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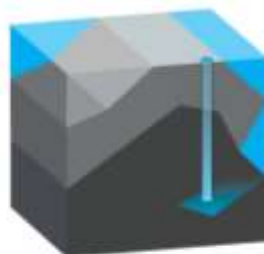
**SYNERGY CONCEPTS**



# DIRECT INJECTION OF CO<sub>2</sub> FROM A SHIP IN THE BALTIC SEA



CCUS ZEN data collected by Tallinn  
University of Technology  
Department of Geology



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**KLIIMAMINISTEERIUM**

Funded by

Estonian Ministry of Climate

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("CETP")



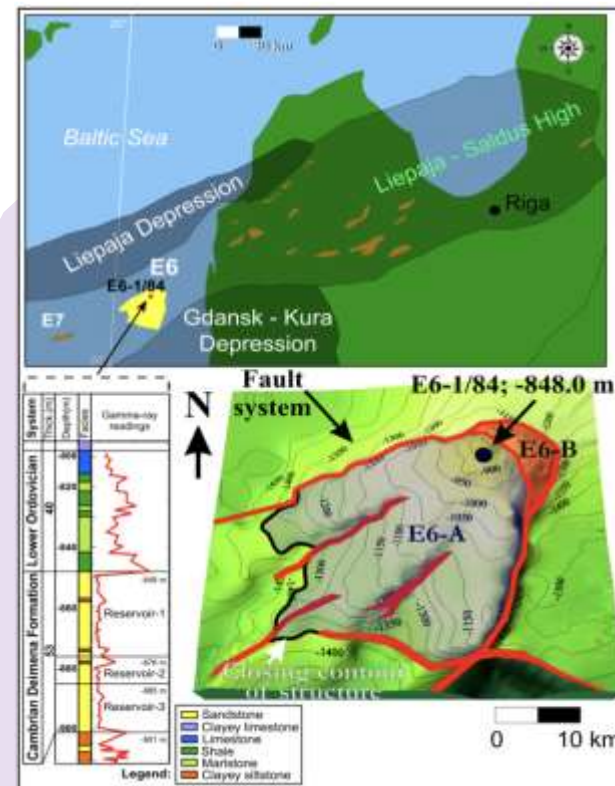
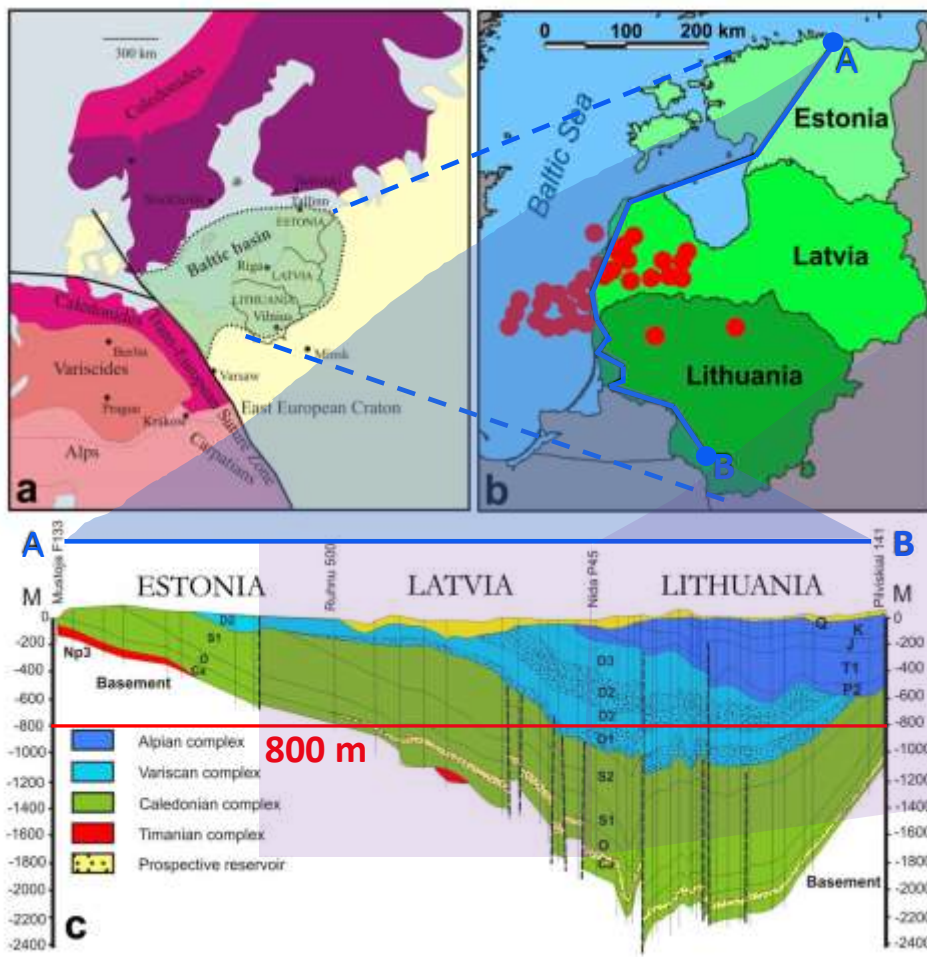
Dr. Kazbulat Shogenov & Dr. Alla Shogenova

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# GEOLOGICAL BACKGROUND OF THE BALTIC OFFSHORE STRUCTURE

Baltic scenario



System	Facies	Depth (m)	Thick. (m)
Devonian		-37.5	560.5
		-580	
Silurian		-702	122
Ordovician	Saldus	-712.5	10.5
		-848	146
Cambrian	Deimena	-901	53
		-1018	117
Proterozoic		-1068	50

Legend

Sea water	Oil-bearing limestone
Sandstone	Carbonate shales
Clayey siltstone	Granite
Clayey limestone	

- Total area: 600 km<sup>2</sup>
- Trap area of compartment E6-A: 553km<sup>2</sup> & E6-B: 47km<sup>2</sup>
- Reservoir: Porosity (14–33%, av. 21%)
- Permeability (10–440 mD, av. 150 mD)
- Silurian-Ordovician shale cap rock of 400–1000 m thick
- Reservoir temperature: 36°C

Oil reserves: 362 MMBO  
 Oil flow: 2.7 m<sup>3</sup>/day



# Baltic scenario

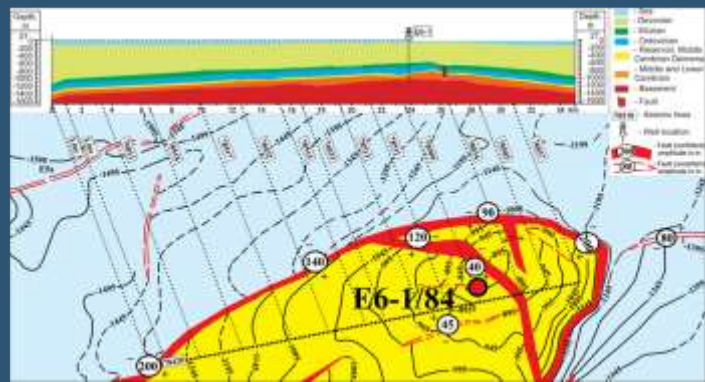
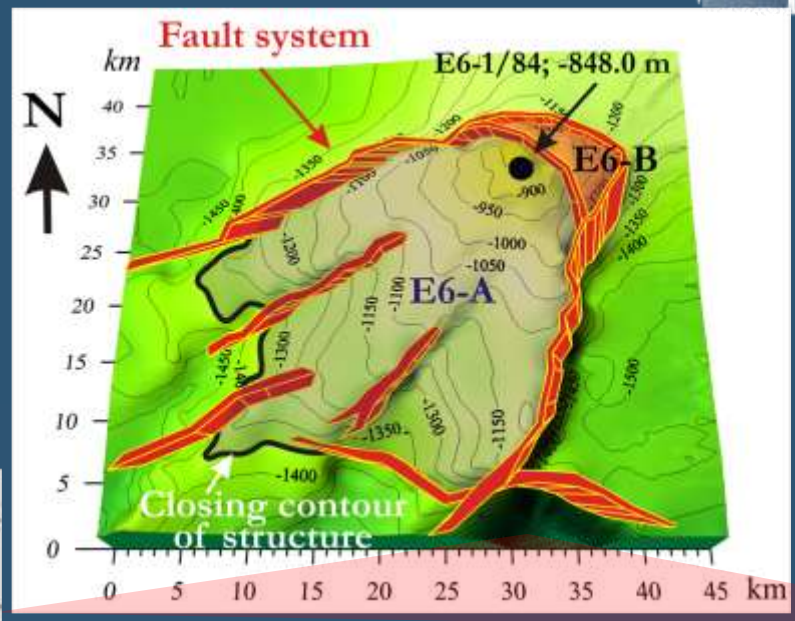
## CO<sub>2</sub> STORAGE CAPACITY, MT

Reservoir	E6	E6-A	E6-B
SALDUS F. OIL RESERVOIR	65-144 (mean 110)	60-133 (mean 100)	5-11 (mean 10)
	Optimistic: 251-602 (mean 377) Conservative: 101-243 (mean 152)	Optimistic: 243-582 (mean 365) Conservative: 97-233 (mean 146)	Optimistic: 8-20 (mean 12) Conservative: 4-10 (mean 6)
	Optimistic: 320-745 (mean 490) Conservative: 170-385 (mean 265)	Optimistic: 305-715 (mean 470) Conservative: 160-365 (mean 250)	Optimistic: 15-30 (mean 20) Conservative: 10-20 (mean 15)

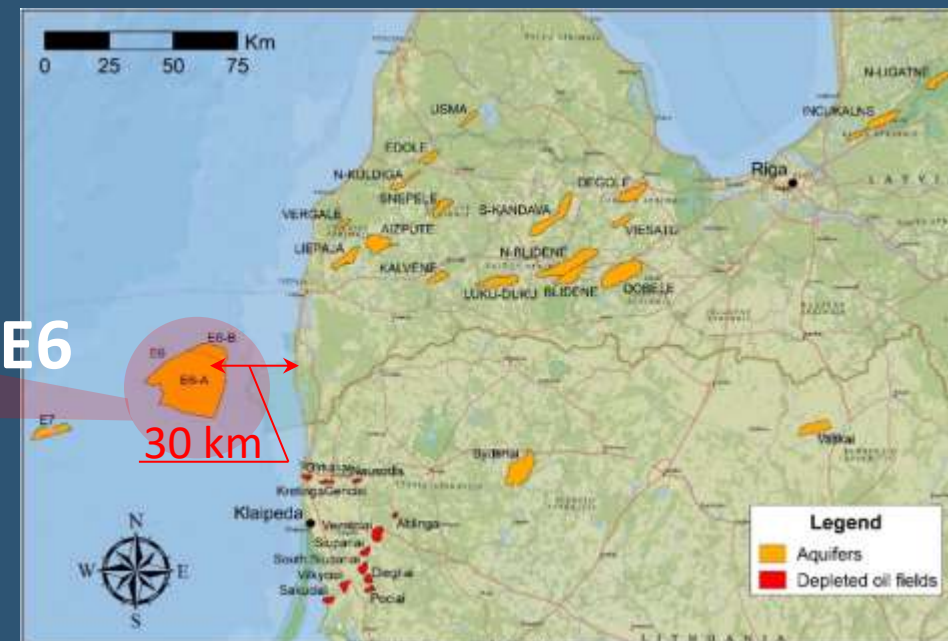
System	Facies	Depth (m)	Thick (m)
Devonian	Yellow	-37.5	
		560.5	
Silurian	Green	-580	122
Ordovician	Blue	-702	10.5
		-712.5	
Cambrian	Red	-848	53
		-901	
Proterozoic	Red	-1018	117
		-1068	50

## E6 PROPERTIES

Salinity: 99 g/l  
 Thickness: 53 m  
 Density of CO<sub>2</sub> in situ: 658 (kg/m<sup>3</sup>)  
 Net Gross ratio of aquifer: 0.90  
 Reservoir temperature in situ: 36°C  
 Reservoir pressure in situ: 9.3 mPa  
 Area E6: 600 (km<sup>2</sup>)  
 E6-A: 553 km<sup>2</sup>  
 E6-B: 47 km<sup>2</sup>  
 Porosity: 21%  
 Permeability: 170 mD

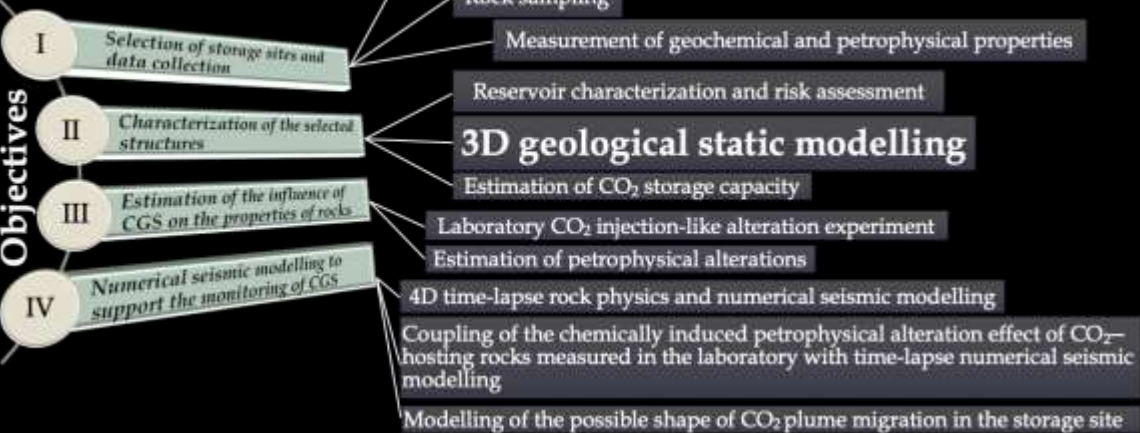


Reservoir quality: 'good'  
 Application for CGS: 'appropriate'  
 (average porosity 21%; permeability 150 mD)





Objectives

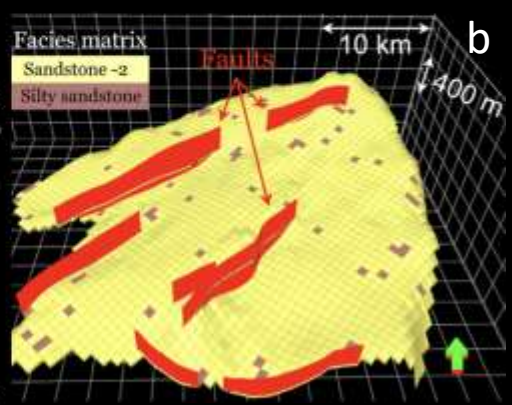
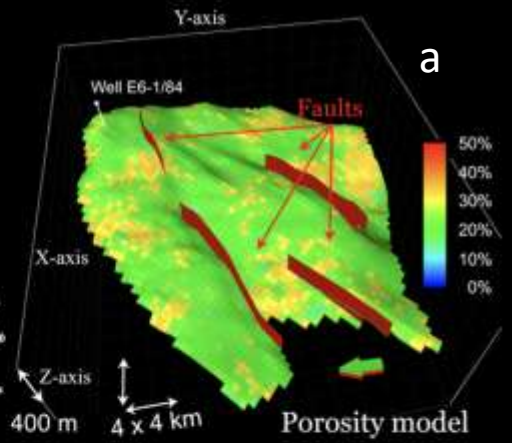
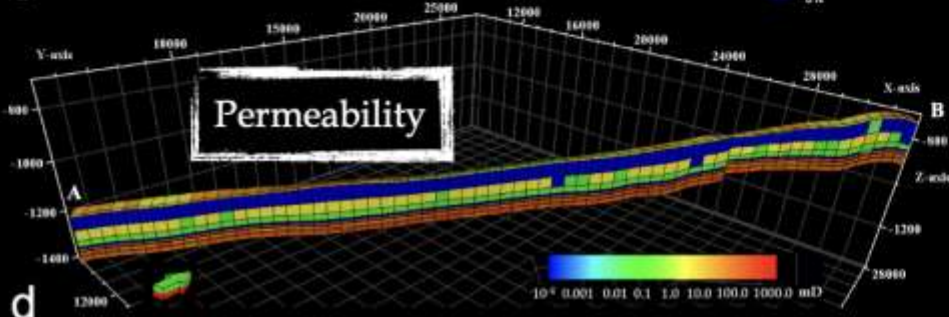
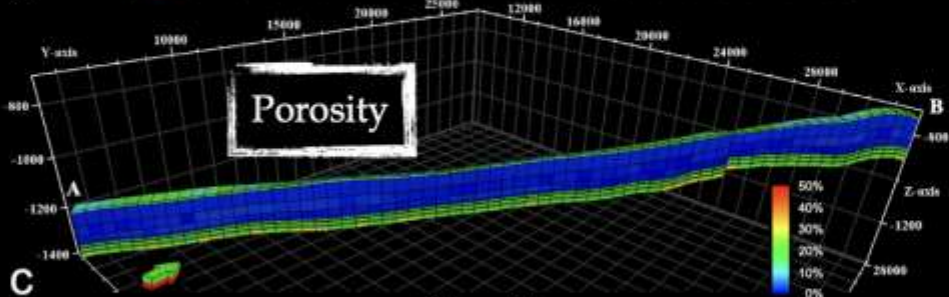
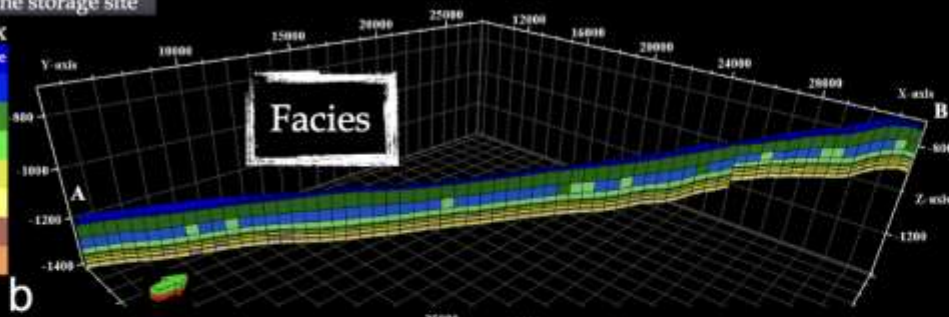
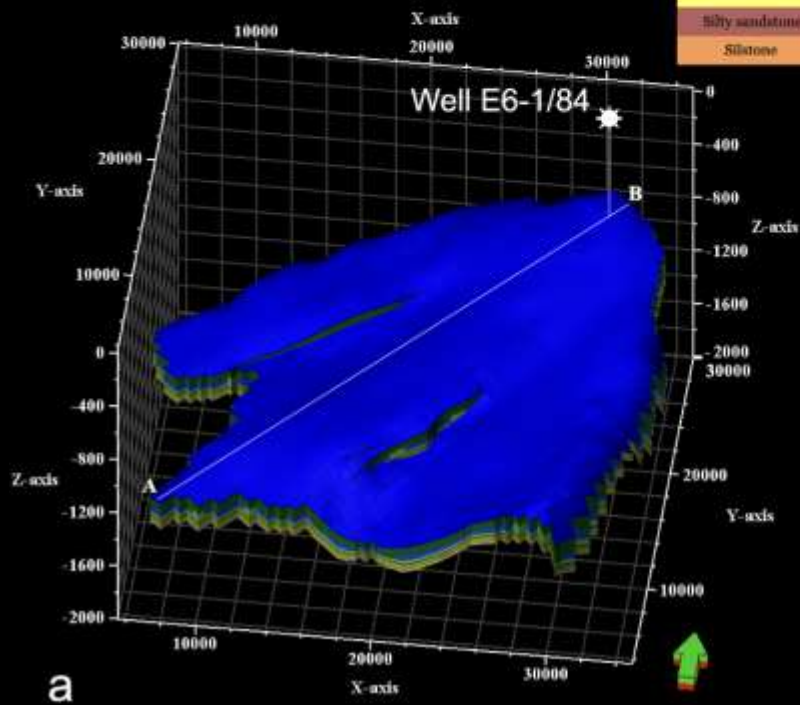


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(a) 3D geological static facies model of the E6-A compartment of the E6 offshore structure with location of the well E6-1/84. All layers of the 3D model are shown. The white line A-B represents the geological cross section shown in "b-d". Cross sections of (b) facies, (c) porosity and (d) permeability distribution along the line A-B

**Facies matrix**

Oil-bearing limestone
Limestone
Shale
Marlstone
Sandstone-1
Sandstone-2
Silty sandstone
Siltstone



(a) 3D geological static facies model of the E6-A compartment, showing the lowermost layer 10 of the Cambrian Deimena. (b) 3D geological static porosity model with the lowermost layer 10 of the Deimena Formation

Baltic scenario



# DATA AND METHODS - CCUS ZEN

## Baltic scenario

- ▷ CO<sub>2</sub> emissions produced in 2022 and reported in EU ETS were used for the CCUS scenario.
- ▷ Additionally, bio-CO<sub>2</sub> emissions were assessed from national reports for Estonia and data on bio-CO<sub>2</sub> for Lithuania were added from data from CaptureMap provided by Endrava used to map CO<sub>2</sub> emissions sources in the CCUS ZEN project.
- ▷ Minimum, maximum, and average capacities were estimated using minimum, maximum, and average porosities and different efficiency factors (4 and 20, respectively) for optimistic and conservative cases for all structures in our previous research (Shogenov, 2013a, 2013b).
- ▷ Data on CO<sub>2</sub> storage sites and CO<sub>2</sub> emission sources collected by the CCUS ZEN project in the Q-GIS system was used and updated to propose Baltic onshore and offshore CCUS clusters.





# CO<sub>2</sub> EMISSIONS IN BALTIC COUNTRIES

Baltic scenario



8.7 MT

1.5 MT

4.7 MT

14.9 MT [2022]

1.3 MT

Bio-CO<sub>2</sub>  
EMISSIONS





# BALTIC CROSS-BORDER SCENARIO

## BALTIC SCENARIO



NEE - North-Eastern Estonia, PP - Power Plant, SOP - shale oil plants, WtE - Waste to Energy Plant, TP - Thermal Power Plant, t – tonnes

ESTONIAN CLUSTER (SILLAMÄE AND MUUGA PORTS)	N	Plant Name	Region	Sector	CO <sub>2</sub> produced in 2022, t		Total CO <sub>2</sub> , t
					Fossil CO <sub>2</sub>	Bio- CO <sub>2</sub>	
1	Auvere PP	Auvere	Power	910,442	241,618	1,152,060	
2	Auvere SOP	Auvere	SOP	905,078	-	905,078	
3	VKG SOP	NEE	SOP	39,253	-	39,253	
4	VKG Energia North TP	NEE	Power	560,197	-	560,197	
5	Kiviõli Chemical Plant	NEE	SOP	168,389	-	168,389	
6	Horizon Paper Factory	Kehra	Paper	10,667	199,400	210,067	
7	Utilitas Tallinn PP	Tallinn	Power	6,766	192,840	199,606	
8	Iru WtE	Iru	WtE	644	129,146	129,790	
Total CO <sub>2</sub> produced							3,364,440

1	Latvenergo Tec-2	Riga	Power	487,953		487,953	
2	Latvenergo Tec-1	Riga	Power	165,651		165,651	
Total CO <sub>2</sub> produced							653,604

1	Fortum Klaipeda WtE	Klaipeda	WtE	125,717		125,717	
2	Orlen Lietuva	Klaipeda	Refineries	1,668,831		1,668,831	
3	Akmenės Cement	Klaipeda	Cement	1077011		1,077,011	
4	Schwenk Latvia	Klaipeda	Cement	750,000		750,000	
Total CO <sub>2</sub> produced							3,621,559

14 EMITTERS IN 3 BALTIC COUNTRIES LOCATED NEAR PORTS, PRODUCED 7.639.603 TCO<sub>2</sub> IN 2022



# CONCLUSIONS

Baltic scenario

▷ Large industrial CO<sub>2</sub> emissions produced in 2022 in Baltic countries: **14,9 Mt**, including **1,3 Mt** of BIO-CO<sub>2</sub> emissions

▷ CO<sub>2</sub> emissions considered in the CTS Baltic Scenarios: **7,6 Mt**

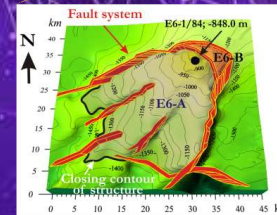
**ESTONIAN CLUSTER: 3,4 Mt** of CO<sub>2</sub>

**LATVIAN CLUSTER: 653 Kt** of CO<sub>2</sub>

**LATVIAN-LITHUANIAN CLUSTER: 3,6 Mt** of CO<sub>2</sub>

▷ CO<sub>2</sub> storage capacity in the E6 offshore structure in total was estimated: **490 Mt** and **265 Mt** for optimistic and conservative, respectively

▷ Storage capacity within Baltic scenarios will be enough for **136** and **34 years** for optimistic and conservative cases, respectively







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# THANK YOU FOR YOUR ATTENTION!



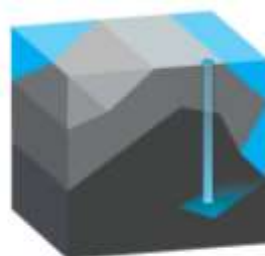
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