

HERCCULES
full CCUS chain demonstration



Take Away Messages

**Dissemination event
on CO₂ Capture,
Transport, Use and
Storage (CCUS)**

June, 13th 2024

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Innovate
UK

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1 INTRODUCTION

On June 13th 2024, the **Dissemination Event on CO₂ Capture, Transport, Use and Storage (CCUS)** took place in Tallinn, Estonia. It has been organised by the company **SHOGenergy** and the **TalTech Department of Geology**, in representation of two unique Horizon Europe projects:

- **HERCCULES (HEROES IN SOUTHERN EUROPE TO DECARBONIZE INDUSTRY WITH CCUS)** is the first full chain CCUS demonstration project in Southern Europe, focusing on the cement and energy from waste sectors in Northern Italy and Greek clusters. HERCCULES is coordinated by LEAP (Piacenza Energy and Environment Laboratory), supported by the Horizon Europe programme for 5 years (2023-2027) and co-financed by the industrial partners of the consortium, which brings together a total of 25 partners; and
- **CCUS ZEN (Zero Emission Network to facilitate CCUS uptake in the industry)** project focuses on the Baltic and Mediterranean regions and aims to increase and share knowledge on CCUS and accelerate its uptake. The project is coordinated by SINTEF, funded by the Horizon Europe programme for 2.5 years, and includes 15 project partners and 40 network partners. The CCUS ZEN project develops cross-border, long-term, full value chain CCUS scenarios in the Baltic and Mediterranean regions.

The event has been a successful example of liaison activities between this two sister projects.

The event framework

To meet the climate targets of the Paris Agreement, global CO₂ emissions must be reduced significantly by 2050. European Union is planning to reduce at least 55% of greenhouse gas emissions (GHGE) by 2030 compared to 1990 and 40% of GHGE by 2030, compared to 2005, with a final target to reach climate neutrality including net-zero greenhouse gas emissions by 2050.

About 50% of the CO₂ emissions in Europe come from industry and energy sectors. Carbon Capture, Utilization and Storage (CCUS) is one of the 8 strategic net-zero technologies, that can play a crucial role in ensuring that energy-intensive industries and the power sector in Europe can transit to climate neutrality and the EU can deliver its net-zero commitments.

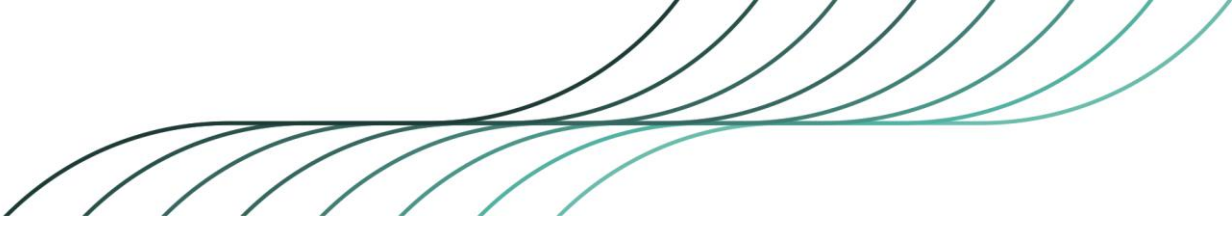
Net-Zero Industry Act proposed to accelerate CO₂ capture and reach geological storage capacity of 50 Mt of CO₂ annually by 2030, and support carbon capture and storage projects by enhancing the availability of CO₂ storage sites.

Event highlights

With more than 50 participants in presence and 40 connected online, including consortium members, relevant stakeholders and general public from both HERCCULES and CCUS ZEN projects, the event has been divided into 3 main sessions:

The first session was convened by Martina Fantini from EUCORE Consulting, and included a presentation of HERCCULES and CCUS ZEN projects made by Maurizio Spinelli (LEAP, project coordinator) and Romain Viguier (SCCS), respectively. Following this introduction, Adriano Carrara (A2A Spa) and Matteo Foidelli (TPI – SIAD group) provided a comprehensive overview of CO₂ Capture in Waste to Energy plants.

The second session, convened by Pierre Cerasi (SINTEF) comprised a technical discussion on CCUS projects and future scenarios. It started with a presentation from Roberto Ferrario (ENI) on infrastructures



for transport and storage and some examples of project sites in Europe. Subsequently, Alla Shogenova (TalTech and Shogen) and Leandro-Henrique Sousa (Rambol, CCUS ZEN) presented an in-depth analysis of the Baltic and Mediterranean Regions CCUS scenario. Their presentation included a techno-economic modelling and an analysis of the value chain.

The **third section** was focused on Regulations, Public Acceptance and Policies and it was convened by Alla Shogenova. The first presentation was done by Ingvild Ombudstvedt (IOM LAW, CCUS ZEN) and it aimed at examining the regulatory challenges that must be overcome. It was followed by the presentation of Anne Kantel from Fraunhofer ISI on public perception of this technology, as well as the potential role of policy makers in advancing its development. To conclude, a Panel discussion was launched involving the CCUS ZEN networking partners and the HERCCULES local stakeholders.

The event has been a success also because several external experts from outside the consortiums have attended in presence. The questions that were brought up by them were both interesting and valuable for the partners, which led to significant discussions among all the audience.

The projects in numbers

HERCCULES: Starting date: January 1st 2023; Project duration: 60 months; EU contribution: € 29.632.076,48; 25 partners: Laboratorio Energia Ambiente Piacenza, EU CORE Consulting Srl, Energean Oil & Gas - Energeiki Aigaiou Anonymi Etaireia Erevnas Kai Paragogis Ydrogonanthrakon – S.A., Buzzi Unicem Spa, Titan Cement Company Ae, Sumitomo Shi Fw Energia Oy, Air Liquide Italia Spa, Fraunhofer Gesellschaft zur Forderung der Angewandten Forschung Ev, Politecnico di Milano, The Boston Consulting Group Srl, Agencia Estatal Consejo Superior de Investigaciones Cientificas, Celitement GmbH & Co. Kg, Universiteit Utrecht, Wietersdorfer Alpacem GmbH, Artidek, MTU SHOGenergy, Lappeenranta-Lahden Teknillinen Yliopisto Lut, Tecno Project Industriale Srl, Associazione Clust-Er Energia e Sviluppo Sostenibile, Centre for Renewable Energy Sources and Saving Foundation, A2A Ambiente Spa, Eni Spa, A2A Spa, Buzzi Unicem SRL, SNAM Spa.

CCUS ZEN: Starting date: 1st August 2022; Project duration: 2.5 years; EU contribution: €1.782.627,50; 16 partners: SINTEF, Tallinn University of Technology, CO2 Value Europe Aisbl, Perspectives Climate Research, Panstwowy Instytut Geologiczny - Panstwowy Instytut Badawczy, Novia University of Applied Sciences, Geological Survey of Denmark and Greenland, Middle East Technical University, Bureau de Recherches Geologiques et Minières, Iom Law, Technip Energies France, Ramboll Danmark AS, Axelera - Association Chimie-Environnement Lyon et Rhone-Alpes, University of Yliopisto, The University Of Edinburgh.

2 AGENDA OF THE EVENT (PLANNED)

Time*	Topic	Speaker
09:00 – 09:30	Registration of the participants and coffee	
09:30 – 11:00	<i>Session 1. Introduction of Horizon Europe projects and CCUS technology</i> <i>Convener: Martina Fantini (EUCORE–HERCCULES)</i>	
09:30 – 10:00	Introduction to Horizon Europe HERCCULES project	Maurizio Spinelli, Project Coordinator (LEAP)
10:00 – 10:30	Introduction to Horizon Europe CCUS ZEN project	Romain Viguier (SCCS – CCUS ZEN)
10:30 – 11:00	CO ₂ Capture in Waste to Energy plants	Adriano Carrara / Matteo Foiadelli (A2A SpA /TPI – HERCCULES)
11:00 – 11:30	Coffee break	
11:30 – 13:00	<i>Session 2. CCUS projects and future scenarios</i> <i>Convener: Pierre Cerasi (SINTEF - CCUS ZEN)</i>	
11:30 – 12:00	Infrastructures for the transport and storage Examples of Projects sites in Europe	Roberto Ferrario (ENI - HERCCULES)
12:00 – 12:30	Techno-economic modelling of the Baltic CCUS Scenario (Denmark, Sweden & Germany)	Leandro-Henrique Sousa (Rambol-CCUS ZEN)
12.30 – 13.00	Analysis of the value chain scenarios in the Baltic and Mediterranean Regions	Alla Shogenova (TalTech-CCUS ZEN)
13.00 – 14.00	Lunch	
14.00 – 16:30	<i>Session 3. Regulations, public acceptance and policies</i> <i>Convener: Alla Shogenova (TalTech–CCUS ZEN, SHOGenergy–HERCCULES)</i>	
14:00 – 14:25	Regulatory aspects: Obstacles/barriers to overcome	Ingvild Ombudstvedt (IOM LAW- CCUS ZEN) online
14:25 – 14:50	Public acceptance and the role and the potential contribution of the policy makers	Anne Kantel (Fraunhofer ISI - HERCCULES)
14.50 – 15:15	CCS Developments in the Baltic States	Janis Volberts (Bellona Europe)
15:15 – 16:15	Panel discussion involving CCUS ZEN networking partners, HERCCULES and local stakeholders	Anne Kantel (Fraunhofer ISI - HERCCULES)
16.15 – 16.30	Wrap-up session	Alla Shogenova (TalTech-CCUS ZEN) Martina Fantini (EUCORE–HERCCULES)
16.30 - 17.15	Farewell Coffee	

*Timings are expressed in local time (UTC+2)

3 BIOGRAPHIES AND TALKS

3.1 SPEAKERS

3.1.1 **Maurizio Spinelli** (LEAP - HERCCULES project Coordinator)

Maurizio Spinelli is the Head of the low carbon technologies unit at Laboratory of Energy and Environment Piacenza (LEAP), a research center located in Italy working on the energy-environmental sector. He got his PhD in Energy and Nuclear Science and Technology defending the thesis "Advanced technologies for CO₂ capture and power generation in cement plant". Involved in Horizon projects for more than 10 years, he is now the coordinator of HERCCULES project.



"HERCCULES was born with the very ambitious aim of demonstrating for the first time the feasibility of the whole CCUS chain in southern Europe"

"We have a highly skilled partnership and a great budget, almost 40 M€"

*** Public slides available in Zenodo ***

3.1.2 **Romain Viguier** (SCCS - CCUS ZEN)

Romain Viguier is the Business Development Manager for Scottish Carbon Capture and Storage at the University of Edinburgh. Romain is a certified Prince2 project manager with a PhD in Chemistry, he was CEO of a Green Chemistry start-up company from 2007 to 2014 and joined SCCS to support the commercialization and deployment of CCS as a climate change mitigation solution. Romain leads WP5 on Knowledge Sharing Communication and Dissemination



"CCUS must not only be economically viable for the industry but also positively perceived by the public to ensure successful implementation."

"Please, contact us to be part of the network"

*** Public slides available in Zenodo ***

3.1.3 **Adriano Carrara** (A2A SpA - HERCCULES) - **Matteo Foiadelli** (TPI Tecno Project Industriale SIAD group - HERCCULES)

Adriano Carrara

Responsible of the CCUS research area in A2A group, the first Italian operator in environmental sector and the second player for power generation. Adriano has a PhD in Energy and Environmental Technologies. With more than 15 years of experience in WtE and energy generation, including renewables, he is expert in technologies for Carbon Capture in Energy from Waste sector.

Matteo Foiadelli

Management engineer, part of the Technoproject Industriale Group a company belonging to SIAD Group specialised in capture and liquefaction plants of CO₂. With more than 14 years of experience in industrial engineering, he is today project manager of production of technical gases, capture and liquefaction of CO₂. Among his expertise, carbon capture using amines in Energy from Waste.



***“Currently our biggest CO₂ recovery plant from WtE is in Duiven and produces 12ton/h with a product purity of 99.9%”
(Matteo)***

“The most interesting technologies for Energy from Waste now are :

- 1. Amines (traditional)***
- 2. Calcium Looping***
- 3. Molten carbonate FCs” (Adriano)***

*** Public slides available in Zenodo ***

3.1.4 **Roberto Ferrario** (ENI - HERCCULES)

Roberto Ferrario is the Head of the CCUS Innovative Solutions department in the CCUS Business Unit at ENI. Starting from 2000, he covered multiple technical and management roles at ENI innovation projects and since 2020 he is the technical advisor for the CCUS Business Unit at ENI, in charge of research and development planning, scientific communication and dissemination.



“The geographical distribution of storage sites is not even”

“We need support mechanisms in place”

“Political support is largely different”

*** Public slides available in Zenodo ***

3.1.5 **Leonardo-Henrique Sousa** (Rambol - CCUS ZEN)

Leandro-Henrique Sousa is a senior consultant in the Energy Transition division of Ramboll, based in Copenhagen, Denmark. His expertise consists of technical consultancy in CCUS and hydrogen concept and feasibility projects development, primarily in the transportation section of the respective value chains. He leads the development of the Baltic value chain under the scope of the CCUS ZEN project and is here to present the technical modelling performed.



“In a chain, each ring needs to be ready”

“Storage is limited by the volume they can receive from emmitters”

“It is a concept among many possible concepts”

*** Public slides available in Zenodo ***

3.1.6 **Alla Shogenova** (TalTech & SHOGen - CCUS ZEN and HERCCULES)

Alla Shogenova is a senior researcher in Tallinn University of Technology and Director for Research in SHOGenenergy company. She is working in CCS projects since 2006 and teaching CCUS at national and international levels since 2011. She is a WP3 leader in CCUS ZEN project and Task leader in the HERCCULES project.



“We have analysed more than 12 scenarios and each one has several options”

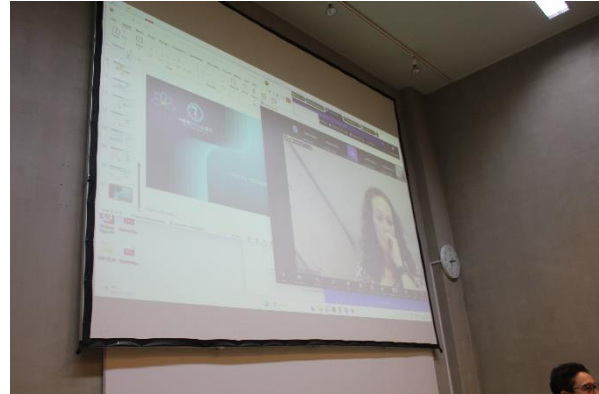
“The best CCU scenario for Estonia is CO₂ mineral carbonation using oil shale ash”

“Technical and non technical data were integrated in order to analyse the value chain scenarios”

*** Public slides available in Zenodo ***

3.1.7 **Ingvild Ombudstvedt** (IOM LAW - CCUS ZEN)

Ingvild Ombudstvedt is an economist and lawyer, and the owner of IOM Law. She has been working with legal issues related to CCUS for over a decade and is actively involved in standardisation efforts for ISO TC265 on CCS and CO₂-EOR.



“The Helsinki Convention is an additional complication to the Baltic Sea Region, prohibiting offshore storage of CO₂”

“The CCS directive has been transposed in different ways in the region”

“There are no barriers left in the London Protocol for offshore storage of CO₂”

*** Public slides available in Zenodo ***

3.1.8 **Anne Kantel** (Fraunhofer ISI - HERCCULES)

Anne Kantel is a political scientist working as a senior researcher at the Competence Center for Energy Policy and Energy Markets at the Fraunhofer Institute for Systems and Innovation Research in Karlsruhe, Germany. She completed her PhD on the topic of legitimacy of environmental policies at the American University, Washington, DC. Her work focuses on questions of actors, social acceptance, and energy justice in technical-social systems with an emphasis on CCUS and green hydrogen technologies.



“We need public perception before the implementation stage”

“Community-acceptance is highly context-dependent”

“Trust is a topic”

*** Public slides available in Zenodo **

3.1.9 **Janis Volberts** (Bellona Europe)

Janis joined Bellona to identify and support the role to be played by ports for industrial decarbonisation solutions, such as CO2 capture, transport and storage. Janis' work will focus on projects in Central and Eastern Europe, with a particular emphasis on the Baltic region. Janis' previous roles include being Head of the Innovation Centre at the Transport and Telecommunication Institute, State Secretary at the Ministry of Education and Science of Latvia, Head of Investment Attraction and the Export Promotion Division at the Ministry of Economics of Latvia. Janis has two Master degrees – one in Project Management at Boston University as a Hubert H. Humphrey Fellow, and second in Law and Finance at Riga Graduate School of Law.



***“We are finally
over with
chicken and
egg problem
for storage”***

***“Extremely slow
but on shore
storage is
happening”***

***Public slides available in Zenodo ***

3.2 CONVENERS

Martina Fantini is a mechanical engineer with a PhD in Energy Technology, both from Politecnico di Milano. After extensive international experience at UPC in Barcelona and at TU Delft (Process and Energy Department) in the Netherlands, where she carried out her post-doc experience, she worked at LEAP – Laboratorio Energia Ambiente Piacenza as senior researcher. She is now a senior consultant in European design at EUCORE consulting.



Pierre Cerasi is a senior researcher at SINTEF Industry in Trondheim, Norway. His main expertise is in geomechanics and flow in porous media and he has been applying this expertise to CO₂ geological storage since 2009. He participates in the team coordinating the CCUS ZEN project at SINTEF.



Alla Shogenova is a senior researcher in Tallinn University of Technology and Director for Research in SHOGenergy company. She is working in CCS projects since 2006 and teaching CCUS at national and international levels since 2011. She is a WP3 leader in CCUS ZEN project and Task leader in the HERCCULES project.



3.3 PANELISTS

3.3.1 **Pantelis Vogiatzis** (ENERGEAN – HERCCULES)

Dr. Pantelis Vogiatzis has academically integrated engineering and law with specialized doctoral research in EU law. He holds an honors degree in environmental engineering from the University of Salford, UK, and the University of Waterloo, Canada. He earned his postgraduate degrees in environmental law and policy from Nottingham University Law School, UK, and the International University of Andalusia, Spain. He also holds a PhD degree in EU environmental law, with a specialization in climate policy and regulation, from the University of Newcastle upon Tyne School of Law, UK.

He has extensive professional experience of over 20 years in regulatory and institutional affairs, corporate operations and compliance, energy and environmental policy. He has held key senior positions in energy companies and organizations in Greece and internationally. Since May 2024, he is the CCS Commercial Lead at EnEarth S.A., an Energean company.

He is an active member of professional and scientific organizations, committees and associations. Additionally, he retains parallel academic activities as visiting Professor at the Athens University of Economics and Business in the postgraduate program "Law & Economics in Energy Markets".



“Prinos turns 43 years, 43 years of inspiration and of awareness of local communities”

“ After the elections, we will have a new Commission for Energy. It is important to keep the direction”

“There is a target and renewables are not enough”

3.3.2 **Lucio Panarisi** (Air Liquide italia – HERCCULES)

Lucio Panarisi is a Business Developer at Air Liquide Italia, specializing in the development of energy transition projects. With a focus on carbon capture and green hydrogen initiatives, L.P. works primarily with industries in hard-to-abate sectors to support decarbonizing their activities. In addition to these responsibilities, he coordinates Air Liquide's activities for the Herccules project, further advancing the company's commitment to building valuable partnerships that are essential to implement the energy transition.



“CALLISTO project is a great example of cross-border industrial collaboration to support the decarbonization of two clusters of emitters, one in Fos Marseille and the other in Ravenna”

“AirLiquide has already started applying its proprietary CO₂ capture technology, named Cryocap, to decarbonize the assets of its clients and its own”

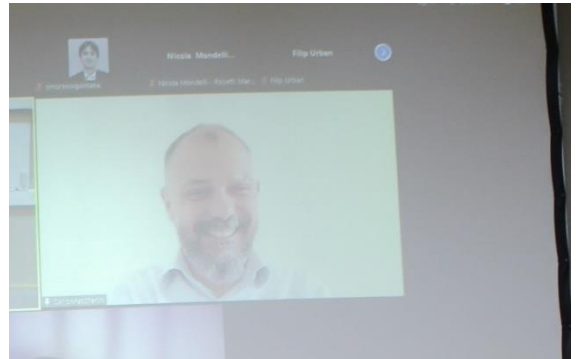
3.3.3 Carlo Maccherini (Global CCS Institute)

Carlo has joined the Global CCS Institute in November 2023 working for the BD Team as Senior Business Development European Lead from the London Office, bringing his experience as Business Developer and Account Manager gained working for Financial Institutions, Private Companies in the renewable energies industry, European Institutions operating in the solar market and innovative Startups in the online marketplace industry.

His passion for business development and startups coupled with tourism and enology also led him also to create the very first portal for booking wine experiences and cooking classes in Italy, which he still considers his greatest achievement.

Carlo's focus in the last few years has been the development of expansion strategies into new markets and at the same working with key accounts to increase the profitability of the project he was working on.

Originally from Italy, he holds a bachelor's degree in political science. He had the opportunity to live and work in different countries such as Belgium, Switzerland and finally the UK where he finally decided to settle down".



“What is that makes a project successful? PORTHOS is both. What is important is reacting to obstacles”

“Also the « unsuccessful » projects proved the success of CCUS because the unsuccess is not related to technology”

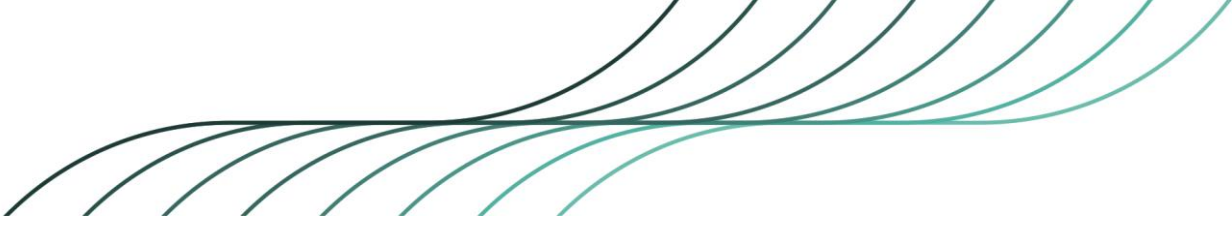
3.3.4 Dr. Moises Covarrubias Perez (C4U)

Dr. Moises Covarrubias Perez is a Research Fellow at Earth System Governance Project and WCEL (IUCN), and a former Climate Change Scientist at the C4U Project, with over ten years of experience conducting and communicating interdisciplinary research on energy, environment, and climate change policy. I hold a PhD in Climate Policy from Wageningen University and Research, and several diplomas and certifications in environmental law and governance from prestigious institutions such as the University of Cambridge and the United Nations.



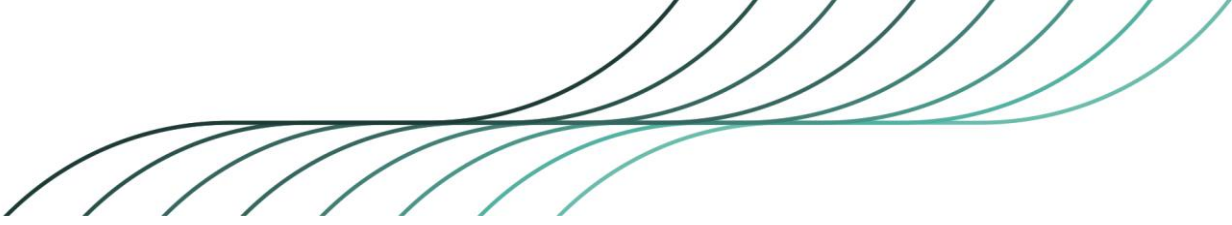
“We have to:

- ***Gain societal trust in CCS/CCU industry.***
- ***Observe the industry’s compliance in guaranteeing the environmental safety of mitigation technologies adopted on earth systems, and a just transition.***
- ***Publicly support CCUS industry investments, only when societal concerns are addressed.***
 - ***Avoid unbalanced policy structures that disproportionately benefit the industry.***
 - ***Facilitate a shift in paradigms from techno-economic approaches towards Policy-Business-Societal System Dynamics approaches.”***



4 PICTURES FROM THE WORKSHOP







HERCCULES

full CCUS chain demonstration

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