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Carbon Capture and Storage Program

Main achievements of CCSP

Sebastian Teir

CCSP Final results seminar 12.10.2016, Helsinki

Carbon Capture and Storage Program (CCSP)

- 1.1.2011 – 31.10.2016
  - Volume: 15 M€, main part of the funding from Tekes
- Targets
  - Technological readiness for pilots and demonstrations
  - Strong scientific basis for development of CCS

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Consortium partners

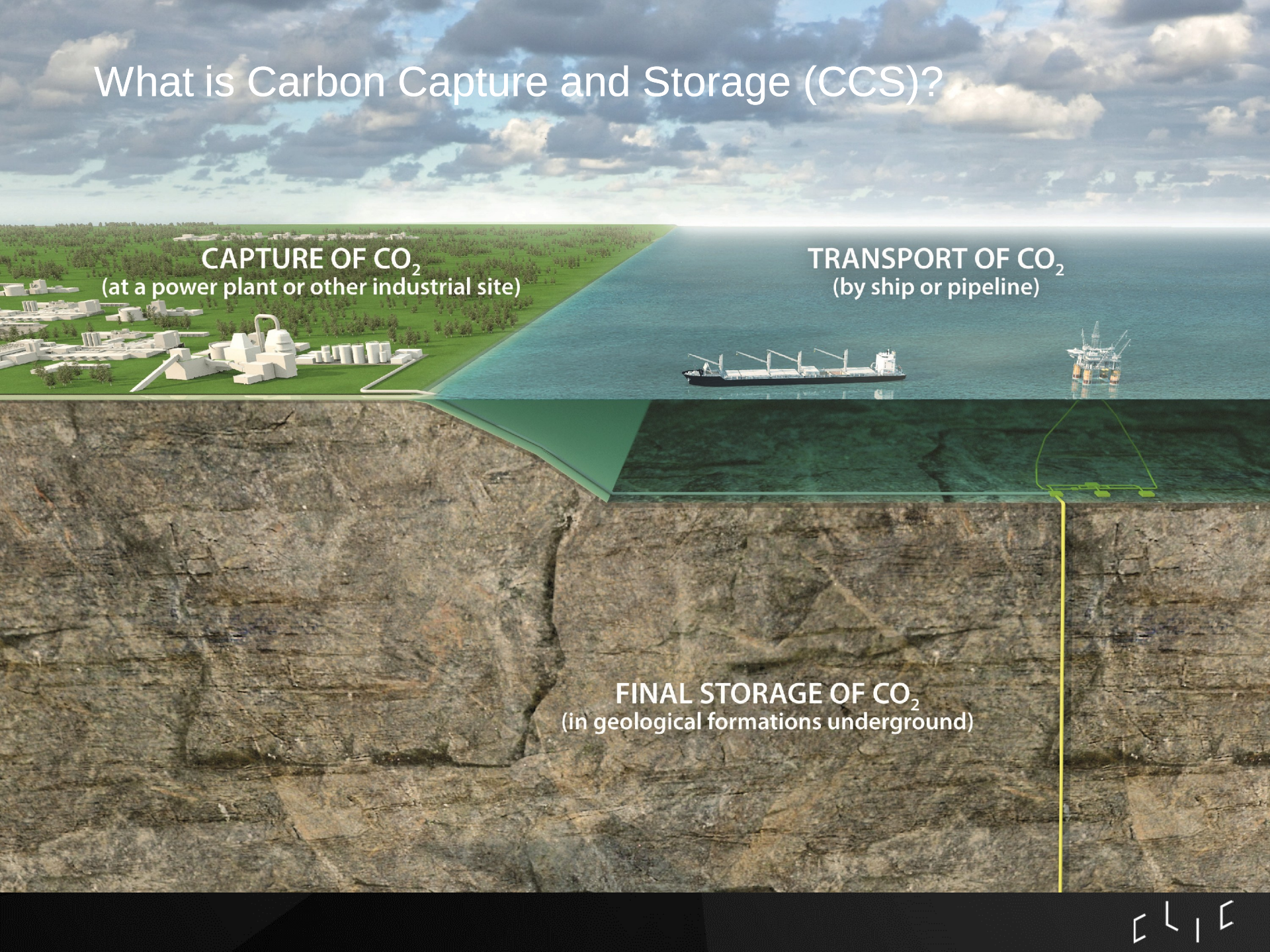
Industry partners 52 %

Fortum Oyj **19 %**, Ramboll Finland Oy **14 %**,
Vibrometric Oy **12 %**, Helen Oy **8 %**, Gasum Oy **6 %**,
Amec Foster Wheeler Energia Oy **6 %**, Neste Jacobs Oy **5 %**,
Neste Oil Oyj **5 %**, ÅF-Consult Oy **5 %**,
Fortum Power and Heat Oy **4 %**, SSAB Europe Oy **3 %**,
Oil and Natural Gas Corporation (ONGC) Ltd **3 %**,
Nordkalk Oy **3 %**, Oulun Energia **2 %**, Stora Enso Oyj **2 %**,
Tapojärvi Oy **1 %**, Andritz Oy **1 %**, Outotec Oyj **1 %**

Research partners 48%

VTT Technical Research Centre of Finland **44 %**,
Aalto University **14 %**, Lappeenranta University of Technology **13 %**,
Geological Survey of Finland **7 %**, Åbo Akademi University **5 %**,
Tampere University of Technology **5 %**, University of Oulu **5 %**,
University of Tampere **4 %**, Finnish Environment Institute **2 %**

What is Carbon Capture and Storage (CCS)?



Strong scientific basis for development of CCS

- An active international R&D cooperation
  - IEA GHG
  - NORDICCS
  - Bastor
  - Negative CO_2
- Foundation of long-term research strengthened
- New experimental test rigs were created
- Participation in international networks
  - IEA GHG ExCO
  - BASREC
  - ZEP
  - EERA
  - EASAC

Technological readiness for pilots and demonstrations

- Comprehensive knowledge on the feasibility of CCS applications suitable for Finland
- First accredited method in the world for measuring amine emissions from carbon capture facilities
- Chemical looping combustion of biomass successfully demonstrated at 20 kW_{th} scale
- First pilot in Europe for producing calcium carbonate from CO_2 and slag

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Role of CCS for Finland

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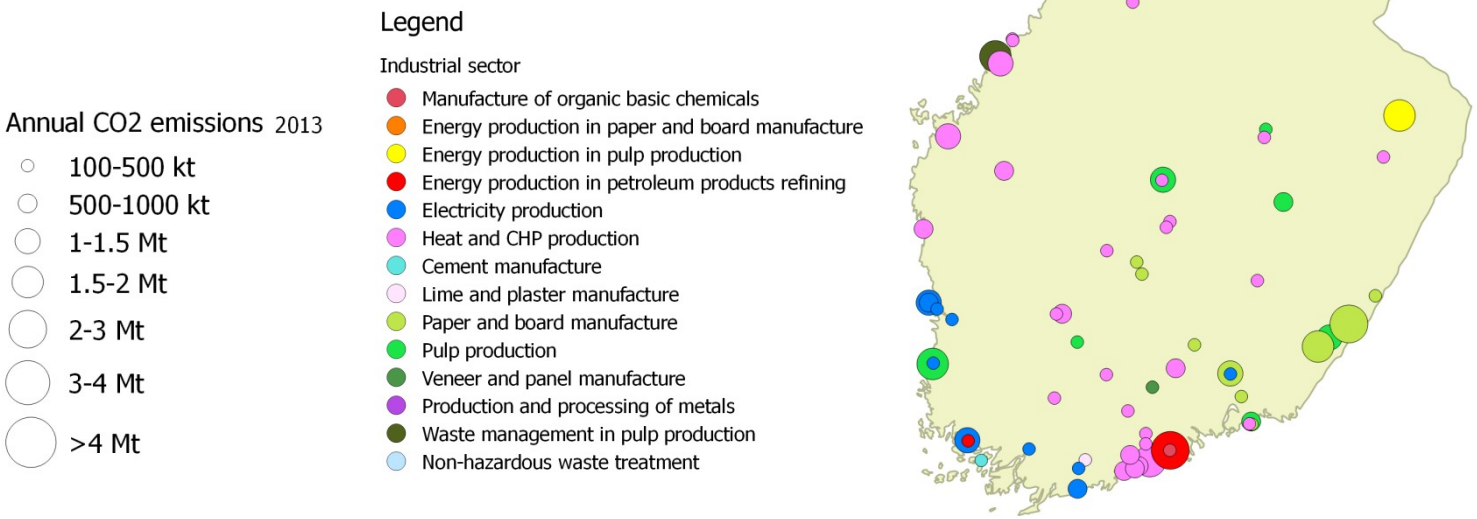
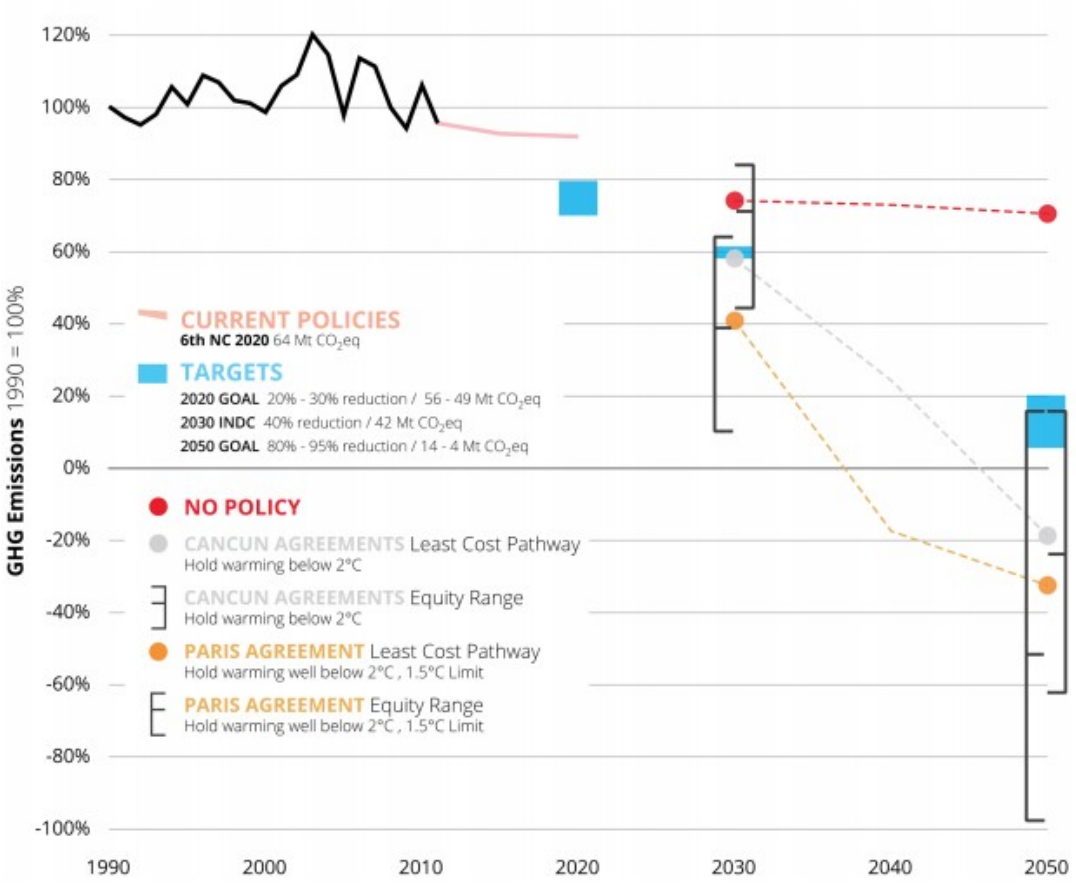
Situation in Finland

- Greenhouse gas emissions in Finland 56 million t (2015)
  - of which 80% CO_2
- EU's strategy: 80-95% reduction when compared to 1990 levels by 2050
  - Finland's GHG emissions in 70 million tonne in 1990



SITRA: Finland's targets not yet in line with the Paris Agreement



Source: SITRA/Climate Analytics – What does the Paris climate agreement mean for Finland and the European Union?

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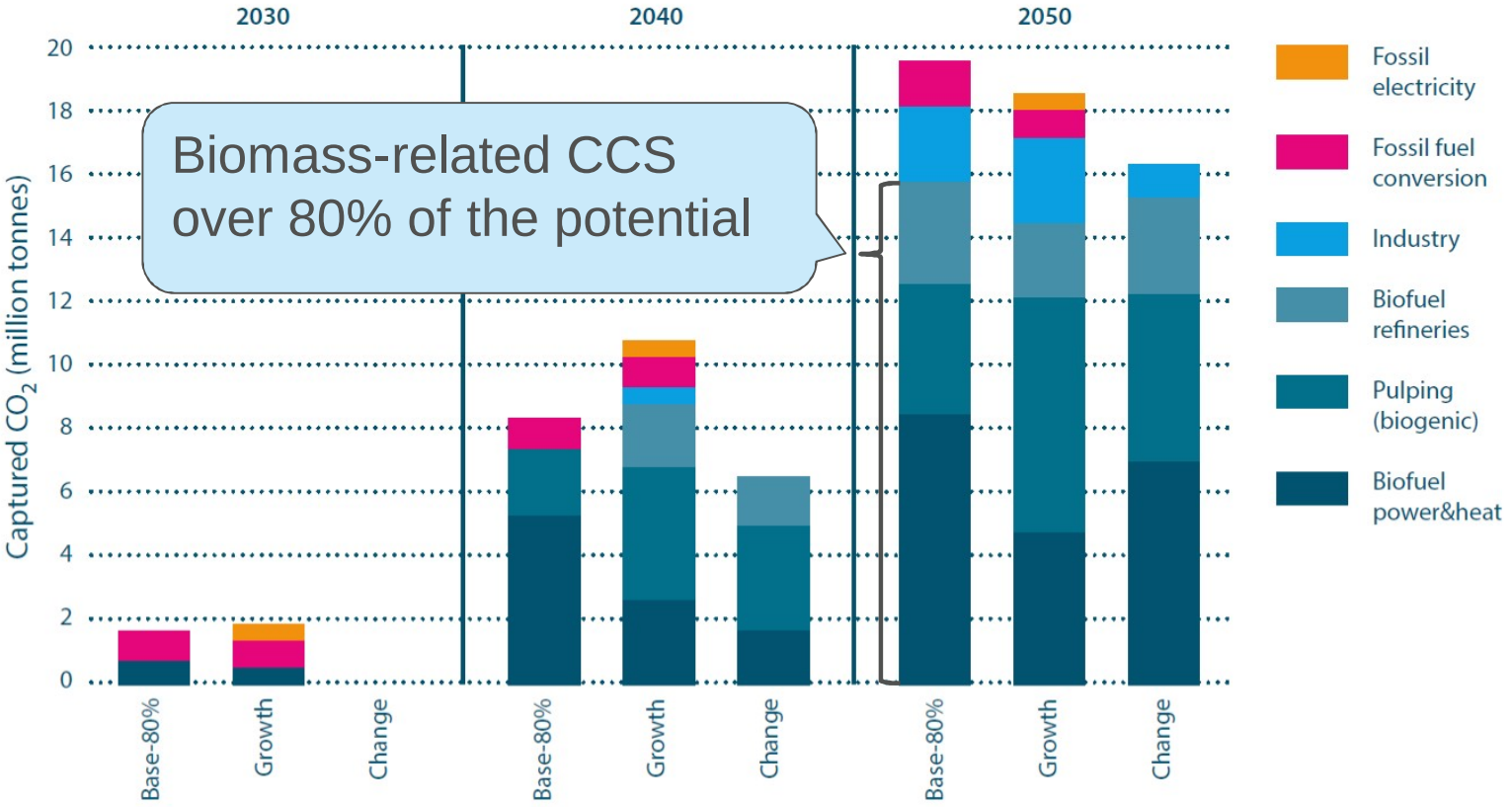
In Finland, one third of the needed reduction of GHG emissions by 2050 could cost-effectively be achieved with CCS



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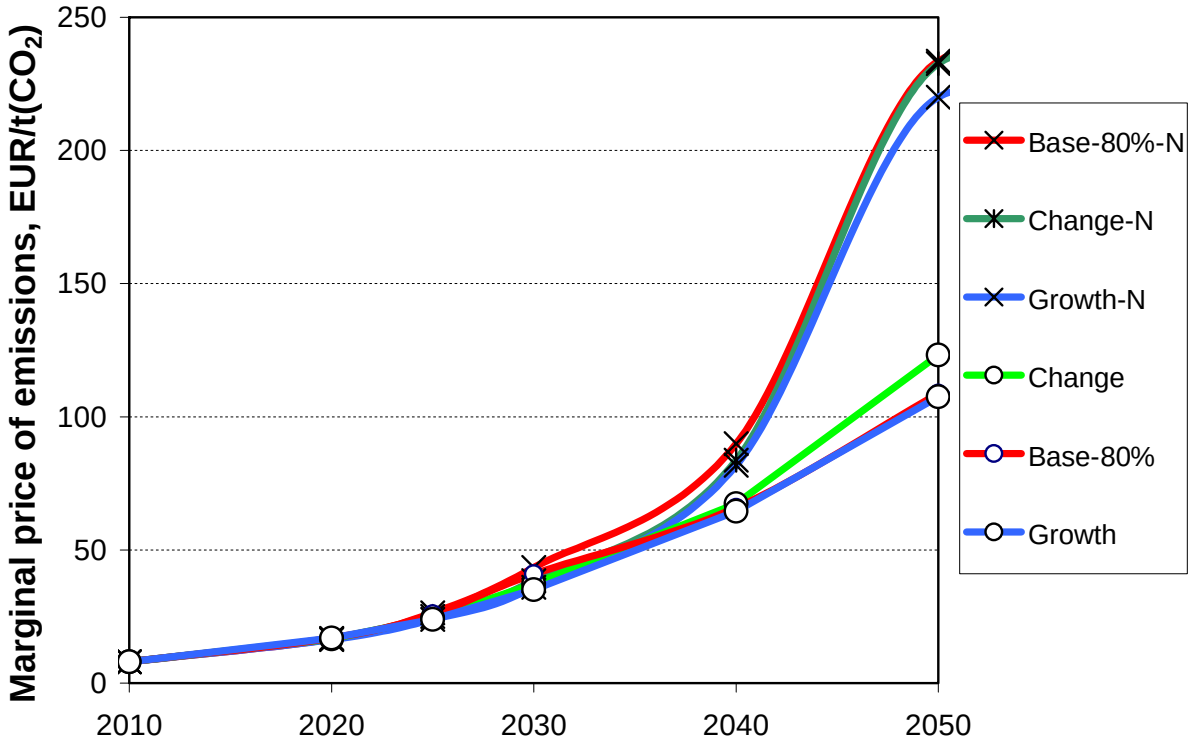
Without CCS, the assumed price of emission allowances by 2050 will be more than twice as high

- In Finland, the exclusion of CCS would double the annual climate change mitigation costs by 2050



Capture of CO_2

- There is a large capture potential (30 million tonne CO_2) at a total cost of 45-60 €/t CO_2 for CCS
  - most cost-efficient applications are among CHP plants fired with biomass, production of liquid biofuels and pulp & paper industry

Transportation of CO_2

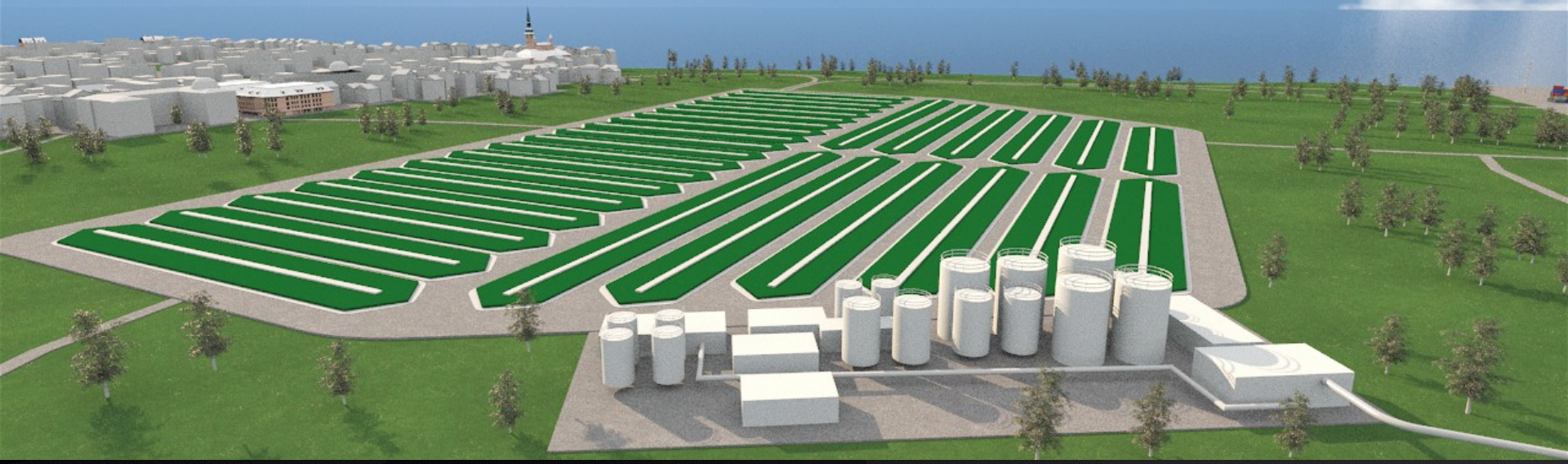
- Shipping of CO_2 would be a large share of the costs (10-20 €/t)
  - CO_2 hubs would facilitate ship transportation
  - Finland's bedrock is also suitable for intermediate storage of CO_2 instead of steel tanks, making transportation costs cheaper

Storage of CO_2

- Closest injection sites in the North Sea and Barents Sea
- The geological storage potential of CO_2 in the Baltic Sea was estimated at 16 Gt

Utilisation of CO_2

- Very little direct effect on reducing CO_2 emissions
- Could have an important role in renewable energy systems for converting renewable electricity into hydrocarbons
- Certain concepts, like converting slags and ashes into more valuable products by CO_2 mineralization, already seem commercially viable



Current barriers

- Most technologies for CCS are ready for application but currently there are no financial motivations to reduce CO_2 emissions
  - Financial support for early application of CCS in Europe is needed to ramp up the CCS deployment
- In order for bio-CCS to be applied, the benefit from the negative net emissions of bio-CCS needs to be acknowledged and accounted for in the EU ETS and other climate policy frameworks.

Proposed actions

1. Planning of stakeholder and public engagement as well as communication activities
2. Incentives for application of bio-CCS and decarbonizing the industry
3. Demonstration of CCS for combined heat & power plants combusting biomass and peat
   - Opportunity for Finnish technology and service export (e.g. fluidized bed boilers, hot solid looping reactors, emission measurement)
4. Demonstration of CCS for pulp and paper plants
5. Demonstration of CO_2 hubs in Europe and intermediate storage in Finland
6. Continued development and piloting of future technologies related to CCS and CCU
   - Hot solids looping technologies for biomass
   - Combined valorization of mineral resources and CO_2 mineralization
   - Concepts utilizing captured CO_2 as a process medium to produce materials, transportation fuels, power-to-gas, or other chemistry products

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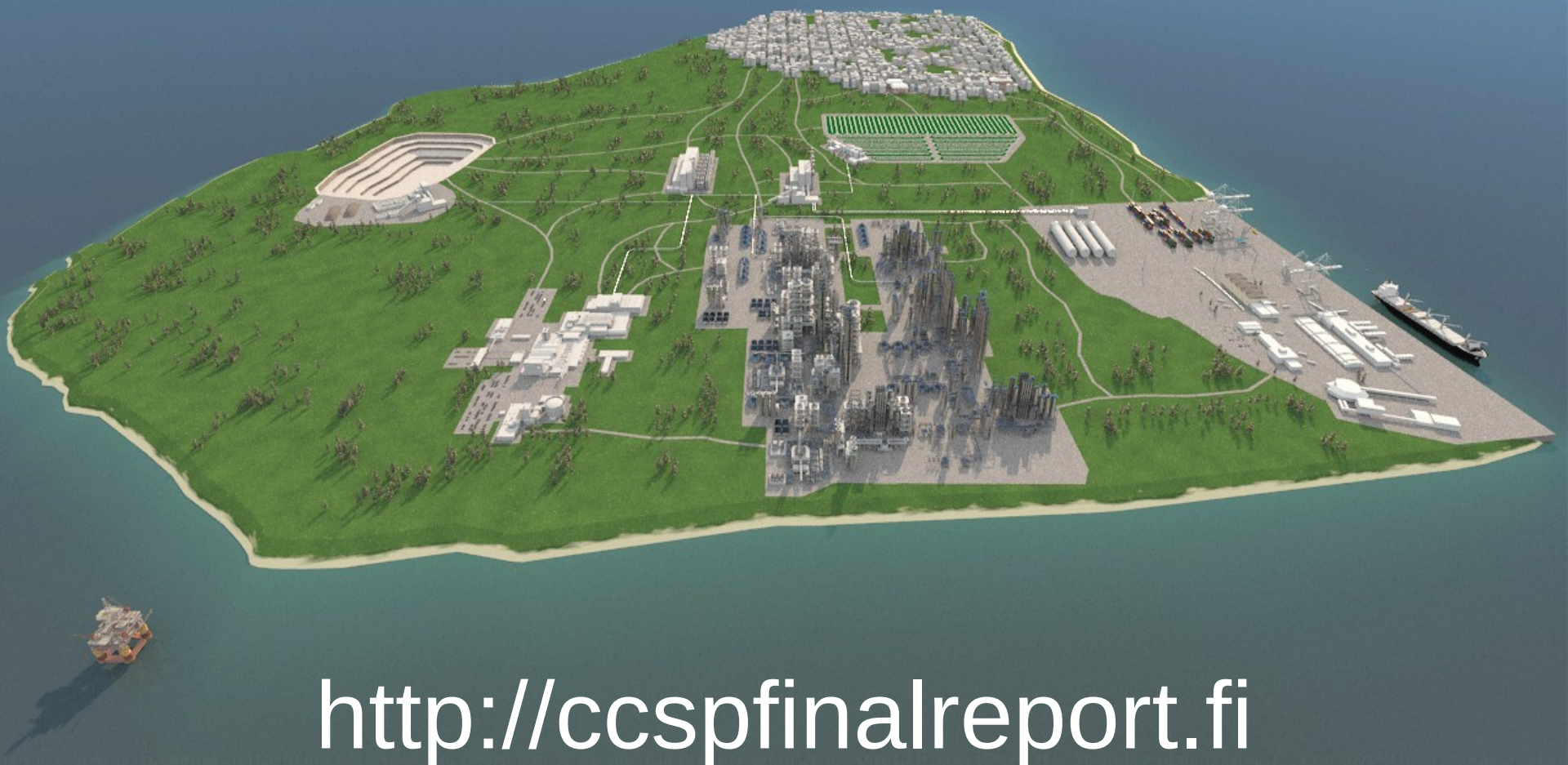

http://ccspfinalreport.fi

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Thank you!