Preparation for CCS in Finland

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- **Developments in CCS, EU's climate and energy policy as well as the directive of geological storage of CO_2 has increased interests in CCS also in Finland**
- **Rapid ongoing capture technology development may provide technological opportunities for Finland**
- **Because of the nature of the Finnish bedrock and Quaternary deposits, no suitable sedimentary-origin storage options for CO_2 in Finland may occur**

Transportation and storage of CO_2

- The largest point sources of CO_2 emission are power plants, steel plants, and oil refineries and they are situated in the coastal region
- In Finland all deep rocks are expected to be crystalline basement rock and not suitable for CO_2 storage.
- The same situation applies for the near Finland water in the Baltic Sea
- The storage potential increases in the southern Baltic Sea, outside of Finnish economic zone
- Transportation of CO_2 plays thus an important role in application of CCS in Finland due to the large distances to areas with high potential for storage in other countries
- There may be potential for intermediate storage in Finland, because of previous analogies in storing gases and liquids in excavated bedrock caverns
- The health and environmental effects of CO_2 may manifest themselves mainly in the transportation and storage infrastructure and during the operation phase

Mineral carbonation

- Mineral carbonation studies in Finland were begun by Åbo Akademi and Aalto University in the turn of millenium
- The most common Finnish Mg rich rocks are ultramafic rocks, of these rocks the most interesting for CCS purposes are the serpentines.
- Detailed study of ultramafic rocks suitable for carbonation has been made by Aatos et al. (2006)
- The estimated sequestering capacity of serpentine material in the Outokumpu-Kainuu ultramafic rock belt is about 2-3 Gt CO_2
- A multi-step carbonation process for serpentine, using a pressurized fluidized bed reactor, is currently under development in Åbo Akademi. The process has been tested in the laboratory settings, but the process requires still too much energy (Zevenhoven et al., 2010)

Capture

- The power and heat sector seems to have the largest potential for CCS application in Finland and there is large potential in bio-CCS in Finland
- Finland has a strong positioning in CFB oxyfuel technology field, and new significant breakthroughs are expected in CCS in connection to CHP power plants, bio-CSS and CLC technology

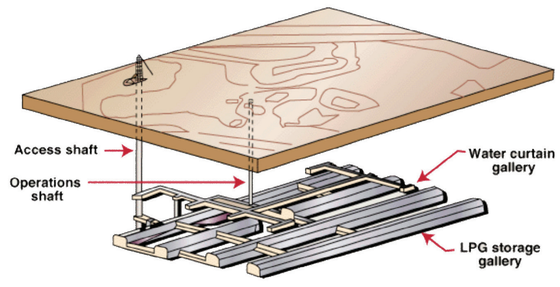

Fig 3. Intermediate storage site situated in Sidney. ELGAS CAVERN SCHEMATIC Source: Oil and Gas Journal. (The Allen Consulting Group 2009)

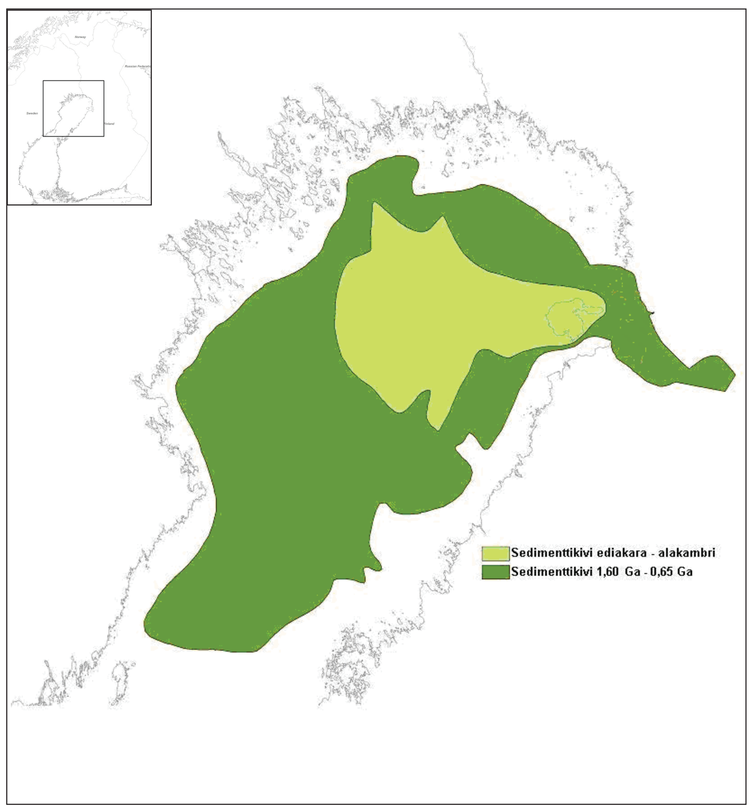

Fig. 1. Sedimentary rocks in the Bothnian Bay basin. (Modified: Wannäs 1980, Lunqwist 1996.)

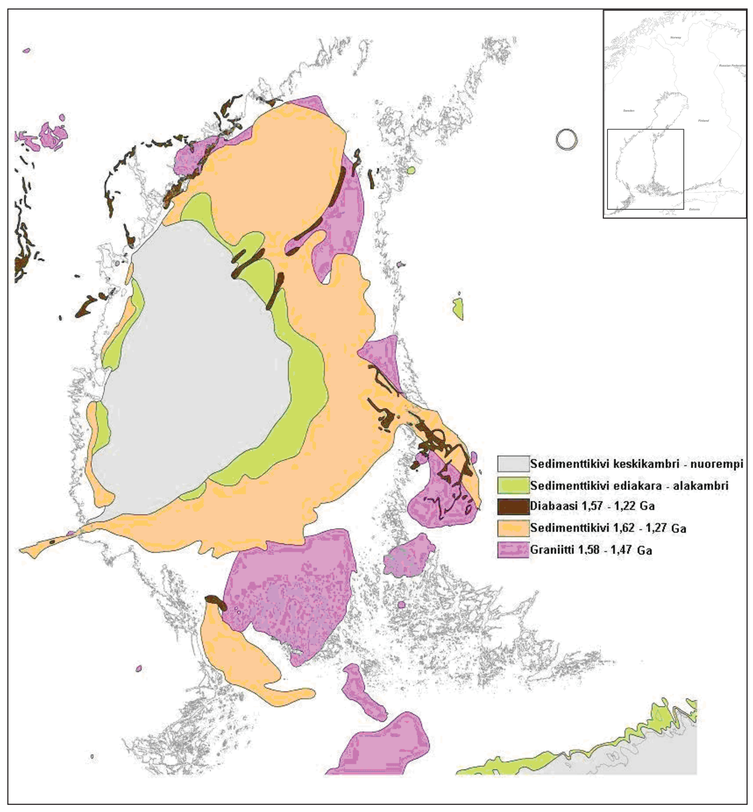

Fig. 2. Geology of the Bothnian bay (Modelled after: Koistinen et al., 2001).

Current issues & research activities

- The national preparation process of implementing EU Directive for geological storage for CO_2 is going on and led by the Ministry of the Environment
- Research and development on CCS technologies is carried out by several companies, research institutes and universities in Finland: Åbo Akademi, Aalto University, University of Turku, University of Oulu, University of Helsinki, VTT, GTK and others
- The objective of the Cleen Oy's CCSP project (started 2011) is to strengthen positioning of Finnish industry and research organisations in CCS technology field. The programme consortium consists of 9 research organisations and 17 industrial partners

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