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ENeRG GEO ENeRGY

Annual Baltic Carbon Forum in Tallinn Reported Recent Technological and Regulatory Developments on CCUS in the Baltic Sea Region

The annual Baltic Carbon Forum (BCF2025) took place in Tallinn on 9 - 10 October, organised by BASRECCS Association, with funding from Nordic Energy Research and industrial partners (SCHWENK Latvia, Minijos Nafta and Akmenes Cementas).

The conference featured speakers were participants from academia, research institutes, the cement industry, the energy sector, the chemical industry, oil and gas companies, CCUS project developers, NGOs (Bellona, Global CCS Institute, CCUS Association Poland, Bioenergy Association of Finland, etc.), technology providers, policymakers and regulators (NGCCUS, Nordic Energy Research, Ministry of Climate of Estonia), the Asian Development Bank, IOM Law and students.

ENeRG partners from TalTech, SHOGenergy, PGI-NRI, AGH and GEOECOMAR were among the colleagues of the BCF2025 Organising Committee, session chairs and presenters.

The BCF2025 consisted of six sessions over two days, with a site visit to the UP Catalyst Facilities at the end of the first day. UP Catalyst presented its CCU project technology during the first session, '' Status of CCUS in the Nordic and Baltic Regions", which was chaired by Prof. Mayur Pal, chairman of the BASRECCS

Dr. Alla Shogenova (TalTech & SHOGenergy) was the convener of session 2 "Regulatory Framework and Public Perception". Dr. Pawel Gladysz (AGH), president of the CCUS Poland Association, delivered a presentation about CCUS developments in Poland. Pawel noted the current work in the new HELCOM CCS working groups (Environmental and Regulatory), which include researchers and experts from all BSR countries nominated by their national ministries. The experts engaged include BASRECCS and ENeRG members, who were also BCF2025 participants (Alla Shogenova, Monika Konieczyńska, Adam Wójcicki, Pawel Gladysz, and others).

Figure 1. Participants of the BCF2025 in Tallinn

On the 9th of October, the breaking news came from the neighbouring country, where the Parliament of Latvia approved new regulations allowing for industrial-scale CO_2 underground storage and paving the way for widespread adoption of CCUS technology in the Baltic Region. Latvia has the most favourable geological conditions in the region for underground CO_2 storage.

Session 3 featured presentations by industrial project developers from Denmark about the Greensand and Greenstore projects by INEOS, Germany about the CO_2 capture by Messer Gas, the INIG-PIB about the CO_2 storage capacity in Poland, and the CO_2 mineral carbonation project in Estonia by RAGN-Sells OSA.

The final session of this day had four talks, including "State of Play of CCS in Europe" by Carlo Maccherini from Global CCS Institute.

The second day began with a Keynote talk about the CO_2 capture project at the Broceni cement plant in Latvia. The session 5 "Technologies and Recent Advances in CCS" chaired by Janis Volberts (Bellona) had three presentations on modelling and pore space, including one by Dr. Eugene Holubnyak (Wyoming University and AVALON, USA).

Dr. Kazbulat Shogenov (SHOGenergy) delivered a presentation on techno-economic modelling of the Baltic offshore cross-border CCUS scenario using direct injection from ships during session 6, which was chaired by Dr. Alla Shogenova. This study includes current research findings from the CETP CTS project, which was financially supported by the Clean Energy Technology Partnership and the Estonian Ministry of Climate.

Dr. Alexandra Dudu (GEOECOMAR) delivered one oral and two poster presentations on CO_2 storage and CCS activities in Romania, as well as CETP CTS project CCS Scenarios in the Black Sea.

The BCF2025 was finalised with Panel Discussion.

For more information and Live Broadcast please visit https://www.baltic-carbon-forum.com/2025/

Alla Shogenova
BASRECCS
Board member

The Newsletter content

CTS project: European Scenarios for CCS Value Chains with Direct Ship Injection

The CTS project (CO_2 Transport and Storage directly from a ship: flexible and cost-effective solutions for European offshore storage) aims to demonstrate the techno-economic feasibility of direct CO_2 injection from ships to unlock the full potential of CCS for European industry. The project is funded under the CET Partnership and coordinated by NORCE. The consortium includes R&D partners: University of Évora, DTU, SHOGEnergy, GeoEcoMar, as well as industry partners: NEMO, Brevik, Wellperform and UGV.

The project focuses on four regions: the North Sea, the Black Sea, the Baltic Sea, and Atlantic Coast of Portugal. Each regional team has developed CCS value chain scenarios. Using the TEA tool developed under Horizon 2020 Strategy CCUS project https://strategyccus.brgm.fr/, the CTS team evaluates the costs, the CO_2 abated, and the infrastructure needs to identify the benefits of direct injections while reducing costs and increasing flexibility across the full implementation cycle compared to traditional storage value chains.

The key findings so far are:

• Direct injection from ships is constantly more cost-effective than traditional shipping solutions, while also providing greater flexibility, resilience and faster delivery.

• In a direct comparison - see Baltic scenario below - where all other factors remain equal, direct injection delivers savings of approximately €1 billion in transport and storage costs, reducing the total cost per ton from 38 € to 35 €.

• For near-shore storage, pipelines remain the most economical option (e.g., Portugal, Black Sea).

For large and complex scenarios (particularly in the Baltic Sea and the North Sea) further optimisation is required. This includes ship routing, volume allocation, number of connection points and wells, fuel types and emissions, and timing. Work on these optimisations will continue into 2026. The North Sea represents the largest scenario, handling close to 70 million tonnes of CO_2 annually from four European ports and six local emitters, utilising four storage sites. The scenario effectively consists of four distinct clusters, each with unique configurations that will undergo detailed analysis in early 2026 (see Fig. 2). Before optimization, direct injection results in billion-euro savings for storage operators, equivalent to €5-7 per tonne. Additionally, the operational cost, such as fixed power from shore or nearby installations versus ship-based power plants - are highly dependent on electricity versus fuel costs. Overall costs are influenced by inflation, social discount rates, and the timing of cluster components becoming operational.

In the Baltic Sea scenario, the E6 offshore geological structure in Latvian waters has been identified as the most promising storage site, thanks to its unique geological characteristics and high storage capacity. The scenario includes 16 CO_2 emitters across three countries, which collectively generated 9.4 Mt of CO_2 in 2023. During the operational period from 2031 to 2065, and estimated

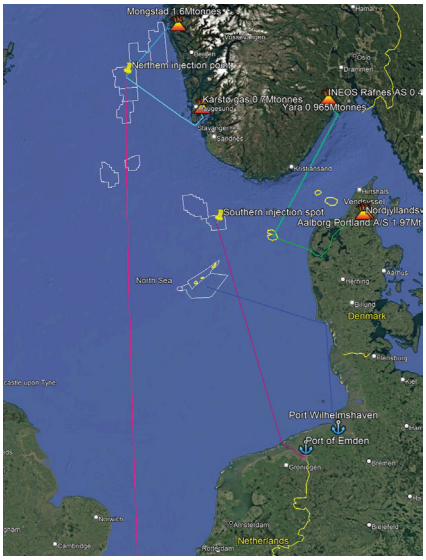

Figure 2. North Sea Scenarios.

353 Mt of CO_2 will be captured and stored (including 280 Mt of abated emissions). For the direct injection scenario, the injection will be carried out using six specially designed NEMO ships that will collect captured CO_2 from four ports (Figure 3). The estimated total cost for capture, transport, and storage using the NEMO solution is €103 per tonne of CO_2. Over 34 years, this cost reduction translates into potential savings of nearly €1 billion.

For the Portuguese scenario, long-term direct CO_2 injection by ship is not intended to replace pipeline-based transport and injection. However, direct ship injection can offer flexibility, enabling faster deployment of CCS technology to meet national decarbonisation commitments. While several major CO_2 emitters are located near the coastline, only the southernmost sources will be evaluated for direct ship injection, as they are the only ones likely to be cost-competitive with pipelines serving multiple sources along the route to storage. The techno-economic analysis will also examine whether the higher OPEX associated with ship-based injection -partially driven by the need to liquefy the CO_2—can be offset by cost savings in storage, particularly through reduced CAPEX for dedicated offshore platforms. In the Black Sea region, CCS chains have been designed for Romania and Ukraine. For Romania, two emission clusters - located in the Călărași and Constanța areas - emit around 2.18 million tonnes of CO_2 annually. The estimated total storage capacity for these sites is approximately 59 million tonnes, primarily within the Lebăda Est, Lebăda Vest, and Sinoe offshore structures.

The Ukrainian scenario focuses on industrial emission clusters in the Odesa and Mykolaiv regions, with annual CO_2 emissions of about 3.7 million tonnes. Nearby geological formations offer an estimated storage capacity of 55.14 million tonnes. Given the proximity of offshore storage, pipelines emerge as the most cost-effective solution, with direct ship injection ranking second. While slightly more expensive, ship-based injection provides greater resilience and flexibility of storage. The integration of the Romanian and Ukrainian scenarios will explore cross-border potential for a coordinated CCS strategy in the Black Sea region.

Beyond technical design, the project addresses regulatory frameworks and stakeholder engagement essential for advancing ship-based CCS solutions in Europe. Additionally, LCA and UNFC classification of the value chains are scheduled for 2026.

This research is funded by CETPartnership, the Clean Energy Transition Partnership under the 2022 CETPartnership joint call for research proposals, co-funded by the

European Commission (GA N°101069750) and funding organizations listed at https://cetpartnership.eu/funding-agencies-and-call-modules."

Project website www.cts-cetp.net

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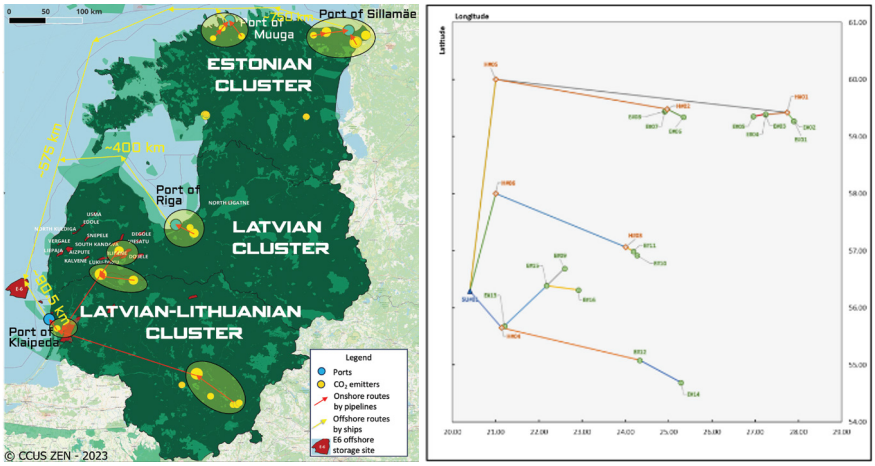

Figure 3. Baltic Sea Scenarios integrated into Strategy CCUS tool.

Study on Geothermal Energy for Greenhouse Development in Ukraine

In 2025, a project was launched to assess the geothermal potential of the Lviv region in western Ukraine, with a pilot study focusing on the Busk site. The program was led by tight collaboration between Dutch and Ukrainian partners — TNO, DTESS, FoodVentures, and Geothermal Ukraine — as well as the Embassy of the Kingdom of the Netherlands in Ukraine and the Netherlands Enterprise Agency (RVO). The project was supported by the Dutch Embassy in Kyiv and funded by RVO under the Private Sector Development Program.

The study aimed to evaluate the feasibility of using geothermal energy for greenhouse heating, contributing to low-carbon agricultural production.

The resource assessment phase focused on identifying and evaluating geothermal reservoirs by integrating geological, geophysical, and hydrothermal data. Approximately 100 hydrothermal and hydrocarbon wells across 12 oil and gas fields in the Lviv region were investigated. Two key geological layers, the Neogene (ND-14) and the Devonian (D1), were identified as target reservoirs.

Using TNO's specialised geothermal assessment tools such as Doublet-Calc1D, which estimates geothermal power based on reservoir and well characteristics, and ThermoGIS, a 2D mapping tool that models spatial variations in reservoir properties, the team developed a detailed understanding of the region's geothermal potential.

The Neogene (ND-14) formation, located at depths between 1,400 - 3,500 meters, demonstrated water temperatures exceeding 50 °C, with good porosity (10–23%) and permeability (up to 100 mD). This makes it a highly promising geothermal reservoir, particularly in the southwestern Lviv region, with an estimated thermal output potential of up to 30 MW and production temperatures above 70 °C (figure 4).

The Devonian (D_1) formation, found at depths around 2,300 m, consists of sandstones, dolomites, and limestones with temperatures ranging from 40–95 °C. However, it has low permeability (≈1 mD) and little geothermal potential. While less favourable for large-scale heat extraction, its examination revealed important geological constraints and data gaps. At the Busk pilot site, direct geothermal heating alone proven unable to fulfill the peak demand of 37 MW required for 20 hectares greenhouse heating. However, the study demonstrated that hybrid systems, which combine geothermal energy with shallow geothermal systems and other renewable sources, are a technically and economically feasible solution for sustainable greenhouse development.

Beyond technical aspects, the project also examined Ukraine's policy and regulatory framework, market, and stakeholder landscape. It identified several enabling conditions, including growing agricultural energy demand and supportive renewable energy policies, alongside challenges such as complex permission procedures and limited local expertise in geothermal technologies.

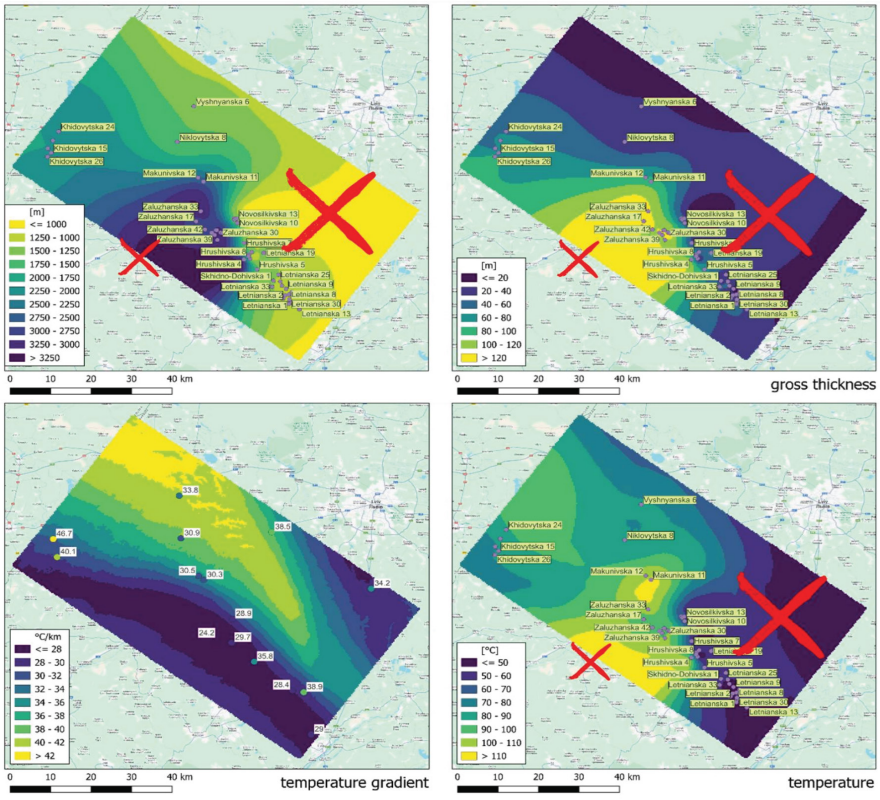

Figure 4. Clockwise from top left: top depth, gross thickness, temperature gradient and temperature at mid aquifer depth ND-14. Crosses indicate areas where extensive extrapolation took place.

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ENeRG – European Network for Research in Geo-Energy

ENeRG – European Network for Research in Geo-Energy is an informal contact network open to all European organisations with a primary mission and objective to conduct basic and applied research and technological activities in the field of sustainable use of the underground for the energy transition.
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First BASRECCS Workshop – Decarbonizing the Future: Innovations in CCUS, Geothermal and Hydrogen

BASRECCS organised the inaugural multidisciplinary research workshop for students on the 15 September 2025, in the GeoEnergy Research Group MLAB building at Kaunas Technical University. The workshop looked at advances and research trends in CCUS, Geothermal and Hydrogen, emphasising their importance and synergy in transforming the energy landscape and achieving carbon neutrality. The one-day event featured seven invited key talks, presentations by industry leaders, researchers and postdoctoral students, as well as an experimental facility demonstration at the KTU GeoEnergy Research and Innovation Laboratory.

Figure 5. Participants of the first multidisciplinary student workshop organised by BASRECCS in Kaunas Technical University

Alla Shogenova presented "CCUS in the Baltic Sea Region: technological developments, synergy scenarios and regulatory challenges", which included an overview of political and regulatory CCUS landscape in Europe, as well as developments in the BSR. Ignas Vaiceliunas (Minijos Nafta, Lithuania) gave the second talk on "Lithuanian Subsurface resources an overview". Martand Singh Rao (NTNU, Norway) delivered the third talk on "Geothermal Driven Energy Pile: An Innovative and Patented Solution for Heating/Cooling Buildings". Janis Volberts, a BASRECCS adviser from Bellona, delivered talk 4 on "Innovation management. The case of CCS". Simonas Valadkevicius of Lava Stream (Lithuania) gave talk 5 about "Beyond Heat Geopressured storage and huff & puff Geothermal". Ali Abdelshafy (TU Delft) spoke on "The role of CCUS in decarbonising the hard-to-abate industries". Klaus Reinhofer (Honeywell, Europe) delivered the final talk on "The use of Heat Pumps in a decarbonised world".

After visiting the Design Lab at MLAB, where 3D printing technology was displayed, two KTU postdoctoral students presented their research findings on Hydrogen storage modelling (Apoorv Verma) and CO_2 storage modelling experiments (Schruti Malik).

The workshop was attended by more than 30 researchers, industry leaders, PhD and Master students. The workshop was primarily financed by Nordic Energy Research and KTU GeoEnergy Research Group MLAB, with supplementary assistance by Minijos Nafta, Akmenes Cementas and Schwenk Latvia companies.

For more information and presentations visit www.baltic-carbon-forum.com/2025/workshop/

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