# GreenCEM Highlights of technical solution

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#### Demo-scale and full-scale CO<sub>2</sub> capture on kiln 87

- > Aalborg Portland has 6 cement kilns
  - > 5 kilns producing white cement
  - > 1 kiln producing grey cement
- Grey cement Kiln (called Kiln 87)
  - > Producing grey cement
  - 1.1-1.2 mio. ton CO<sub>2</sub> per year (~50% of Portlands emissions)
- > Requirements for the solution
  - > Technical feasible and mature
  - > Integration to existing plant
  - > Two designs
    - > Demo: 200,000 ton/year
    - > Full-scale: 1,000,000 ton/year (90% capture efficiency)







# Amine capture technology

the only technical mature solution at this scale



Total energy demand for Kiln 87 min. 100 MW steam

- Heat recovery from hot flue gas
  - > White cement kilns: Flue gas ok
  - > Grey kiln: Flue gas too cold
- > Heat recovery of kiln radiation heat

# Heat recovery - White kiln flue gas systems

#### Total of 20 MW possible involving all five lines



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## Heat recovery – kiln radiation

- Configuration:
  - > Shell heat exchanger, water as medium
  - > Thermoelectric system
- > Roughly estimated ~20 MW total all kilns to be recovered.
- > Technology for producing steam not commercially available.
- > Possible but research project in itself



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# Heat integration

how do we find 100 MW of heat for steam production?

- Highly complex solution to cover at best 40% of the demand
- Heat recovery from white kilns require all kilns in operation at the same time
- Radiation heat recovery is technical inmature and also requires all kilns in operation.





## Three realistic options for generating 100 MW steam

Cooling water CO<sub>2</sub> capture unit as. Cooler Cooling wat Heat pump 'oole Lean/rich heat exchange Steam Lean solvent pump Electric boiler Gas fired boiler Advanced heat pump •Relatively cheap Relatively cheap Expensive •Can use renewable power •Can use biogas

• Expensive operation

- •Expensive operation
- •Emit CO<sub>2</sub> -> requires larger capture plant

- •Not fully mature, but individual components well proven
- Use only around 35 MW power



Power

## Example: E-boiler



#### Layout - Local liquefaction and interim storage

CO<sub>2</sub> pipeline

Fluegas condensate storage & treatment

#### CO<sub>2</sub> capture unit

CO<sub>2</sub> storage tanks

CO<sub>2</sub> compressor and liquefaction Fluegas condenser

Tteam production

Cooling towers

CC process equipment electrical & controls

Existing kilns

#### We are partner on several large scale CCS projects Selected flagship projects



COWI og Citec skal bidra til å realisere karbonfangst i Oslo

Klementrud: Carbon capture, transport and storage

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#### Vestforbrænding intensiverer sin CO2-indsats

Vestforbrænding, som længe har arbeidet med at mindske udledningen af CO2, intensiverer nu sin indsats. Det sker over en bred front med fangst, lagring og medvirken til udvikling og brug af nye teknologier - herunder Power-to-X. Og det vil ske i et tæt samarbejde med både private og offentlige aktører. Rådgivningsvirksomheden COWI er en af de samarbejdspartnere, der skal medvirke til at realisere Vestforbrændings ambitioner om at stå klar allerede i 2025.



Vestforbrænding: Carbon capture, transport and storage



Green Fuels for Denmark: Carbon capture and power-to-x



Technical Director, Ph.D.

More than 20 years of experience in the energy sector. Deep insight into leading Green Hydrogen and CCU

projects in DK (i.e., electrolysis, power-to-x and carbon capture).

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