewed the cost of MRV as a larger barrier to scaling compared with conventional CDR (A/R, biochar) and chemical CDR (e.g. DACCS)
- In aggregate:
 - 28% of respondents disagreed,
 - 11% strongly disagreed,
 - 18% strongly agreed with the statement



Ranking the largest barriers to reduce MRV costs



Qualitative results

- **When asked what areas of the CDR process was most costly, respondents mainly identified OPEX as the costliest element**
 - Labour was the costliest item with responses ranging from ‘field work at sea’ (DOC) to, ‘labour expenditure’ (mineralisation), to ‘data collection in the field’ (A/R).
 - For CAPEX; set up, measurement instruments and software e.g. ‘laboratory testing by third parties, and intermittent sub-surface testing provided by third parties’ (BECCS, DACCS, mineralisation respondent).
- **Resolving MRV uncertainties**
 - Respondents identified a need for investment in sensors and scanners, increased field surveys and sampling
 - ‘new sensors could reduce uncertainty by 30+%' (OAE)
 - ‘increased field surveys could increase certainty to 90%' (A/R)
 - ‘investment to increase either accuracy of instruments with wide spatial range or sampling density of instruments with low spatial range would reduce uncertainty by 10%' (mineralisation)

Summing up

- **We hypothesised that MRV costs would be considered a significant barrier to scaling CDR.**
 - The average MRV cost, relative to the total cost of removal for GRI = 12% and Frontier = 23%.
- **Technological breakthroughs, scaling production and learning by doing will likely do more to lower average CDR costs than purely targeting MRV.**
 - Implication for Govt. is that strategies to reduce MRV costs need to be part of a broader policy package that addresses innovation challenges within the CDR value chain i.e. more effective sorbents, more efficient pyrolysis techniques and core R&D + deployment.
 - Respondents highlighted importance of digitalisation & automation, particularly in data verification and remote sensing for better measurement + investments to improve modelling accuracy and next generation sensors.
- **Uncertainty still prevails with CDR – but importance of this is related to use cases of purchased removals.**
 - Confidence and credibility can be enhanced by establishing upper and lower bounds for outcomes and adopting a conservative baseline approach for MRV.
 - Policymakers should use a probabilistic approach to crediting underpinned by experimental and theoretical estimates, that provide bounds for what has occurred, ensuring that credits are issued conservatively.

Summing up cont.

- **Respondents identified a need for regulatory certainty and improved standardisation between jurisdictions as general barriers – aligns with what we are seeing in the literature.**
 - Surmountable given that jurisdictions such as the EU and UK are developing CDR standards – however divergence remains a risk given that the US is charting a different course.
- **The US has made targeted investments to improve MRV:**
 - SEA- CO₂ programme to advance cost-effective MRV for mCDR,
 - \$15 million available by DoE to develop method-agnostic MRV best practices and technologies.
- **UK Direct Air Capture competition (£100m) and the Net Zero Hydrogen Fund (£240m) provide CAPEX support to scale up deployment.**
 - Is there scope for more support for MRV in the UK? Novel methods, liability/risk transfers, probabilistic thresholds etc.

Policy recommendations

1. **DESNZ** should **prioritise the harmonisation of MRV practices and principles between jurisdictions** such as the EU and US and focus on developing common MRV data collection and management practices in order to better facilitate interoperability and cross-jurisdictional comparisons **while not stifling innovation in MRV protocols**. Protocols must be adaptable and flexible without enshrining standards that become outdated in a few years' time.
2. **Greater transparency can overcome information asymmetries** that stymie market development and increase costs. Support for data sharing infrastructure is needed in order to make large datasets/simulations publicly available and auditable.
3. **DESNZ** should develop MRV support mechanisms – e.g a dedicated CDR innovation fund - that are adaptive and recognise the varying needs of different CDR processes, through for example, **targeted CAPEX support for advanced sensors, remote sensing applications and AI-driven data verification**. Additionally, for labour intensive CDR pathways, **OPEX support should defray labour costs through subsidies or tax incentives**. All aspects of the MRV process should be digitalised – such that so called **digital MRV (dMRV) becomes the norm**.

Policy recommendations

4. **SDOs** and jurisdictions should **adopt conservative approaches to crediting**. This approach could also include the use of **probabilistic thresholds** that are tailored to, individual CDR methods, **conservative discounting and baselining** in addition to conventional risk management approaches such as buffer pools or insurance.
5. **DESNZ** + other agencies should develop a framework that **allows MRV protocols to be graded** based on their performance against the minimum standards from Recommendation 1 to **ensure a race to the top for quality** and alignment with emerging market preferences for high quality CDR. Where protocols are shown to be misaligned with UK best practice, **MRV providers should be given time to rectify to ensure alignment with market demands and regulatory requirements**. Ensuring adherence to a minimum standards framework could be fulfilled by an **MRV regulator**.
6. **Economic approaches to valuing temporary storage should move towards method specific MRV cost assumptions**. This is an important step forward, not least because it might change how we currently perceive the cost-effectiveness of temporary storage versus more durable CDR.

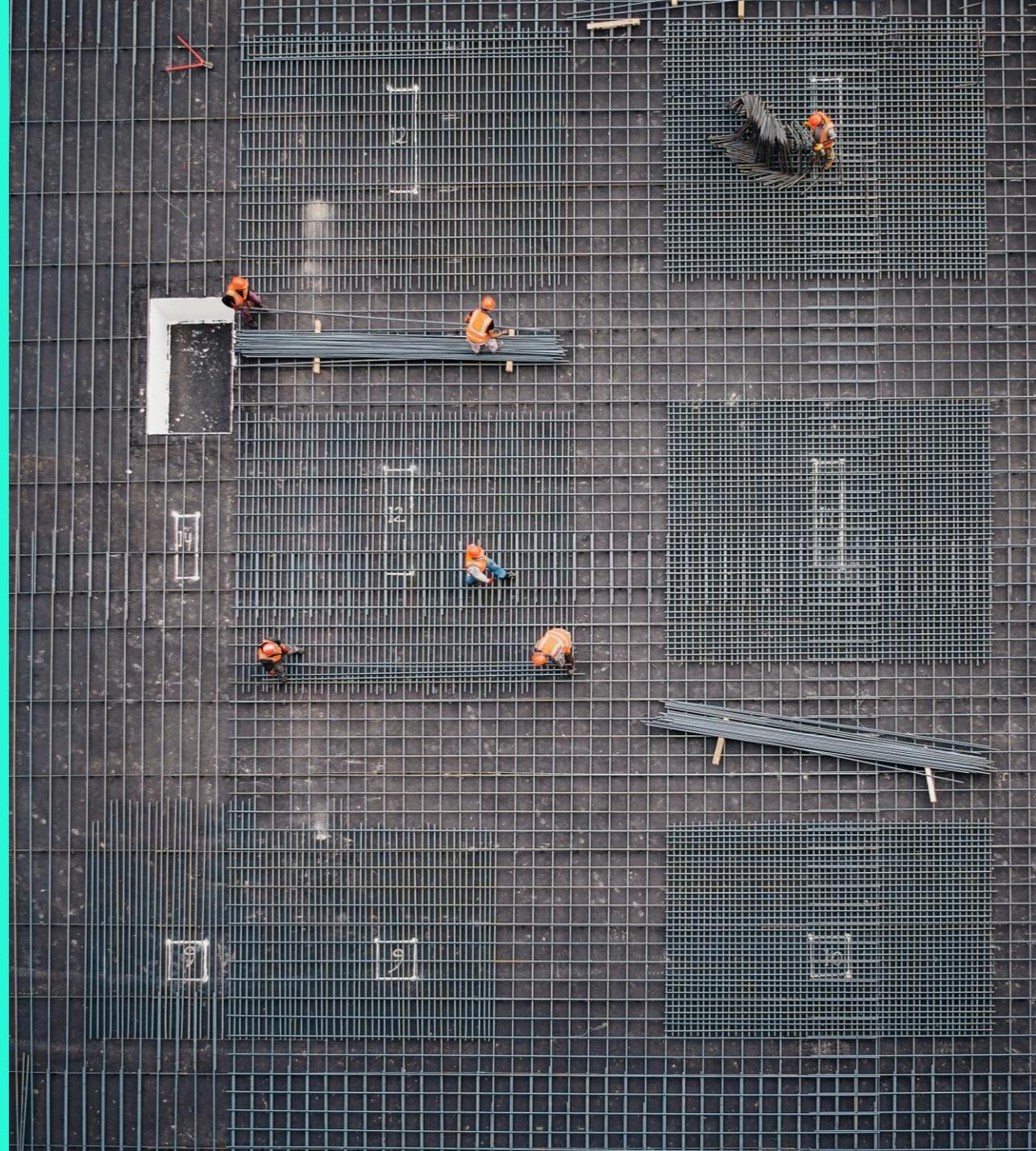
Q&A

- Leo Mercer (l.w.mercer@lse.ac.uk)
- Josh Burke (j.burke2@lse.ac.uk)
- Sue Rodway Dyer (sue.rodway-dyer@bristol.ac.uk)

5. External presentation

MRV in practice: a software solution and a case study of its application by a CCUS project in the US

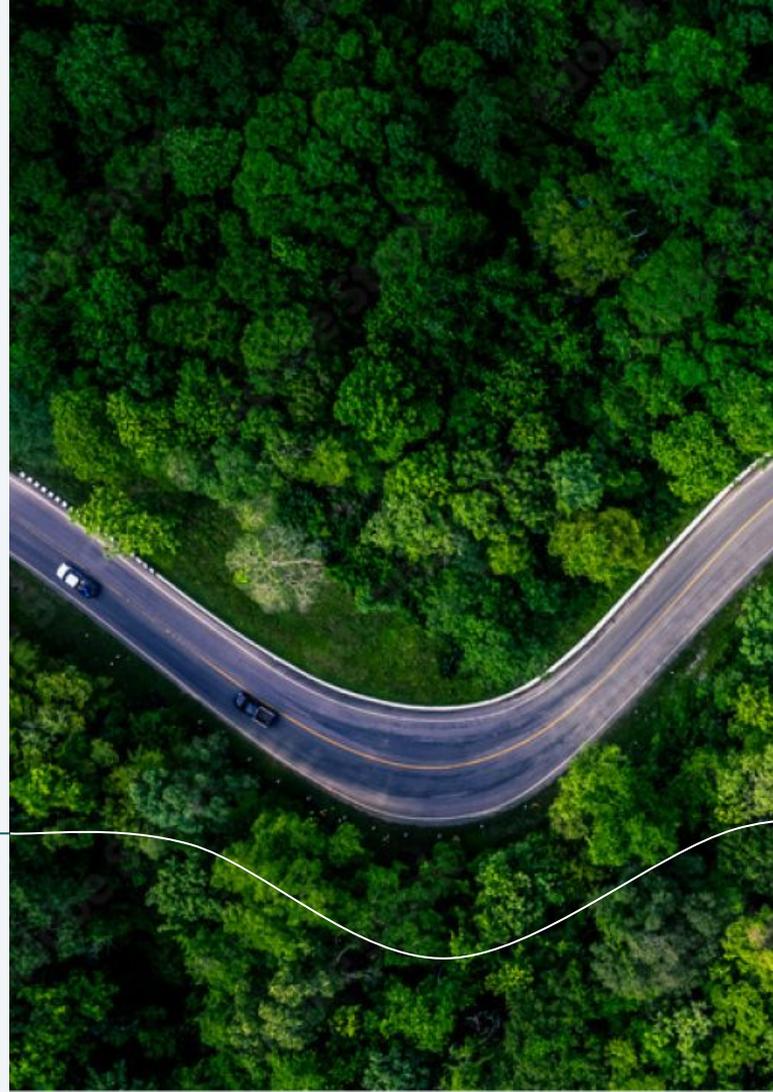
Mike Rolfe & Jonathan Broer
(Validere)



Validere Platform Overview - CCSA

Sept 17th, 2024

Confidential - Do not share without request



Agenda

- Validere Platform overview
 - MRV Solution Overview
- Relevant CCS Customer (U.S.) Case Study
 - Context/Landscape
 - Validere Product Implementation
 - Next Steps

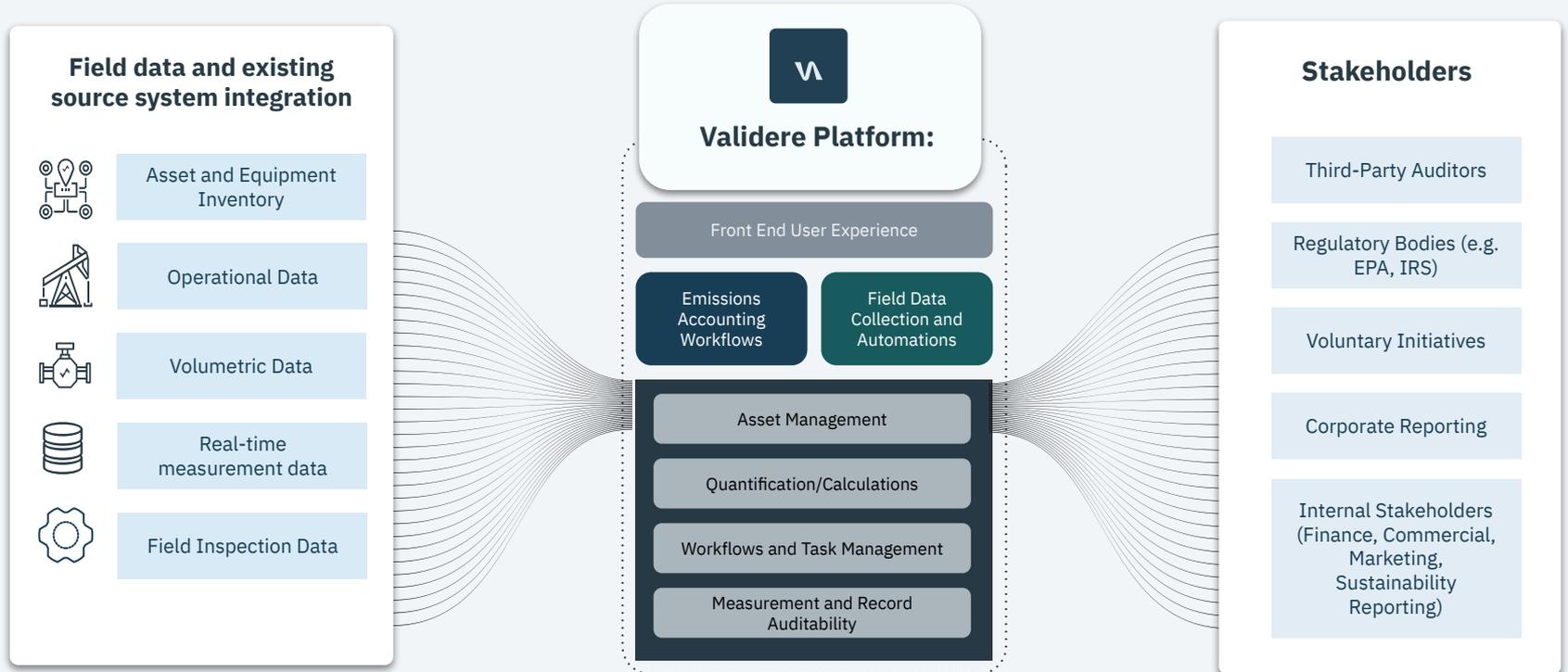


Validere Platform Overview



Platform Overview

The Validere software platform is a SaaS that enables seamless data aggregation and integration to facilitate a configurable and intuitive customer experience to support robust MRV strategy.



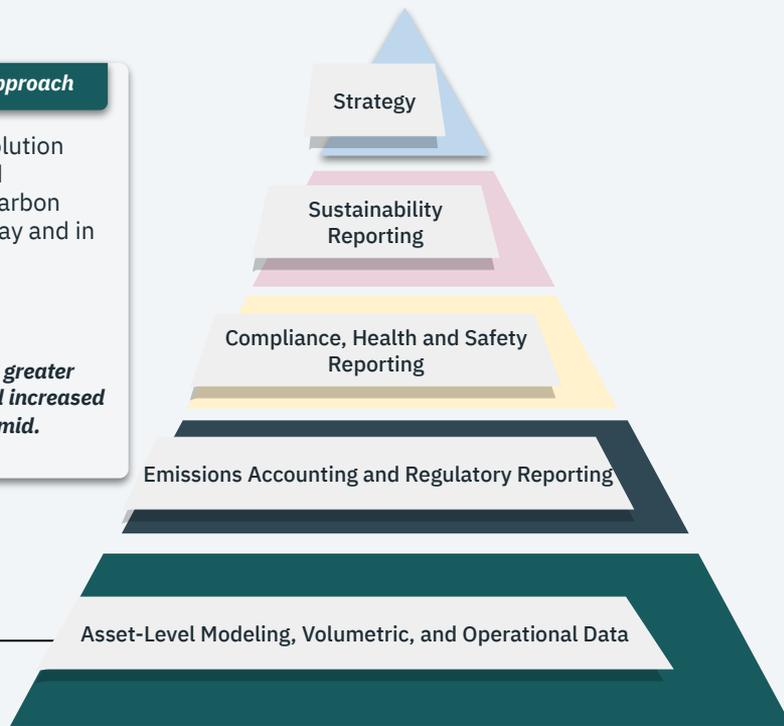
Why Validere

The journey towards accurate and strategic emissions management starts with a base of an accurate asset-level emissions accounting layer. Validere's approach is to start with an accurate as possible asset model and layer in volumetric and operational data to help operationalize emissions management and inform robust MRV strategies.

Bottom-Up MRV Approach

Validere enables you to build a solution from a foundation of accuracy and auditability that will support the carbon accounting use cases for both today and in years to come.

This bottom-up approach ensures greater confidence, more useful insights, and increased value as you move up the pyramid.





Current Offerings

“All-in-one” Operations and Emissions Management software solution for Energy and Heavy-Industry

Integrated Emissions Accounting



Operational MRV Platform

Environmental Regulatory Reporting

- ✓ Federal Reporting (US Subpart-W, CAN GHGRP)
- ✓ Provincial, State-level reporting (TIER, D60)
- ✓ CACs, HAPs reporting (NPRI, Rolling 12s)

Voluntary and Corporate Initiatives Tracking

- ✓ Net-zero goals and tracking
- ✓ Carbon sequestration projects
- ✓ OGMP 2.0, SASB, GRI reporting
- ✓ Scope 2 and 3 tracking

Manage Mobile Field Team Operations



Field Data Workflows

Environmental Compliance

- ✓ Leak Detection and Repair
- ✓ Air Permit Management (e.g. Title V)
- ✓ NSPS, Engine Testing (e.g. OOOOa, OOOOb, JJJJ)

Health and Safety and Site Inspections

- ✓ Routine Site Inspections
- ✓ Spill tracking and management
- ✓ Waste Management Tracking



Transparency, Traceability, and Troubleshooting

The screenshot displays the Validere platform interface for a calculation result. The breadcrumb navigation shows: Organization > Equipment > Calculation Results > Calculation Result Detail. The user is logged in as Valinex Energy.

Organization (Selected): Home, Dashboards, Organization, Facilities, Flows, Networks, Equipment, Devices, Records, Calculations, Reports, Forms, Scenarios, Data Tools, Workflows.

Calculation Result Detail

- Last Run:** Jun 04 2024 04:57:18 MDT
- Last Run By:** Caelum Kamps
- Reporting Scenarios:** TIER LIFE (Selected), Global Emissions, AQM
- Results:**
 - Mass CO2: 22,319.25 tonnes
 - Mass CO2eq: 22,319.25 tonnes
- Details:**
 - Facility: Firebag
 - Equipment: Catalytic Heaters
 - Equipment Type: Catalytic Heater
 - Library: Alberta GHG Quantification Methodologies
 - Estimation Method: Fuel Combustion CO2
 - Calculator Name: Equation 1-3a: Gaseous fuel combustion emission CO2 (based on volume)
- User Inputs:**
 - Fuel amount: 12,106,005 m³ (Flow: Fuel to Catalytic Heaters)
 - Carbon content: 0.503 kg/m³ (Flow: Firebag Sample Point)
- Equation 1-3a: Gaseous fuel combustion emission CO2 (based on volume)**
Alberta GHG Quantification Methodologies
- $$mass_{CO_2} = 1000 \times 3.664 \times CC \times FA$$
- Equation 1-3a

The Validere Platform is built with auditability as a primary priority. Throughout our application, you will see options to leave notes, attach files, identify source data, and ensure transparency. We understand that users do not want a black box, and we have designed our platform with that in mind. Some key features that support this are:

- Calculation detail views
- Excel exports
- Change logs for records and assets
- Notes
- Attachments
- Source data linking
- QA/QC reports
- Status for assets and calculations



Relevant Case Studies

Validere Platform Case Study - CCUS



U.S. based Industrial Carbon Capture, Transport, and Storage company implements Validere software solution for volumetric accounting, emissions quantification, and data auditability for Regulatory Reporting and Credit Generation



Context

- Customer has captured >1MMTPA of Industrial CO2 Captured. Currently one of the largest private companies sequestering anthropogenic CO2 in the U.S.



EPA Regulatory Oversight

- EPA approved MRV plan to demonstrate that the CO2 is disposed of in secure, geological state. Standardized reporting templates for **Subpart UU, RR** established



Current Capture Sites and Transportation

- Captures CO2 from 4 major regional industrial sites (Examples include Fertilizer, biofuel and ethanol facilities) and transports via ~300 miles of CO2 pipeline to over 20 injection sites for longterm geological storage.



Timelines

- Currently expanding to add new capture system to a 5th facility and transport back to existing injection sites in 2025



45Q Tax Credit

- Permanent sequestered CO2 via 45Q Tax Equity Partnership in the U.S. administered by the IRS and projects to be valued at an estimated \$400M over the lifecycle of the project in tax credits
 - For **geologic sequestration**, facilities must capture and store at least **25,000 metric tons of CO₂ per year**
 - Recent Inflation Reduction Act (IRA) looks to increase price of credits per metric ton



Next Steps

- Onboard new facilities and volumes being onboarded in 2025 to the Validere platform, continue to expand training and adoption of software to support continuous executive-level decision making and analysis



How Validere MRV software helps support standardization,
reporting and transparency

Validere Platform supports Enterprise MRV software solution

Metered Volumetric Data

Metered CO2 Injected Volumes for Volumetric Accounting

Description:

Validere models out the underlying asset base and allow for metered volumetric data to be ingested on a high granularity and frequency and stored for visualization, accounting, quantification and allocations

Key Features:

- ✓ Configurable and dynamic asset hierarchy to organize operational data
- ✓ Align volumetric data frequency with reporting requirements and cadence

Templated Emissions Reporting

Scope 1, 2 and 3 Calculations and Regulatory Report Generation

Description:

Validere quantifies Scope 1, 2 and 3 emissions to support a full lifecycle analysis of operations as well as help in support regulatory report generation for EPA Subpart UU, RR annual reporting

Key Features:

- ✓ Out-of-the box emissions calculation libraries including volumetric calculations and engineering estimates
- ✓ Templated report generation aligned with jurisdictional specifications for federal reporting requirements

Insights and Decision Making

Auditability, and Executive Level Dashboarding

Description:

Validere enables full auditability of calculations in order to help support troubleshooting and to surface auditable insights and visualizations all the way to the executive level

Key Features:

- ✓ Customizable dashboards and visualizations
- ✓ Reporting on corporate goals and targets with direct tie-in to underlying data to support insights and decision making

Note on EPA's Subpart RR Reporting

Elements of US EPA's Subpart RR Reporting for reporting of greenhouse gases (GHGs) from facilities that inject carbon dioxide underground for geologic sequestration highlighted below:

- **Monitoring, Reporting, and Verification (MRV):** Facilities must submit an **MRV plan** to the EPA, outlining how they will monitor, report, and verify the amount of CO₂ sequestered underground.
- **CO₂ Storage Reporting:** Facilities are required to track and report the amount of CO₂ that is permanently stored underground, including details about the storage site, injection volumes, and pressure conditions.
- **Leakage Monitoring:** Operators must monitor for potential CO₂ leakage from the storage site and report any leaks to the EPA.
- **Annual Reporting:** Facilities must provide annual reports on the quantity of CO₂ injected, the amount that remains underground, and the results of leakage monitoring.

Modelling Assets and Connectivity

The screenshot displays the Validere Platform interface for the Skandier Cement Plant asset. The left sidebar contains navigation options: Home, Dashboards, Organization, Assets, Flows, Emissions Sources, Devices, Records, Calculations, Reports, Forms, Events, Scenarios, Data Tools, and Workflows. The main content area shows the asset details for 'Skandier Cement Plant' (ASSET), including a 'Delete' and 'Edit' button. The 'Overview' tab is active, showing a status of 'Active' and a creation date of 'Mar 18, 2024 08:30pm'. The 'Details' section provides location coordinates (61.738887° N, 9.547218° E), basin information (Norway/LUK), and facility type (CCS). A map view shows the plant's location in a forested area. Below the details, the 'Flows' section is active, displaying a table of flows with columns for Flow, Type, Asset, Emissions Source, Status, Product Category, Product Type, Origin, and Destination.

Flow	Type	Asset	Emissions Source	Status	Product Category	Product Type	Origin	Destination
CCS Source 3	Production Volume	Skandier Cement Plant	-	Active	Natural Gas	Natural Gas	-	-
CCS Source 3 - Line Loss	Fugitive	Skandier Cement Plant	-	Active	Natural Gas	Natural Gas	-	-

The Validere Platform enables customers to model out assets to represent as accurate as possible real-life asset configurations, including sites, emissions sources, sinks, and connectivity between sites. Assets include the ability for:

- Assets contain equipment or emissions source, devices for streaming measurement and flows for connectivity or volumetric modelling
- Operational data can be aggregated at various levels of hierarchy
- Extensive change logs keep track of who and what data has changed in the platform or underlying data about the asset itself.



Volumetric Accounting and Allocations

The screenshot displays the 'Records' section of the Validere platform. The interface includes a sidebar with navigation options like Home, Dashboards, Organization, Records, Calculations, Reports, Forms, Events, Scenarios, Data Tools, and Workflows. The main content area shows a table of records for 'CCS Allocation' in the period 'Jan, 2023 - Dec, 2024'. The table has columns for Time Period, Flow, Type, Asset, Emissions Source, Status, Record Status, Volume, and CO2 Content. The records list various production and delivery flows from assets like NOR Carbon Line, Hvordan Industrial Plant, Renor Refinery, and Skandier Cement Plant.

Time Period	Flow	Type	Asset	Emissions Source	Status	Record Status	Volume	CO2 Content
Dec 2023	NOR Carbon Line - Sent	Production Volume	NOR Carbon Line	-	Active	Unlocked	169,022,767 m ³	-
Dec 2023	CCS Source 5	Production Volume	Hvordan Industrial Plant	-	Active	Unlocked	24,463,383.84 m ³	990,000 ppm
Dec 2023	CCS Source 4 - Line Loss	Fugitive	Renor Refinery	-	Active	Unlocked	4,537,558.58 m ³	-
Dec 2023	CCS Source 3	Production Volume	Skandier Cement Plant	-	Active	Unlocked	51,945,370.89 m ³	960,000 ppm
Dec 2023	CCS Source 4	Production Volume	Renor Refinery	-	Active	Unlocked	19,947,022.42 m ³	1,000,000 ppm
Dec 2023	CCS Delivery 2	Production Volume	Nor Cluster CCS Injection 2	-	Active	Unlocked	24,463,383.84 m ³	960,000 ppm
Dec 2023	CCS Source 3 - Line Loss	Fugitive	Skandier Cement Plant	-	Active	Unlocked	11,816,558.94 m ³	-
Dec 2023	NK Processing Plant - Line Loss	Fugitive	NK Processing Plant	-	Active	Unlocked	2,315,080.87 m ³	-
Dec 2023	NK Processing Plant	Production Volume	NK Processing Plant	-	Active	Unlocked	15,948,405.03 m ³	980,000 ppm
Dec 2023	CCS Source 5 - Line Loss	Fugitive	Hvordan Industrial Plant	-	Active	Unlocked	1,145,848.08 m ³	-
Dec 2023	NOR Carbon Line - Line Loss	Fugitive	NOR Carbon Line	-	Active	Unlocked	24,492,942 m ³	-
Dec 2023	NK Refinery	Production Volume	NK Refinery	-	Active	Unlocked	32,225,643.15 m ³	970,000 ppm
Dec 2023	NOR Carbon Line - Delivered	Production Volume	NOR Carbon Line	-	Active	Unlocked	144,529,825 m ³	-
Dec 2023	CCS Delivery 1	Production Volume	Nor Cluster CCS Injection 1	-	Active	Unlocked	71,692,393.32 m ³	980,000 ppm
Dec 2023	Primary EOR Site	Production Volume	Primary EOR Site	-	Active	Unlocked	48,174,048.17 m ³	975,322,581 ppm

Along with emissions quantification the Validere platform supports the ability to aggregate, and run automated calculation logic on volumetric data to estimate, and allocation volumetric streams.

Volumetric streams are modeled as “Flows” that can lead into, out of, or connect assets. Volumetric data can be streamed into the platform on a recurring cadence as metered data, estimated based on equipment inputs, or allocated based on configuration of an asset network.



Dashboarding and Analysis



Quantified emissions data from volumetric CO2 data is calculated and can be generated for reporting and analysis. The Validere Platform supports

- Self-serve custom reporting
- Templated reports from defined regulatory outputs
- Dashboarding and analysis of metered volumetric data and quantified emissions data

How We Work With Our Customers



Implementation & Deployment

- Dedicated Implementation Team with support of extended team where required
- As frequent as daily engagements for team and delivery alignment, in addition to collaborative working sessions for activities like mapping, data ingestion, training etc.
- If desired, use a centralized software or artefact to manage implementation activities (i.e. Jira)
 - Dedicated team to drive and manage implementation
 - Regular engagement cadences for updates and input
 - Collaborative tools and processes to manage progress



Software-related Support & Customer Success Services (Included in SaaS subscription)

- Questions, defects, requests managed through support team
- Maintenance of calculation libraries as regulations are updated
- Product release notes and specific deployment details and support as required
- Minimum bi-annual success alignment meetings & Executive Business Reviews



Additional Services Available

- **Managed Services**
 - Support in ongoing operation of Validere Platform with or on behalf of customer (i.e. ongoing data ingestion, master data management and updates)
- **Consulting Services**
 - Regulatory reporting support
 - Emissions management advisory





Validere Provides a Range of Data Integration Options

Third-Party Integration

Use Case

Customer had **invoices from numerous providers with all different formats** that had to be consolidated into a single location for emissions quantification

Integration Approach - SFTP

Validere built vendor / source specific data pipelines to enable automated ingestion with minimal preprocessing requirements by the customer

Learnings & Key Considerations

Since data processing happens in the Validere Platform, establishing a process to keep data pipelines up to date is important

Corporate Data Lake Integration

Use Case

Customer **consolidated data from numerous field data capture systems into a corporate data lake**, providing a centralized location for emissions quantification input data

Integration Approach - API

Validere's API was used to receive daily volume and operating condition datasets for increased data availability with reduced data gathering effort for air emissions team

Learnings & Key Considerations

When multi-purpose data lakes are involved, understanding the scope and utility of the data being integrated is important

Source Systems Integration

Use Case

Customer had **volumes and operating hours from field tags in corporate PVR system** that required direct integration to Validere Platform

Integration Approach - API

Validere's API is used to automate the processing, transformation, and ingest of PVR exports to simplify monthly data uploads to the Platform

Learnings & Key Considerations

Data straight from source system requires processing before use to identify and address anomalies, noise, erroneous readings, etc.



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Subpart UU: Injection of Carbon Dioxide (CO₂)

Subpart UU covers **facilities that inject carbon dioxide (CO₂) underground for purposes other than geologic sequestration**. This could include enhanced oil recovery (EOR) or other processes where CO₂ is injected underground.

Key points of Subpart UU:

- **Reporting Scope:** Facilities that inject CO₂ must report the amount of CO₂ they inject underground, even if it's not for the purpose of permanent sequestration.
- **Monitoring and Measurement:** Facilities are required to monitor and report the **quantity of CO₂ received, injected, and transferred**.
- **Exemptions:** If CO₂ injection is not for geologic sequestration (e.g., it's used in enhanced oil recovery and then released), facilities still need to report the data under Subpart UU, but they are not subject to the more stringent requirements of Subpart RR (see below).

Subpart UU focuses on providing data related to CO₂ injections that are not intended for long-term storage, helping the EPA monitor how much CO₂ is being used and released in different industries.

Subpart RR: Geologic Sequestration of Carbon Dioxide

Subpart RR is more comprehensive and applies to facilities that **inject CO₂ for the purpose of long-term geologic sequestration**—a process that involves capturing and storing CO₂ underground to prevent its release into the atmosphere.

Key points of Subpart RR:

- **Monitoring, Reporting, and Verification (MRV):** Facilities must submit an **MRV plan** to the EPA, outlining how they will monitor, report, and verify the amount of CO₂ sequestered underground.
- **CO₂ Storage Reporting:** Facilities are required to track and report the amount of CO₂ that is permanently stored underground, including details about the storage site, injection volumes, and pressure conditions.



Cost Considerations- Software

Validere SaaS Platform

The following proposal includes access to features and functionality within both of the following software packages:

Emissions Management

Emissions management software that streamlines regulatory and voluntary emissions quantification and reporting, supporting compliance with diverse regulations and empowering organizations to monitor and report emissions data effectively

Field Data Workflows

Streamline operational data collection with configurable forms, events, and workflow templates for efficient regulatory compliance. Schedule, assign, and manage tasks while notifying users of upcoming deadlines. Pre-configured templates and workflow logic are provided during onboarding and can be made accessible via desktop and mobile applications including offline access via our mobile application

Note: These packages can be purchased and implemented separately. When implemented together they are fully integrated (i.e. leverage the same base asset inventory) and do not exist as two distinct modules. Additionally, Validere is open to working together to structure a long-term contact that provides optionality and consideration of current vendor costs and potential termination fees/penalties

Annual SaaS Platform Fee*

Billable on the first day of each year within the term

No limit on number of user access or user accounts within organization

Base onboarding, ongoing support and maintenance included in annual software platform fee

Initial Term

36 months

Term Start Date

TBD

Asset Scope

All assets owned and operated by Chesapeake or Chesapeake & Southwestern

Base Onboarding, Ongoing Support

Standard onboarding, configuration, and support included in SaaS

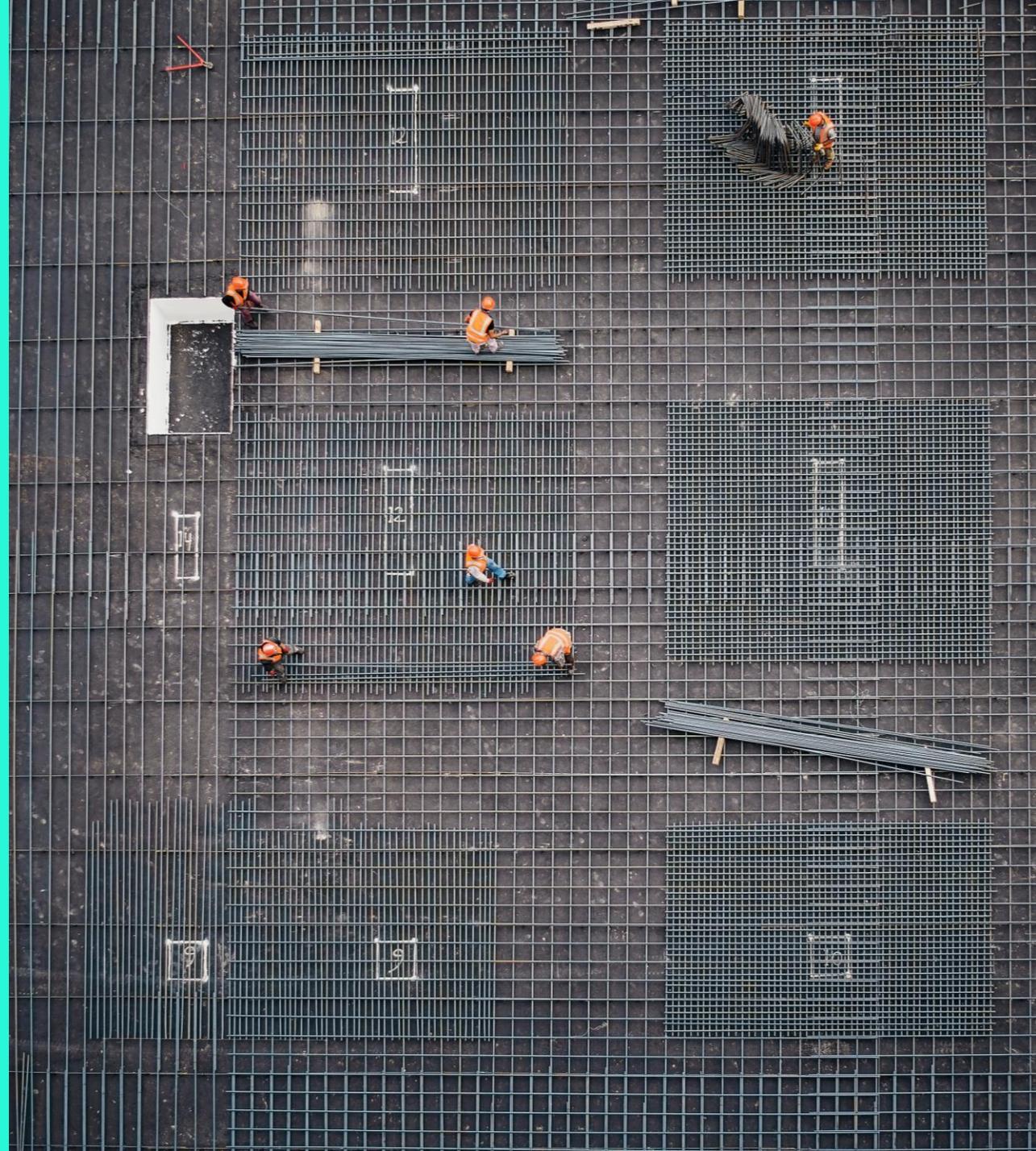
Additional Professional Services and Reporting Support

Additional professional services and support are available and subject to additional scoping beyond the scope of this proposal. Examples are outlined on subsequent slides

* Pricing valid 30 days. Taxes additional. All pricing in USD

6. Conclusions and AOB

Suzie Ferguson (TWG Co-Chair)



7. Conclusions & AOB

- AOB
- Review any actions arising from meeting
- Next TWG Meeting: 03 December 2024
- Key upcoming meetings:
 - Regulation and Policy Working Group: 18 September
 - Supply Chain Working Group: 24 September
 - All-member forum: 20 September
- Close meeting

