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Update on the BASTOR Project

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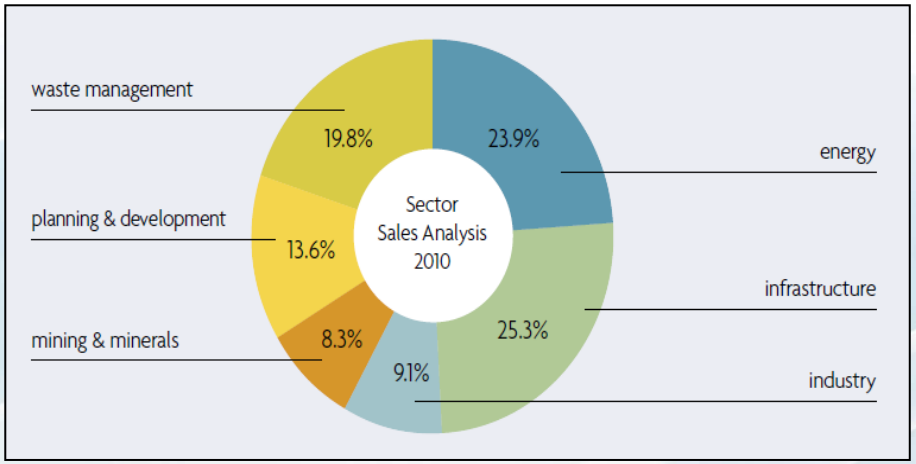
OUTLINE

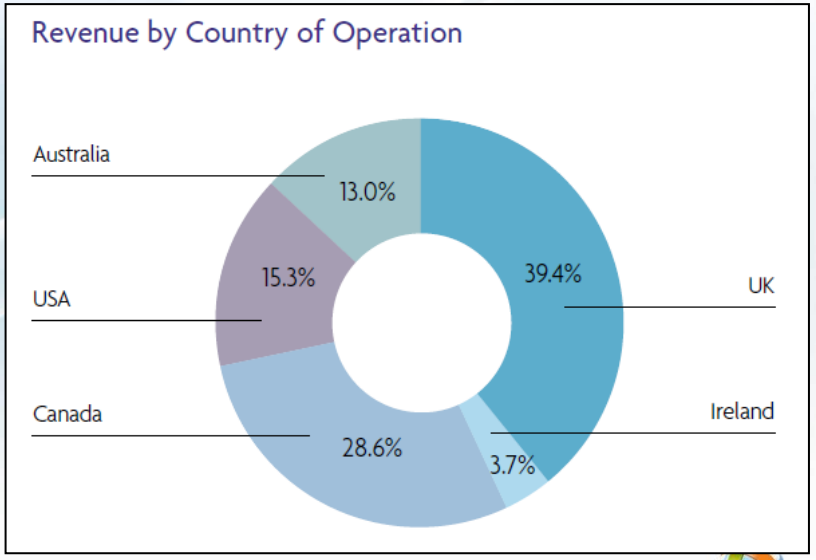
- Introduction
- What is the BASTOR Project?
- SLR's Current Assignment
- Activities to date
- Current findings
- Way forward

FIRST - THE COMMERCIAL

Overview:

SLR has approximately 1,000 staff in offices in Europe, North America, Australasia and Africa. We provide global advice and support on a wide range of strategic and site specific environmental issues to a diverse and growing base of business, regulatory and governmental clients. Turnover in 2012 was c.100million euros.





OIL AND GAS SERVICES

- Prospectivity evaluation
- Exploration planning
- Operations geology
- Data room and portfolio evaluation
- Evaluation of farm-in and farm-out opportunities
- Procurement and contract negotiation
- Management of exploration programmes
- Administration of exploration research projects
- Promotion and dissemination of research results
- CPR reports for AIM listings
- Oil spill contingency planning
- Environmental monitoring
- Planning and management of oily waste arisings

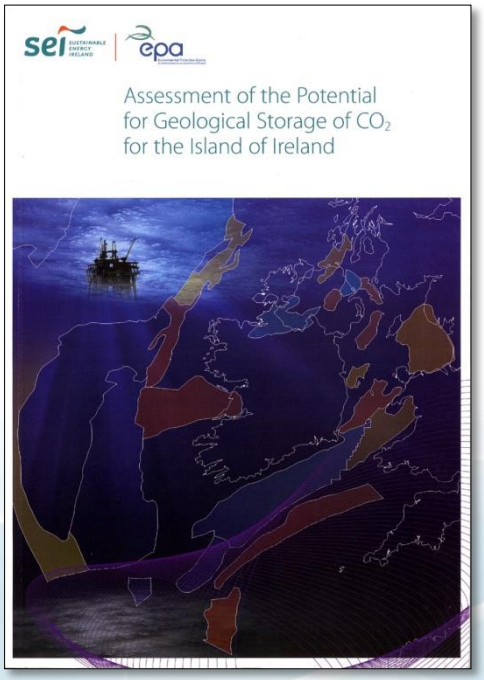
SLR AND CCS

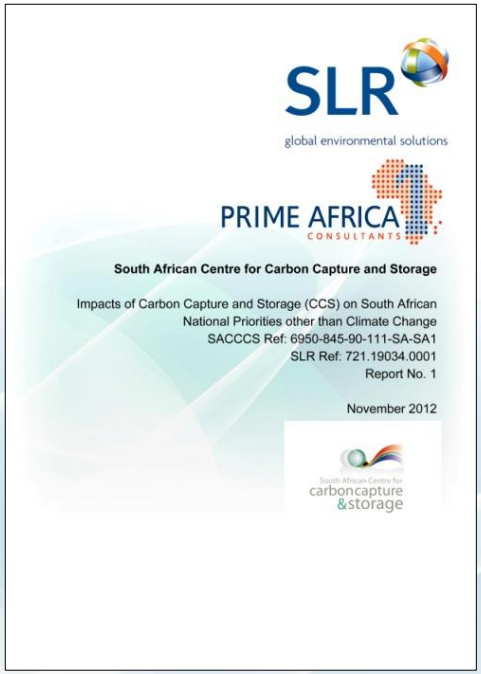
- Active CCS practice based in Dublin
- Draw on technical expertise from SLR around the world
- Active in CCS since mid 1990's
- Focus on transport and storage, and wider implications of CCS
- Projects around the world
  - Currently working in Baltic Sea, offshore Nova Scotia and South Africa

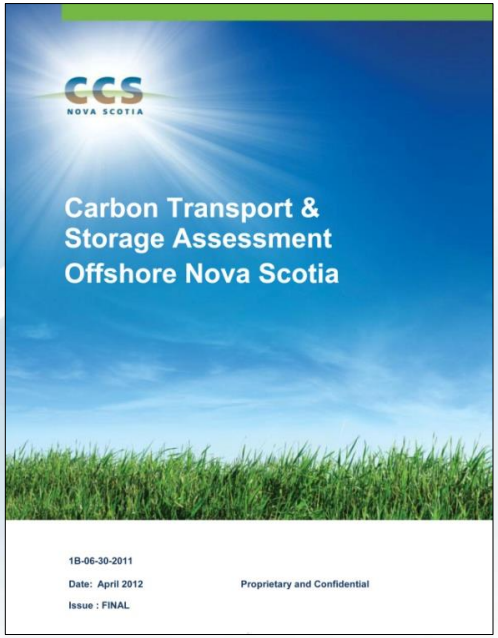
EXAMPLES OF PAST CCS PROJECTS

- Assessment of the All Island Potential for Geological Storage of Carbon Dioxide in Ireland (EPA and GSNI).
- Carbon Capture Ready components of proposed new coal fired power station (RWE)
- Preparation of FP7 Application for EU Funding of Multi National Research Project on CCS Storage Site Characterisation
- Potential for Carbon Dioxide Sequestration in the Clare Basin (ESB)
- The Re-Use of Offshore Oil and Gas Pipelines (DTI)
- Report on Infrastructure, Availability and Costs for CO_2 Transportation and Storage Offshore – Southern North Sea (DTI)

EXAMPLES OF CCS REPORTS







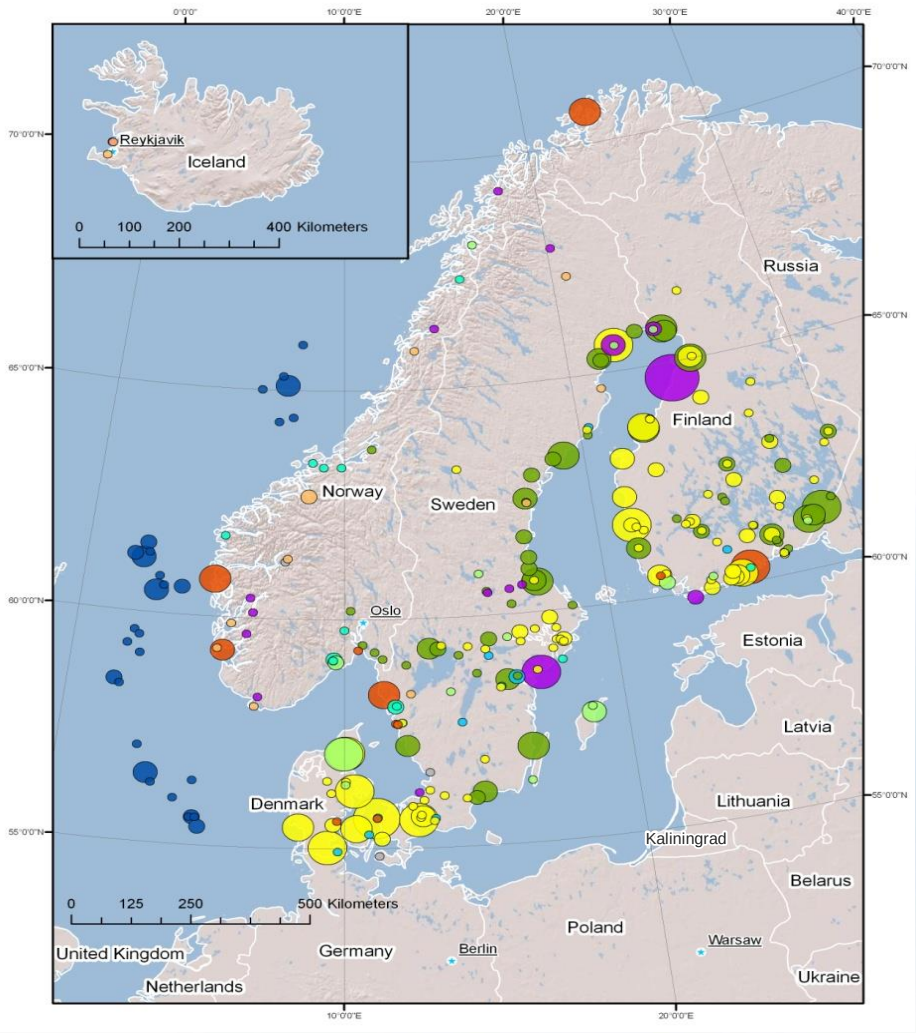
THE BASTOR BALTIC SEA CO2 PROGRAMME

- Bastor Programme: collaboration between
  - Finland
    - VTT
    - Finnish Industrial Partners
  - Sweden
    - Elforsk
    - Swedish Industrial Partners
    - Global CCS Institute
  - Others?

BASTOR
BALTIC SEA STORAGE OF CO2

- Study on CO_2 storage potential in Baltic Sea region
- Study based on analysis of previously measured available data
- Focus is on the southern part of the Baltic Sea region
- The first phase started by the Finnish CCSP research programme
- Current phase continued by the Swedish CCS Project consortium

SOURCES OF CO2



Legend

- Cement and lime production
- Iron and steel production
- Non-ferrous metal production
- Offshore oil and gas activities
- **Oil and** gas refineries
- Other
- Power and heat production
- Production of chemicals
- Pulp and paper production
- Waste treatment or incineration

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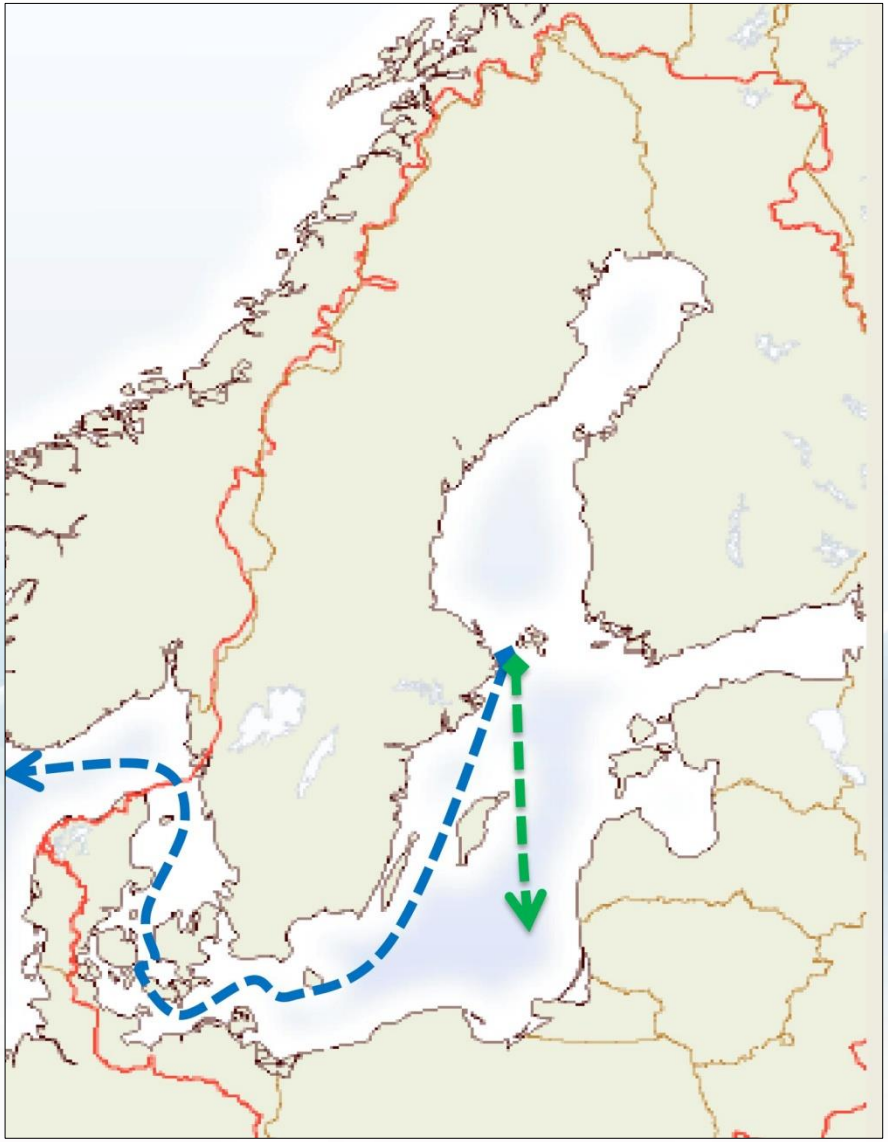
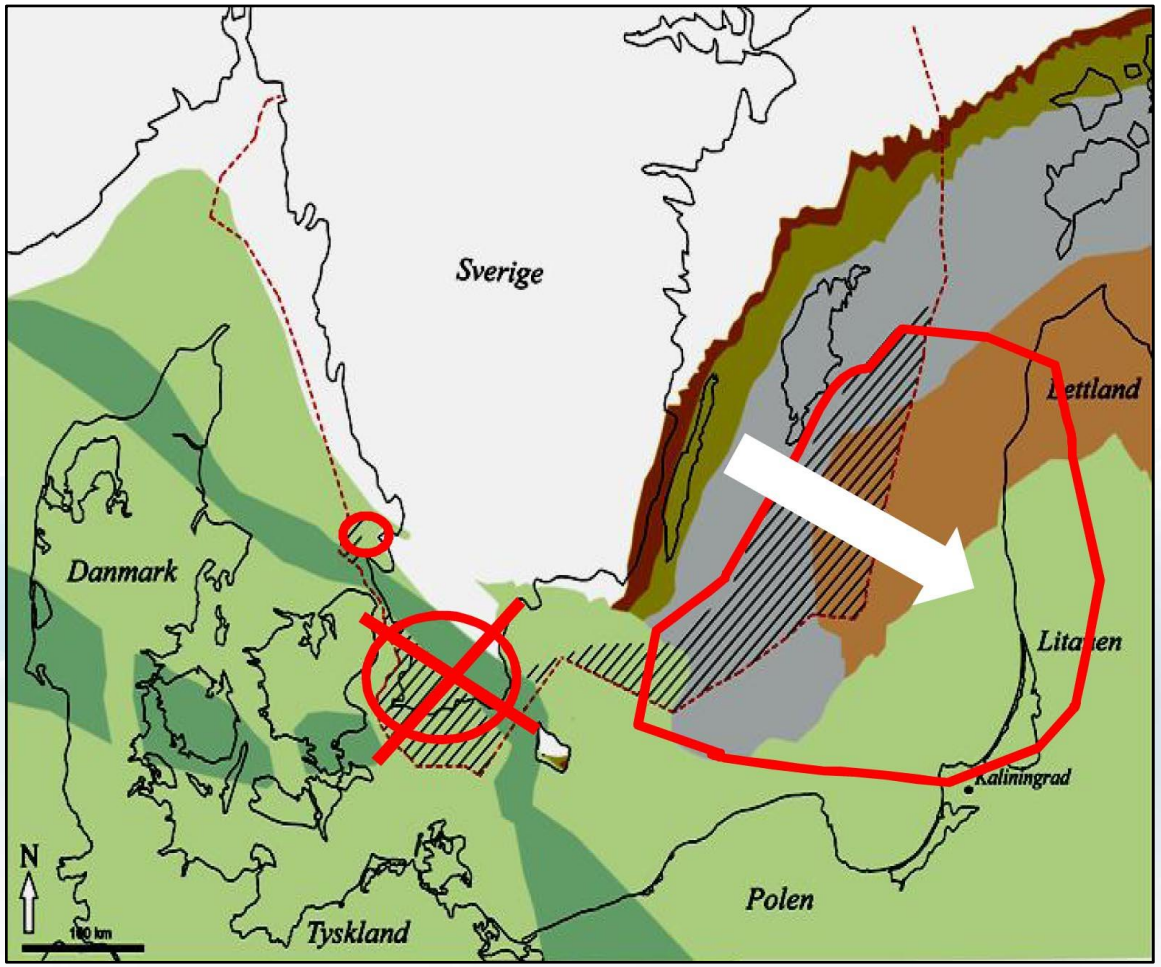
THE TRANSPORT PENALTY?



SOUTHERN PART OF BALTIC SEA

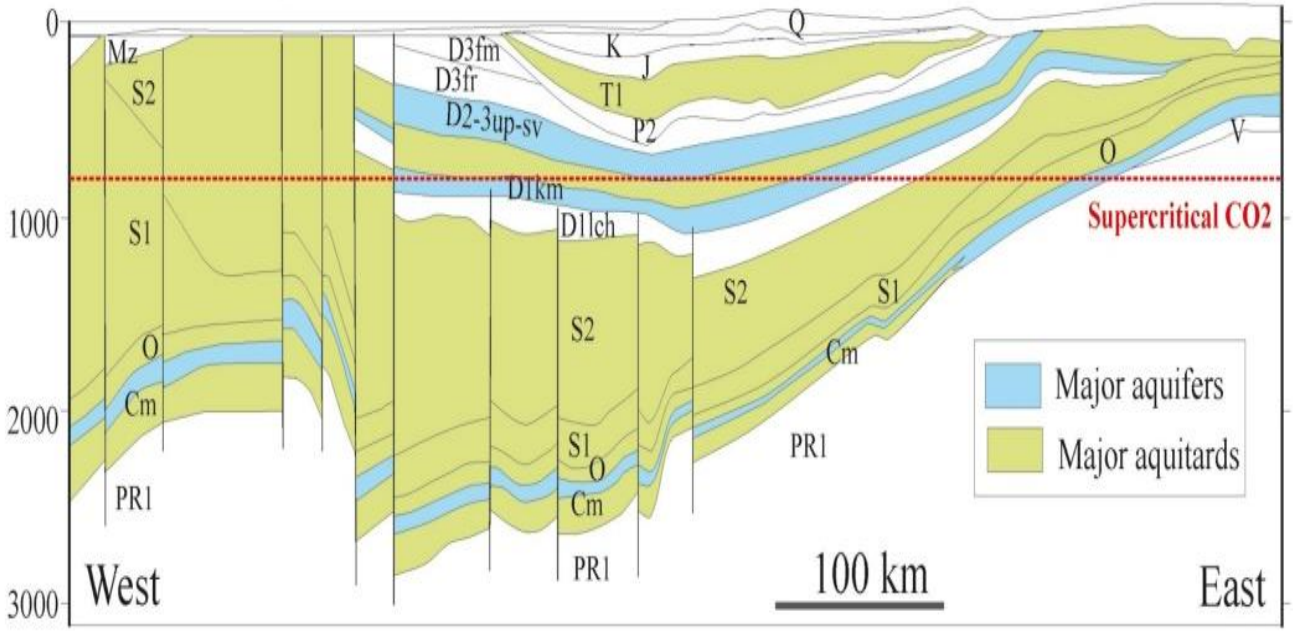


Source: Erslstöm, SGU, (OPAB)

DEFINITION OF THE STUDY AREA

Identification of saline aquifers for CO2 storage

Depths of base of the Baltic Basin



Geological cross section west-east

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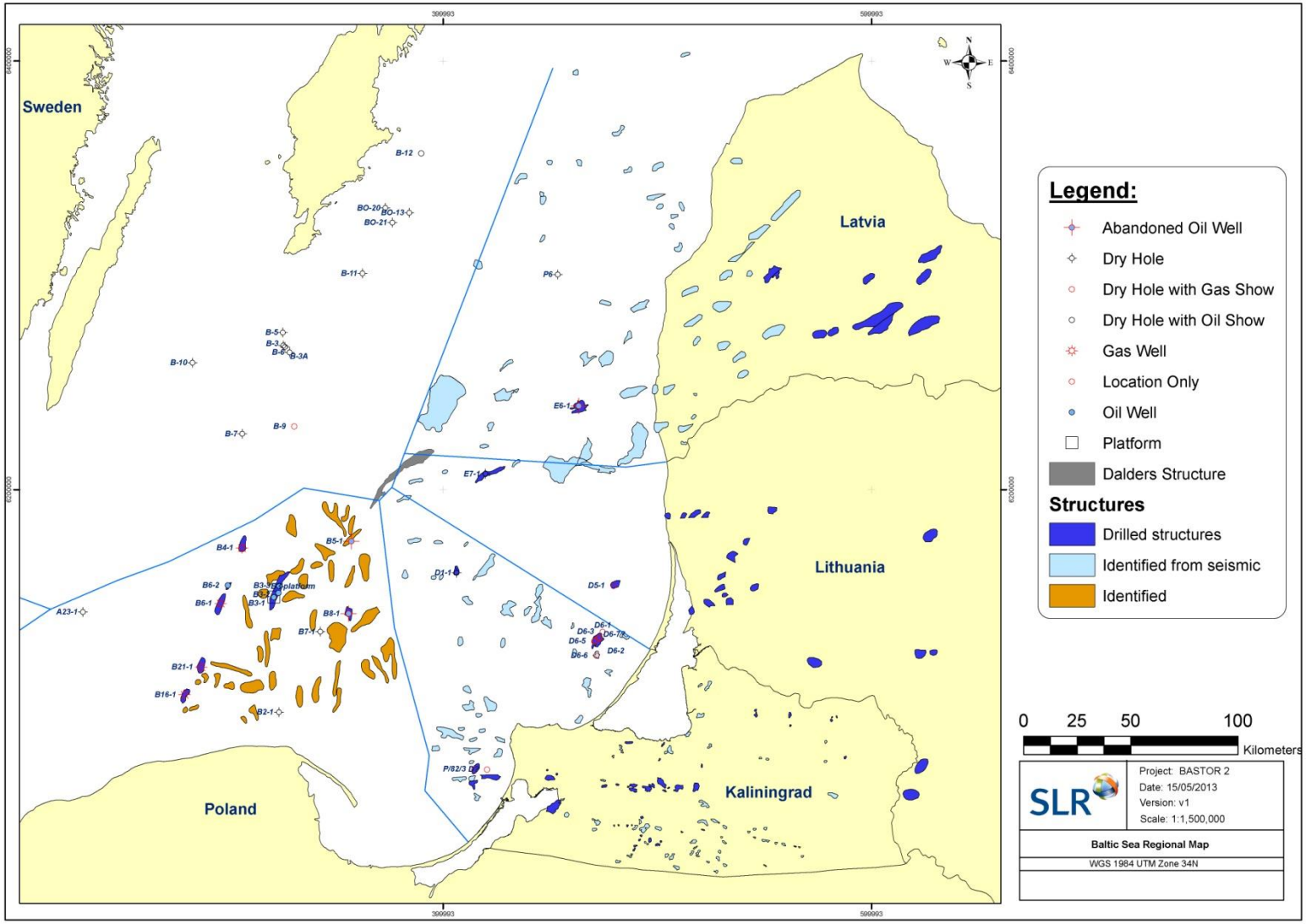
MAIN TASKS

- Data compilation
- GIS map creation
- Basin screening
- Calculation of theoretical storage potential
- Build static model
- Final closure structure selection and modelling
- Dynamic modelling of selected structures
- Injection test methodology
- Final report

DATA COMPILATION TO DATE

- Data sources
  - Published literature
  - OPAB/Svenska
  - Latvian Environment, Geology and Meteorology Centre (general data)
- Data includes
  - Onshore and offshore structure maps (almost all)
  - Cambrian reservoir isopach maps (Sweden, Lithuania, Poland, Kaliningrad)
  - Well data (Sweden, Latvia, some Lithuania)
  - Reservoir and seal formation properties (Sweden, some Lithuania and Poland)
  - Reservoir conditions/production data (Sweden, some Lithuania)

KEY OFFSHORE WELLS AND STRUCTURES



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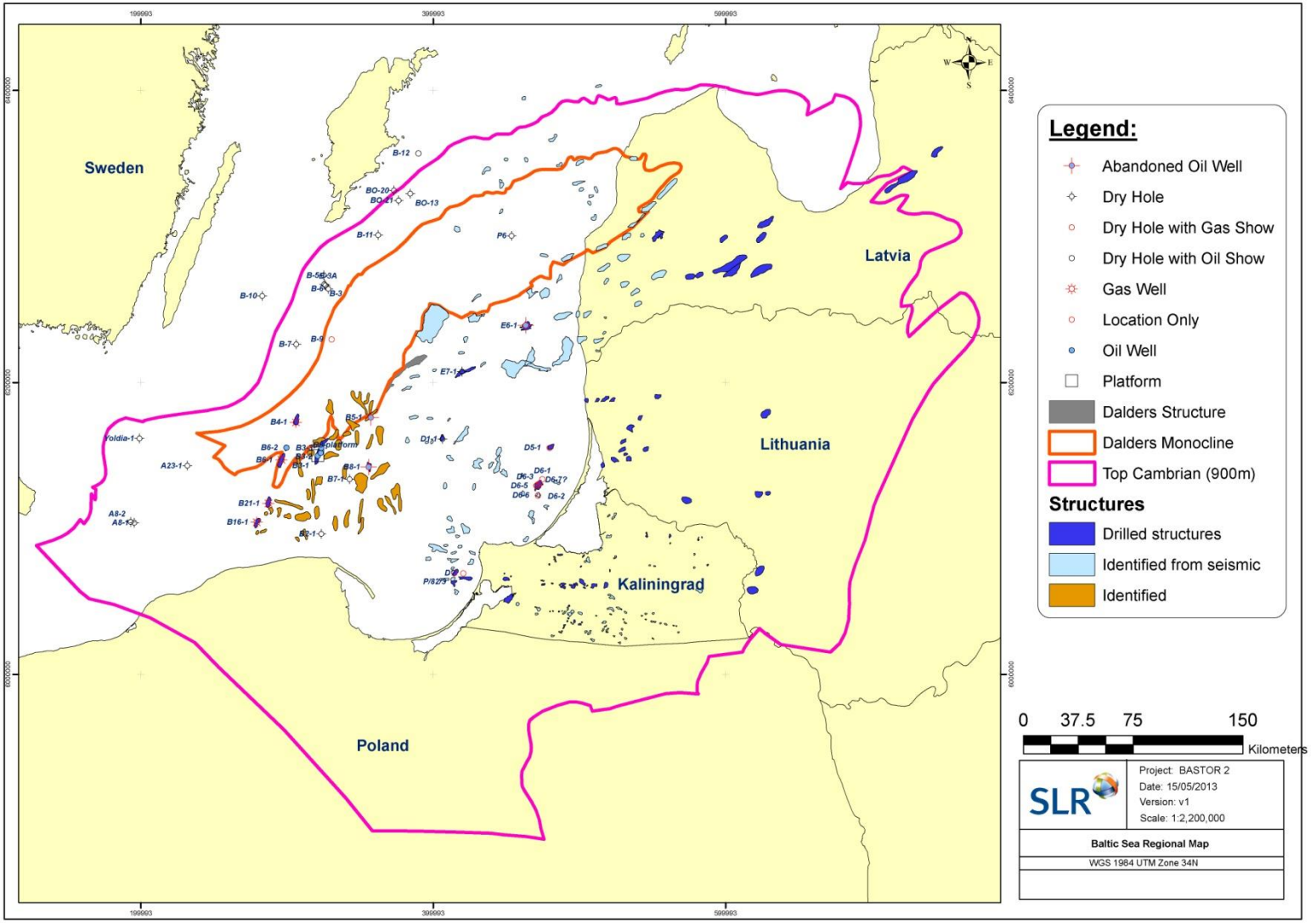
CAMBRIAN RESERVOIR & DALDERS MONOCLINE



BASIN SCREENING – MINIMUM CRITERIA

	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**

BASIN SCREENING – SECONDARY QUALIFIERS

	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**

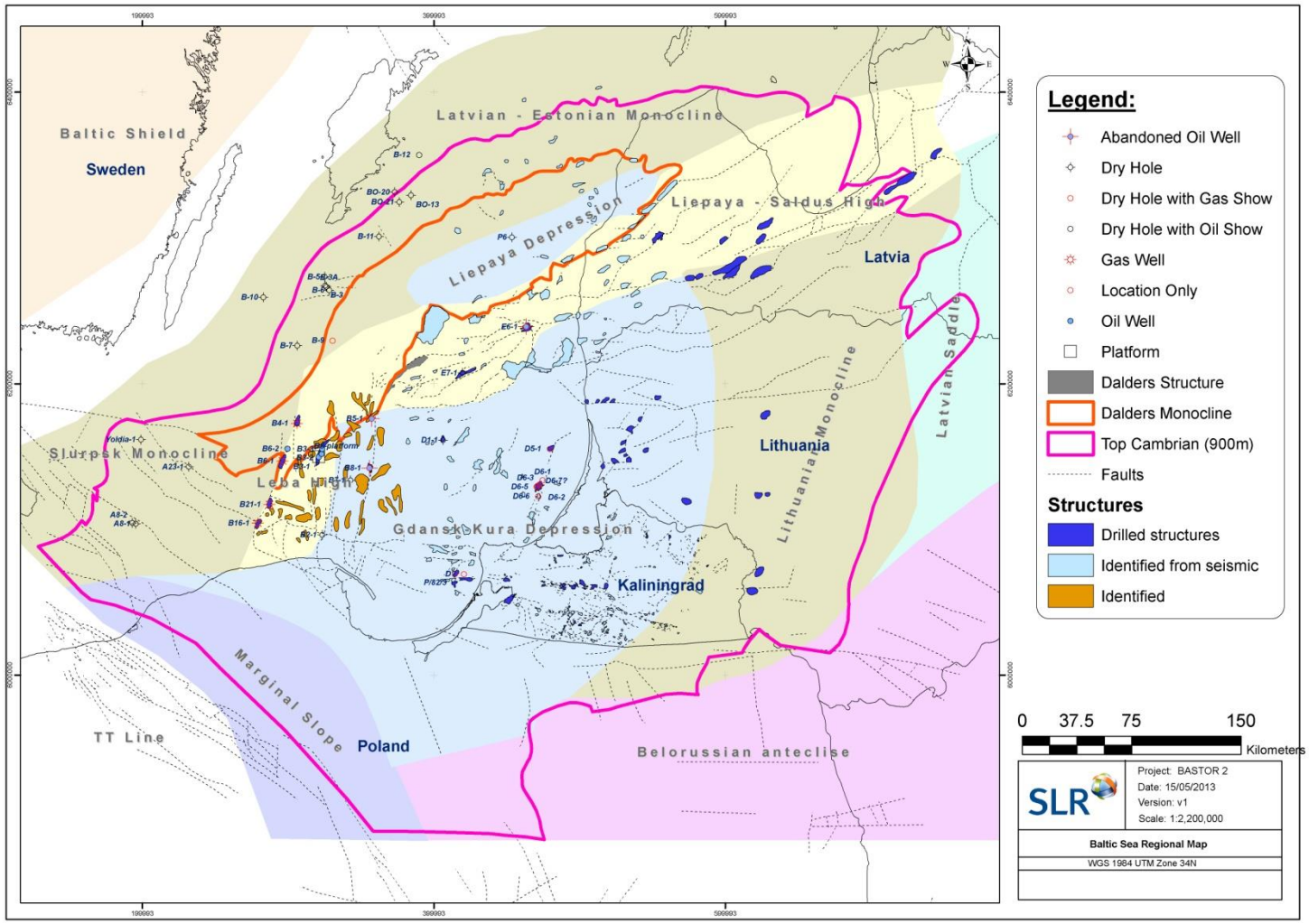
	Potential Criterion	Poor Potential	Good Potential	Weight
1	CO_2 sources	At >500 km distance	At <500 km distance	0.08
2	Physical accessibility	Difficult	Good	0.03
3	Infrastructure	None or poor	Developed	0.05
4	Hydrogeology Flow systems	Shallow, short	Deep and/or long	0.08
5	Geothermal regime[1]	Warm	Cold	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**

RANKING OF BALTIC SEA SUB BASINS FOR CO2 STORAGE

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

- Four main sub basins identified and ranked in order of suitability for CO_2 storage
- The border zones have potential storage capacity in saline aquifers
- Existing oil and gas fields have limited storage capacity except as local sites for specific projects (e.g. Lotos refinery in Gdansk to B3 Field offshore Poland)

REGIONAL MAP OF SEDIMENTARY BASINS WITH CO_2 STORAGE POTENTIAL



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METHODOLOGY FOR CALCULATION OF STORAGE POTENTIAL

- Digitise closures at Cambrian level from maps and reports
- Source field & reservoir data from various reports
- Apply EU GeoCapacity CO_2 storage capacity formula to obtain
  - Regional estimates based on bulk volume of aquifers
  - Regional estimates based on trap volumes
  - Capacity estimation in hydrocarbon fields (Schuppers et al 2003)
  - Capacity estimation in hydrocarbon fields (Bachu 2007)

BALTIC SEA SUMMARY STORAGE POTENTIAL	Estimated CO_2 Storage Capacity (10^6 tonnes)
Individual Baltic Sea Field Total	852.28
Dalders Structure	127.91
Dalders Monocline	1923.55
Regional Cambrian Below 900m	16221.56

Health warnings

• Limited well data for Dalders area – calculations for structures are based on static reservoir model volumes, LGMC Cambrian structure data and the E6-1 well data

• Dalders Monocline uncertainty – thickness was assumed to increase from the south west (about 30m) to the north east (about 110m) based on the reservoir thickness observed in the P6 and B-9 wells.

Regional Estimates for CO_2 storage potential in saline aquifer in the Cambrian below 900m are comparable to Sliaupa, S. 2009

Estimated CO2 Storage Capacity (10^6 tonnes)	Latvia	Lithuania	Poland	Kaliningrad	
				from Literature	from LO&G report
Hydrocarbon - General Storage Potential		28.87	3.28	15.10	167.10
Hydrocarbon - Field Storage Potential		1.86	2.62		
Saline Aquifer - Field Storage Potential	633.46				
TOTAL	**633.46**	**30.72**	**5.90**	**15.10**	**167.10**

Total	**852.28**

Health warnings

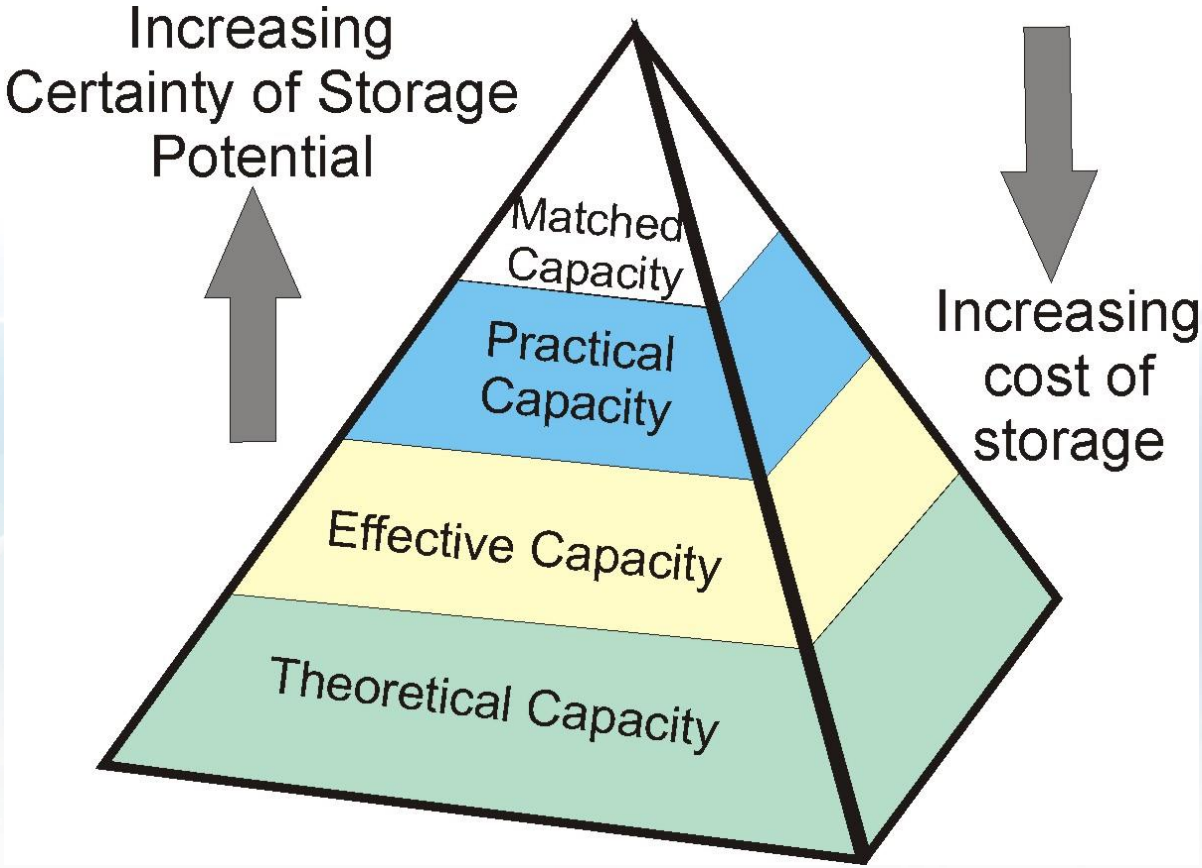
• OOIP and EUR values used for hydrocarbon fields based on the LO&G report data are likely to be overestimated (demonstrated by Svenska data for 3 onshore Lithuanian fields).

• 40 new structures indentified in Poland (for a total surface of 1,046 km^2) in addition to the 7 structures from BASTOR1, but no reservoir or field data are available for these structures. Hence, the total theoretical storage capacity for Poland still remains low.

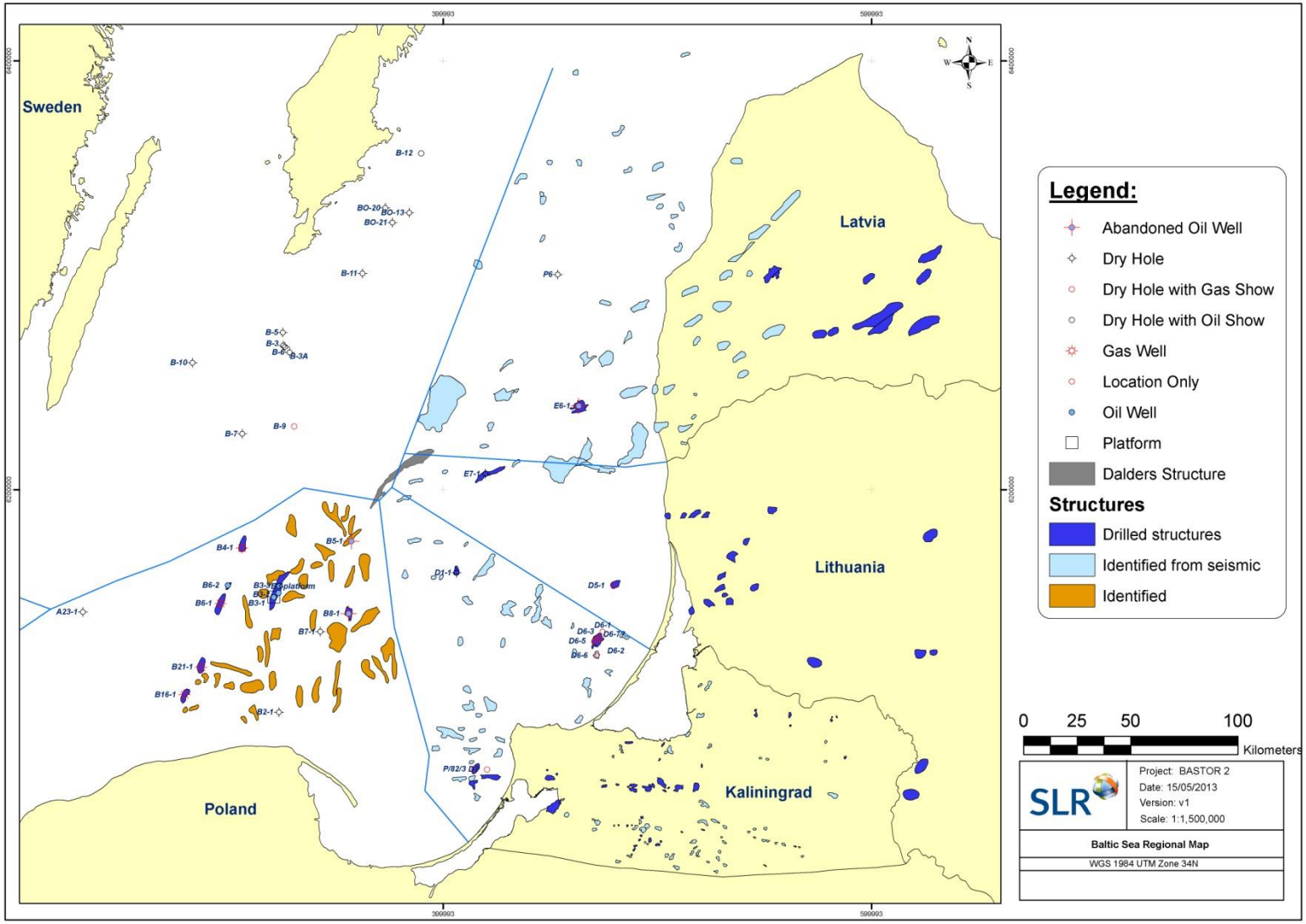
• Additional 145 structures have been identified in Kaliningrad from published literature. The combined surface area including these new structures is 708 km^2 vs 419 km^2 previously in BASTOR1 with more reliable structure outlines. Storage capacity estimations are still mostly based on EUR from the LO&G report with only an additional 15.1Mt from 12 additional structures (the largest of which is D6-1 field) for which more recent published EUR data is available..

• Latvia storage capacity data is based on individual structure outlines and estimated based on well data form E6-1, E7-1 and P6 wells.

TECHNO ECONOMIC RESOURCE PYRAMID (CSLF 2007)



THE JURISDICTIONAL CHALLENGE



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NEXT STEPS – BASTOR 2

- Obtain additional data from selected Kaliningrad fields to increase regional theoretical storage capacity (in discussion with VNIGRI)
- Obtain additional data from selected Polish offshore fields to increase storage capacity and obtain reservoir data (in discussion with PGI)
- Refine static reservoir models and choose target structures
- Build dynamic models on chosen target area based on the static reservoir models and production field data
- Assess sealing cap rock potential
- Develop an injection test methodology to include MMV programme
- Compile final report

CCS IS SEEN AS AN ESSENTIAL TOOL TO COMBATING GLOBAL WARMING

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