WORKSHOP WITH A FOCUS ON ENHANCED WEATHERING

12th November 2024
Brugge (Belgium) and online (Teams)

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor CINEA can be held responsible for them.

C-SINK WORKSHOP FOCUSED ON ENHANCED WEATHERING AS CDR TECHNOLOGY: C-SINK PROJECT

Jennire V Nava Rosario
ICAMCYL
12th November 2024

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor CINEA can be held responsible for them.

Funded by the European Union

Funded by
the European Union

C-SINK

CONTENTS

- General information

- C-Sink Objectives
- C-Sink Expected Outcomes & Impacts
- C-Sink WPs Structure

- Consortium
- Partners Overall Involvement

- C-SINK Gantt chart & first results

- EW within the C-SINK project

Funded by
the European Union

GENERAL INFORMATION

- PROJECT NAME: Actions required to secure the large-scale deployment of the leading CDR approaches to meet EU climate targets.
- CALL/TOPIC: HORIZON-CL5-2022-D1-01-01-two-stage
- PROJECT STARTING DATE: 1 June 2023
- PROJECT END DATE: 31 May 2027
- PROJECT DURATION: 48 Months

Funded by
the European Union

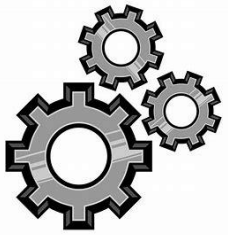
C-SINK GENERAL OBJECTIVE

C- SINK will establish the foundations upon which to **build a standardized and transparent European CDR market** with trustworthy accounting methodologies based on robust Monitoring, Reporting, and Verification (MRV) pre-standards and policy strategies. **Comprehensive scientific assessments** will be made of the various CDR approaches, in terms of **(a)** their potential uptake of CO_2 (or particulate carbon in the case of biochar), and **(b)** their safety and other impacts over time.

Funded by
the European Union

CONTEXT (CDR TECHNOLOGIES)

- CO_2 fixation by plants and microorganisms (BCO_2)
- Afforestation (AF)
- Biochar (BC)
- Artificial soils (AS)
- Biochar with carbon capture and storage (BCCCS)
- Bioenergy with Carbon Capture and Storage (BECCS)
- Enhanced weathering (EW)



1) Their potential for carbon offsetting
2) Permanence
3) Environmental & social impacts
4) Large-scale potential

Funded by
the European Union

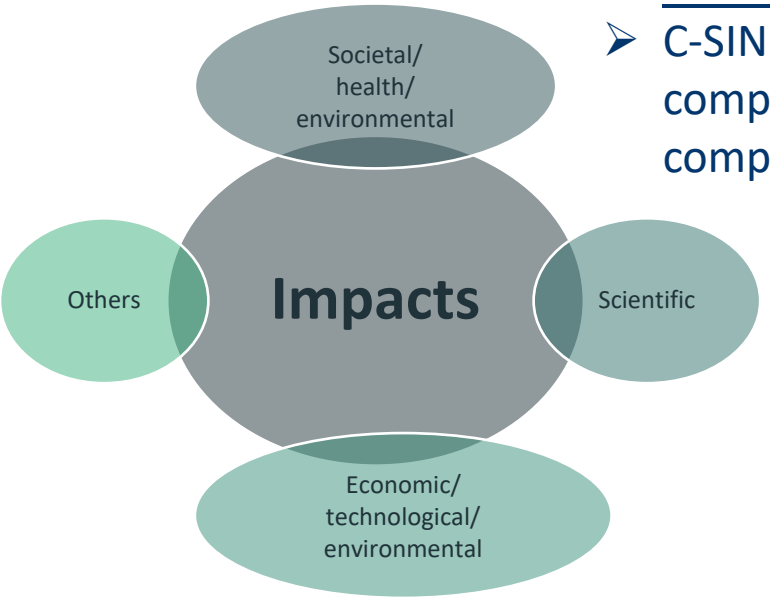
C-SINK SPECIFIC OBJECTIVES

- ✓ **SO1 – Define gaps in current technical knowledge and barriers to wider acceptance of individual CDR approaches**
- ✓ **SO2 – Contribute to effective CDR accounting systems and their standardization through the development of pre-standards for the elements of MRV**
- ✓ **SO3 – Develop technically, environmentally, and socially robust and efficient regulatory frameworks to support CDR uptake at scale.**
- ✓ **SO4 – Evaluate environmental, social, and governance (ESG) criteria related to individual CDR technologies.**
- ✓ **SO5 – Perform a total economic assessment of seven CDR approaches**
- ✓ **SO6 - Promote CDR technologies by engaging key stakeholders and increasing public acceptability**

Funded by
the European Union

C-SINK EXPECTED OUTCOMES & IMPACTS

- 7 CDR technologies with TRL8 with their corresponding methodology, and standardization.
- 7 CDR´s parametrization, limitations, as well as cost estimation, social-environmental impact, and the investigation of ripple effects and scale of deployment for each technology, will be done.



- C-SINK will develop methodologies for CDR monitoring and verification testing at lab and field testing, providing comparable data of carbon removal options.
- C-SINK will use industrial scale data to estimate cost from operations of mining companies, biochar companies and technoeconomic engineering in order to compare the different CDR options.

- C-SINK will promote MRV pre-standards for 7 CDR technologies.
- C-SINK will create a new virtual cluster/community called CO_2 Removal Helix for DC&E strategies during and beyond the project.

Funded by the European Union

C-SINK STRUCTURE

C-SINK

WP1 Project coordination, ethics and data management

- Risks
- Ethic monitoring
- DM
- T&F reporting

WP2 **C-SINK CDR solutions comprehensive analysis and characterization**

(Database, quantification, Life cycle inventory, case study values, limitations)

Parameters → WP3

KPIs, Process definition → WP4

Regulatory barriers → WP4

State of the art data → WP5

impacts inventory → WP5

WP3 Methodologies for monitoring, reporting and verification of CO_2 removal

(Pre-standards for MRV)

Liability ↔ WP3 / WP4

WP4 Legal framework, regulatory barriers, policy roadmap recommendations

(Regulatory framework, market creation)

Impacts analysis ↔ WP4 / WP5

Assessment framework ↔ WP4 / WP5

WP5 Social, Environmental and total economic value assessment

(Social and environmental implications, cost benefit analysis)

WP3 → *Accountancy* → WP6

WP4 → *Governance* → WP6

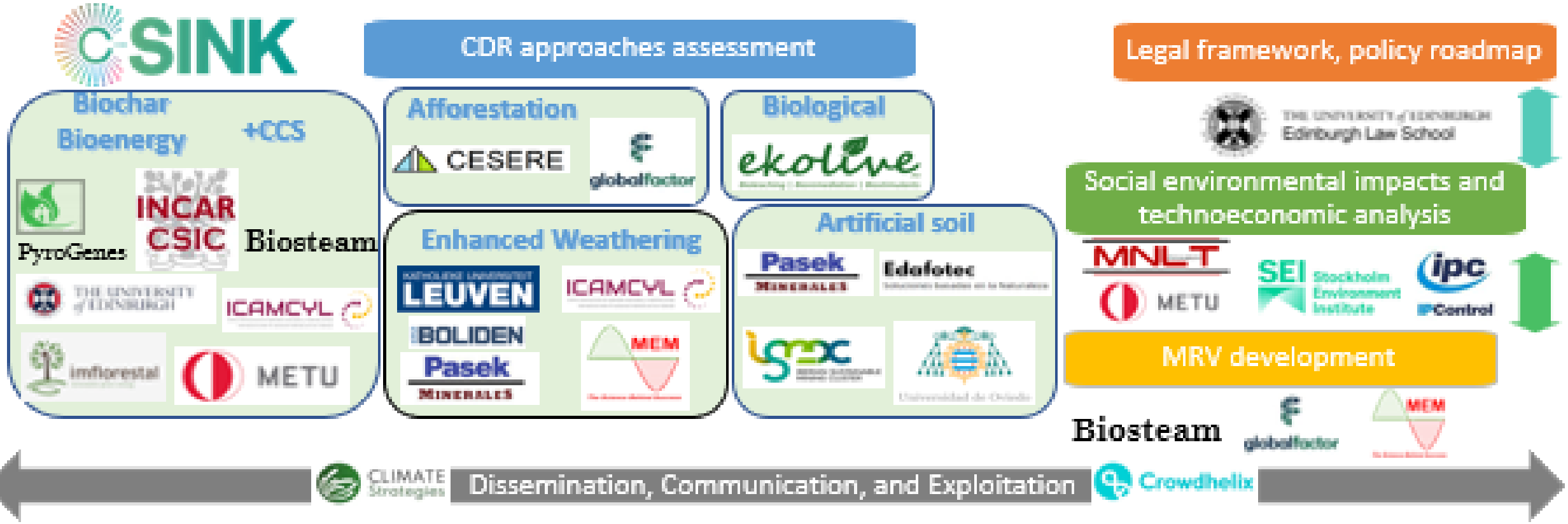
WP5 → *CDR development impact analysis* → WP6

WP6 Dissemination, exploitation and communication

Funded by the European Union

CONSORTIUM

- ✓ 24 organisations from 11 different European countries
- ✓ 15 Industries & SMEs
- ✓ 2 industry-driven clusters and foundations
- ✓ 3 Research Centers
- ✓ 4 Universities



Funded by the European Union

OVERALL INVOLVEMENT

C-SINK

WP nº	Work Packages	WP Leader	Participants
1	Project coordination, ethics and data management	ICAMCYL	All
2	C-SINK CDR solutions comprehensive analysis and characterization	UED University of Edimburgh	METU, imflorestal, PyroGenesys, MEM, Biosteam, Edafotec Soluciones basadas en la Naturaleza, INCAR CSIC, ICAMCYL, BOLIDEN, globalfactor, CLIMATE Strategies, Pasek Minerales, ekolive, CESERE, Crowdhelix, MNLT
3	Methodologies for monitoring, reporting and verification of CO2 removal	MEM Mine Environment Management Ltd	globalfactor, CESERE, Biosteam, ipc IPControl, THE UNIVERSITY of EDINBURGH Edinburgh Law School, ekolive, MEM, INCAR CSIC, imflorestal, Pasek Minerales, Edafotec Soluciones basadas en la Naturaleza, PyroGenesys, KATHOLIEKE UNIVERSITEIT LEUVEN, BOLIDEN, ICAMCYL, METU, SEI Stockholm Environment Institute
4	Legal framework, regulatory barriers and policy recommendations	UED	ICAMCYL, ipc IPControl, ekolive, Edafotec Soluciones basadas en la Naturaleza, PyroGenesys, INCAR CSIC, CESERE, MEM, imflorestal, SEI Stockholm Environment Institute, METU, globalfactor, BOLIDEN, Biosteam
5	Social, Environmental and total economic value assessment	SEI Stiftelsen the Stockholm Environment Institute	ICAMCYL, THE UNIVERSITY of EDINBURGH Edinburgh Law School, CESERE, SEI Stockholm Environment Institute, METU, Biosteam, ekolive, Edafotec Soluciones basadas en la Naturaleza, MEM, PyroGenesys, Pasek Minerales, imflorestal, INCAR CSIC, globalfactor
6	Dissemination, Exploitation and Communication	SCS Stichting Climate Strategies	All

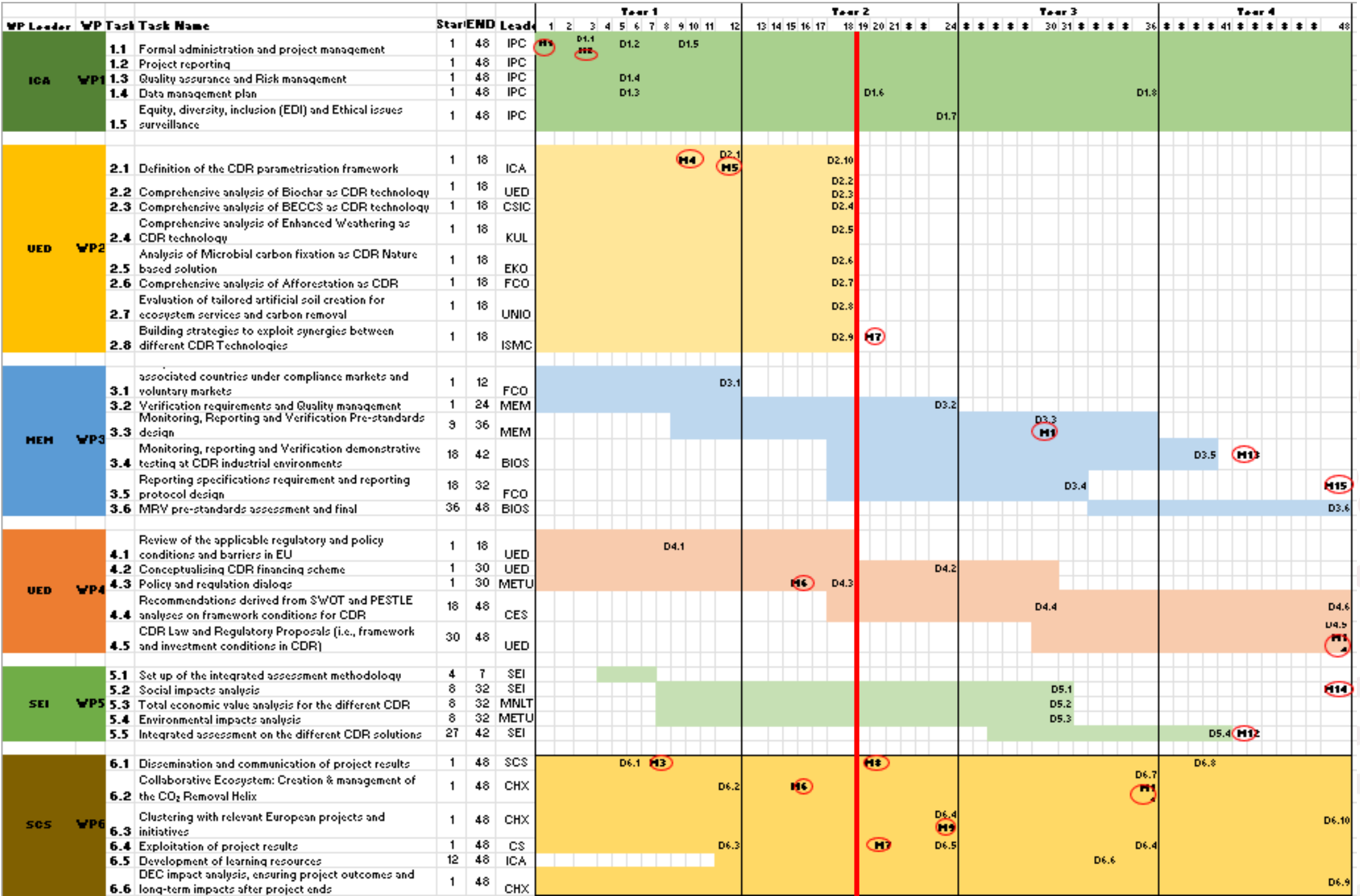
ICAMCYL– INNOVATION PROCUREMENT

ICAMCYL is a Non-profit research foundation created by the main industries of Castilla y León region (Spain)

>15 ongoing European project

https://www.icamcyl.com/en

ICAMCYL
Centro internacional de materiales avanzados y materias primas
International center for advanced materials and raw materials



C-SINK GANTT

Timings
Deliverables
Milestones

M18

Funded by
the European Union

C-SINK RESULTS

19 deliverables submitted (M18)
13/19 public reports
6 milestones have been reached (M18)

MS#	Milestone name	Related WP	Due month	Beneficiar	Means of verification	Status
MS1	Kick off meeting	1	1	IPC	Formal start of the project.	Covered
MS2	Advisory board formed	1	3	IPC	First introductory meeting with the fifth advisory board members and consortium members.	Covered
MS3	Project branding and online presence	6	6	SCS	Logo, website and social media accounts online.	Covered
MS4	Public consultation on CDR assessment framework	2	10	ICA	Documents online and open to receiving feedback from stakeholders/public for two months	Covered
MS5	Process diagrams completed	2	12	ICA	7 process diagrams completed and reported D2.1	Covered
MS6	Effective strategies for interaction with policy m	4, 6	16	METU	Attendance of at least 10 EU relevant public bodies to workshops and	Covered

#	Deliverable name	W	lea	Typ	Dissemina level	Dat	Evaluator	Delivery D	Status
D1.1	Constitution of the different Management Bodies	1	1-IPC	R	SEN	3	ICA	23/09/2023	Submitted
D1.2	Risks identification revision	1	1-IPC	R	SEN	6	ICA	28/11/2023	Submitted
D1.3	Data Management Plan I	1	1-IPC	DPM	SEN	6	ICA	28/11/2023	Submitted
D1.4	Quality Plan	1	1-ICA	R	SEN	10	ISMC	26/03/2024	Submitted
D1.5	C-Sink Project Handbook	1	1-ICA	R	SEN	10	ISMC	21/03/2024	Submitted
D1.6	Data Management Plan II	1	1-ICA	DPM	SEN	20	ISMC		
D1.7	Ethic requirement report	1	1-ICA	R	SEN	24	ISMC		
D1.8	Data Management Plan III	1	1-ICA	DPM	SEN	36	ISMC		
D2.1	CDR assessment framework for harmonized comparison	2	1-ICA	R	PU	12	UED	24/05/2024	Submitted
D2.2	Biochar for Carbon dioxide removal	2	20-UED	R	PU	18	PYR		
D2.3	CSS Biochar	2	METU	R	PU	18	IMF		
D2.4	BECCS for CDR	2	CSIC	R	PU	18	METU		
D2.5	Enhanced Weathering for CDR	2	KUL	R	PU	18	BOL		
D2.6	Microorganisms for CDR	2	EKO	R	PU	18	BIOS		
D2.7	Afforestation for Carbon dioxide removal	2	FCO	R	PU	18	CES		
D2.8	Artificial Soils as CDR option	2	EDA	R	PU	18	UNIOVI		
D2.9	CDR synergistic solutions	2	ISMC	R	PU	22	MEM		
D2.10	Harmonised comparison of CDR technologies	2	ICA	R	PU	18	FCO		
D3.1	Analysis of existing MRV schemes	3	FCO	R	SEN	12	CES	07/06/2024	Submitted
D3.2	Quality management systems for verification bodies	3	BIOS	R	PU	24	ISMC		
D3.3	MRV pre-standards Interim report	3	BIOS	R	PU	30	IPC		
D3.4	CDR project reporting recommendations	3	FCO	R	PU	32	ICA		
D3.5	MRV practical challenges	3	22-MEM	R	PU	40	BIOS		
D3.6	MRV pre-standards Final set and recommendations	3	22-MEM	R	PU	48	UED		
D4.1	Regulatory and policy conditions for CDR in EU	4	20-UED	R	PU	18	IPC		
D4.2	Investment conditions in CDR	4	20-UED	R	PU	24	PYR		
D4.3	Skills requirements and availability in EU Public Authorities for CDR development	4	20-UED	R	PU	24	FCO		
D4.4	Recommendations on framework conditions for CDR I	4	CES	R	PU	30	MNLT		
D4.5	Workshop conclusions	4	METU	R	PU	48	SCS		
D4.6	Recommendations on framework conditions for CDR II	4	CES	R	PU	48	IPC		
D5.1	Social acceptability of CDR technologies	5	SEI	R	PU	32	ECT		
D5.2	Techno-economic impact assessment of CDR technologies	5	20-UED	R	PU	32	MNLT		
D5.3	Environmental impact assessment of CDR	5	METU	R	PU	32	CSIC		
D5.4	Integrative assessment of CDR technologies	5	CES	R	PU	42	ECT		
D6.1	DEC Plan I	6	SCS	R	PU	6	ISMC	30/11/2023	Submitted
D6.2	CO_2 Removal Helix I	6	CHX	R	PU	12	ICA	27/05/2024	Submitted
D6.3	Exploitation of results I	6	MNLT	R	PU	12	CS	31/05/2024	Submitted
D6.4	Clustering activities I	6	CHX	R	PU	24	SCS		
D6.5	Exploitation of results II	6	MNLT	R	PU	24	CS		
D6.6	Training material report	6	ICA	R	PU	34	ISMC		
D6.7	CO_2 Removal Helix II	6	CHX	R	PU	36	ICA		
D6.8	DEC Plan II	6	SCS	DEC	PU	40	ISMC		
D6.9	Final dissemination and communication activities overview	6	SCS	R	PU	48	CS		
D6.10	Clustering activities II	6	CHX	R	PU	48	SCS		

Funded by the European Union

C-SINK

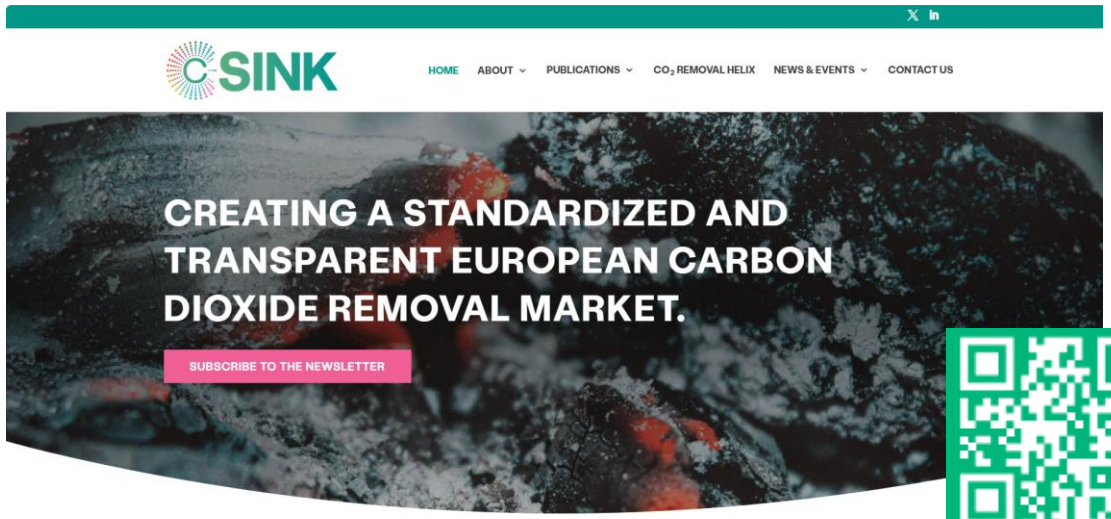
C-SINK RESULTS

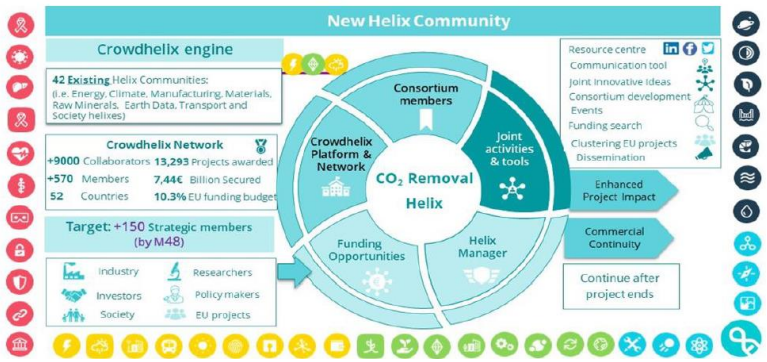
1 KoM
5 research seminars
>20 Conferences, seminars & exhibitions participations
6 posters & 2 scientific papers
2 workshops focused on CDR-T

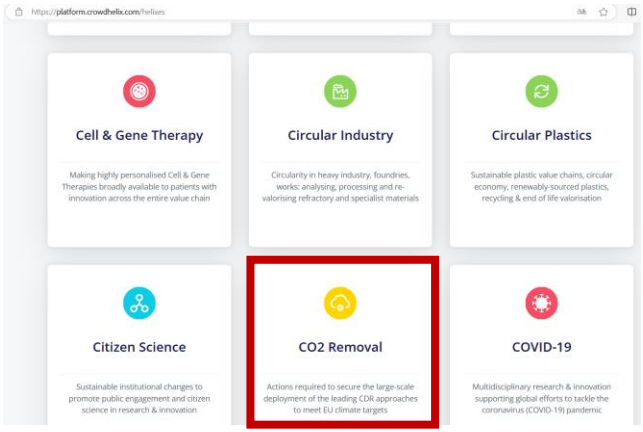
Funded by the European Union

C-SINK RESULTS

C-SINK social media (website, LinkedIn, X)
1 CO_2 Removal Helix platform (128 Members)
1 newsletter
1 learning resource







C-SINK Actions required to secure the large-scale deployment of the leading CDR approaches to meet EU climate targets

C-SINK– FACTSHEET LECTURE 1 DELIVERED BY ICAMCYL & EKOLIVE

CARBON DIOXIDE REMOVAL TECHNOLOGIES (CDR-T): BIOLOGICAL CO_2 FIXATION (BCO_2)

INTRODUCTION

In the Paris Agreement (United Nations, 2015), the necessary bases were established to address the issue of climate change as urgent, using the highest level of technological and scientific knowledge to contain and address the problem on a global scale. Subsequently, the Intergovernmental Panel on Climate Change (IPCC) announced the results of a rigorous assessment based on scientific, technical, and socio-economic data available in the literature on global warming of 1.5ºC and the comparison between global warming of 1.5ºC and 2ºC above pre-industrial levels. Resulting model pathways with no or limited overshoot of 1.5ºC indicate that emissions must decline by 45% to keep warming below 1.5ºC by 2030, and towards net zero by 2050 (IPCC, 2018b). The C-SINK project funded by Horizon Europe aims to establish the foundations to build a standardized and transparent European CDR market with trustworthy accounting methodologies based on robust Monitoring, Reporting, and Verification (MRV) pre-standards and policy strategies.

WHAT IS CARBON DIOXIDE REMOVAL (CDR)?

Following the IPCC's 8th Assessment Report, CDR refers to activities that remove carbon dioxide (CO_2) from the atmosphere and store it permanently (IPCC, 2018a). They can be grouped into nature-based and technology-based removals (Meyer-Ohlendorf, 2020). Nature-based enhancing biological sinks of CO_2 are, among others, afforestation (AF), reforestation (RF), and soil carbon sequestration (SCS) as a result of BCO_2. Technology-based removals employ chemical engineering to achieve long-term removal and storage. Among others, an example is bioenergy with carbon capture and storage (BECCS), but there are additional approaches including improving soil quality, enhanced weathering, and the production of biochar (Ornelas et al., 2023).

GLOSSARY

Aerobic metabolism: Type of metabolism which occurs in the presence of oxygen.

Anaerobic metabolism: Type of transformation produced with no presence of oxygen.

Autotrophic bacteria: Type of bacteria which synthesizes their own food. They derive energy from light, utilize simple inorganic compounds like CO_2, water, etc., and convert them into organic compounds to supplement their energy requirements.

Biological carbon fixation (BCO_2): A nature-based technology in which living organisms absorb and convert CO_2 into organic matter through biochemical pathways (Berg, 2011). Organic compounds created by BCO_2 are used to store energy and to build other biomolecules. Carbon is primarily fixed through photosynthesis, when sunlight is available, and chemosynthesis, in the absence of sunlight.

Heterotrophic microorganisms: Organisms that obtain their energy and carbon from organic compounds.

Soil microbiota: The abundance and diversity of microbes residing in the soil (bacteria, fungi, archaea, protists, and algae).

DEFINING CO_2 REMOVAL FROM A BCO_2 STANDPOINT & PROCESS

CO_2 removal by BCO_2 refers to the amount of CO_2 that is consumed and stored by microorganisms in the soil and plants growing in a defined area. When plants photosynthesize, they take CO_2 from the atmosphere and convert it into organic

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor CINEA can be held responsible for them.

Funded by the European Union

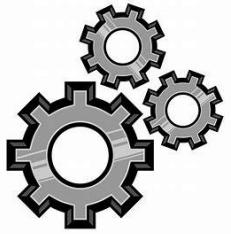
EW WITHIN THE C-SINK PROJECT

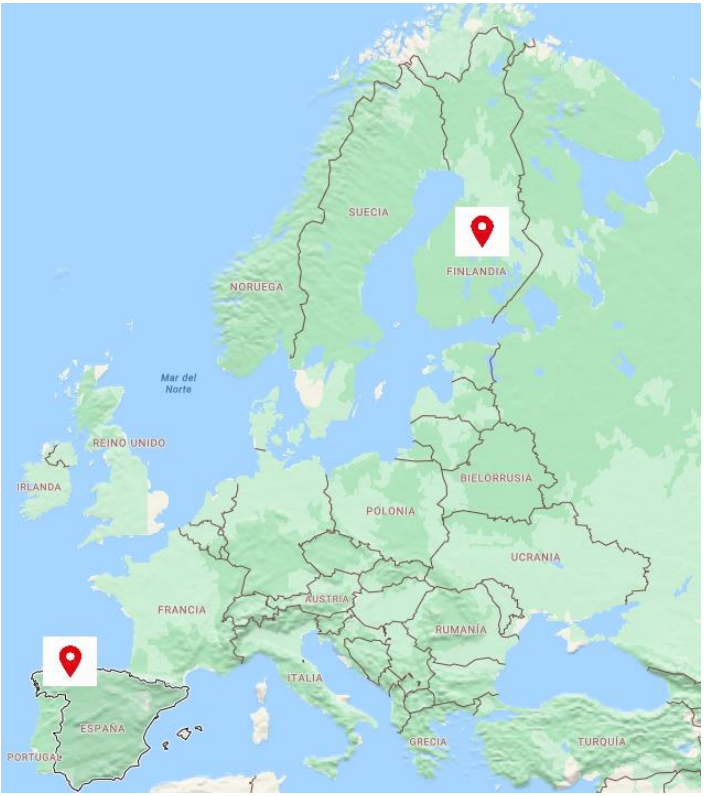
C-SINK

WP2 T2.4 4 Del

<u>C-SINK CDR solutions comprehensive analysis and characterization</u>

- ✓ 2 Del CDR assessment framework for harmonized comparison
- ✓ 1 Del Enhanced Weathering for CDR
- ✓ 1 Del related to synergies





WP3 WP4 WP5 WP6

Methodologies for monitoring, reporting, and verification of CO_2 removal

2 pilots

Social, Environmental, and total economic value assessment

- ✓ Legal framework, regulatory barriers, and policy recommendations

Dissemination, Exploitation, and Communication activities

THANKS FOR LISTENING!

Jennire Nava
jv.nava@icamcyl.com

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor CINEA can be held responsible for them.

Funded by
the European Union