global environmental solutions

Update on the BASTOR Project

CCSP Helsinki

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6th September 2012

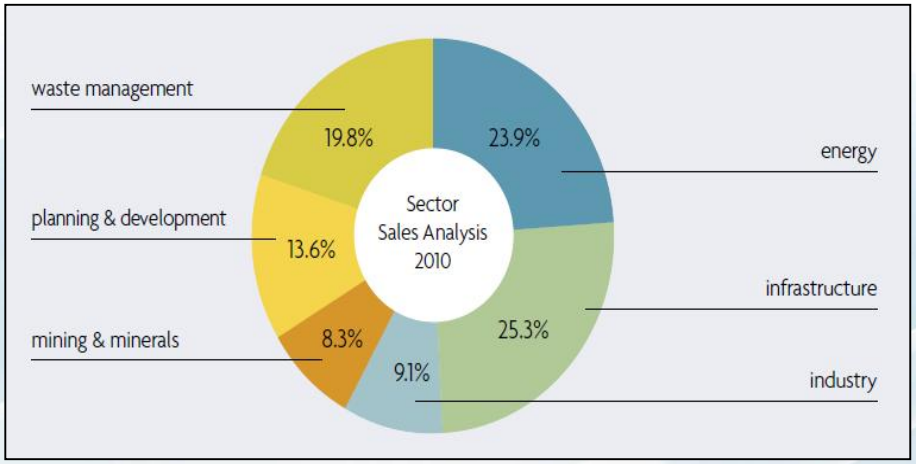
OUTLINE

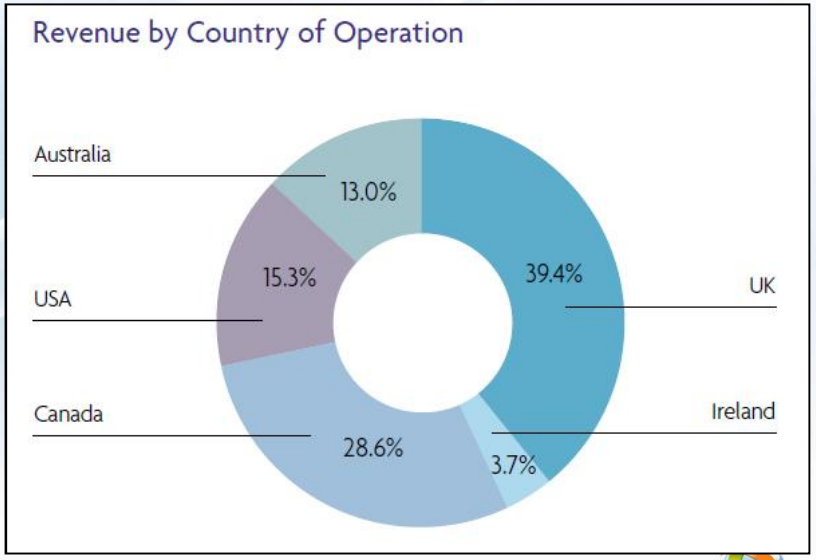
- Introduction
- What is the BASTOR Project?
- SLR's Current Assignment
- Activities to date
- Current findings
- Way forward

FIRST - THE COMMERCIAL

Overview:

SLR has approximately 900 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 2011 was c. £85 m.





TECHNICAL AREAS

- Acoustics and air quality
- Archaeology
- Asbestos management
- Civil and infrastructure engineering
- Ecology and arboriculture
- Energy and carbon management
- Waste permitting and licensing
- Waste strategy and technology
- Effluent and leachate treatment
- Environmental Impact Assessment
- Landscape architecture
- Land quality and regeneration
- Chemistry
- Technology Assessment
- Waste Management
- Process Engineering
- Sustainability
- Toxicology
- Traffic and transportation
- Valuation and property services
- Hydrogeological risk assessment
- Flood risk assessment
- Geographical information systems and mapping
- Geology and geotechnical engineering
- Industrial permitting and compliance
- Surveying
- Monitoring

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
- Focuses on transport and storage
- 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 CO2 Transportation and Storage Offshore – Southern North Sea (DTI)

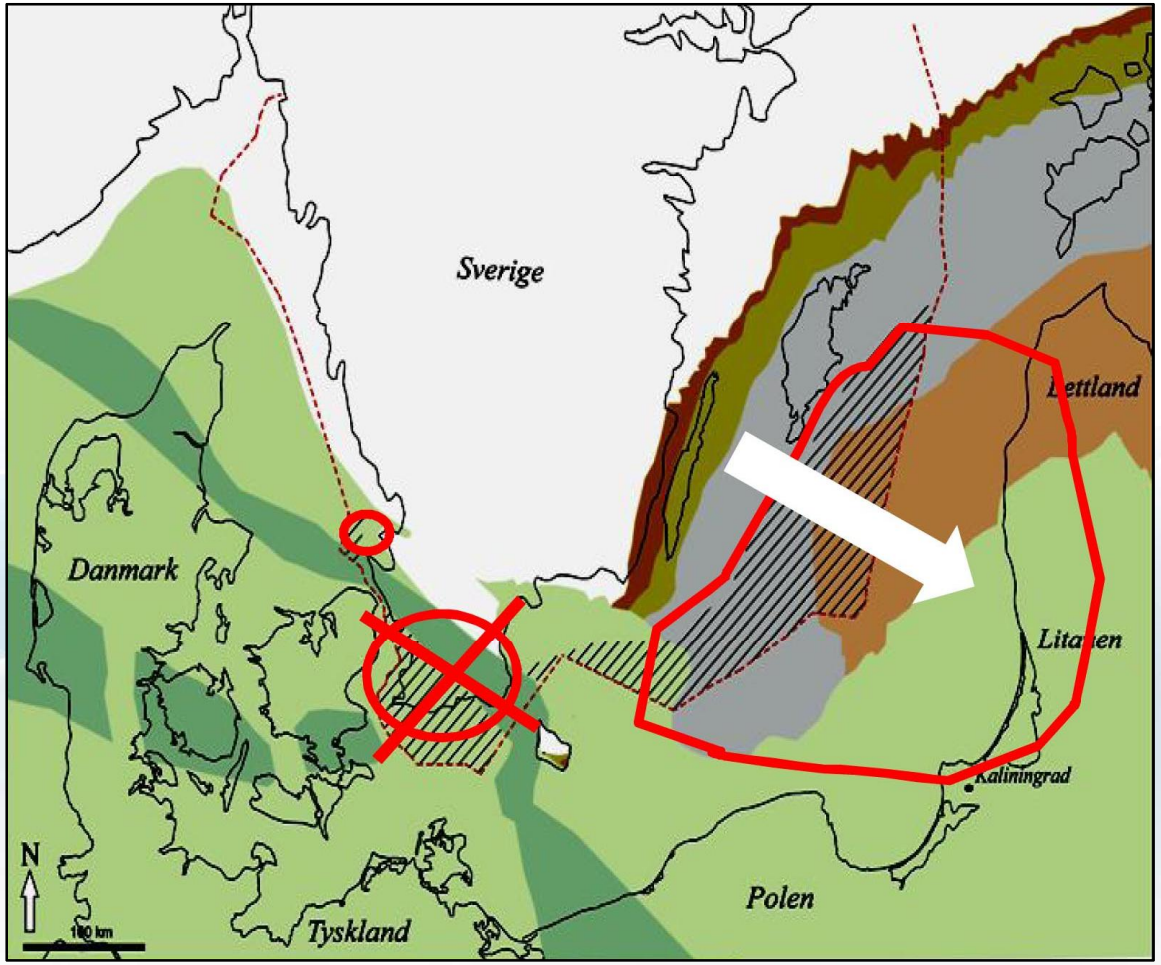
BASTOR
BALTIC SEA STORAGE OF CO2

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

MAIN TASKS

- Data compilation
- GIS map creation
- Basin Screening
- Calculation of theoretical storage potential
- Build static model
- Final interim report

SOUTHERN PART OF BALTIC SEA

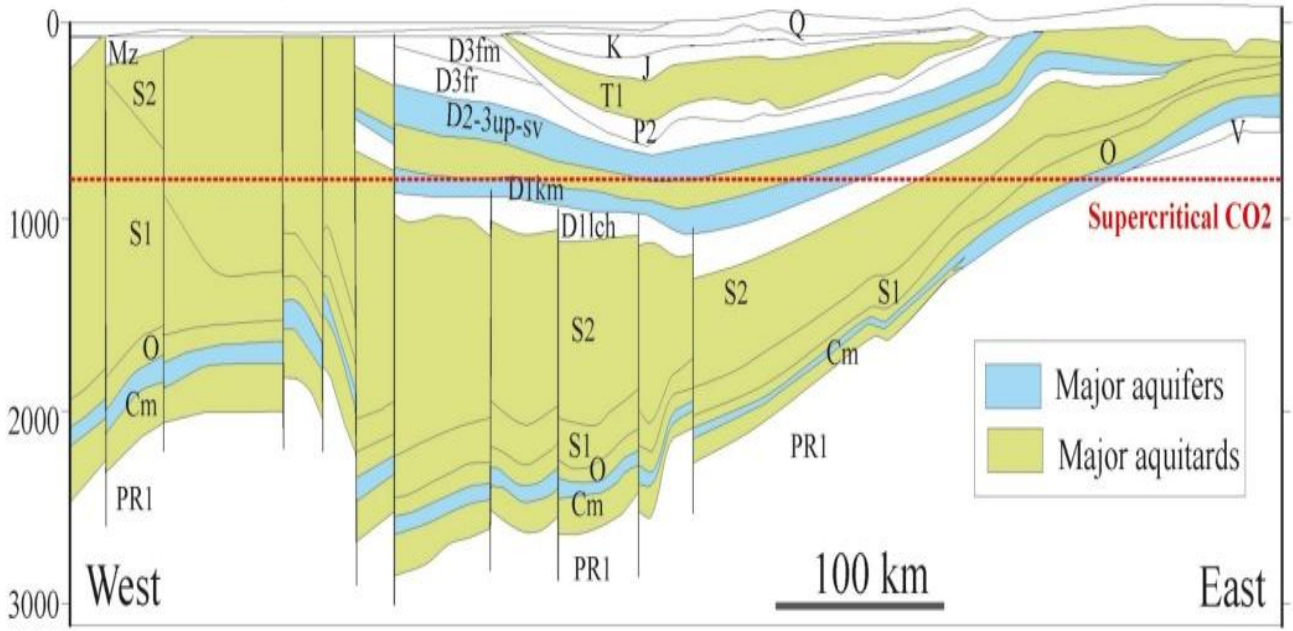


Source: Erslstöm, SGU, (OPAB)

DEFINITION OF THE STUDY AREA

Identification of saline aquifers for CO2 storage

Depths of base of the Baltic Basin

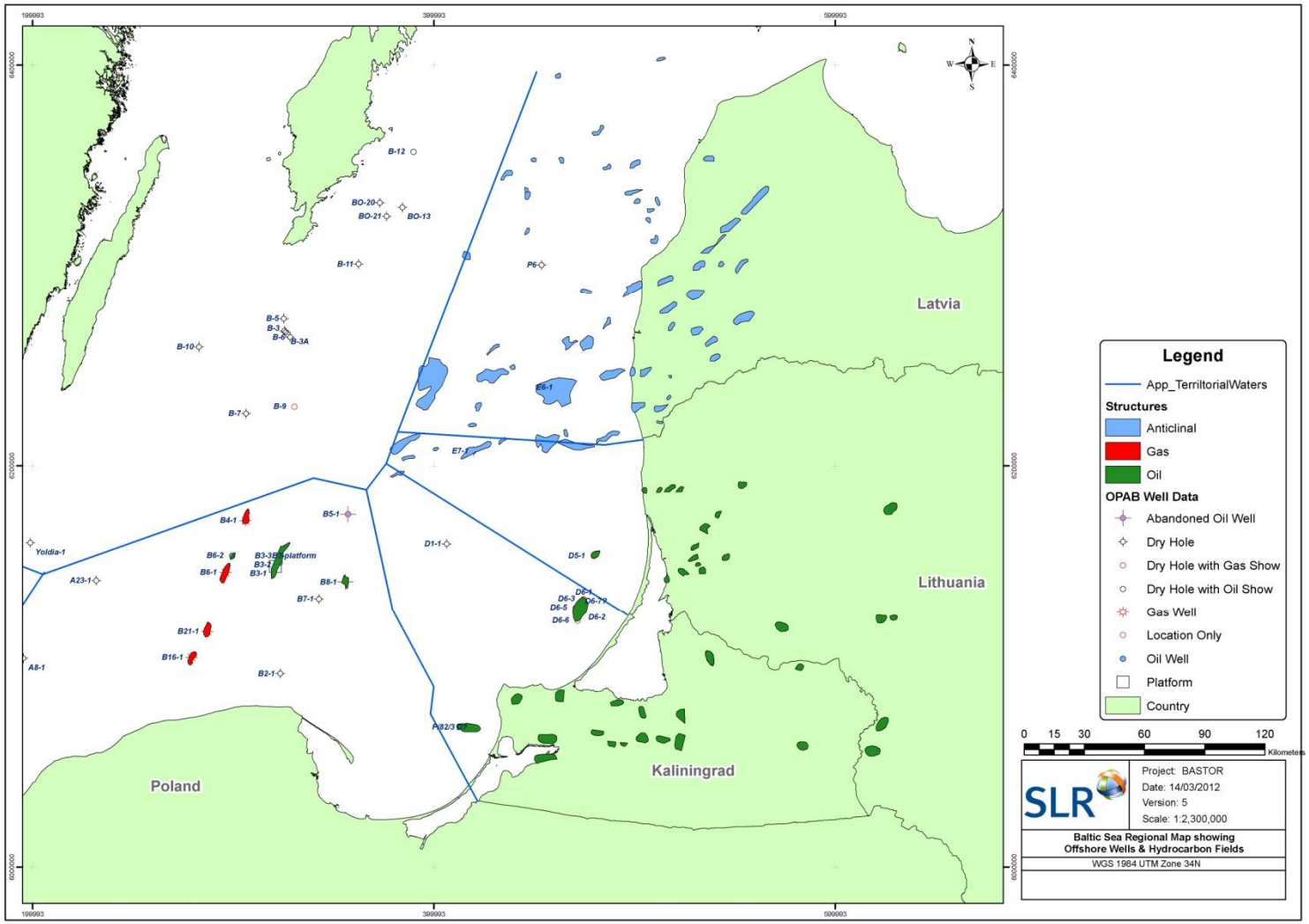


Geological cross section west-east

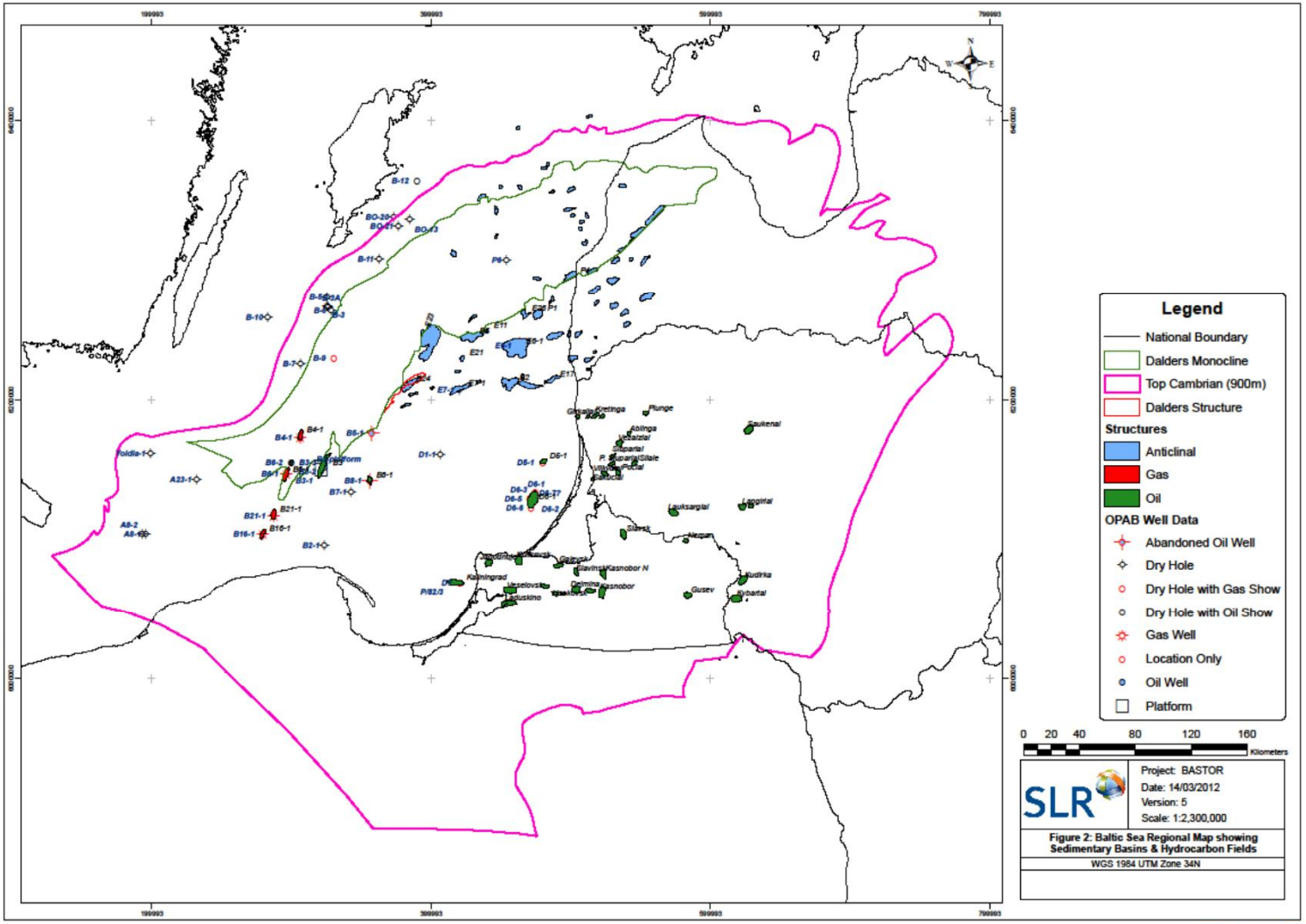
DATA COMPILATION TO DATE

- 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)
  - Well data (Sweden, some Lithuania)
  - Reservoir and seal formation properties (Sweden, some Lithuania and Poland)
  - Reservoir conditions/production data (Sweden, some Lithuania)

KEY OFFSHORE WELLS AND STRUCTURES



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**

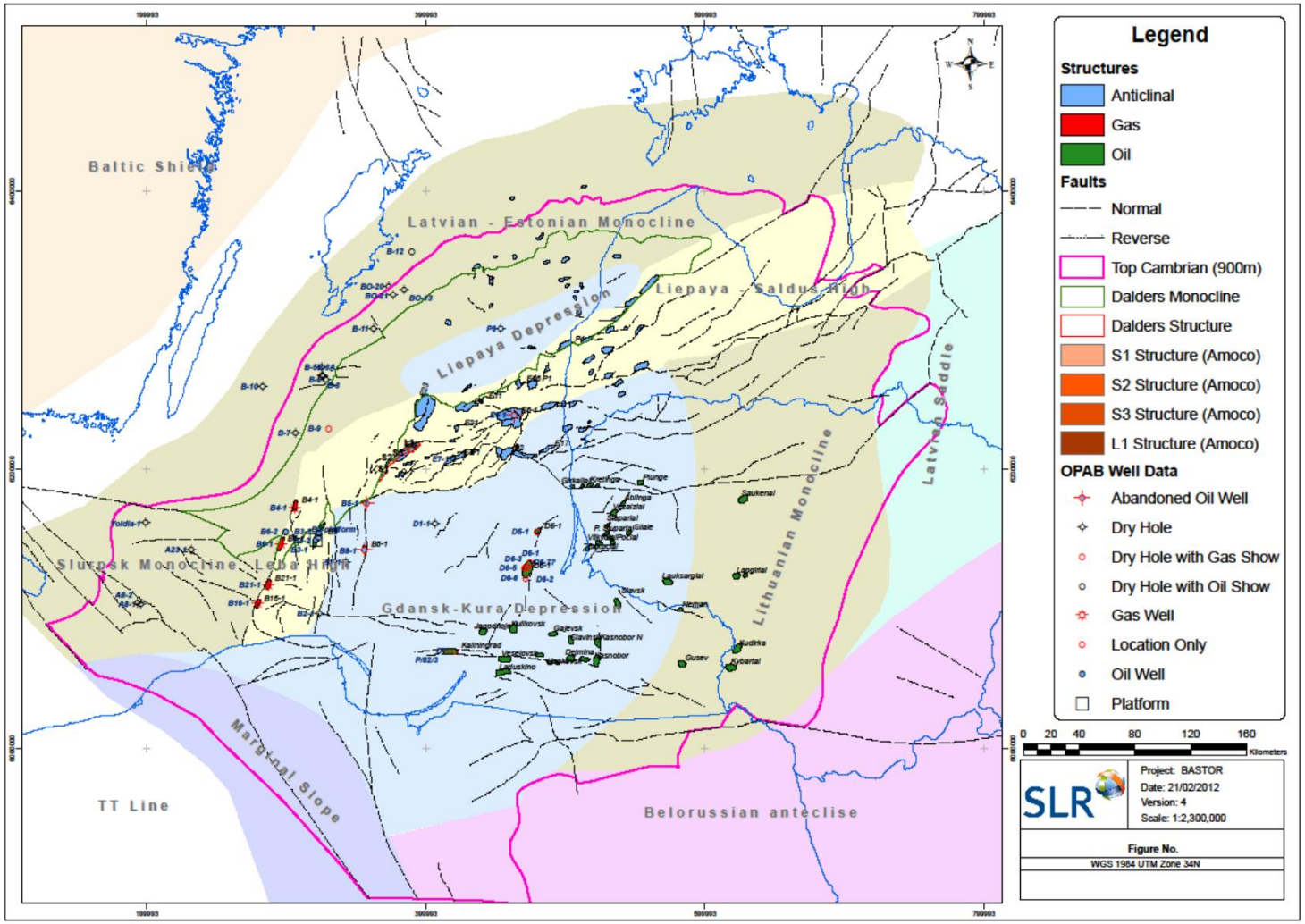
	Potential Criterion	Poor Potential	Good Potential	Weight
1	CO_2 sources	At >500 km distance	At <500 km distance	0.08
2	Physical accessibility	Difficult	Good	0.03
3	Infrastructure	None or poor	Developed	0.05
4	Hydrogeology Flow systems	Shallow, short	Deep and/or long	0.08
5	Geothermal regime[1]	Warm	Cold	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 CO2 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 CO2 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	259.88
Dalders Monocline	2077.07
Regional Cambrian Below 900m	16221.56

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).

• No data for Kaliningrad Fields other than EUR estimates from LO&G (assumed FVF from Svenska onshore Lithuanian fields)

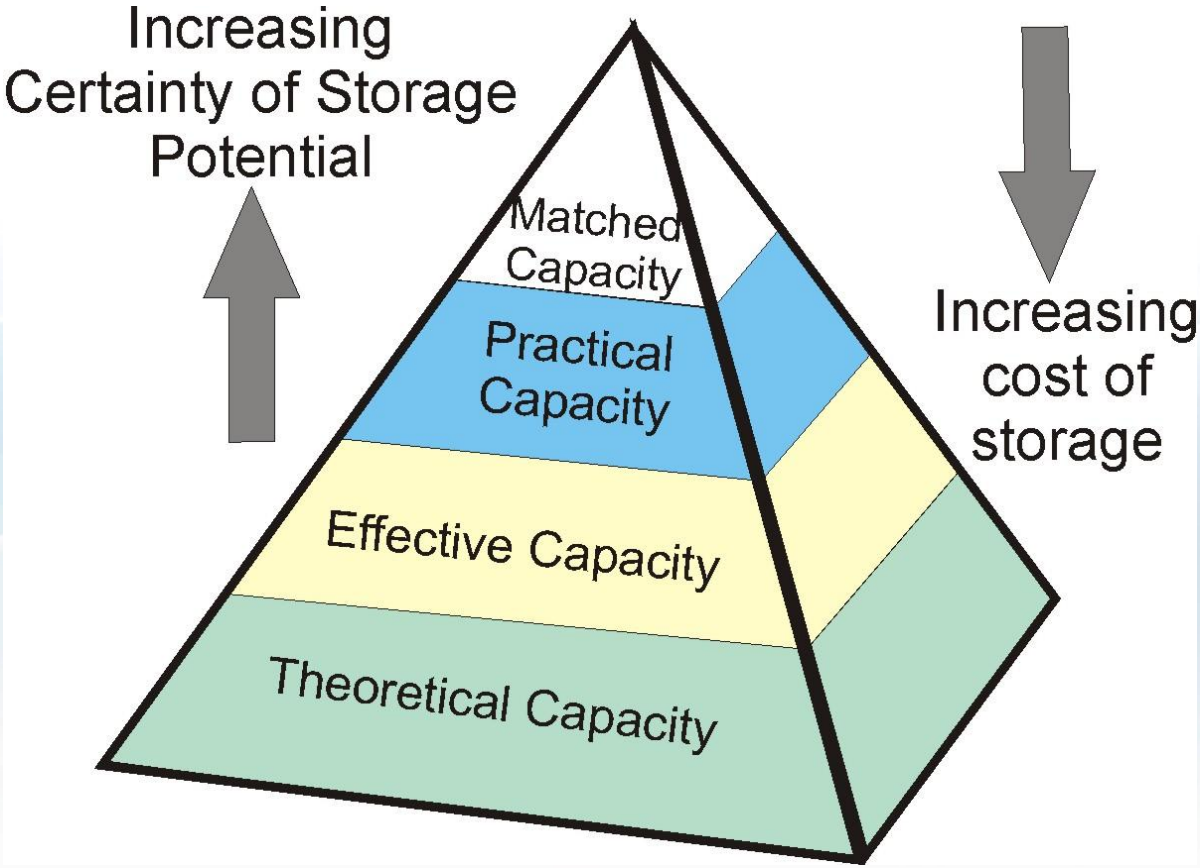
• Wide range of estimates for Latvia from 10Mt in 3 fields to 63Mt in 5 fields – hydrocarbon field estimates from LO&G data are assumed based on the E6-1 well data, FVF, RF and OOIP are all estimated. Higher values are obtained using saline aquifer calculation based on Amoco data and E6-1 well data.

• Limited well data for Dalders area – calculations for structures L1, S1, S2 and S3 based on the Amoco 1994 report and the E6-1 well data

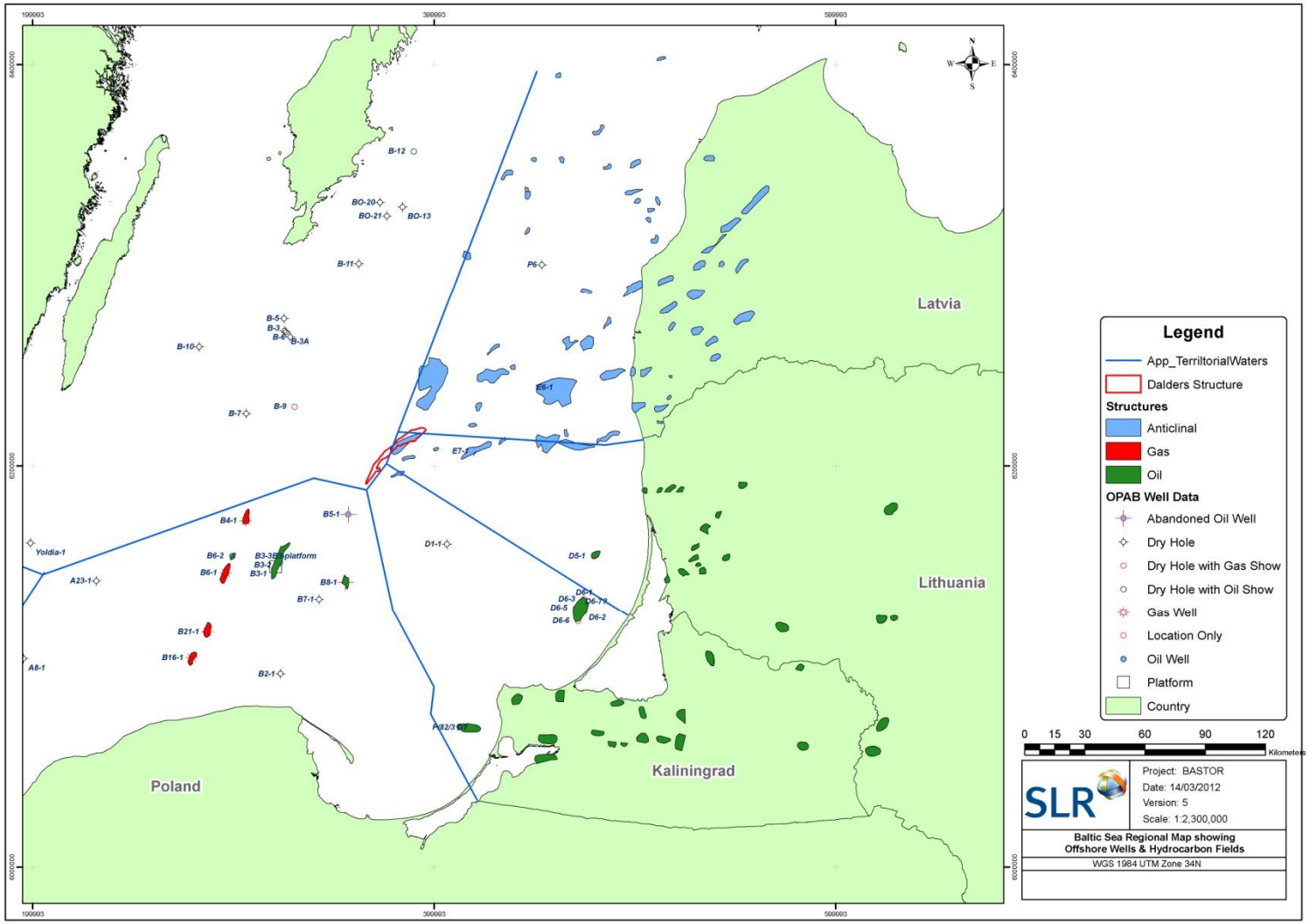
• Dalders Monocline uncertainty – assumes an average sandstone thickness for the entire area, potential for storage before spill point and onshore migration needs to be further investigated

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

TECHNO ECONOMIC RESOURCE PYRAMID (CSLF 2007)



THE JURISDICTIONAL CHALLENGE



NEXT STEPS – BASTOR 1

- Incorporate Latvian data currently being purchased
- Build static reservoir model of Dalders and Monocline
- Complete interim report with:
  - sweet spots for storage identified
  - static reservoir model defined

WAY FORWARD - BASTOR 2

- Obtain more regional and national data
- Expand modelling to cover other structures
- Dynamic modelling of key structures
- Possible recommendations for test injection programme