



Norcem CO₂ Capture Project

Technical Meeting - CSLF 28. October 2014

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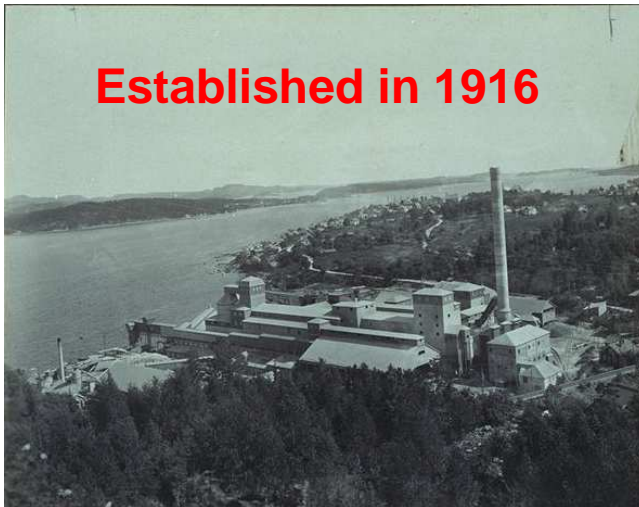
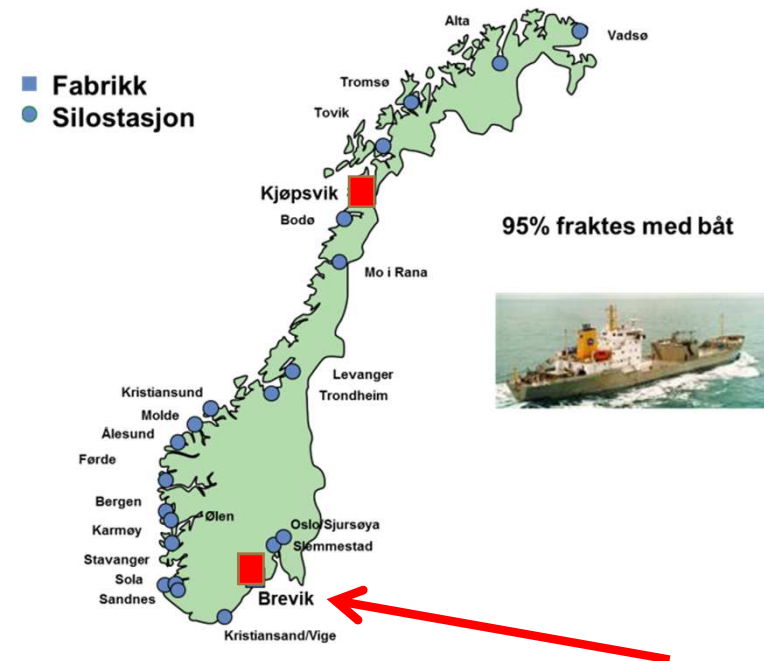
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■ Norcem CO₂ Capture Project

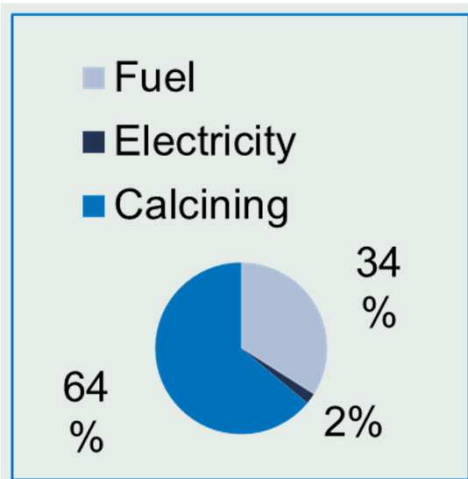
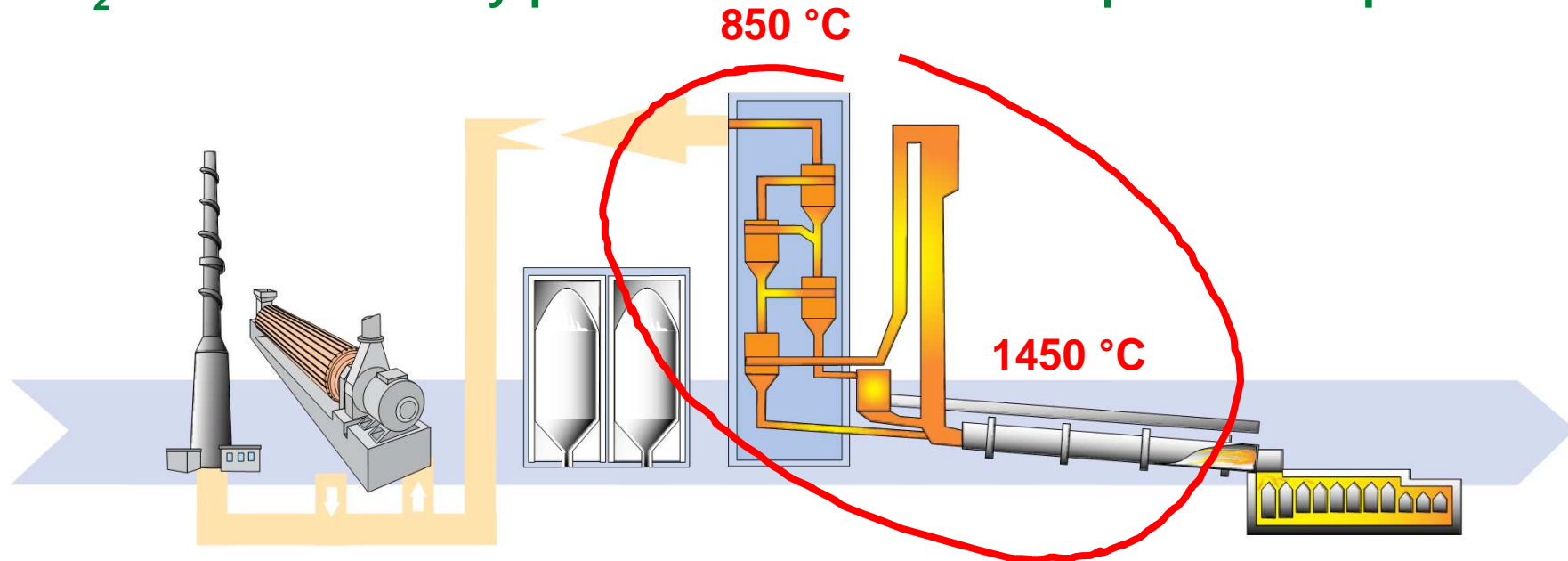
- **Project launched in May 2013 - plan to conclude in Mar 2017**
- **Project on behalf of the European Cement Industry!**
- **Partners:**
 - **Norcem**
 - **HeidelbergCement**
 - **ECRA (European Cement Research Academy)**
 - **- Role: Technical support & dissemination of project results**
- **Total budget: 93 M NOK (11.7 M €)**
- **Gassnova / Climit-Program: 75 % funding**

Norcem Brevik

- Established: 1916
- Middle sized cement plant → 1.3 mill tons/ year
- One of the most modern cement plants in Europe
 - Utilisation of alternative fuels: 60 % → 75 %
 - Equipped with SO_x- and NO_x-scrubbers



CO₂ – Unavoidable by-product from the cement production process



Two CO₂ sources:

- 1) 2/3: Raw Materials ($\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2\uparrow$)
- 2) 1/3: Fuels (Cyclone Tower & Kiln System)

Norcem Brevik: ~ 800 000 t CO₂ annually

Mandate and main objectives

■ Small scale test centre

■ Studying and comparing four different CO₂ capture technologies.

- Various stages of development

■ Qualification of technologies:

- Determine how suitable these are for implementation in modern cement kiln systems.

■ Transport and storage is not part of the study


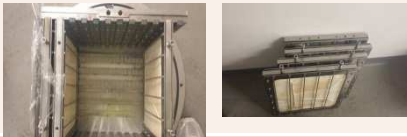


■ Important focus areas:

- CO₂ Capture rate, energy consumption, performance impact due to flue gas impurities, costs (CAPEX/ OPEX), space requirement

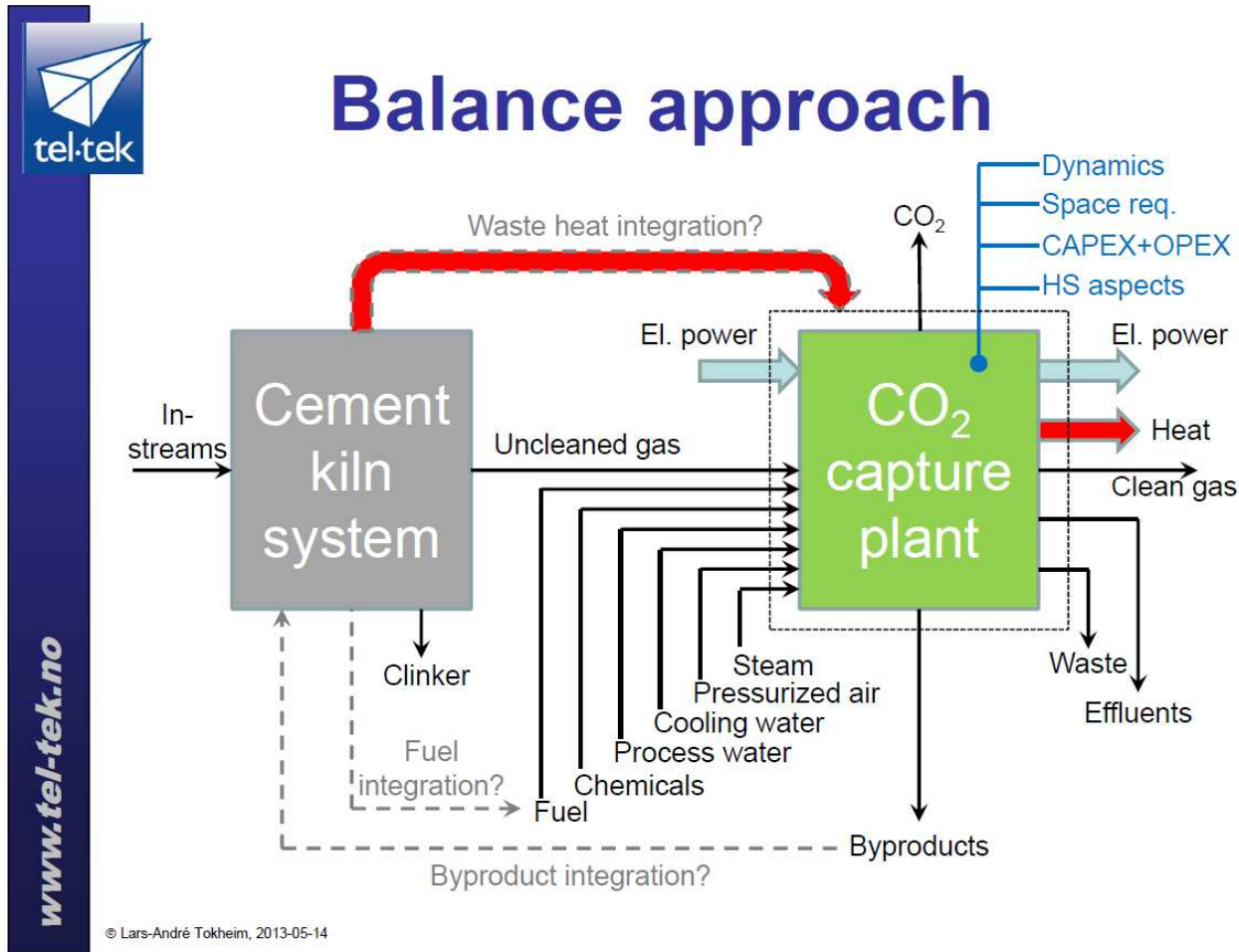
■ Full Scale Perspective

- Utilization of waste heat
- Full scale not necessarily 100 % capture

The four post-combustion capture technologies

Technology	Provider/ Developer	Comments
<p>Amine Technology 1st gen. Mobile test unit (MTU) - Capacity: 2000 t CO₂/year</p>	<p>Aker Solutions</p> 	<ul style="list-style-type: none"> • 6 months test program (May – Oct 2014) • 90% capture, RBD: ~3,0-3,2 MJ/kg CO₂ • Low degradation, low emissions • <u>Next step:</u> Commercialization?
<p>Membrane Technology 3rd gen 20” test pilot, Membranes from NTNU</p>	<p>DNV KEMA, NTNU & Yodfat Engineers</p> 	<ul style="list-style-type: none"> • 6 months test program (May-Oct) • Capture Performance: 60-70 % CO₂ • <u>Next step:</u> On hold!
<p>Solid Sorbent Technology 3rd gen Bench scale Fluidized bed unit Poly-imide based sorbent</p>	<p>RTI</p> 	<ul style="list-style-type: none"> • 3-months test program (Apr-Jun 2014) • Sorbent loading: 5-7 wt% • <u>Next step:</u> • 3-floor pilot (2016) • Long term performance testing • New sorbents (sorbent loading: 9-11 wt%)
<p>Calcium Looping 2nd gen Test campaigns with 200 kWth pilot (University Stuttgart)</p> <p>Slide 6 – March 2013 Liv Bjerge</p>	<p>Alstom Power</p> 	<ul style="list-style-type: none"> • 1 year program • Limestone from Norway • Limestone reactivity/ degradation over time • <u>Next Step:</u> • Not decided but logical next step - larger demonstration pilot to be tested on real conditions

Benchmark Study | Commercial Scale Perspective



Conclusions

- **4 post-combustion technologies are demonstrated**
- **Major part of planned testing is completed**
 - RTI continue into a phase II
 - Membranes on hold!
- **Benchmark Study – Important outcome of the project – Comparison of technologies in a commercial scale perspective.**
- **Before summer 2015 Norcem will have much more knowledge regarding the realism of industrial carbon capture; especially in the cement industry**
 - Benchmark Study will be updated after RTI Phase II



Thank you for your attention!