

Nordic CCS research and the need for Baltic Cooperation



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Focus of the presentation

Nordic.... and especially Finnish view

- What is the actual interest and attitude on CCS and CCS related R&D today?
- Most essential R&D topics
- Actors of CCS R&D
- The Finnish CCSP program
- Need and importance of Baltic cooperation

Status of CCS today

- In Finland (and Sweden) CCS has not ever seen as the primary tool to tackle climate change
- CCS has been seen more as one instrument perhaps needed to have a workable orchestra
- In Finland renewables and nuclear power have major role in battle against climate change
- No serious large scale activities to implement industrial scale CCS

However, Finland, Sweden and most of the Nordic countries have presented targets to reduce dramatically CO₂ emissions before 2050....and more or less realised that this cannot be done without CCS

Who are active reserach organisations in the CCS R&D field?

- Norway
 - SINTEF, NTNU, Universities, etc. ; large number of projects and partners
- Sweden
 - Chalmers University, Uppsala University, SGU, Mefos, IVL, etc.
- Denmark
 - GEUS, DTU, etc.
- Iceland
 - University of Iceland
- Finland
 - VTT, GTK, Universities (Aalto, Åbo Akademi, Lappeenranta, Tampere, Oulu), etc.

Topics specific for Nordic countries

- Situation in Norway (and also in Denmark) very different compared to Sweden or Finland
- Industrial emissions – More similarities
 - Steel, cement, oil industry
- Storage of CO₂ – Norway and Denmark (and Iceland) have storage capacity but Finland none and Sweden relatively limited
- Potential storage capacity in Baltic Sea region
- Mineral carbonisation – Developed in Finland (and Iceland)
- Transportation is an issue for all but transportation distance varies
- Biogenic CO₂ emissions especially in Finland and Sweden
- Development of capture technologies – Oxyfuel, CLC and some special technologies

Interest on CCS correlates with interest/funding on CCS R&D

- Last 4..5 years poor for CCS R&D
- During last years interest has decreased almost all the time
- Need for mitigation of climate change realised in speeches but...
- Political targets: significant reduction of fossil fuels in energy production results in feeling to reduce need for CCS
- However, industrial CO₂ emissions play significant role in overall CO₂ emissions in Nordic countries
 - Steel, oil, cement, lime industry
- Potential of BioCCS – How could this opportunity be utilised?

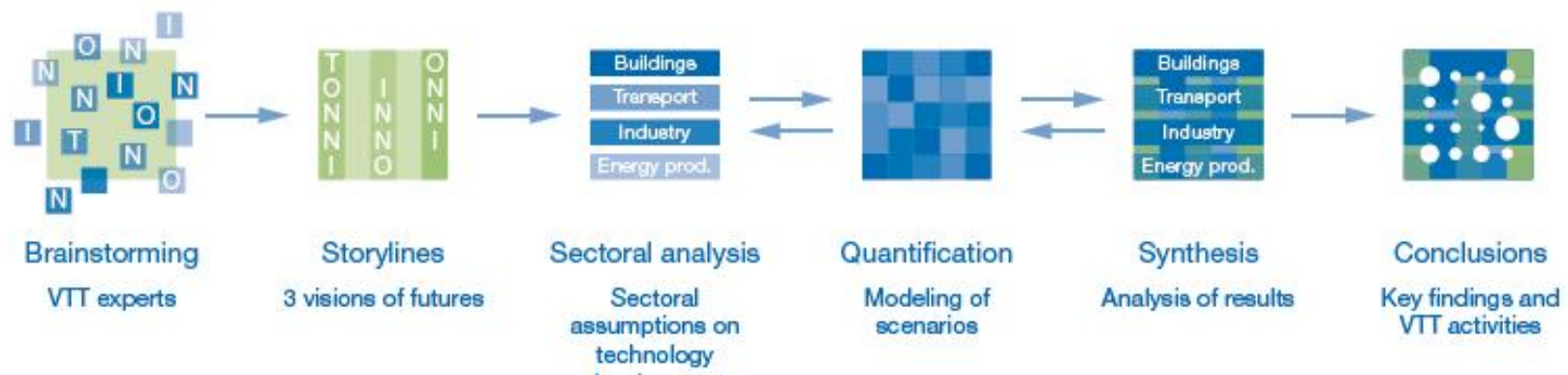
low carbon finland 2050

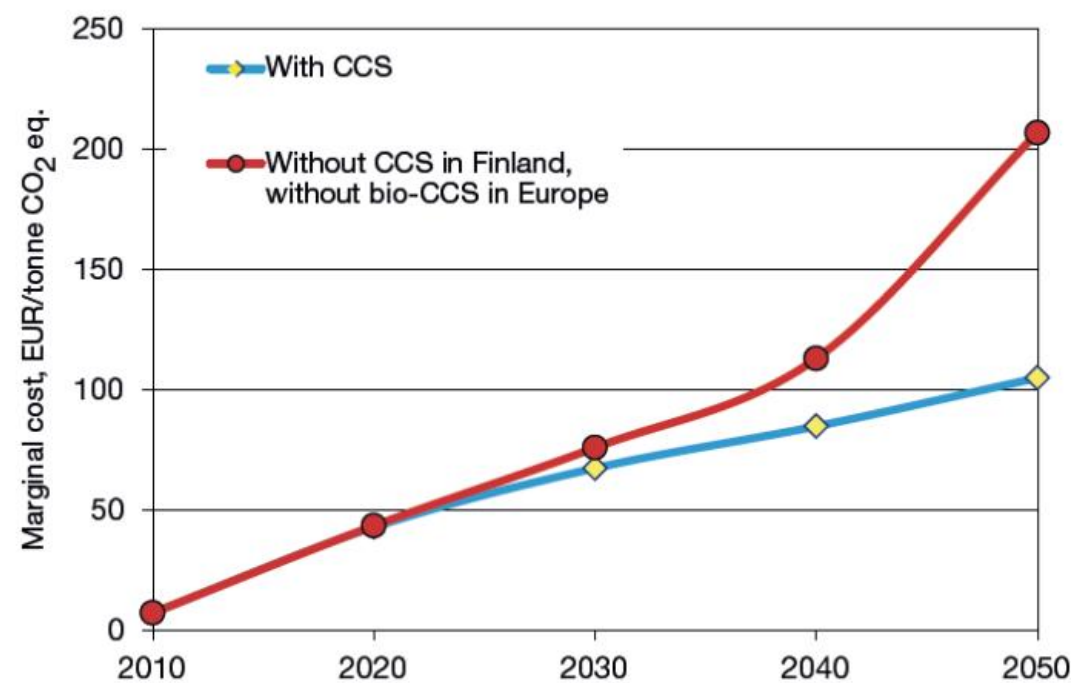
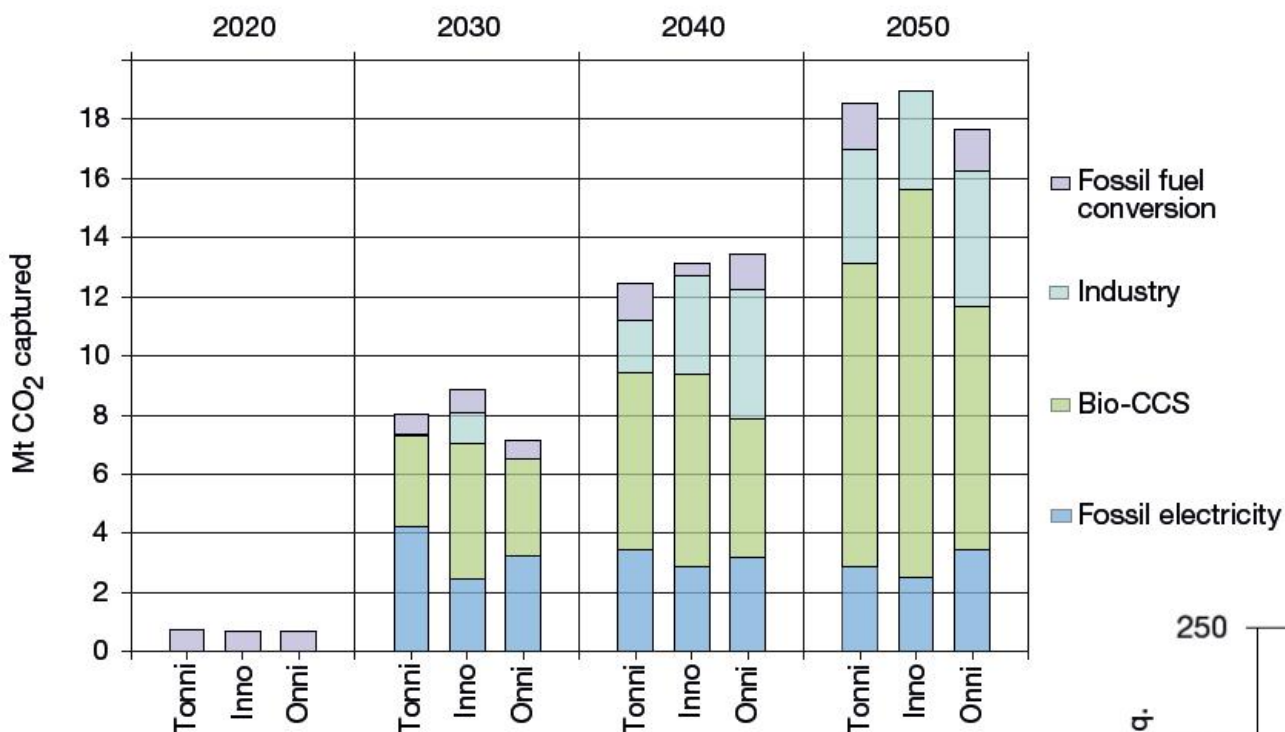
VTT clean energy
technology strategies
for society



<http://www.vtt.fi/inf/pdf/visions/2012/V2.pdf>

Process of creating Low Carbon Finland 2050 scenarios





Source: Low Carbon Finland 2050 – VTT clean energy technology strategies for society

NORDIC CCS Competence Centre

- NORDICCS is a virtual carbon capture and storage (CCS) networking platform aiming for increased CCS deployment in the five Nordic countries.
- NORDICCS is financed by Nordic Innovation and the partners themselves.

Research Partners

VTT Technical Research Centre of Finland

Chalmers University of Technology

IVL Swedish Environmental Research Institute

Geological Survey of Sweden (SGU)

GEUS

University of Iceland

SINTEF Petroleum Research

Norwegian University of Science and Technology (NTNU)

Tel-Tek

University of Oslo

User/industry Partners

Reykjavik Energy

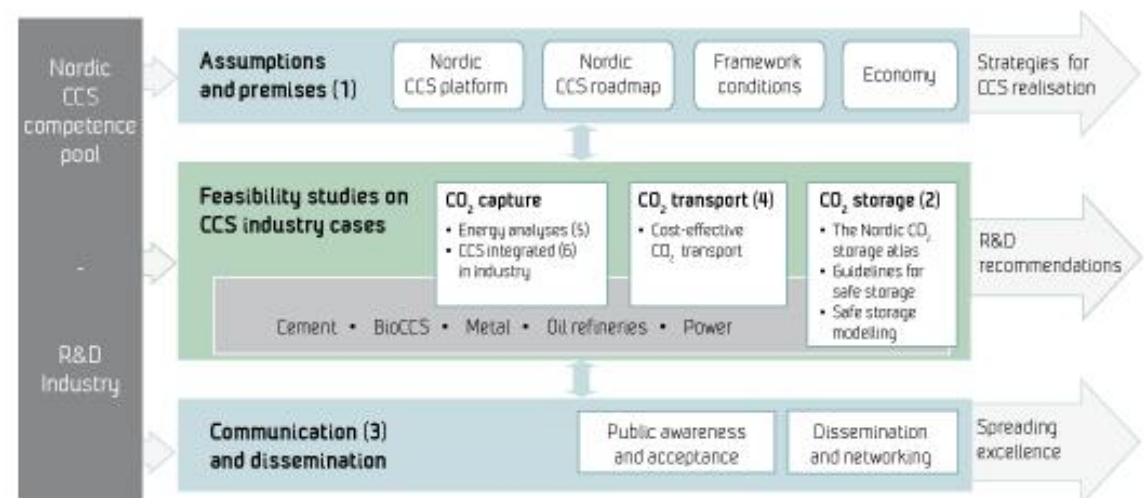
Statoil Petroleum AS

Gassco

Norcem AS

Vattenfall AB

CO₂ Technology Centre Mongstad – TCM DA



CLEEN

Cluster for Energy and Environment



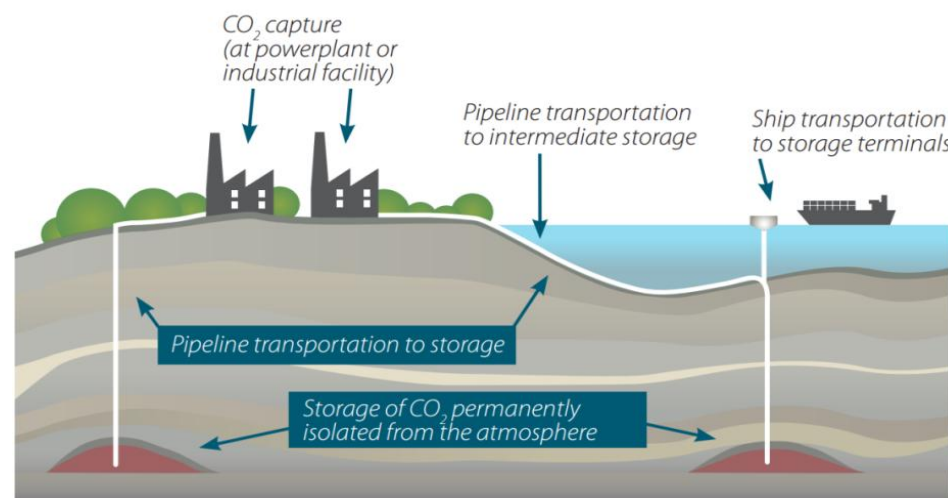
ccsp

Carbon Capture and Storage Program

Program overview

Carbon Capture and Storage Program (CCSP)

- The objective is to develop CCS-related technologies and concepts, leading to essential pilots and demonstrations by the end of the program.
- A further objective is to create a strong scientific basis for the development of CCS technology, concepts and frameworks, and to establish active, international CCS co-operation.
- Key facts
 - Program duration: 2011-2015
 - 17 industrial partners, 9 research partners
 - Volume: ~3 M€/a
- <http://www.cleen.fi/en/ccsp>



Main focus areas of CCSP

- **WP1: Overcoming non-technical barriers for CCS**
- **WP2: Concepts for CCS in CHP (Combined Heat and Power)**
- **WP2: CCS related to multi-fuel technologies and bio-CCS**
- **WP3: Solid looping technologies, such as Chemical Looping Combustion (CLC) and calcium looping**
- **WP4: Monitoring technologies**
- **WP5: Mineral carbonation**
- **WP6: Utilization of microalgae for CO₂ capture and biogas/-fuel production**

Main achievements

- Laboratory-pilot for a process that converts steelmaking slag and CO₂ into calcium carbonate successfully completed
- Evaluation of the geological storage potential of CO₂ in the Baltic Sea, in collaboration with the Swedish CCS project (Bastor)
- Successfully developed competitive methods for detecting solvent emissions from CO₂ capture plants (Ramboll)
 - FINAS accreditation for nitrosamines in 2013
- New seismic monitoring sensors for CO₂ storage built and tested (Vibrometric)
- Techno-economic evaluations: significant reductions in CO₂ emissions possible for steel industry
- Comprehensive models related to various CO₂ capture processes developed

Research achievements in numbers

- 5 Ph.D. Theses
- 22 international journal articles
- 41 conference articles
- 26 Master's Theses
- 3 Bachelor's Theses
- over 90 internal technical reports



International CCS network activities



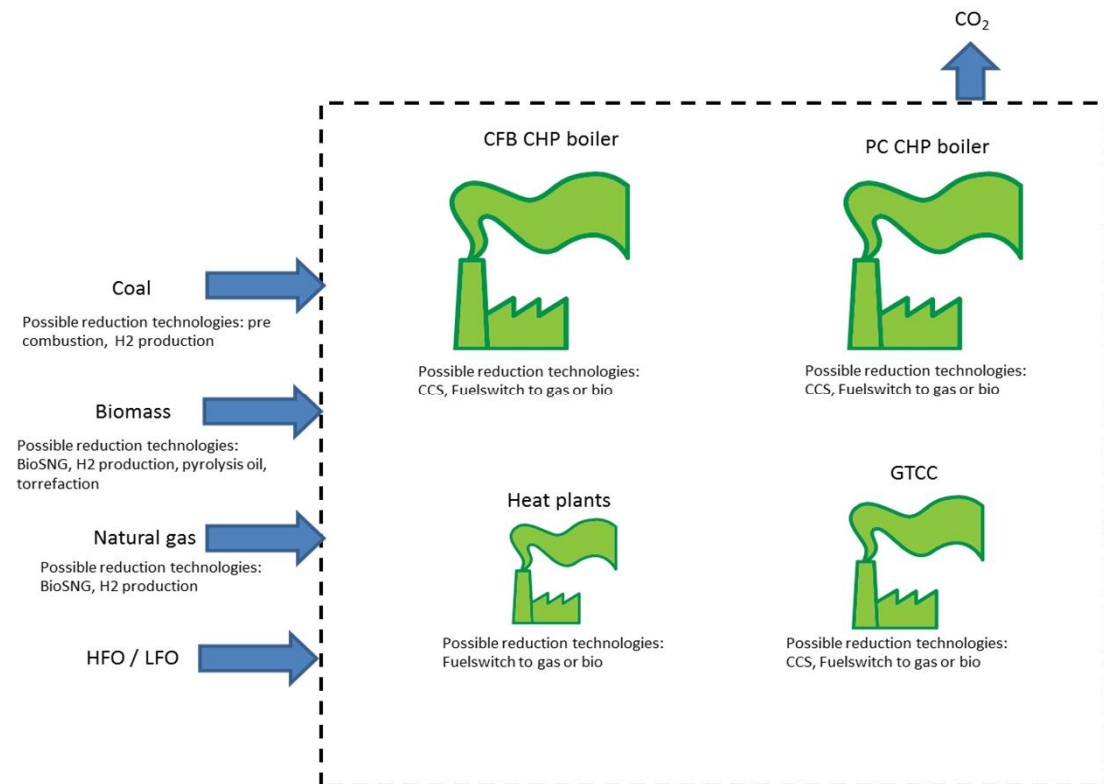
- IEA GHG ExCo
- IEA CCS
- Zero Emission Platform (ZEP) ...Joint BioCCS task force
- EERA CCS
- NordiCCS
- EASAC
- CO2GeoNet, CGS Europe
- Gas union
- EU MUSTANG

WP1 focus: Overcoming non-technical barriers for CCS

- To identify options for overcoming non-technical barriers for CCS implementation in Finland
 - Legislation
 - Operational frameworks for economic profitability
 - Public acceptance
 - Sustainability of CCS
 - Dissemination

WP2: Evaluation of flexible CCS-CHP concepts and systems

- Increasing share of intermittent renewable power will cause a demand for balancing power.
 - Can CCS systems operate more flexibly?
- Assess the economy of CO₂ capture systems in CHP environment under demand for balancing power due to high share of renewable power



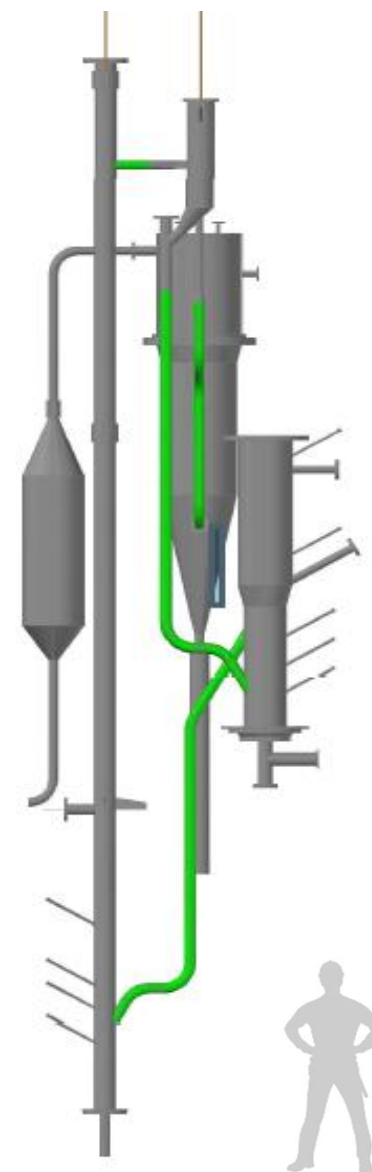
WP2: Evaluation of bio-CCS potential for pulp & paper industry (with IEA GHG)

- To evaluate options for post-combustion CO₂ capture using MEA within the integrated pulp and paper mill
 - How much CO₂ can be avoided
 - Techno-economical evaluation
- Collaboration with IEA GHG



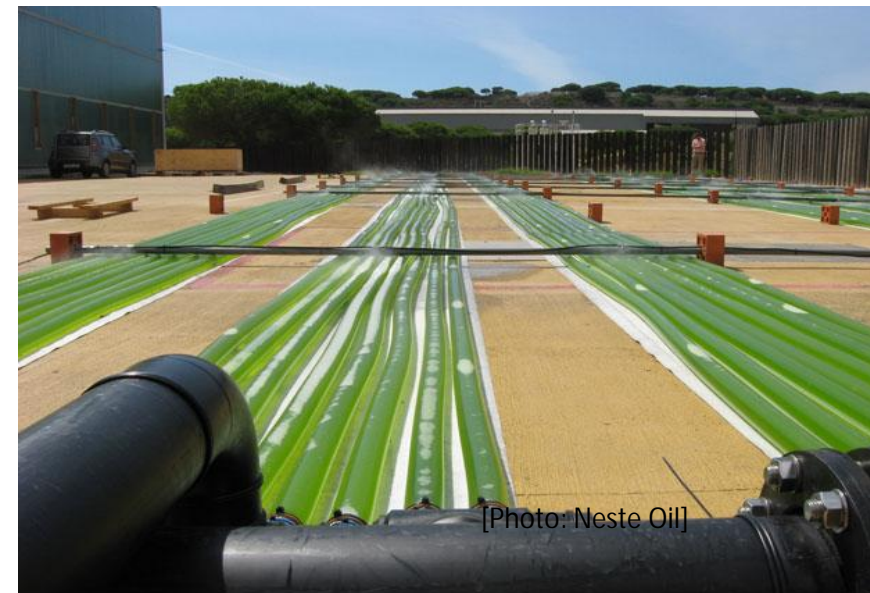
WP3: PDU of chemical looping combustion (CLC)

- CLC has the potential for the lowest efficiency losses of CO₂ capture technologies
- Existing process development unit (PDU) for gasification (200 kWth) at VTT's new test center Bioruukki will be with minor modification turned into a bio-CLC PDU



WP6: Utilisation of microalgae for CO₂ capture and biogas/-fuel production

- Solutions for capturing CO₂ by microalgae
 - Co-utilisation of waste water
 - Co-production of biogas/-fuel
- Case study: utilisation of microalgae for CO₂ capture and biogas/-fuel production in a gas refinery (Hazira, India)
 - Goal: readiness for an industrial CCU pilot/demo
- New partner from India



Cross border co-operation between Baltic Sea countries - Need and importance



Common questions to all countries

- Acceptability of CCS?
- Where to store CO₂?
- How to transport CO₂ to storage site?
- How to motivate/push politicians and decision makers to understand need to do something?
- How to maximise efficiency of technology and whole CCS chain?
- Could we benefit from collaborative actions with other Baltic Sea countries?
- How could we start CCS industry in Baltic Sea region?
- How to finance?

Cross-border collaboration in the Baltic Sea region is an imperative in order to achieve progress!

- Baltic Sea collaboration will enable
 - To strengthen the role of the Baltic Sea countries in CCS development
 - To push politicians to act against climate change
 - In EU Baltic Sea countries together are much stronger than single countries alone
 - To assist in finding funding for CCS R&D
 - To accelerate development by increasing exchange of knowledge

But there are also challenges...

- National grants difficult to synchronise between different countries
- Different national views on CCS
- Commercial interests of parties does not necessary favour R&D
- EC Horizon 2020 – Funding available but strong competition
- Piloting and demonstration projects are expensive



Thank You



TECHNOLOGY FOR BUSINESS

**Co-operation does not start by itself
or automatically.**

We have to do it!