





A framework for the selection of promising CCUS value chains in the Baltic and Mediterranean regions

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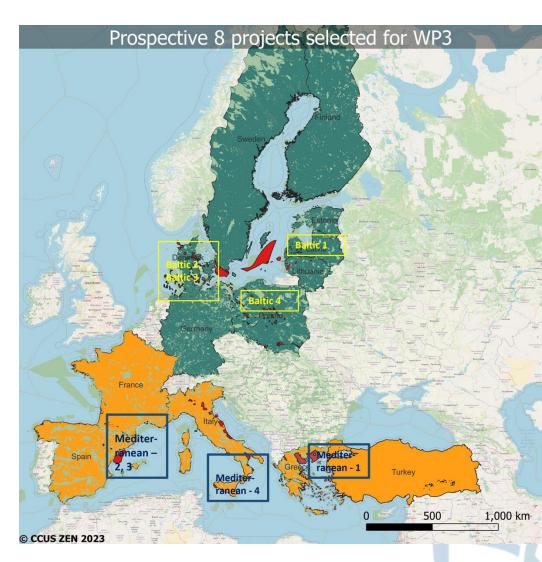
Summary

- The objective of this study is to propose a framework for the selection of national and cross-border CCUS value chains and to apply it to eight case studies in the Baltic and Mediterranean regions studied by the Horizon Europe CCUS-ZEN project.
- ► Technical and non-technical data were first collected and integrated into a common GIS project for eight countries in the Baltic region and five countries in the Mediterranean region.
- ▶ To apply SWOT analysis to the prospective CCUS cluster projects, internal and external groups of parameters were first developed.
- ▶ Internal technical groups (strengths and weaknesses) include 1) CO₂ emission plants, 2) CO₂ storage sites, 3) available and planned infrastructure, and 4) CO₂ use options.
- An external technical group includes 1) characteristics of the area around the storage site, and non-technical external groups include 1) social, 2) political development, 3) international and national regulations, 4) MRV (Monitoring Reporting and Verification), 5) financial, 6) Readiness of CCUS value chain, which were analysed for opportunities and risks.
- The developed framework includes 24 internal quantitative technical parameters and 14 external qualitative parameters, which were collected for eight CCUS value chains.
- For qualitative parameters, questions with numbers were developed to be able to include external parameters in the quantitative SWOT analysis.
- However, offshore and onshore CCUS projects must adhere to different regulatory frameworks and some other studied issues. Despite these differences, it is possible to perform a unified quantitative analysis for all projects (both onshore and offshore) by utilizing common internal technical factors and a streamlined list of external technical and non-technical parameters.
- > Here, we reported the qualitative results of analysis and the framework for the quantitative SWOT analysis, which will be performed at the next step of this study using statistical multivariate analysis.

INTRODUCTION



- ➤ Today, CCUS projects around the world inject about 50 Mt of CO₂ annually. To achieve climate neutrality, we must increase CO₂ storage from millions to billions of tons per year. One effective way to accelerate this necessary scale-up is by implementing CCUS clusters and hubs.
- The application of CCUS clusters and hubs offers many advantages:
 - √ faster scaling
 - ✓ lower unit costs
 - ✓ reduced investment
 - ✓ reduced cross-chain risks
 - ✓ governmental support
 - ✓ the creation of new jobs
 - ✓ potential revenues from CO₂ utilization
 - ✓ synergies with renewable energy sources and CO₂-negative technologies
 - ✓ increased public awareness
 - ✓ improved public perception
- This study proposes a framework for selecting national and cross-border CCUS clusters and hubs (value chains)
- The framework is applied to eight case studies in the Baltic and Mediterranean regions (12 countries involved) and has been developed by the Horizon Europe CCUS-ZEN project
- Technical and non-technical data were first collected and integrated into a unified GIS project for 6 countries in the Baltic region and 5 countries in the Mediterranean region.

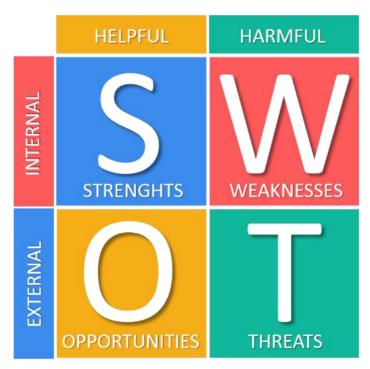


Location of the studied value chains in the Baltic and Mediterranean Regions. Storage sites are shown in red. The green colour is for the Baltic, and the orange is for the Mediterranean Region.



Methodology

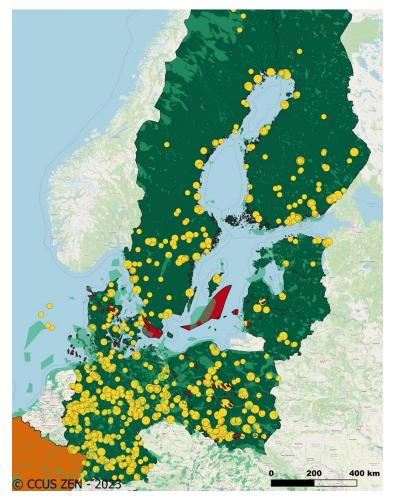
- > SWOT analysis, which stands for strengths, weaknesses, opportunities, and threats, is a strategic planning technique used to assess various factors related to project planning
- To quantify the SWOT analysis, we will apply the methodology established by Chang & Huang (2006) at the next step of this study.
- The Quantified SWOT analytical method incorporates the principles of Multiple-Attribute Decision Making (MADM), using a multi-layered approach to simplify complex issues.
- ➤ Since we need to analyse both quantitative and qualitative data, a statistical methodology is necessary.
- ➤ In this study, it was suggested that the weights of internal and external factors be treated equally. The weights of the key factors will be calculated using the Analytic Hierarchy Process (AHP), as proposed by Saaty (1980), and applied to the SWOT analysis by Chang & Huang (2006).
- ➤ This methodology could be applied at the final step of this study, after clarifying how many parameters (technical and non-technical could be analysed together statistically for all the proposed CCUS projects)



Multivariate SWOT analyses of CCUS value chains



Baltic technical data

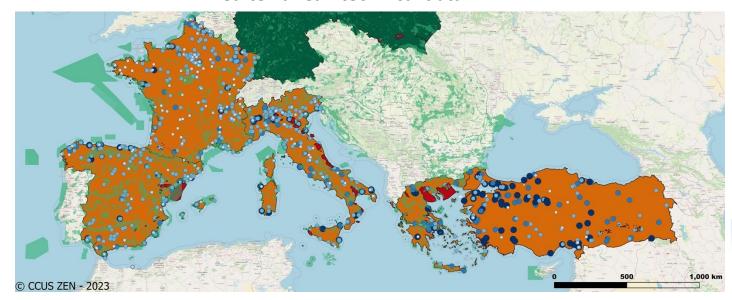


Technical and non-technical data for two regions were collected and integrated into GIS

Collected Layers:

- > CO₂ emission sources (yellow and blue circles)
- ➤ CO₂ storage sites (red polygons)
- Natura 2000 areas (Light green areas)
- ➤ Available infrastructure (pipelines, ship routes)

Mediterranean technical data

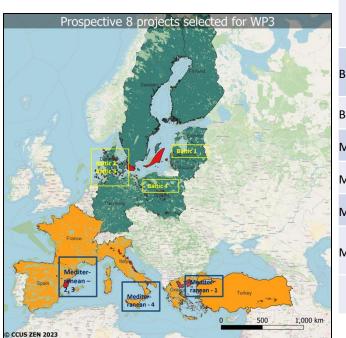




Parameters of the studied value chains in the Baltic and Mediterranean Regions

M-1-M-4 - Mediterranean-1-Mediterranean-4, respectively

8 large CCUS cluster projects were selected, with 4 projects from each studied region for the more detailed technical analysis, integration with CO₂ use options and consideration of non-technical parameters

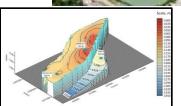


e	Project ID	Value chain name	Involved countries	N. of countries	Total produced CO ₂ emissions, Mt/y	N. of emission sources	N. of emission clusters	Storage sites	N. of storage sites	Total CO2 storage capacity, Mt	Total years for storage	Distance emission sources - storage sites km
h d h	Raltic-1	Baltic Lat-Lit- onshore	Latvia Lithuania	2	4.25	6	2	North Blidene, Blidene and Dobele	3	403	> 40	9-150
n								Gassum, Voldum,				
	Baltic-2	DE DK SWE Jutland network Onshore & offshore transport & storage	Germany Denmark Sweden	3	22.66	33	9	Jammerbugt	8	928	> 40	5-750
								Inez, Bifrost,				
								Greensand,				
4.9								Lisa, Thorning				
-	Baltic-3	Copenhagen	Germany Denmark Sweden	3	5.9	16	4	Rødby, Havnsø, Stenlille	3	657	> 40	5-115
•	Raltic_/I	North Poland onshore	Poland	1	8.19	11	4	Konary J, Kamionki K	2	381	52	4.2-38.2
	N/I_1	_	Türkiye Greece	2	40.0	16	2	Prinos	1	1000	25	120-360
	M-2	Ebro offshore	Spain and France	2	23.82	32	3	Castellon	1	200	20	50-470
-	N1_2	Beaucaire onshore	France	1	1.17	2	1	Haut d'Albaron	1	34	29	27
3		Southern Italy network and Athen, Greece	Italy and Greece	2	41.1	32	6	Bradanica	1	344-1376	7.8 -19	50 - 450
	Total ra	nge for all clusters	11	1-3	1.2-40	2-33	1-9		1-8	34-1400	8-> 40	5-750
km.												

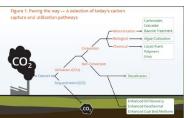


SWOT analyses of CCUS value chains

A qualitative SWOT analysis was applied to prospective CCUS cluster projects, evaluating technical and non-technical parameters







	INTERNAL FACTORS Strength and Weakness	EXTERNAL FACTORS Opportunities and Risks			
	Technical	Technical	Non-technical		
	CO ₂ emission plants	The area	Social considerations		
		surrounding the storage site	Political development		
1	CO ₂ storage sites	DEGOLE "Imanta" DEGOLE Broceny Cement	Regulatory requirements		
The second secon	Infrastructure (available	PELE Rupnica VIESATU As" JTE DOBELE BLIDENE	MRV (Monitoring		
	and planned)	Ab "Akmenes Cementas" va"	Reporting and Verification) processes		
	CO ₂ use options		Financial parameters		









INTERNAL GROUP FACTORS

EXTERNAL GROUP FACTORS

Technical (24 factors)

CO₂ emission plants

- (I1) Number of countries
- (I2) Number of clusters
- (I3) Number of plants
- (I4) Fossil CO₂ emissions (Mt)
- (I5) Bio CO₂ emissions (Mt)
- (I6) Captured CO₂ emissions (Mt)
- (I7) Number of plants planned CO₂ capture
- (18) Number of plants planning H2 production

CO₂ storage sites

- (19) Number of storage sites
- (I10) Porosity of the reservoir rocks (average, decimal)
- (I11) Permeability of the reservoir rocks (average, Md)
- (I12) Well injectivity (Mt/y)
- (I13) Thickness of primary cap rocks, m
- (I14) CO₂ storage capacity (total, Mt)
- (I15) Storage Readiness Level (SRL) (1-9)

Technical (5)

The area in and around the storage site

- (E10) Storage site located in the densely populated area (Low -1, medium -2, 3, high -4)
- (E11) Storage site area belonging to landlords (Yes 4, No -1)
- (E12) Storage site located in seismic risk area (no seismic risk -1, low seismic risk -2, seismic risk in the neighbouring region -3, average seismic risk -4, high seismic risk -5)
- (E13) Storage site located in Natura 2000 area/other protected area (100% located in the protected area 5, 50% located in the protected area 4, 25% 3, 10% 2, not located 1)
- (E14) Transport routes are going through Natura 2000 area/other protected areas (100% located in the protected area 5, 50% 4, 25% 3, 10% -2, no located 1)

Legend

No CCS regulations

CO2 storage site location

National Regulations combined with CO2 Storage Sites

Non-technical (9)

Social

(E1) Level of public acceptance (low - 1, medium - 2)

Political development

(E2) Political development

Favourable (4-5), Business as usual (2-3)

Unfavorable (1)

International Regulations

(E3) London Protocol (LP):

Non-member - 1, Member of London Convention - 2

Member of LP - 3

Amendment to Article 6 to LP implemented - 4

Provisional Application of Article 6 to LP - 5

National Regulations

(E4) EU CCS Directive implemented:

Any CO₂ injection banned (1)

CO₂ storage permitted for research (2)

CO₂ storage permitted offshore or onshore (3)

CO₂ storage permitted onshore and offshore (5)

No CCS Regulations (0)

MRV (Monitoring Reporting and Verification)

(E5) MRV Readiness

Low (1), Medium (2), High (3)

(E6) Accounting Readiness

Low (1), Medium (2)

Financial

(E7) Governmental financial support for CCUS projects Not available (0), available (3)

Readiness of CCUS

value chain

(E8) Value chain readiness

Developing Capture (1), Capture available (2)

Developing Capture & Transport (2)

Capture and transport available (4)

Developing Capture, transport and storage (3)

Capture, transport and storage available (6)

Capture in development, storage is available (3) None (0)

(E9) CCUS in Industrial strategy/plan

Yes (3), No (1), No strategy/plan (0)



- (I16) Transport distance (max, km)
- (I17) Transport distance (total, km)
- (I18) Total CO₂ emissions per distance unit (t/km)
- (I19) Number of wells in operation
- (120) Number of old abandoned wells
- (I21) Number of planned PCI projects

CO₂ use options

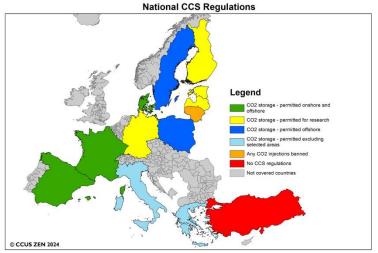
- (I22) Number of CO_2 use projects in operation, or R&D
- (I23) Longevity of CO₂ use products (years)
- (I24) Bio-CO₂ to be used (Mt)



Multivariate SWOT analyses of CCUS value chains

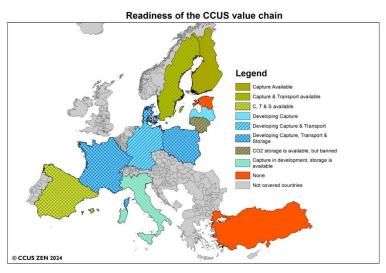


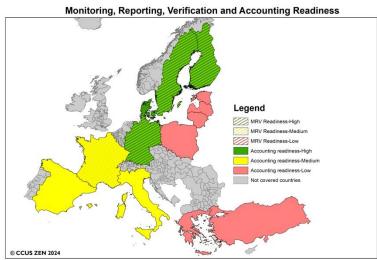
Non-technical layers in GIS

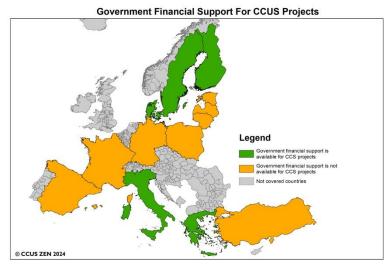






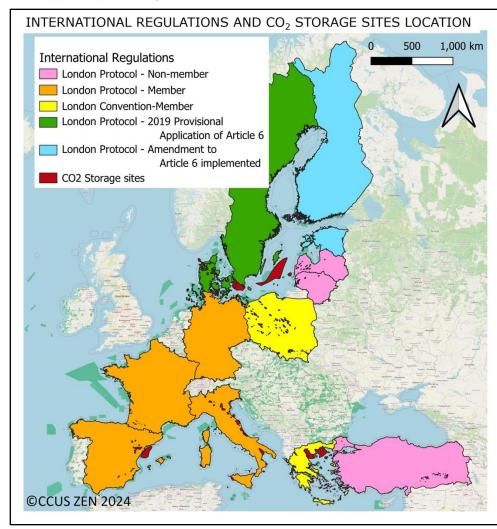


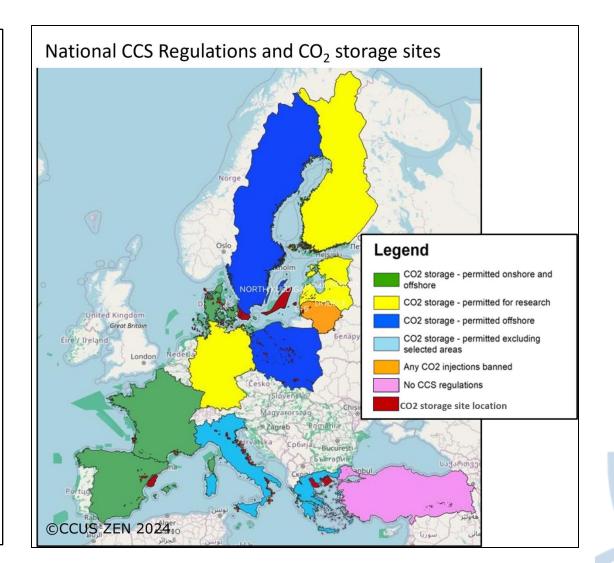






Non-technical data combined with technical data





4 Baltic projects

Baltic-1 (B-1)

Latvia-Lithuania



Baltic-1 CLUSTER (B-1)

Latvia-Lithuania Storage sites **BALTIC 4 CLUSTERS** Shipping lines Pipelines Baltic -2, Germany, Denmark, Sweden, 20/33 emitters (9 Lithuania, 6 emitte clusters), 8 storage (2 clusters), 2 storage Poland, 18/11 emitters Denmark, Sweden, 16 (1 cluster), 2 storage

emitters (4 clusters), 3 storage sites

Advantages (B-1 & B-4) High storage capacity, Close location of

emitters to storage sites, 3 PCI projects in

Baltic-1 and Baltic-4

Onshore-

Challenges (B-1 & B-4) Regulatory

Social - landlords

No yet governmental support

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High storage capacity

favourable CCS policies and

financial governmental

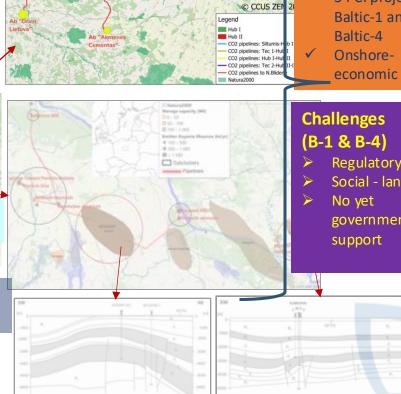
support in Denmark

Advantages

(B-2 & B-3)

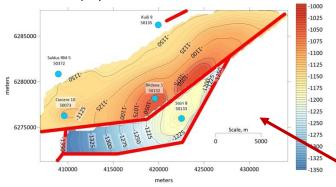
regulations

Map of the Top of Gassum formation for Stenlille and Havsno structures. Source: Gregersen et al, 2023





Contour maps of the top of the Cambrian Deimena Formation in the North Blidene (left) and the Blidene (right) structures. The fault line is indicated with a red polyline



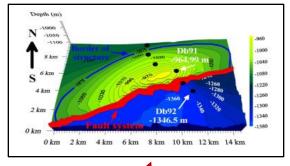
Latvian CO₂ emitters (4):

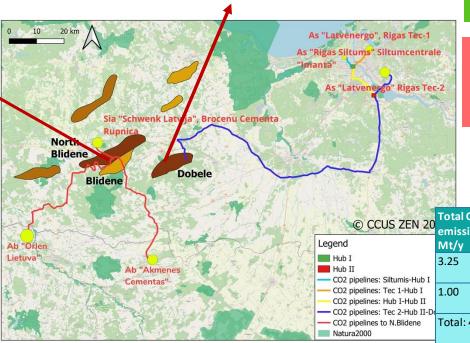
- Latvenergo PP (2 plants)
- Rigas Siltums Thermal Plant
- "Schwenk Latvia" SIA (Cement plant)

Lithuanian CO₂ emitters (2):

- Orlen refinery
- Akmenes cement plant (acquired by SCHWENK)

Baltic project Baltic-1 CLUSTER (B-1) Latvia-Lithuania





Advantages

- / High storage capacity (0.4 Gt CO₂)
- ✓ Close location of emitters to storage sites,
- ✓ 2 PCI projects in the Baltic-1
- ✓ Onshore- economic

Challenges

- Regulatory
- Social landlords
- No yet governmental support

The state of the s				
Total CO ₂ emissions, Mt/y	Storage sites	CO ₂ Storage Capacity, Mt	Distance from emission to storage site, km	Transport options
3.25	North Blidene & Blidene	297	9-70 km	pipeline
1.00	Dobele	106	150 km for Latvenergo Tec-2	pipeline
Total: 4.25	North Blidene, Blidene and Dobele	Total: 403	9-150 km	pipeline

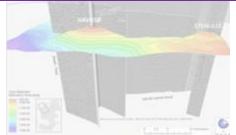
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Advantages (B-2 & B-3)

- ✓ High storage capacity
- √ favourable CCS policies and regulations
- financial governmental support in Denmark

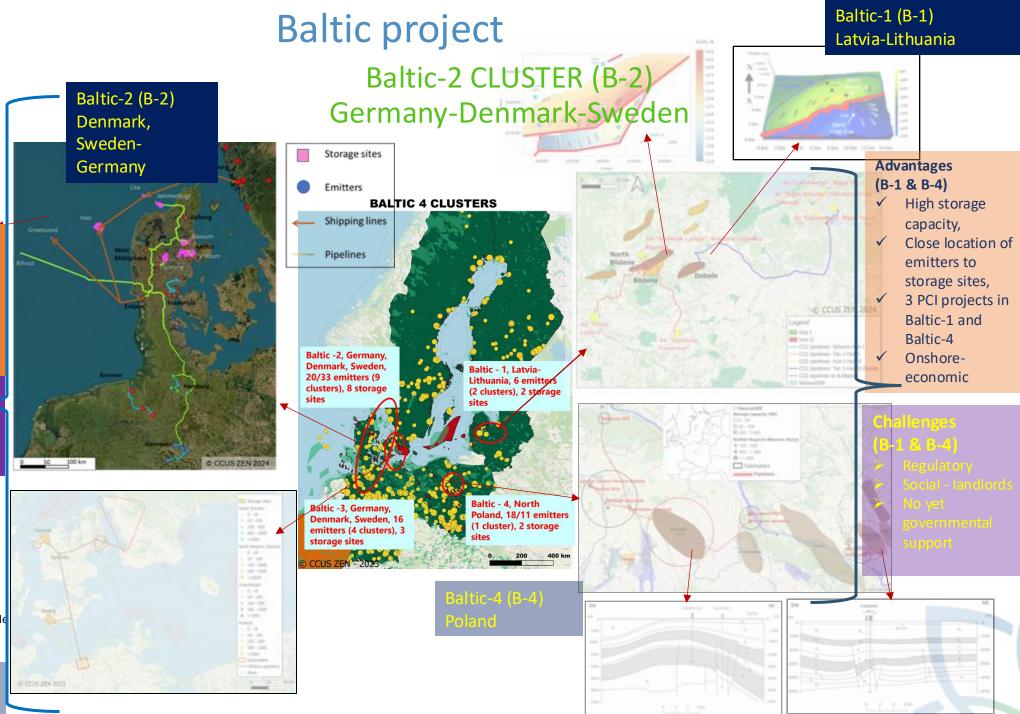
Challenges (B-2 & B-3)

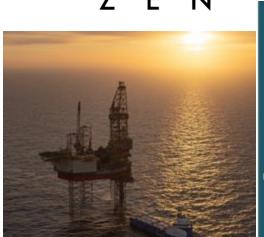
- Regulatory in Germany
- Complicate transport structure and long distances



Map of the Top of Gassum formation for Stenlille and Havsno structures. Source: Gregersen et al, 2023

Baltic-3 (B-3)-Denmark, Sweden-Germany





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Baltic project Baltic-2 CLUSTER (B-2) Germany-Denmark-Sweden

Storage sites

Shipping lines

Emitters

Pipelines

Advantages

- High storage capacity
- favourable CCS policies and regulations
- financial governmental support in Denmark

Challenges

- Regulatory in Germany
- Complicate transport structure and long distances

- 33 significant emitters with a capture capacity of about 22,66 Mt of CO₂ annually
- ≥ 20 of them have a high potential to adopt CO₂ capture
- Eight geological storage sites in Denmark onshore and offshore with a mean capacity of around 928 Mt
- Among these, Bifrost and Greensand
- ▶ Six projects with CO₂ use options elaborating CO₂ conversion into methanol with a conversion rate of up to 72%
- → 30% of captured CO₂ could be used and 70% stored
- ▶ 15.1 Mt CO₂ could be injected annually
- ▶ 6 Mt CO₂ could be used annually within 15 CCU plants

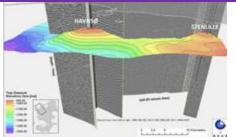


Advantages (B-2 & B-3)

- High storage capacity
- favourable CCS policies and regulations
- financial governmental support in Denmark

Challenges (B-2 & B-3)

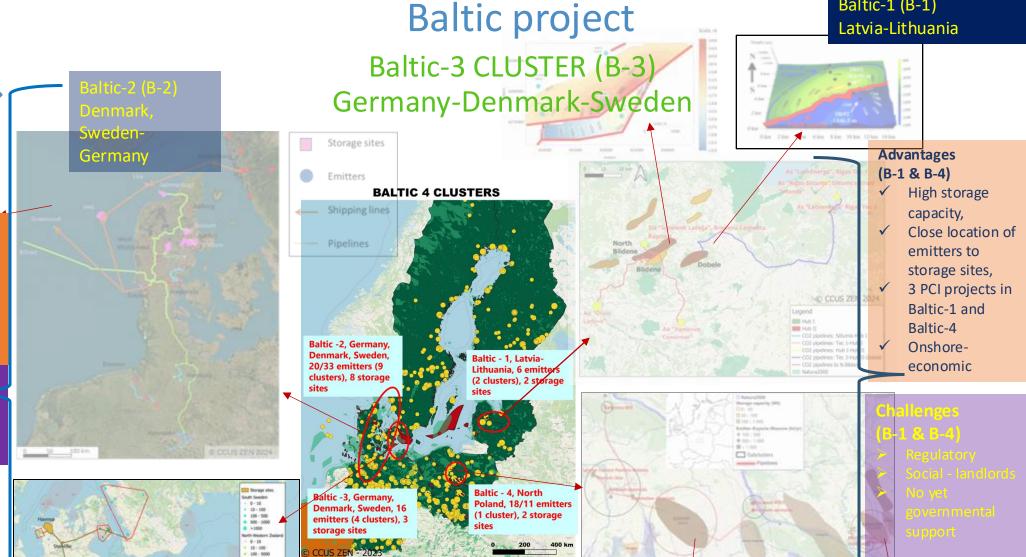
- Regulatory in Germany
- Complicate transport structure and long distances



Map of the Top of Gassum formation for Stenlille and Havsno structures. Source: Gregersen et al, 2023

D CCUS ZEN 2023

Baltic-3 (B-3)-Denmark, **Sweden-Germany**



Baltic-1 (B-1)

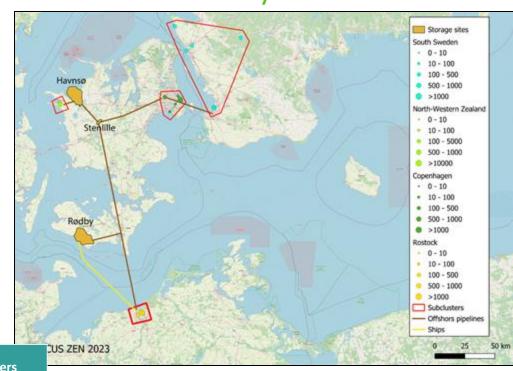


Top Generality Execution times (mod.) Fig. 6 accounts from times (mod.) Fig. 7 acco

Map of the Top of Gassum formation for Stenlille and Havsno structures. Source: Gregersen et al, 2023

Total CO, **Emitters** Country Cluster emissions number [Mt/yr] Germany Rostock Cluster 2.5 **Denmark** Copenhagen Cluster 1.2 North-western 0.53 Zealand Cluster South Sweden 1.5 Sweden 6 Cluster 5.7 13 Total

Baltic project Baltic-3 CLUSTER (B-3) Germany-Denmark-Sweden



Storage	On / offshore		ty mean n tonnes)	Status	
name		P90	P10		
Havnsø	Nearshore	204	423	Seismic campaign	
Rødby	Rødby Onshore		449	Seismic campaign	
Stenlille	Onshore	10 (mean)		Seismic campaign finish ed	

Advantages

- ✓ High storage capacity
- favourable CCS policies and regulations
- ✓ financial governmental support in Denmark

Challenges

- Regulatory in Germany
- Complicate transport structure and long distances
- ▶ 4 clusters with 13 emitters
- Maximum emission volume: 5.7 Mt annually
- 3 storage sites
- Maximum storage volume: approximately 456-882 Mt
- Possible transport infrastructure includes pipeline and ship

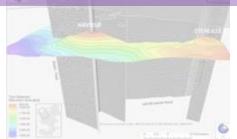
CCUS Z E N www.projectgreensand.com

Advantages (B-2 & B-3)

- ✓ High storage capacity
- favourable CCS policies and regulations
- ✓ financial governmental support in Denmark

Challenges (B-2 & B-3)

 Regulatory in Germany
 Complicate transport structur and long distances



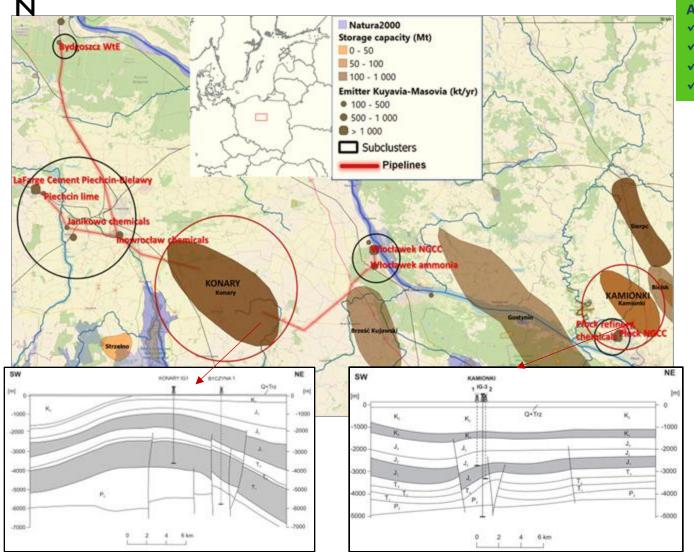
Map of the Top of Gassum formation for Stenlille and Havsno structures. Source: Gregersen et al, 2023

Baltic-3 (B-3)-Denmark, Sweden-Germany



CCUS

Baltic project Baltic-4 CLUSTER (B-4) POLAND



Advantages

- ✓ High storage capacity,
- ✓ Close location of emitters to storage sites,
- ✓ 2 PCI projects in Baltic-4
- ✓ Onshore- economic

Challenges

- Regulatory
- Social landlords
- No yet governmental support
- ▶ 4 sub-clusters with 11 emitters
- ▶ Maximum emission volume: 8,2 Mt annually
- 2 storage sites
- Maximum storage volume: approximately 381 Mt
- ▶ Total pipeline length 108 km



Regulatory readiness of the analysed value chains: Baltic Region

Among higher-readiness value chains are

CCUS projects with CO₂ emission sources in Denmark, Sweden and Germany and CO₂ storage in Denmark (Baltic-2 and Baltic-3).

The main internal strengths of these two value chains:

- ► The high storage capacity associated with the very good reservoir properties, the large thickness of primary cap rocks
- CO₂ capture and use options are under development
- ▶ Many CCUS research and demo projects in Denmark

Their main external opportunities are

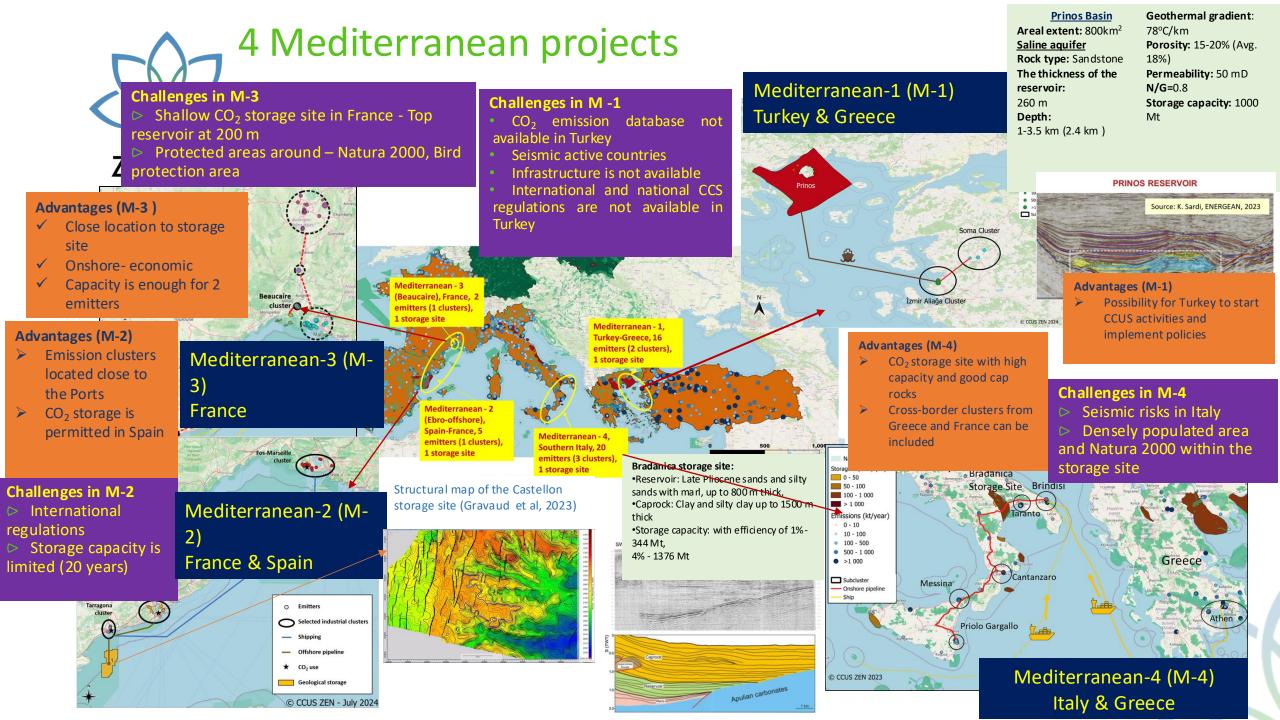
- ► The favourable CCS policies and regulations and financial governmental support in Denmark, where CO₂ storage sites are located
- Sweden and Denmark have deposited a declaration of provisional application of Amendment to Article 6 of the London Protocol

The main risks

- ▶ Among the risks for Baltic-2 and -3 is German international regulations
- Germany has not deposited a declaration of provisional application of Amendment to Article 6 with the IMO. This, in addition to a bilateral agreement, is needed before the export of CO₂ for offshore storage

INTERNATIONAL REGULATIONS AND CO2 STORAGE SITES LOCATION



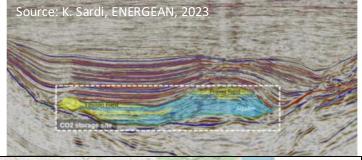




Mediterranean-1 CLUSTER (M-1)
Turkey & Greece



PRINOS RESERVOIR



Advantages

✓ Possibility for Turkey to start CCUS activities and implement policies

Challenges

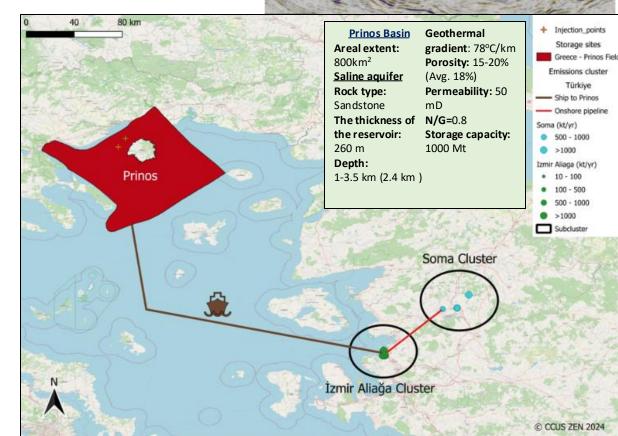
- CO₂ emission database not available in Turkey
- Seismic active countries
- ➤ Infrastructure is not available
- International and national CCS regulations are not available in Turkey

CO₂ emissions:

Soma cluster and İzmir Aliağa cluster − a total of 16 emitters produced 40 Mt CO₂

Transport routes

- Onshore pipeline 120 km
- Ship transport 360 km from İzmir-Aliağa port
- Prinos storage site in Greece with 1Gt of storage capacity
- ► The CO2Fokus project suggests that CO₂ could be used to produce dimethyl ether (DME) in the Aliağa region.





Mediterranean-2 CLUSTER (M-2) France & Spain

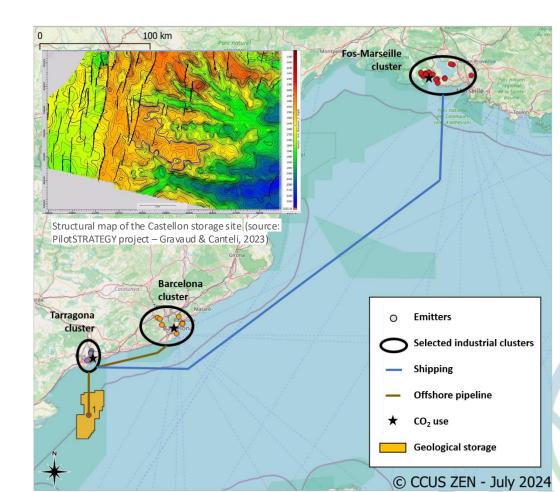


Advantages

- ✓ Emission clusters located close to the Ports
- ✓ CO₂ storage is permitted in Spain

Challenges

- International regulations
- Storage capacity is limited (20 years)
- ► The Mediterranean-2 project comprises 3 clusters of large emitters (32 emitters, producing 23.8 MtCO₂) and one storage site offshore in Spain The industrial clusters:
- Tarragona Spain
- Barcelona Spain
- Fos-Marseille cluster in France
- ► The geological storage site Castellon is located offshore Tarragona in the Ebro Basin (capacity - 200 Mt CO₂)
- Various CO₂ utilization options are considered on the base of CCU feasibility projects in France and Spain
- ▶ It is assumed that 9.8 Mt CO₂ will be captured, from which 6.7 Mt stored and 3.1 Mt CO₂ used





Mediterranean-3 CLUSTER (M-3)

France

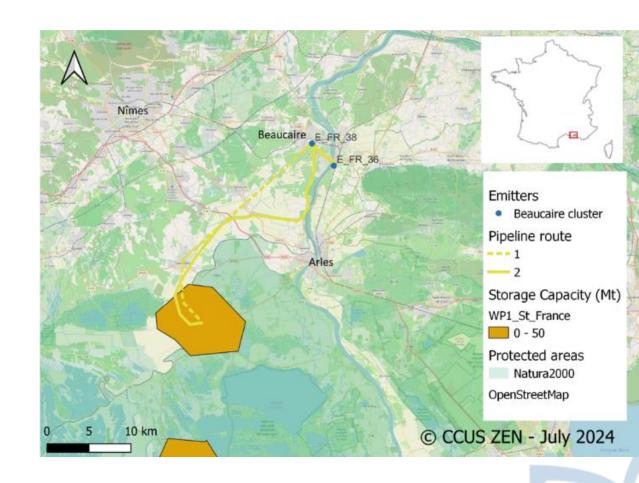


Advantages

- ✓ Close location to a storage site
- ✓ Onshore economic
- ✓ Capacity is enough for 2 emitters

Challenges

- ➤ Shallow CO₂ storage site in France Top reservoir at 200 m
- Protected areas around Natura 2000, Bird protection area
- ► The Beaucaire value chain is a local-scale scenario with two emitters (a paper plant and a cement plant) emitting 1.17 Mt/y
- ► The storage is onshore saline aquifer site Haut d'Albaron, with a storage capacity of 34 Mt
- ▶ The onshore pipeline has a total length of 32.6-38.5 km
- Proximity to the protected area is taken into account
- ▶ In the Beaucaire area, using CO₂ for catalytic methanol production, with a potential of 200 kt CO₂/y, can be considered





Mediterranean-4 CLUSTER (M-4)

France



Advantages

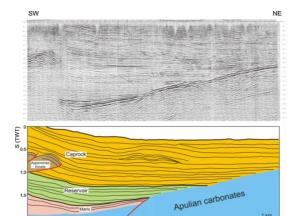
- ✓ CO₂ storage site with high capacity and good cap rocks
- ✓ Cross-border clusters from Greece and France can be included

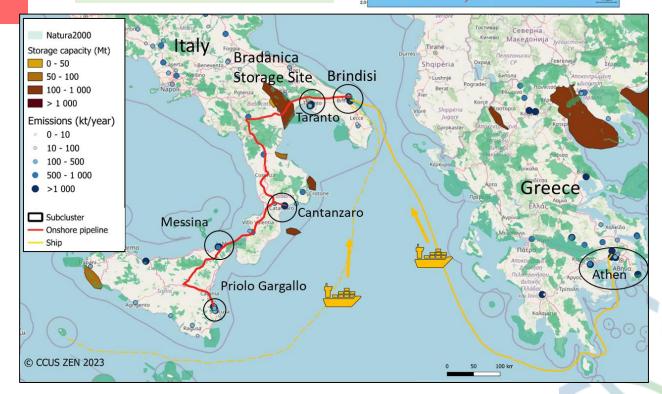
Challenges

- Seismic risks in Italy
- > Densely populated area and Natura 2000 within the storage site
- CCUS value chain from Southern Italy, with 6 clusters, 32 emitters produced 41 Mt/y of CO₂
- ▶ Transport to an onshore storage site Bradanica by pipelines
- Ship transport from France and Greece is proposed, with a harbour in Brindisi
- ▶ Transport distance 50 450 km

Bradanica storage site:

- •Reservoir: Late Pliocene sands and silty sands with marl, up to 800 m thick,
- •Caprock: Clay and silty clay up to 1500 m thick
- •Storage capacity: with efficiency of 1% 344 Mt,
- 4% 1376 Mt







Readiness of the analysed value chains: Mediterranean Region

Mediterranean-2, 3 and 4 value chains, which include emission sources and storage sites in Spain (M-2), France (M-3) and Italy (M-4), are assessed as more ready at the regulatory side than Mediterranean-1.

- ▶ Mediterranean-1 including CO₂ emissions from Türkiye and CO₂ storage in Greece as less ready, considering the regulatory risks:
- ▶ There is a lack of CCS regulations and CO₂ capture and transport infrastructures in Türkiye
- ➤ Türkiye and Greece are not Contracting Parties to the London Protocol and are therefore not bound by its requirements for cross-border CO₂ transport
- ▶ Italy is planning to implement an Amendment and provisional application to Article 6

However, the technical parameters of the storage site in France (M-3) (Haut d'Albaron) are not qualified for the needed requirements.

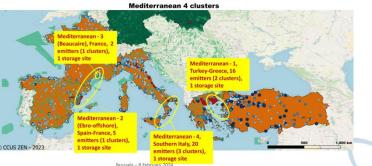
Technical risks for the area around the storage site (external group 1):

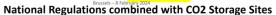
In Italy and Greece, seismic risks should be checked for the storage site areas.

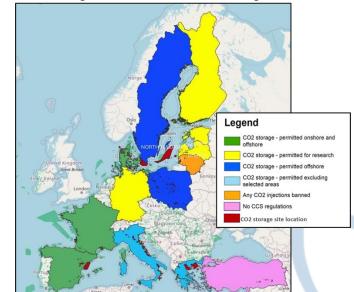
Most countries have risks connected with the location of Natura 2000 areas close to the storage sites or intersected with storage sites.



Four Mediterranean clusters









CONCLUSIONS

- Integrated quantitative analysis can be conducted for both offshore and onshore CCUS projects. However, these projects must adhere to different regulatory frameworks—international, regional, and national regulations for offshore projects and bilateral national regulations for onshore projects
- Despite these differences, it is possible to perform a unified quantitative analysis for all projects (both onshore and offshore) by utilizing common internal technical factors and a streamlined list of external technical and non-technical parameters
- One area with significant uncertainty involves CO_2 utilization options. This uncertainty arises from the lack of established regulations for Bio- CO_2 emissions, the early stages of project piloting and demonstration, and the uncertain market conditions for CO_2 -based products





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Thank you for your attention!



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Developing Project of Common Interests (PCI)

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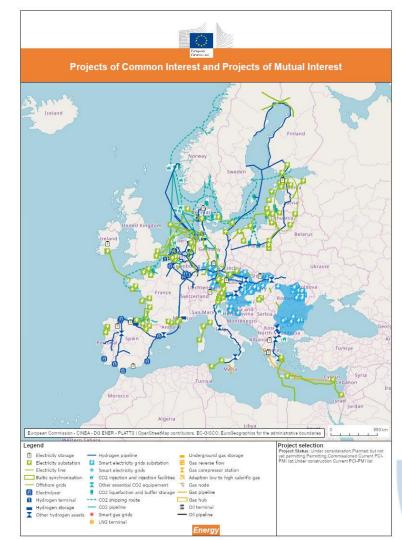




Projects of Common Interest (PCIs) serve as critical energy infrastructure that interconnect systems across European Union member states

PCIs are projects that significantly contribute to the development of EU infrastructure supporting energy links and decarbonization objectives within the EU.

PMIs are equally projects aiming to achieve EU's and countries outside EU climate and energy objectives. These are promoted by a cooperation extending beyond the EU borders





The requirements for obtaining the PCI status are outlined in Article (4) of the TEN-E Regulation

- Regulation (EU) 2022/869 of the European Parliament and of the Council of 30 May 2022 on guidelines for trans-European energy infrastructure, amending Regulations (EC) No 715/2009, (EU) 2019/942 and (EU) 2019/943 and Directives 2009/73/EC and (EU) 2019/944, and repealing Regulation (EU) No 347/2013
- The project must be necessary for at least one of the energy infrastructure priority corridors and thematic areas
 - "Cross-border carbon dioxide network: development of infrastructure for transport and storage of carbon dioxide between Member States and with neighbouring third countries of carbon dioxide capture and storage captured from industrial installations for the purpose of permanent geological storage as well as carbon dioxide utilisation for synthetic fuel gases leading to the permanent neutralization of carbon dioxide."
- The overall potential benefit of the project outweighs its costs.
- The project must involve at least two Member States.

- Security of supply, by interoperability, system flexibility, cybersecurity, and reliable system operation.
- Contribute significantly to sustainability through the reduction of carbon dioxide emissions in the connected industrial installations by maintaining security of supply, increase the resilience and security of transport and storage of CO₂, and efficient use of resources by enabling multiple CO₂ sources and storage sites via common infrastructure that minimise the environmental burden and risk.
- For carbon dioxide projects, the project is used to transport and, where applicable, store anthropogenic carbon dioxide originating from at least two Member States.



The classification as a PCI is crucial for vital energy infrastructure projects within the EU, supporting the European goal for climate neutrality by 2050 by interconnecting energy systems of Member States, enhancing market competition, and securing energy supply.

The selection of PCIs takes place biennially, involving a comprehensive process steered by multi-faceted Regional Groups. These groups are composed of qualified delegates from the European Commission, the Agency for the Cooperation of Energy Regulators, and National Regulatory Authorities.





▶Potential benefits:

- Accelerated permit granting process, enabling efficient implementation of important projects.
- Improved regulatory conditions, encouraging transparency, investor trust and facilitating the development of projects.
- Lower administrative costs through streamlined environmental assessment processes.
- Eligible for the Connecting Europe Facility (CEF), which encompass financial support for feasibility studies and construction.



Four potential PCI were selected, each evaluated based on key criteria to ensure compliance with TEN-E regulations and to measure their contribution toward the EU's climate neutrality goal by 2050

No	PCI name	Infrastructure type	Total transported, CO ₂ , high scenario (Mt/y)
1	Cross-Border Pipeline Infrastructure: Germany-Denmark Link	Pipeline	7.2
2	Cross-border pipeline infrastructure to Port of Gdansk from Lithuania and national pipeline infrastructure to Port of Gdansk in Poland	Pipeline	9
3	Cross-border Pipeline and harbour Infrastructure: Southern Italy-Greece Link	Pipeline / harbour	19.3
4	Harbour and offshore pipeline infrastructure in Tarragona	Pipeline / harbour	9.8

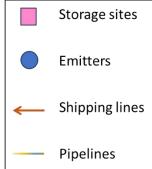




The pipeline infrastructure project, extending from Germany to Denmark, aims to connect emission clusters primarily associated with power generation and cement factories in Germany to permanent geological storage sites in Denmark

- ▶ Project Name: Export pipeline from Krempermoor to Billund
- ▶ Involved Member States: Germany, Denmark
- ▶ Pipeline capacity: 7.4 Mt/y
- Distance: 205 km
- Contribution to market integration
 - > 9 emitters, 8 potential storage sites, CCU capacity of 1.7 MT/y
- Contribution to sustainability
 - Decarbonisation and emissions reduction
- - ▶ Both states are contracting parties to the London Protocol

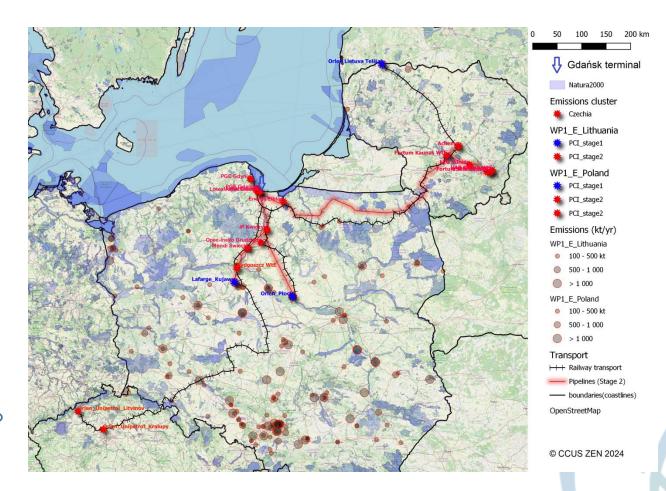






This network report proposes additional detailing and description of a concept for the second stage of the ECO2CEE existing PCI

- ▶ Project Name: Pipelines to the Port of Gdańsk
- ► Involved Member States: Poland, Lithuania, Czechia (storage sites under North Sea in DK, NO, NL and UK)
- Capacity: 9 Mt/y
- Distance: 932 km (pipelines)
- Contribution to market integration
 - Potential 20 emitters with CO₂ transported through pipelines (integrated with railway systems)
- Contribution to sustainability
 - Decarbonisation and emissions reduction
- ▶ Cross-border impact
 - The three emitter countries are not contracting parties to the London Protocol, oppositely to the storage countries





Pipelines and CO₂ harbour infrastructures are proposed as a PCI located in Southern Italy and Greece

- ▶ Project Name: New pipeline in Southern Italy, and new CCS harbour at Brindisi
- ► Involved Member States: Italy and Greece (possibly also France)
- Capacity: 3.0 Mt/y
- Distance: 50-513 km
- - Potential 24 emitters with CO₂ transported through pipelines (integrated with shipping) and one potential storage site
- Contribution to sustainability
 - Decarbonisation and emissions reduction
- ▶ Cross-border impact
 - ▶ While Italy and France are contracting parties of the London Protocol, Greece is not





The Tarragona PCI would enable the export and the storage of CO₂ emissions from the French industrial clusters in Spain

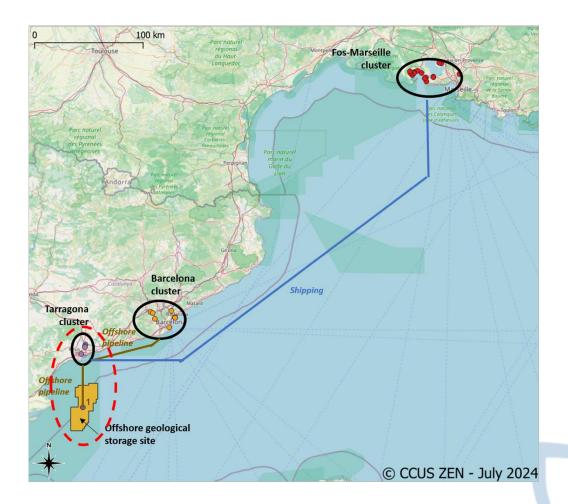
▶ Project Name: Tarragona hub

⊳Involved Member States: Spain, France

Capacity: 9.8 Mt/y

Distance: 48.1 km

- Contribution to market integration
 - ▶ Potential 32 emitters with CO₂ transported through pipelines (integrated with shipping) and one potential storage site
- Contribution to sustainability
 - Decarbonisation and emissions reduction





The project highlights 4 key insights to obtain the PCI status

- ► Technical preparation: displaying the project developer's experience and track record can be a particularly important asset to achieve the PCl status. This can also be achieved with partnerships with institutions holding relevant skills for the project development.
- Stakeholders: it is one of the most key factors to obtain a PCl status for a project. To ensure a sound project development, multiple entities must be brought onboards, as developers or external stakeholders. They can hold distinct roles or skills, contributing to the increase of the level of trust for the project completion.
- Level of maturity: the level of definition of the project is also an indicator of the project capability to achieve the PCl status. A well-defined concept, where multiple scenarios have been analysed and screened, facilitates the construction of a sound PCl application.
- Financing: while a PCI project facilitates the access to project funding, the applicants must show that they can raise the necessary funds to finance the project. This also means that it is important to have a solid economic analysis and business case.





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