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UNFC CLASSIFICATION OF CCS REGIONAL SCENARIOS FOR DIRECT INJECTION OF CO_2 FROM SHIPS WITHIN THE CTS PROJECT

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The work analyzes regional CO2 capture and storage projects directly from ships within the framework of the CTS project. Within the scope of the project, a feasibility study of direct injection of CO2 from ships is provided to reveal the potential of CCS for industry. This improves the flexibility of technical and logistical solutions to create CCS value, reduce costs and demonstrate storage potential in four defined regions: the North Sea, the Black Sea, the Baltic Sea and the Atlantic coast of Portugal. The work examines objects and resources of the geological environment for CO2 capture and storage projects within the Black Sea - for Romanian and Ukrainian projects. Classification of projects in the UNFC was carried out, taking into account the environmental, economic and social viability of the project; project status and degree of geological study. It was established that the projects within the Ukrainian territory correspond to the Screening Projects code - 334 - predicted geological storage, the projects of the Romanian territory with the code 334 have a wider scope of definitions - identified - determined and predicted geological storage.

UNFC КЛАСИФІКАЦІЯ РЕГІОНАЛЬНИХ СЦЕНАРІЇВ ВЛОВЛЮВАННЯ І ЗБЕРІГАННЯ CO_2 БЕЗПОСЕРЕДНЬО З КОРАБЛІВ В МЕЖАХ ПРОЕКТУ CTS

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У роботі проводиться аналіз регіональних проектів вловлювання і зберігання CO_2 безпосередньо з кораблів в межах проекту CTS. В межах проекту передбачено техніко-економічне обґрунтування прямого закачування CO_2 з кораблів для розкриття потенціалу CCS для промисловості. Це покращує еластичність технічних і логістичних рішень для створення вартості CCS, зниження витрат і демонстрації потенціалу зберігання в чотирьох визначених регіонах: Північне море, Чорне море, Балтійське море та Атлантичне узбережжя Португалії. У роботі розглядаються об’єкти і ресурси геологічного середовища для проектів вловлювання і зберігання CO_2 в межах Чорного моря – для румунських і українських проектів.

Проведено класифікацію проектів в UNFC з врахуванням екологічної, економічної та соціальної життєздатності проекту; статус проекту та ступінь геологічного вивчення. Встановлено, що проекти в межах української території відповідають коди Проектів скрінінгу – 334 - прогнозоване геологічне зберігання, проекти румунської території із кодом 334 мають більш широкий масштаб визначень – ідентифіковане – визначене та прогнозоване геологічне сховище.

It is widely accepted that CCUS (Carbon Capture, transport, Utilization and Storage) is required to address the emission from hard-to-abate sectors in the net-zero society. It is a key technology enabler to decarbonize a wide range of industrial applications. In many regions of Europe offshore storage provides a viable option due to a large variety of technological factors (such as availability of fitting geological formations) but also societal factors, as it is often easier to accept offshore storage rather than local storage onshore.

Traditional solutions for offshore storage comprise onshore terminals and hubs and pipelines or ships connecting these to subsurface templates or offshore hubs. Ships are considered solely as the transport solution for gathering the CO2 at ports and delivering to the above-mentioned hubs. CTS will investigate the possibility to use ships as injection vessels.

Large costs and complexity of CCUS value chains hinder spread of technology especially for smaller emitters and storage operators. The CTS team will investigate how using ships as transport and injection vessels can unlock CCUS potential and speed up deployment of CCUS technologies.

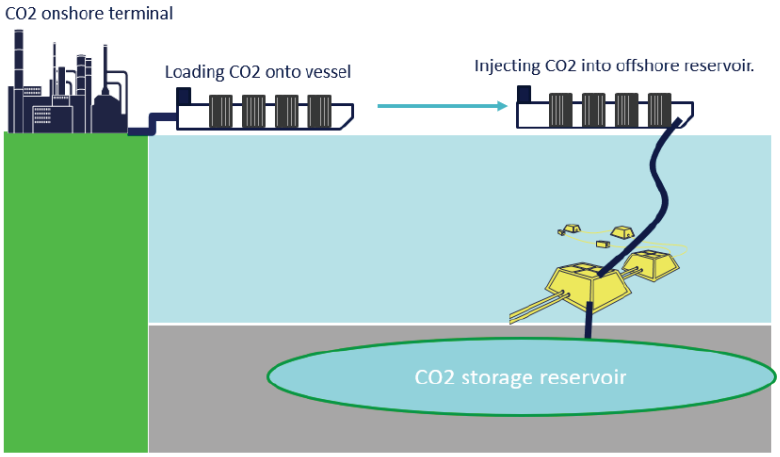


Fig. 1. Concept of direct ship injection as presented by NEMO Maritime

The CTS projects' main objective is to demonstrate techno-economic applicability of direct injection from ship to unlock CCS potential for the industry by increasing flexibility and versatility of the CCS value chain, reduce costs and show storage potential in the four defined regions: the North Sea, Black Sea, Baltic Sea and Atlantic coast of Portugal. The project will contribute to accelerate the development of CCS within the EU community and enable the industry to reach the targets for CCS that have been presented by the EU commission on March 16th, as part of the Net-Zero Industry Act.

Norway, Netherlands, Denmark and UK are pioneering the development of offshore storage in Europe4, where large projects like Northern Lights, Porthos, Aramis, Bifrost and Greensand, HyNet, Teesside together with Humber can be mentioned. ENI is also developing a project for offshore storage in the Ravenna hub in the Adriatic Sea and is planning to demonstrate CO2 storage soon offshore in the west of the UK and in Italy. Heidelberg Materials in Bulgaria is developing a CCS cluster in Varna region with Black Sea storage in ANRAV project.

In geographical regions covered by CTS a considerable effort has been done in order to create CCS value chains. This value chain scenarios lay a solid foundation for CTS project activities. Based on the above-mentioned efforts and with respect to overall Storage Maturation Level (SRL/SML) in the areas selected the following state of the art and progress beyond it can be expected with CTS:

CTS will study the impact of direct injection from ship on the definition of capture clusters and storage facilities by developing CCS scenarios in four different offshore regions in Europe: Norwegian Continental Shelf, Baltics, Black Sea and Atlantic coast of Portugal. The Black Sea scenario is composed from an interlinked Romanian and Ukrainian scenarios.

Romanian scenario. Implementation of CCS in the Black Sea (Romanian part) has been previously assessed in STRATEGY CCUS project as part of Galați region CCUS scenario. The original scenario contained two subclusters, Galați and Tulcea, with different emitters, transport options and storage solutions.

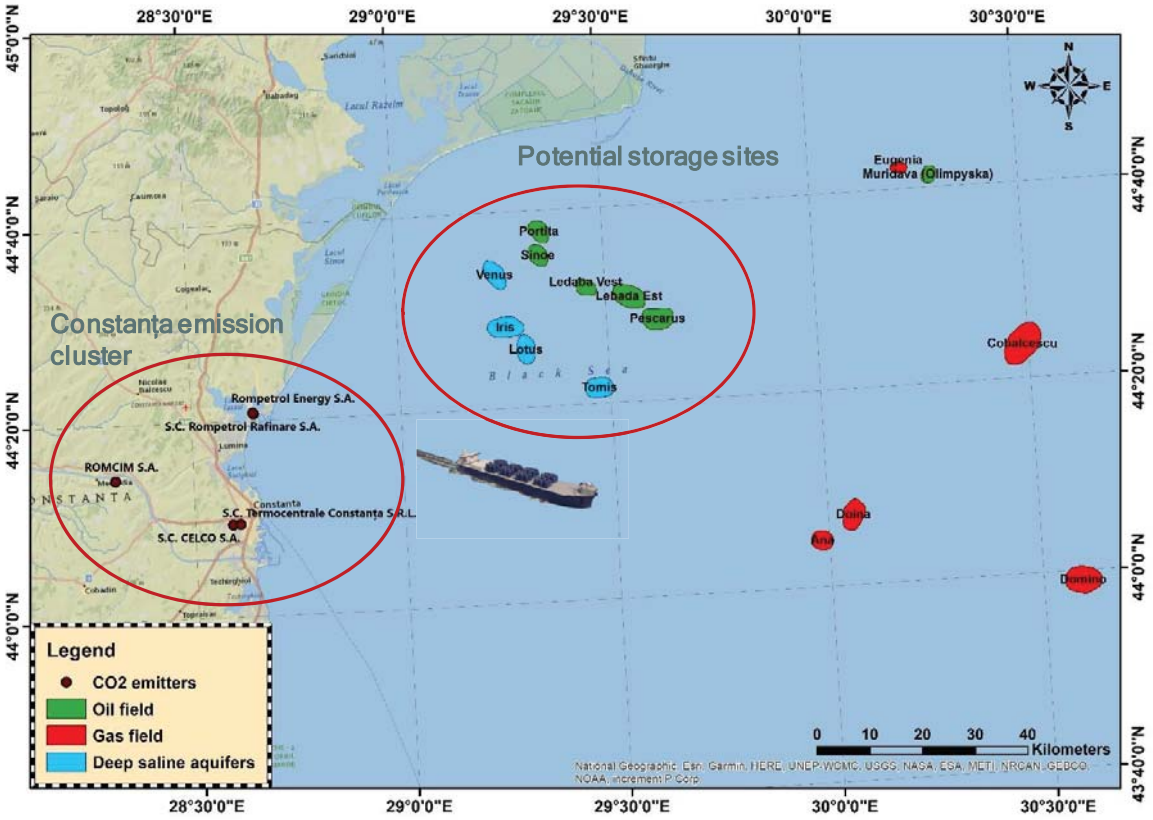


Fig. 2. Emitters and potential storage sites to be used in the updated Romanian CTS scenario

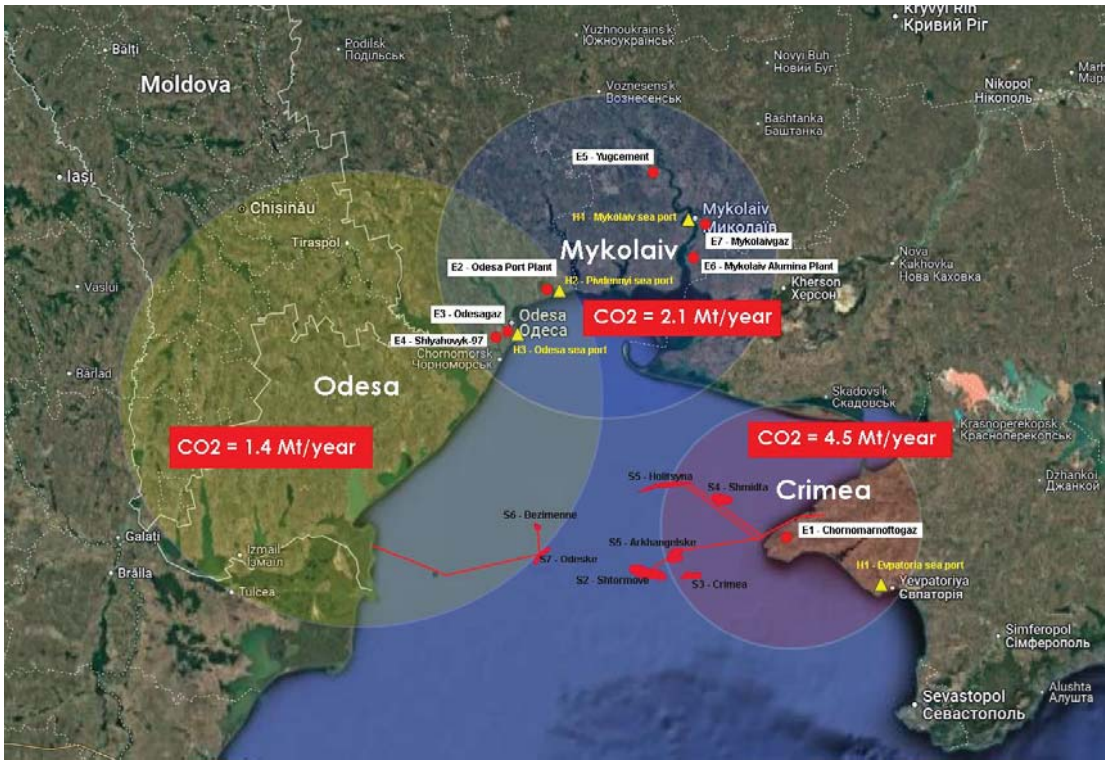


Fig. 3. Ukrainian CTS scenario

The Black Sea integrated scenario will merge the Romanian and Ukrainian scenario, simulating storage of all emissions into Romanian structures but also storage of all emissions into Ukrainian potential storage sites. These simulations will be useful in order to analyze the benefits and potential bottlenecks of cross-border projects. The synergy from cross border cooperation would be estimated by economic modeling in next steps of the CET Partnership project.

As part of the project, a comprehensive feasibility study on the direct injection of CO2 from ships has been conducted to assess the potential of CCS for industrial applications. This study enhances the flexibility of both technical and logistical solutions, aiming to optimize CCS value chains, reduce costs, and demonstrate storage potential across four key regions: the North Sea, the Black Sea, the Baltic Sea, and the Atlantic coast of Portugal. Focusing on CO2 capture and storage initiatives within the Black Sea, specifically for Romanian and Ukrainian projects, the study evaluates geological formations and resources.

The classification of these projects follows the UNFC framework, with particular emphasis on their environmental, economic and social viability, as well as their status and degree of geological exploration. It was determined that projects in Ukraine fall under the UNFC code 334, classified as "Screening Projects" with predicted geological storage. Meanwhile, Romanian projects, also classified under code 334, demonstrate a broader scope, with both identified and predicted geological storage.

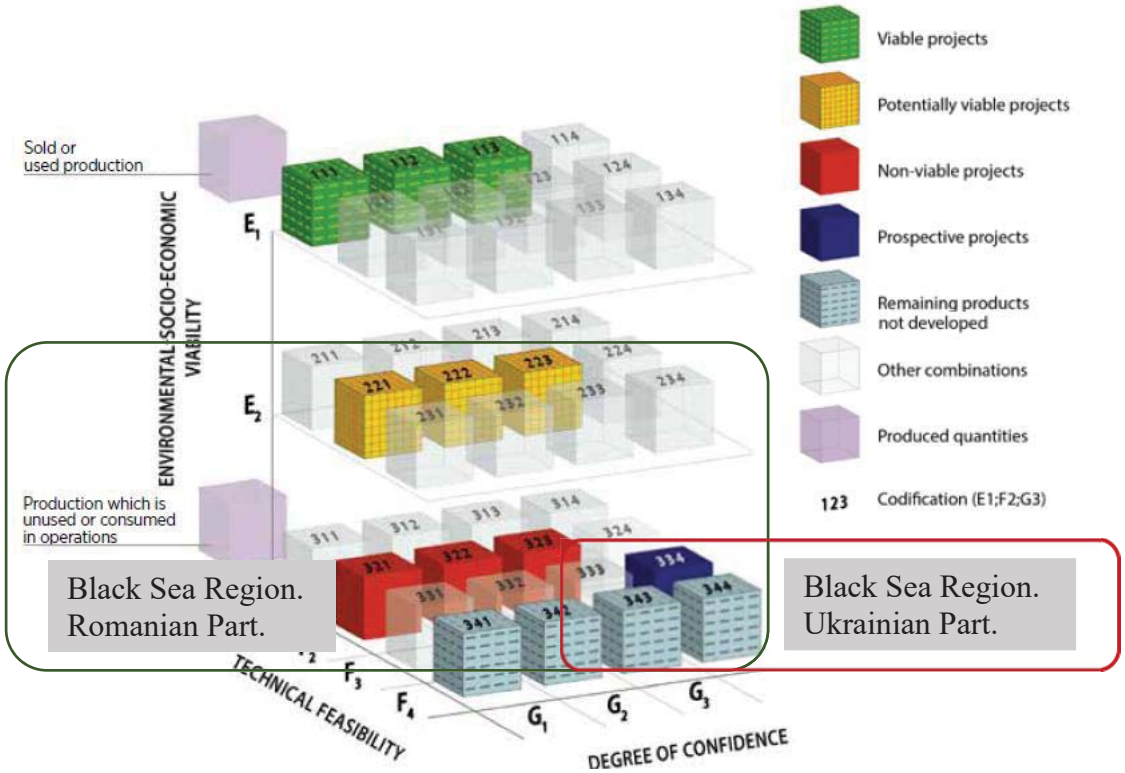
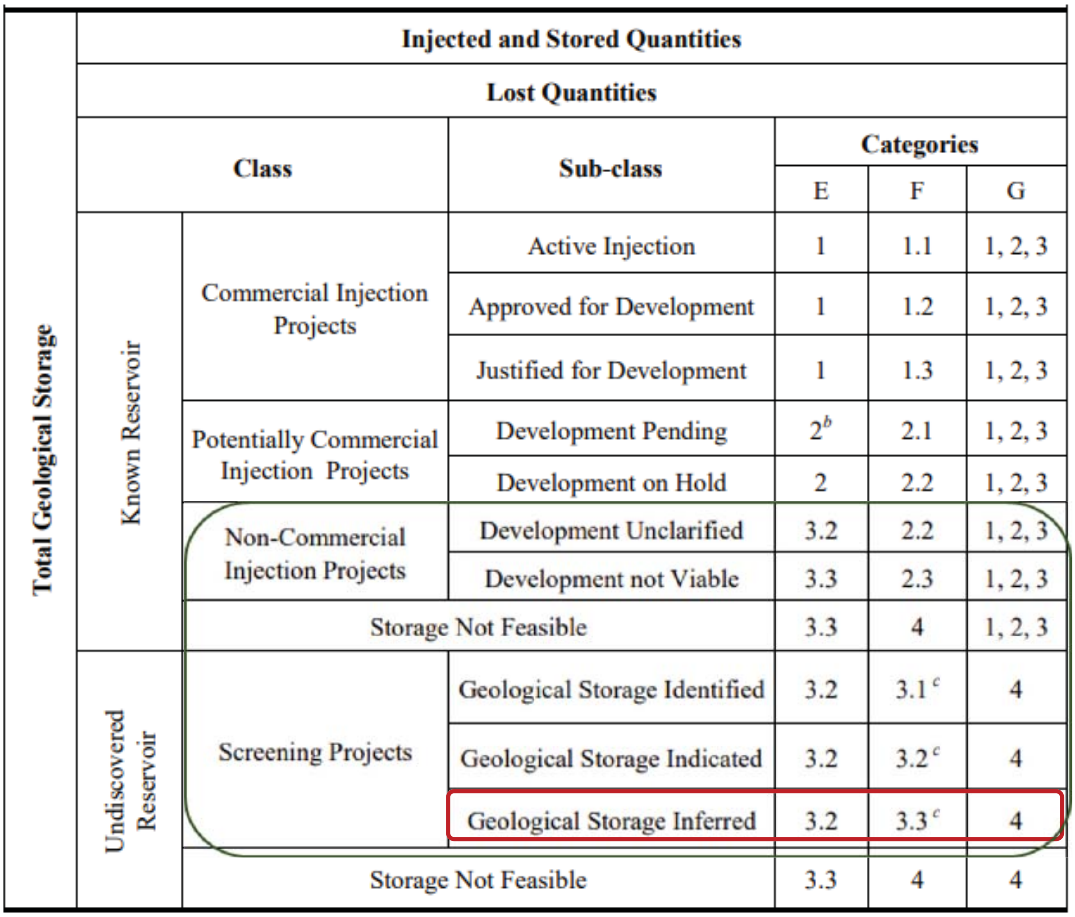


Fig. 4a. UNFC classification of regional CO2 scenarios directly from ships within the CTS project (on the cubic scheme)



Total Geological Storage	Injected and Stored Quantities					
	Lost Quantities					
	Class		Sub-class	Categories		
				E	F	G
	Known Reservoir	Commercial Injection Projects	Active Injection	1	1.1	1, 2, 3
			Approved for Development	1	1.2	1, 2, 3
			Justified for Development	1	1.3	1, 2, 3
		Potentially Commercial Injection Projects	Development Pending	2[b]	2.1	1, 2, 3
			Development on Hold	2	2.2	1, 2, 3
		Non-Commercial Injection Projects	Development Unclarified	3.2	2.2	1, 2, 3
			Development not Viable	3.3	2.3	1, 2, 3
		Storage Not Feasible		3.3	4	1, 2, 3
	Undiscovered Reservoir	Screening Projects	Geological Storage Identified	3.2	3.1[c]	4
			Geological Storage Indicated	3.2	3.2[c]	4
			Geological Storage Inferred	3.2	3.3[c]	4
		Storage Not Feasible		3.3	4	4

Fig. 4b. UNFC classification of regional CO2 scenarios directly from ships within the CTS project (on the table scheme)

Black Sea Region. Ukrainian Part

Black Sea Region. Romanian Part

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