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Screening level assessment for the identification of prospective sites for the geological storage of CO_2 in the Baltic Sea area

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CARBON TRANSPORT & STORAGE ASSESSMENT BALTIC SEA AREA

SCREENING LEVEL ASSESSMENT FOR THE IDENTIFICATION OF PROSPECTIVE SITES FOR THE GEOLOGICAL STORAGE OF CO_2 BALTIC SEA AREA

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SLR Consulting Ireland, 7 Dundrum Business Park, Windy Arbour, Dublin 14, Ireland
T : +353 1 296 4667 **F :** +353 1 296 4676 www.slrconsulting.com

CONTENTS

TABLES

FIGURES

1.0 INTRODUCTION

SLR was commissioned by VTT, Technical Research Centre of Finland to identify and characterise the potential CO_2 storage sites in the southern Baltic Sea. There has been a number of CO_2 storage studies carried out in the Baltic region (Elrstrom, 2011, Erlstrom, 2008, VTT, 2010, Sliaupa S., 2009, Shogenova, 2009). Some of these studies have been funded by the European Commission EUGeocapacity and CO2NET East projects. None of these reports has prioritised CO_2 storage sites in the Baltic Sea Basin from a strategic prospective. This initial screening study applies geological, resource and societal criteria to rank CO_2 storage sites in order of priority for further investigation by SLR in WP2.

2.0 DEFINITION OF THE STUDY AREA

The study area is defined as previously mapped Palaeozoic sedimentary basins in the Baltic Sea Area, as described in the document *Geology and hydrocarbon prospects of the Paleozoic in the Baltic region*, 1993 by Brangulis, Kanev, Margulis and Pomerantseva (see **Figure 2**). This assessment is searching for a geological formation that is ultimately capable of storing 50 million tonnes of dense phase CO_2 per year for a minimum of 25 years. This is based on calculations that show carbon dioxide emissions from stationary sources of up to a gross volume of some 100 million tonnes per year in the Baltic Sea region (Nilsson, 2011).

This report assesses the potential for geological storage of carbon dioxide (CO_2) in sedimentary basins in the Baltic Sea area. Storage potential may exist in depleted oil and gas fields or saline aquifer formations at depths greater than 800m, the minimum depth for CO_2 stability. The Precambrian crystalline basement of the Baltic Sea Basin lacks porosity and permeability for CO_2 storage. The principal stage of basin development was during deposition of a thick Middle Cambrian-Lower Devonian (Caledonian) sequence. This sequence contains sandstone and limestone aquifers that could store CO_2 that are sealed by shale and claystone aquitards (see **Figure 1** below). Mesozoic rocks that unconformably overlie the Paleozoic are not deeply buried enough for CO_2 storage and are confined to the south and southwest of the Baltic Sea area.

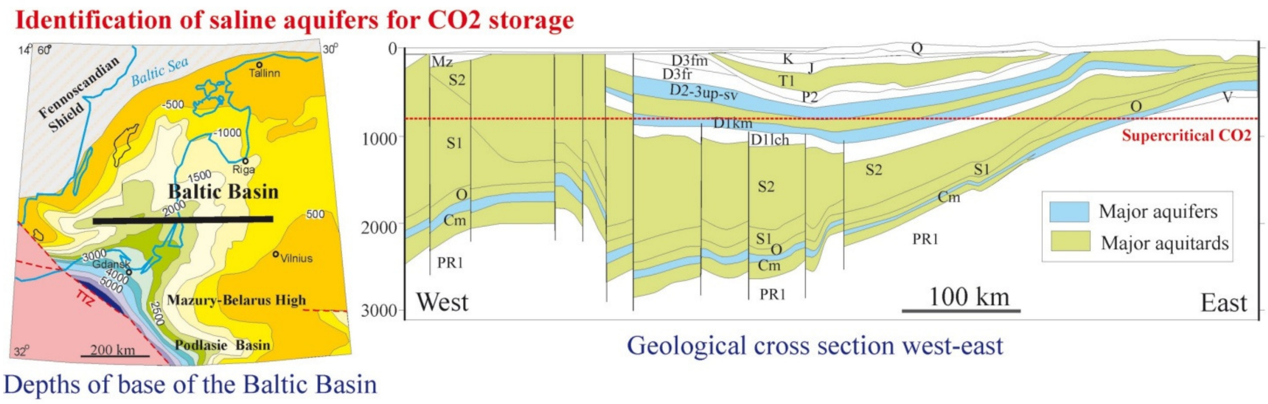

Figure 1 Map showing depth in metres of the Caledonian Baltic Sea Basin with a geological cross section indicating the aquifers that could store CO2 in supercritical state below 800m Cm, Cambrian; O, Ordovician; S1, Lower Silurian (Llandovery and Wenlock series); S2, Upper Silurian (Ludlow and Pridoli series); D1, D2, and D3, Lower, Middle, and Upper Devonian; P2, Middle Permian;T1, Lower Triassic; J, Jurassic; K, Cretaceous; Q, Quaternary (after Sliaupa S., 2009).

The Baltic Sea Basin is a marginal platform depression, deepening from 1 km in the northwest to more than 4km in the southwest, containing un-deformed Palaeozoic rocks underlain by Palaeozoic crystalline basement **(Figure 1)**. The area of the basin is about 200,000km^2 with the long axis being approximately 700 km and the maximum width in the southwest being 400-500 km (A.P. Brangulis, 1993). The structural elements with Caledonian sedimentary deposits are the Slupsk-Latvian-Estonian Border Zone (or Gotland Monocline), the Lithuanian Border Zone, the Liepaja Depression, and the Gdansk-Kura Depression. The sub-basins are separated by the Leba High and Liepaya-Saldus Ridge where structural traps are abundant (**Figure 2**). Palaeozoic terrigenous and volcanic rocks overlie the crystalline basement. There is a 100-150m thick Lower to Middle Cambrian sandstone that is the main hydrocarbon bearing reservoir of the Baltic region (**Figure 4**). The overlying Ordovician rocks comprise interbedded sand and shale members including the Alum Shale. This is followed by interbedded shale and limestone including shallow shelf carbonate rocks. Further limestone and shale was deposited in the Silurian. In the south west graptolitic shales are found. The shales grade to the northeast into marls, limestone, clays and shoal carbonates facies with barrier reefs. The upper part of the Caledonian sedimentary sequence is composed of lagoonal, continental deposits. Within this sequence the Cambrian and Devonian sandstones and the Ordovician and Silurian carbonates have the reservoir potential to store CO2.

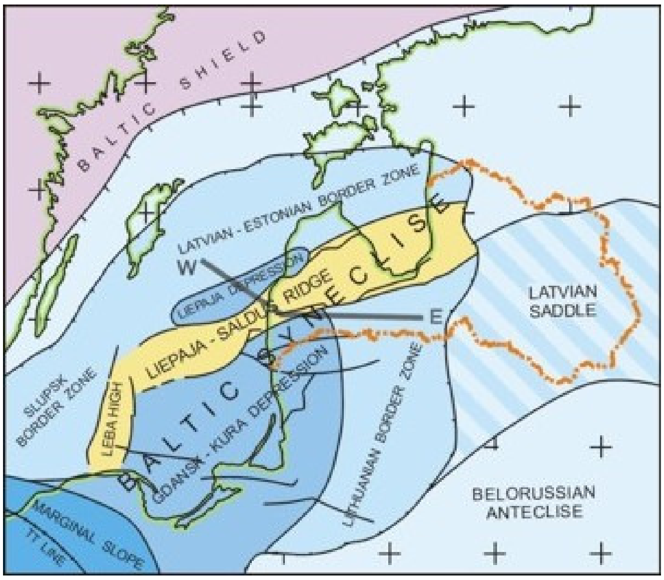

Figure 2 Location basemap of the Baltic Depression showing its various sub-basins, based on Brangulis, A.P., Kanev, L.S., Margulis, L.S. and Pomerantseva, R. A., 1993 *Geology and hydrocarbon prospects of the Paleozoic in the Baltic region.* Geology of Northwest Europe: Proceedings of the 4th Conference edited by J.R.

The main targets for CO_2 storage sites are faulted anticlines, step and nose features associated with the monoclines that occur on the northwest margin of the Baltic Basin. These structures contain the Lower to Middle Cambrian sandstone (Deimena Formation in Latvia, Faludden Sandstone in Sweden) that is the main hydrocarbon bearing reservoir of the Baltic region. There is also the possibility of stratigraphic traps, particularly in the Ordovician shelf carbonate rocks that are porous but not very permeable. There are indications on seismic sections offshore Latvia (A.P. Brangulis, 1993) of possible Ordovician shelf carbonates offshore (see L&OG Report) but poor reservoir quality and small size makes them inappropriate for CO_2 storage (Sweden Baltic Sea OPAB Farmout Prospectivity Appraisal, 1990).

The offshore Dalders Prospect Structure (**Figure 3**), which straddles Swedish, Lithuanian and Latvian territory, has been identified as a potential site for CO_2 storage (Svenska Petroleum Exploration OPAB, 2010). Associated with the Dalders structure is the Dalders Monocline that extends NW to Gotland in Sweden. While storage in confined aquifers and closed structures is the preferred CO_2 sequestration mechanism (e.g. in the CCS-directive from the EC), it would significantly increase the potential of aquifers offshore Sweden if it can be shown theoretically and by demonstration and monitoring projects that CO_2 can be trapped in monoclinal structures (Erlstrom, 2008).

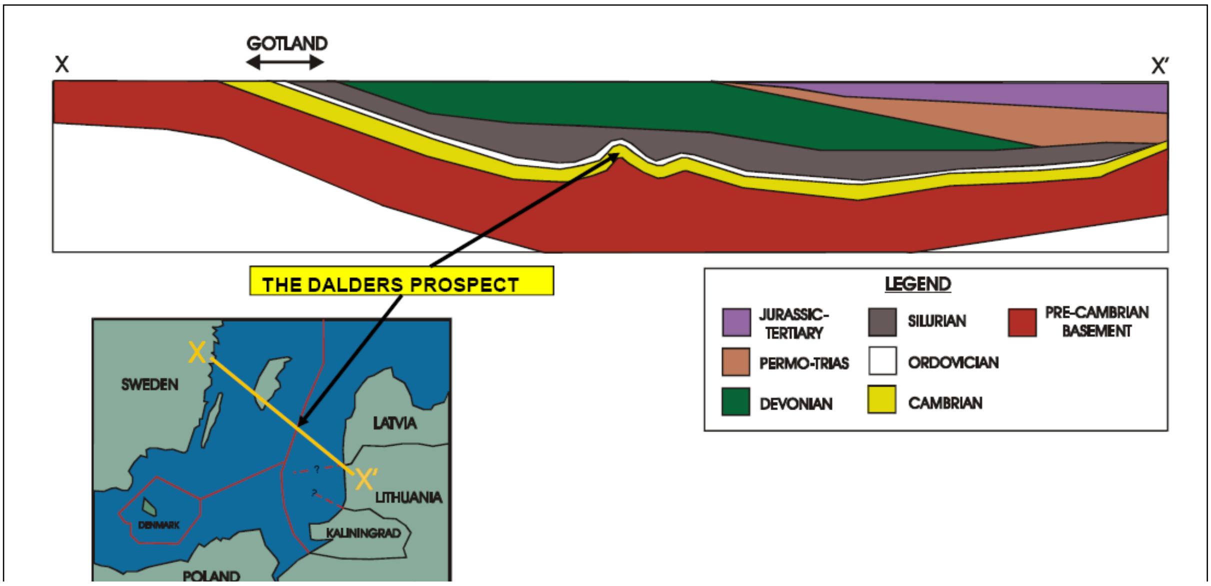

Figure 3 Location of the Dalders Prospect and the Dalders Monocline (from OPAB)

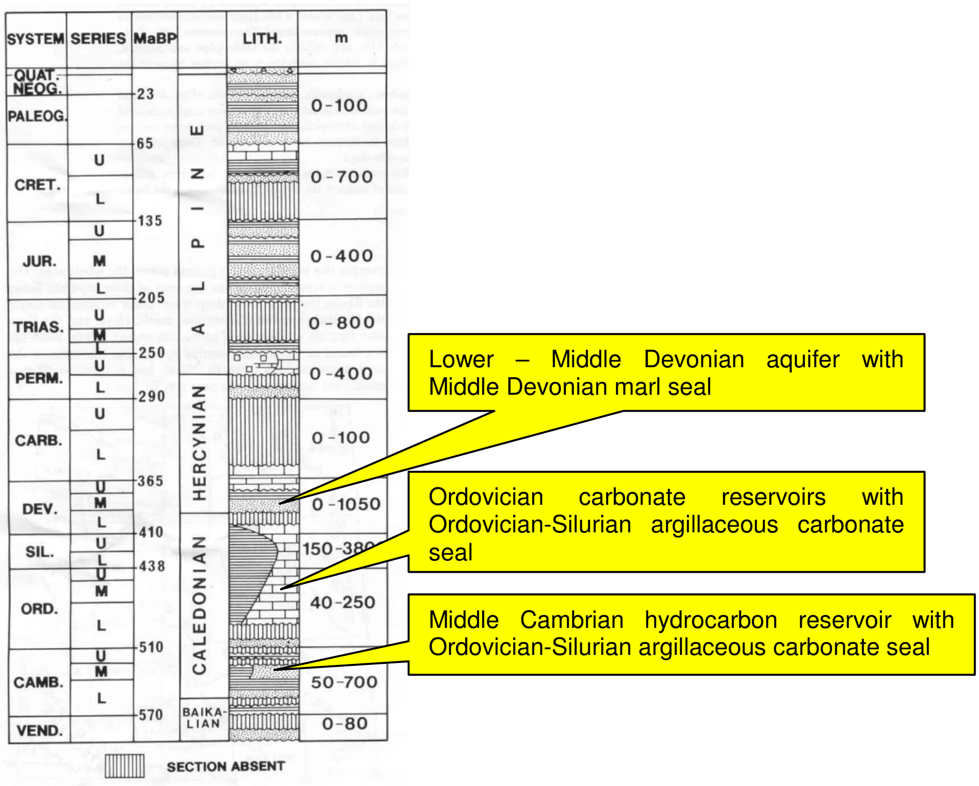

Figure 4 Geological section of the sedimentary basins in the Baltic Sea area (from Brangulis, A.P., Kanev, L.S., Margulis, L.S. and Pomerantseva, R. A., 1993 *Geology and hydrocarbon prospects of the Paleozoic in the Baltic region.* Geology of Northwest Europe: Proceedings of the 4th Conference edited by J.R. Parker, Geol. Soc. Lon.)

3.0 BASIN SCREENING

Sedimentary basins were selected for their suitability for storage of CO_2 in depleted oil and gas fields or saline aquifers using a basin-by-basin approach applying the minimum criteria, secondary qualifiers and weightings as defined in Tables 1 and 2 (modified from Bachu, 2003). Bachu's suitability criteria were broadly classified into three:

1. Basin characteristics, such as tectonism, geology, geothermal and hydrodynamic regimes (these are "hard" criteria because they do not change).
2. Basin resources (hydrocarbons, coal, salt), maturity and infrastructure (these "semi-hard" or "semi-soft" criteria because they may change with new discoveries, technological advances and/or economic development).
3. Societal, such as level of development, economy, political structure and stability, public education and attitude (these are "soft" criteria because they can rapidly change or vary from one region to another).

Table 1 Minimum criteria for consideration of sedimentary basins for CO_2 storage

	Suitability Criterion	*Suitability threshold*	*Weight*
1	Depth	>800 m	0.07
2	Size at surface	>2500 km^2	0.06
3	Seismicity	<High (i.e., not in subduction zones)	0.06
4	Reservoir/Seal	At least one major extensive and competent seal	0.08
5	Faulting and/or fracturing	Low to moderate	0.07
6	Pressure regime	Not overpressured	0.05
7	Regulatory status	Accessible	0.03
		TOTAL	**0.42**

Table 2 Proposed secondary qualifiers for assessing the potential of sedimentary basins for CO2 storage

	Potential Criterion	*Poor Potential*	*Good Potential*	*Weight*
1	CO_2 sources	At >500 km distance	At <500 km distance	0.08
2	Physical accessibility	Difficult	Good	0.03
3	Infrastructure	None or poor	Developed	0.05
4	Hydrogeology Flow systems	Shallow, short	Deep and/or long	0.08
5	Geothermal regime[1]	Warm	Cold	0.10
6	Hydrocarbon potential and industry maturity	None, poor	Large, mature	0.08
7	Coal	Too shallow or too deep	Between 400 and 1000 m depth	0.04
8	Coal value[2]	Economic	Uneconomic	0.04
9	Climate	Arctic and sub-arctic	Temperate	0.08
			TOTAL	**0.58**

The combined weights of Table 1 and Table 2 are equal to 1.0. Individual basins can be ranked according to these criteria to give a value between 0 and 1.

The Baltic Sea Basin is potentially a good candidate for CO_2 storage because it is a stable divergent cratonic basin with limited faulting and extensive sealing shale. It has regional long range flow systems. The cold climate and geothermal gradient increase CO_2 storage capacity and decrease CO_2 buoyancy. There is a proven hydrocarbon system with oil and gas production. However the monoclines around the margins are relatively shallow. In the relatively shallow monocline structures where the target saline aquifer storage reservoirs are less than 800m deep, CO2 sequestration and storage is inefficient (low CO_2 density) and unsafe because of very high CO_2 buoyancy. In terms of size the Baltic Sea sub-basins are all of suitable size but the structures within them are not. The monoclines that form the boundary to the basin may be candidates for CO_2 storage in saline aquifers but further reservoir engineering studies are required to establish the integrity of CO_2 trapping in monoclines where no structural closure exists. This applies in particular to the Dalders Monocline in Sweden.

With respect to physical accessibility and regulatory status the Baltic sub basins were ranked from the point of view of transporting CO_2 from point sources surrounding the Baltic Sea. Both pipeline and shipping transport are considered. In tables 2, 4, 6, 8 and 10 the distance is calculated for point sources in Finland which are the furthest away from the potential storage sites in the Baltic Sea sub basins. Clearly distsnces from other countries will be much less. The Baltic Sea sub-basins could provide accessible CO_2 storage sites below 800m onshore and offshore in shallow water. There are major CO_2 sources surrounding the Baltic Sea Basin and there is a moderate level of pipeline and hydrocarbon production infrastructure. The regulatory status refers to legal and commercial access by Finland and Sweden to CO_2 sinks in the host country.

The results of the screening exercise for sedimentary basins of the Baltic Sea are shown below with additional weightings applied by SLR using a variation of Bachu's methodology (Bachu, 2003).

3.1 Slupsk Border Zone

The Slupsk Border Zone (**Figure 2**) is a monocline at the WNW margin of the Baltic Basin. It contains part of the Dalders Monocline.

Table 3 Criteria for consideration of Slupsk (incl Dalders) Monocline for CO_2 storage

	Criterion	*Threshold*	*Slupsk Monocline*	*Weight*
1	Depth	>800 m	Deep (1000+ m)	0.07
2	Size at surface	>2500 km^2	Moderate size structures	0.06
3	Seismicity	Low (i.e., not in subduction zones)	Low (intracratonic)	0.06
4	Reservoir/Seals	At least one major extensive and competent seal	Excellent	0.08
5	Faulting/fracturing	Low to moderate	Low	0.07
6	Pressure regime	Not overpressured	Normal	0.03
7	Regulatory status	Accessible	Moderately accessible	0.03

Table 4 Secondary qualifiers for assessing the potential of Slupsk for CO2 storage

	Potential Criterion	*Poor Potential*	*Good Potential*	*Weight*
1	CO_2 sources	--	~300 km distance	0.04
2	Physical accessibility	--	Good	0.03
3	Infrastructure	--	No developed pipelines	0.01
4	Flow systems	--	Deep but untested	0.03
5	Geothermal regime	--	Cold	0.10
6	Hydrocarbon potential and industry maturity	--	Good data	0.08
7	Coal	N/A	N/A	0.00
8	Coal value	N/A	N/A	0.00
9	Climate	--	maritime, sub arctic	0.08

Total weightings Table 3 and Table 4 for Slupsk Monocline = 0.76

COMMENTS:

- A potential siliciclastic saline aquifer is present in the Cambrian.

- A significant structure closure has been mapped at the storage reservoir level at the Dalders Prospect.
- Oilfields in Poland, Lithuania and Russia are producing from the Middle Cambrian sandstone reservoir and therefore the Cambrian has proven capacity to store CO_2.
- A significant part of the Dalders monocline is accessible in Swedish territory.
- When the Latvia/Lithuania border is ratified all of the Dalders structure could be accessible for oil field development with CO_2 Enhanced Oil Recovery (EOR).

The score of 0.76 for the Slupsk Border Zone makes it a potential candidate for CO_2 storage. The Dalders Prospect anticline structure (**Figure 3**) is located in water depth of 120m in the central Baltic across Swedish, Latvian and Lithuanian territory. It has a volume estimate of about 300 million barrels of recoverable oil in Cambrian sandstone(Petroswede Svenska Petroleum Exploration, 2010). Structurally it lies on the SE edge of the Slupsk-Latvian-Estonian Monocline on the Liepaya-Saldus High. The Dalders structure and associated monocline is a potential candidate for CO_2 storage based on its favourable depth, size, low seismicity, limited faulting, accessibility and good reservoir seal pair.

3.2 Latvian Estonian and Lithuanian Border Zone (LEL)

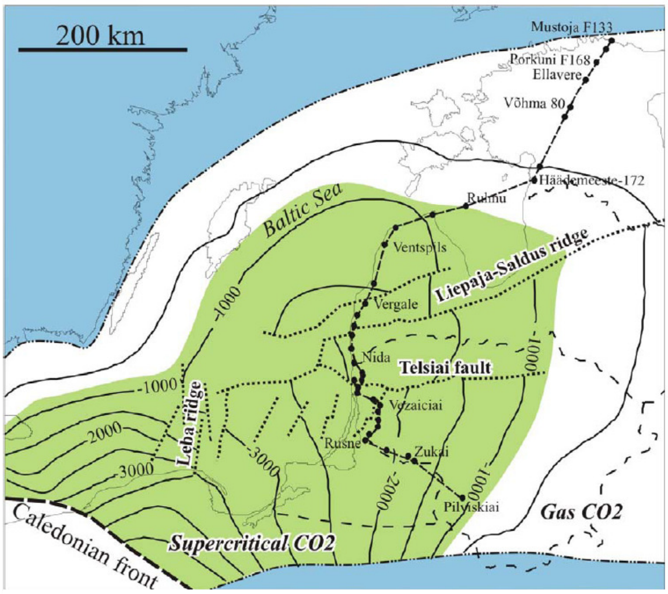

Figure 5 Depth of top of the Cambrian aquifer. The line of the geological cross-section shown in Fig.4 is indicated. The green area indicates the pressure temperature field for supercritical CO_2. (after Sliaupa S., 2009).

The Latvian Estonian and Lithuanian Border Zone is a monoclonal structure that surrounds the margins of the Baltic Basin (**Figure 2**). The Latvian Estonian Monocline is largely offshore and the Lithuanian Monocline is largely onshore. There are a number of oilfields onshore Latvia and Lithuania producing from Cambrian sandstone reservoirs in small anticline traps (e.g. Kuldiga Field). The Devonian aquifer is not buried sufficiently deep to act as a reservoir for CO_2 storage (**Figure 6**). There is onshore pipeline infrastructure in Latvia and an underground gas storage facility at Inčukalns which proves the CO_2 storage capacity of the Cambrian sandstone reservoirs and the physical accessibility. The area is also less than 400kms from CO_2 point sources in Finland.

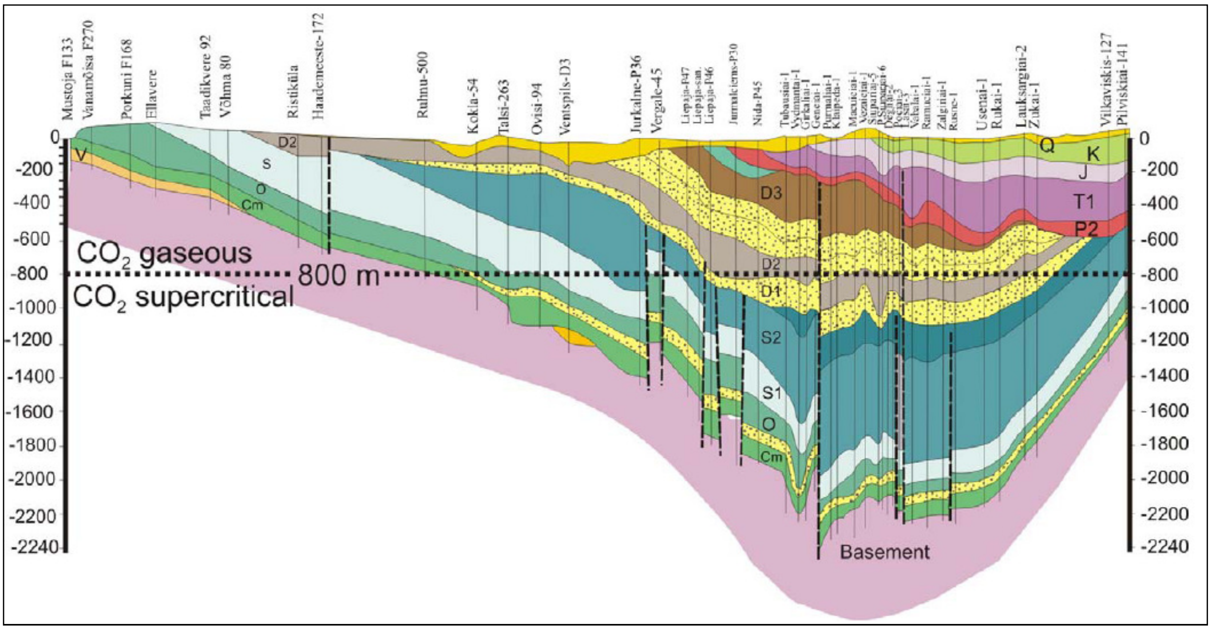

Figure 6 Geological cross section across Estonia, Latvia, and Lithuania (modified after Sliaupa et al. 2008). Major aquifers are shown in yellow. Np3, Ediacaran (Vendian); Cm, Cambrian; O, Ordovician; S1, Lower Silurian (Llandovery and Wenlock series); S2, Upper Silurian (Ludlow and Pridoli series); D1, D2, and D3, Lower, Middle, and Upper Devonian; P2, Middle Permian;T1, Lower Triassic; J, Jurassic; K, Cretaceous; Q, Quaternary. From **Shogenova, 2009.**

Table 5 Criteria for consideration of Latvian Estonian and Lithuanian Monocline for CO_2 storage

	Criterion	*Threshold*	*Latvian Estonian Lithuanian Monocline*	*Weight*
1	Depth	>1000 m	Deep (1000+ m)	0.07
2	Size at surface	>2500 km^2	Small structures	0.02
3	Seismicity	Low (i.e., not in subduction zones)	Low (cratonic)	0.06
4	Reservoir/Seals	At least one major extensive and competent seal	Excellent	0.08
5	Faulting/fracturing	Low to moderate	Low	0.07
6	Pressure regime	Not overpressured	Normal	0.03
7	Regulatory status	Accessible	Moderately accessible	0.07

Table 6 Secondary qualifiers for assessing the potential of Latvian Estonian and Lithuanian Monocline for CO2 storage

	Potential Criterion	*Poor Potential*	*Good Potential*	*Weight*
1	CO_2 sources	--	~400 km distance	0.08
2	Physical accessibility	--	Good	0.01
3	Infrastructure	--	Some pipelines onshore	0.03
4	Flow systems	--	Deep and/or long	0.03
5	Geothermal regime	--	Cold	0.10
6	Hydrocarbon potential and industry maturity	--	Moderate, mature	0.05
7	Coal	N/A	N/A	0.00
8	Coal value	N/A	N/A	0.00
9	Climate	--	Maritime, sub arctic	0.08

Total weightings Table 3 and Table 4 for Latvian Estonian and Lithuanian Monocline = 0.71

COMMENTS:

- Ten sources in Lithuania emit more than 0.1Mt of CO2 per year from an oil refinery (Mazeikiai), an ammonia plant, two cement plants (Akmene) and power plants.
- Two prospective siliciclastic saline aquifers are present in the Cambrian and Lower Devonian. There are no significant structures in the Lower Devonian (Sliaupa S., 2009)
- Oil production onshore Gotland is from Ordovician reefs at shallow depths unsuitable for CO_2 storage.
- Ordovician and Upper Silurian carbonate reefs with storage potential are interpreted on seismic data acquired in the northern part of offshore Latvia.
- Eleven oilfields are producing from the Middle Cambrian sandstone reservoir in Lithuania, but the structures are small and enhanced oil recovery and storage potential is estimated to be negligible, about 5.6Mt (Sliaupa S., 2009).
- One of the 17 major West Latvian structures identified with Cambrian reservoirs, Inčukalns, has been used for underground gas storage since 1968, proving the stability of the sealing cap rock.
- The storage capacity of the Lithuanian Monocline is limited by the size of structures with Cambrian sandstone reservoirs and the restricted area that is sufficiently deep for CO2 storage.

The LEL, with a score of 0.71, is a possible candidate for CO_2 storage based on its favourable depth, low seismicity, good Cambrian and Devonian reservoir/seal pairs, onshore infrastructure and accessibility. Only two structures of capacity greater than 1 Mt CO2 were identified in Lithuania. Ordovician algal reefs occur at shallow depths in small structures in Gotland and onshore Latvia. Thirty large structures are identified in Latvia, onshore and offshore (Sliaupa S., 2009).

3.3 Liepaja-Saldus Ridge

The Liepaja-Saldus Ridge (**Figure 2**) is a regional faulted zone with a complex structure, oriented SW-NE. It extends more than 300 km from the central part of the Baltic Sea to central Latvia onshore. It is bounded by major faults that displace Caledonian sediments up to 600m. The Liepaja-Saldus High has several structures with associated oil prospects offshore Latvia. The Dalders Prospect (**Figure 3**) extends onto the Liepaja-Saldus Ridge.

Table 7 Minimum criteria for consideration of Liepaja-Saldus High for CO_2 storage

	Criterion	Threshold	Liepaja-Saldus High	Weight
1	Depth	>800 m	Deep (1000+ m)	0.07
2	Size at surface	>2500 km^2	Medium size structures	0.06
3	Seismicity	Low (i.e., not in subduction zones)	Low (passive margin)	0.06
4	Reservoir/Seals	At least one major extensive and competent seal	Excellent	0.08
5	Faulting and/or fracturing	Low to moderate	Low	0.07
6	Pressure regime	Not overpressured	Normal	0.03
7	Regulatory status	Accessible	Accessible	0.02

Table 8 Secondary qualifiers for assessing the potential of Liepaja-Saldus High for CO2 storage

	Potential Criterion	Poor Potential	Good Potential	Weight
1	CO_2 sources	--	~400 km distant	0.08
2	Physical accessibility	--	Fair (marine)	0.02
3	Infrastructure	Limited	--	0.01
4	Flow systems	--	Deep and/or long	0.03
5	Geothermal regime	--	Cold	0.10
6	Hydrocarbon potential and industry maturity		Mature	0.05
7	Coal	N/A	N/A	0.00
8	Coal value	N/A	N/A	0.00
9	Climate	--	Maritime, sub arctic	0.08

Total weightings Table 5 and Table 6 for Liepaja-Saldus High = 0.75

COMMENTS:

- Adjacent to Latvian coast.
- Two wells offshore Latvia, E6-1 and P6-1, proved a saline aquifer in Middle Cambrian sandstones and some oil production from Late Ordovician carbonates. No current production.
- A number of structures with prognosed Cambrian sandstone reservoirs have been identified offshore Latvia including the Dalders structure.
- Good potential licence access given Svenska's licence holding in Latvia.

The Liepaja-Saldus Ridge, with a score of 0.75, is a potential candidate for CO2 storage based on its favourable depth, low seismicity, excellent reservoir/seal pairs, and accessibility.

3.4 Gdansk-Kura Depression

The Gdansk-Kura Depression is a large regional structure, extending SW-NE from Poland to the southern part of Western Latvia (**Figure 2**). There are oil discoveries in Poland, Lithuania and Kaliningrad District and several oil prospective structures offshore Latvia.

Table 9 Minimum criteria for consideration of Gdansk-Kura Depression for CO_2 storage

	Suitability Criterion	Gdansk-Kura Depression	Weight
1	Depth	Deep (1000+ m)	0.07
2	Size at surface	Moderate size structures (in Poland ~8,000 km^2)	0.03
3	Seismicity	Low	0.06
4	Reservoir/Seals	Proven excellent	0.05
5	Faulting and/or fracturing	Low to moderate	0.04
6	Pressure regime	Normal	0.05
7	Regulatory status	Reasonably accessible	0.02

Table 10 Secondary qualifiers for assessing the potential of Gdansk-Kura Depression for CO2 storage

	Potential Criterion	Poor Potential	Good Potential	Weight
1	CO_2 sources	--	~400 km distant	0.01
2	Physical accessibility		Good	0.03
3	Infrastructure		Present--	0.05
4	Flow systems	--	Deep and/or long	0.08
5	Geothermal regime	--	Cold - moderate	0.10
6	Hydrocarbon potential and industry maturity		Mature	0.08
7	Coal	N/A	N/A	0.00
8	Coal value	N/A	N/A	0.00
9	Climate	--	Maritime, sub arctic	0.08

Total weightings Table 7 and Table 8 for Gdansk-Kura Depression = 0.75

COMMENTS:

- Contains producing fields offshore Poland and Russia and onshore Russia and Lithuania.
- Existing platforms and pipelines.
- Potential access to storage offshore Poland.
- Possible access to storage offshore Kaliningrad.

The Gdansk-Kura Depression, with a score of 0.75, is a potential candidate for CO2 storage based on its favourable depth, moderate size, low seismicity, proven reservoir/seal pairs and possible licence access through Poland.

3.5 Liepaja Depression

The Liepaja Depression is located north of the Liepaja-Saldus High and extends onshore Latvia. The Liepaja Depression is not a candidate for CO2 storage based on its unfavourable depth. The prospective reservoirs are less than 800m deep.

4.0 BASIN RANKING

Bachu developed a quantitative evaluation of a sedimentary basin's suitability for CO_2 storage. In the table below fifteen assessment criteria are shown with three to five classes defined from the least favourable to the most favourable.

Table 11 Criteria for assessing sedimentary basins for CO_2 geological sequestration (Bachu 2003)

	Criterion	Classes 1	2	3	4	5
1	Tectonic setting	Convergent oceanic	Convergent intramontane	Divergent continental shelf	Divergent foredeep	Divergent cratonic
2	Size	Small	Medium	Large	Giant	
3	Depth	Shallow (<1,500 m)	Intermediate (1,500–3,500 m)	Deep (>3,500 m)		
4	Geology	Extensively faulted and fractured	Moderately faulted and fractured	Limited faulting and fracturing, extensive shales		
5	Hydrogeology	Shallow, short flow systems, or compaction flow	Intermediate flow systems	Regional, long-range flow systems; topography or erosional flow		
6	Geothermal	Warm basin	Moderate	Cold basin		
7	Hydrocarbon potential	None	Small	Medium	Large	Giant
8	Maturity	Unexplored	Exploration	Developing	Mature	Over mature
9	Coal and CBM	None	Deep (>800 m)	Shallow (200–800 m)		
10	Salts	None	Domes	Beds		
11	On/Off Shore	Deep offshore	Shallow offshore	Onshore		
12	Climate	Arctic	Sub-Arctic	Desert	Tropical	Temperate
13	Accessibility	Inaccessible	Difficult	Acceptable	Easy	
14	Infrastructure	None	Minor	Moderate	Extensive	
15	CO_2 Sources	None	Few	Moderate	Major	

In this study a modified version of Bachu's criteria was used to score the sub-basins of the Baltic Sea Basin. Based on the weightings shown in Table 3 to 10 above the basins are ranked as follows Slupsk Border Zone (0.76), Gdansk-Kura Depression (0.75), Liepaja Saldus Ridge (0.75), Latvian Estonian Lithuanian Border Zone (0.71).

Table 12 Ranking of Baltic Sea sub-basins in terms of suitability for CO2 geological sequestration

Rank	Basin	Characteristics	Score
1	Slupsk Border Zone	Proven reservoir/seal pair, moderate size structures, offshore, large saline aquifer, limited faulting, good accessibility, <500kms to strategic CO_2 sources	0.76
2	Gdansk-Kura Depression	Existing oil and gas production infrastructure, moderate sized structures, offshore, fair accessibility, >500kms to some strategic CO_2 sources	0.75
3	Liepaja Saldus Ridge	Proven reservoir/seal pair, moderate size structures, offshore, fair accessibility, <500kms to strategic CO_2 sources	0.75
4	Latvian Estonian Lithuanian Border Zone	Proven reservoir/seal pairs, small structures, potential saline aquifer, only small area sufficiently deep for CO_2 storage, accessible, 250kms to strategic CO_2 sources	0.71

In this initial ranking the Slupsk Border Zone has the highest priority because it contains the Dalders Monocline which is a probable CO_2 storage structure that is accessible to Swedish CO_2 point sources. The Gdansk-Kura Depression is geologically suitable for CO2 storage and has existing oil production infrastructure at PetroBaltic's B3 field and Lukoil's Kratsovskoye field. However access may be restricted depending on the storage capacity of the depleted oil and gas reservoirs when they become available. There are existing plans to use the offshore facilities in Poland to store CO_2 from the Lotos refinery in Gdansk. The Liepaja Saldus Ridge is closer to CO_2 sources in Finland and has potential CO_2 storage in saline aquifers offshore Latvia. The LEL Border Zone has the lowest rank because only a small area is sufficiently deep for CO_2 storage.

5.0 RECOMMENDATIONS

Based on the above rankings it is recommended that:

- A reservoir study of the CO_2 trapping potential of the Dalders Monocline is carried out.
- The hydrocarbon potential of offshore Latvia is further promoted to obtain additional well data that will contribute to the assessment for CO_2 sequestration offshore on the Liepaja Saldus Ridge.
- Discussions with the former PetroBaltic partners are initiated to develop an integrated approach to enhanced oil recovery and longer term CO_2 sequestration using depleting oil and gas fields offshore Poland and Kaliningrad.

In WP2 SLR will study the Slupsk Border Zone and the Gdansk-Kura Depression in more detail.

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