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european cement research academy

ECRA's CCS Oxyfuel Project

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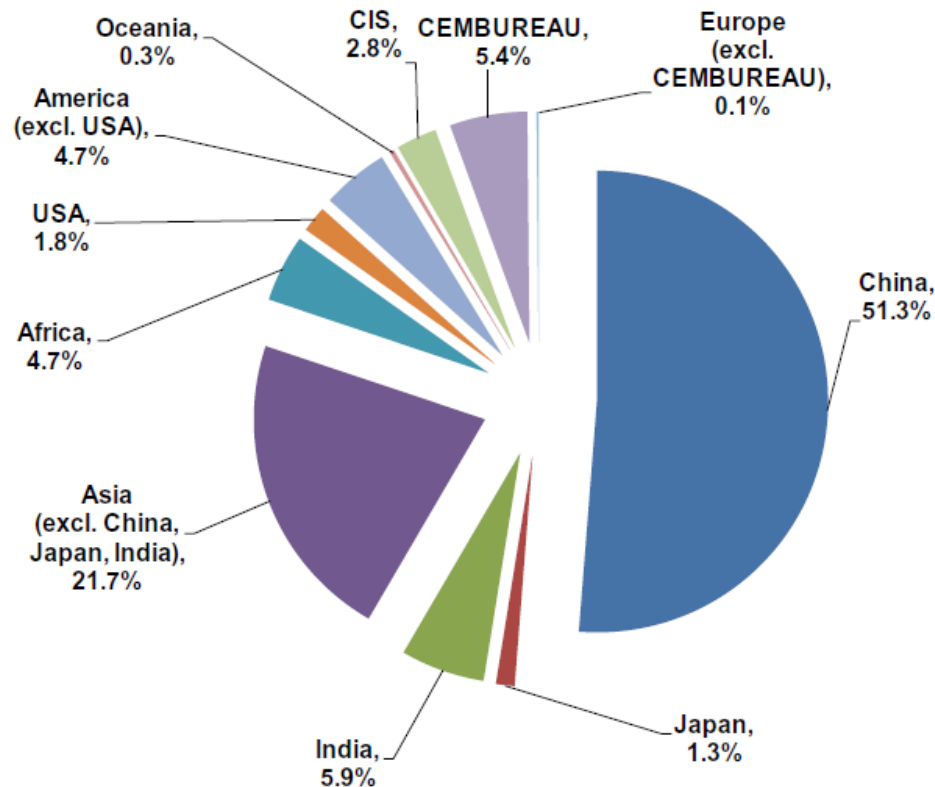
European Cement Research Academy

Finance for Innovation: Towards the ETS Innovation Fund

Brussels, 06 April 2017

World cement production 2015

World cement production 2015,
by region and main countries, %
4.6 billion tonnes

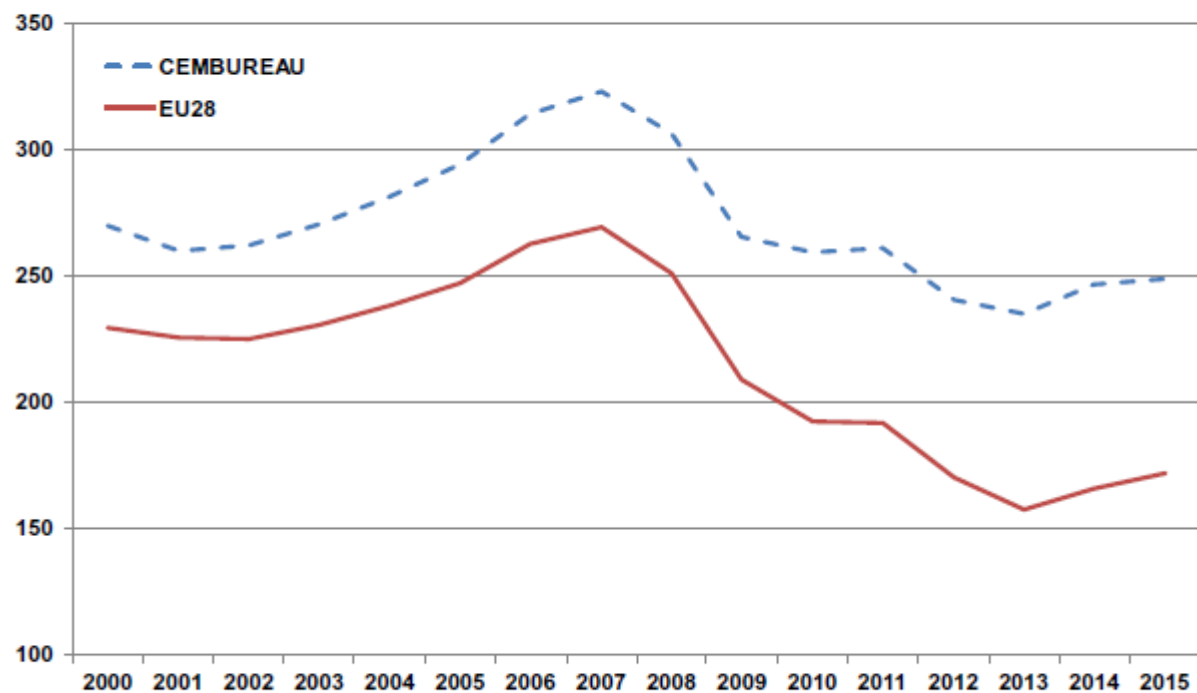


Source: CEMBUREAU

- The global cement production is currently > 4.6 Gt/a - cement is the second-most consumed substance on earth after water.
- The global CO₂ emission from the cement industry contributes to >7 % to the anthropogenic CO₂ emissions.
- More than 60 % of the direct CO₂ emissions are raw material generated - the rest is due to the combustion process.

Cement production in Europe

**Cement production in CEMBUREAU and
EU28 countries**
Million tonnes

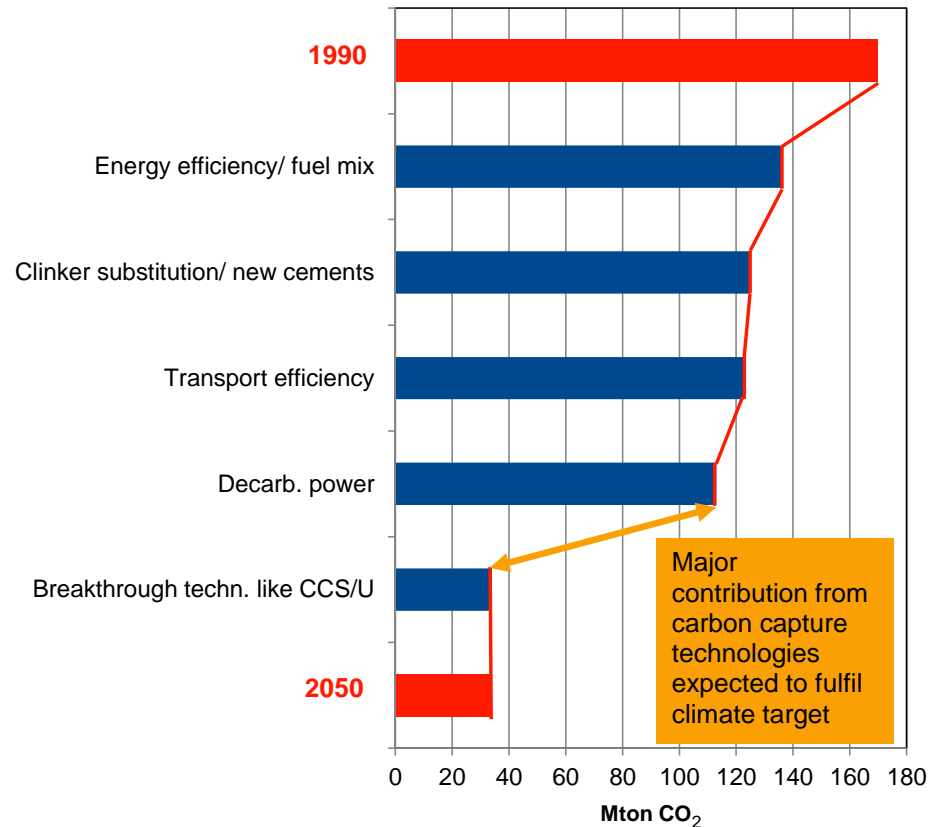


Source: CEMBUREAU

Cement production in Europe has decreased from 270 mio.t in 2007 to 170 mio. t in 2015

Why carbon capture in the cement industry?

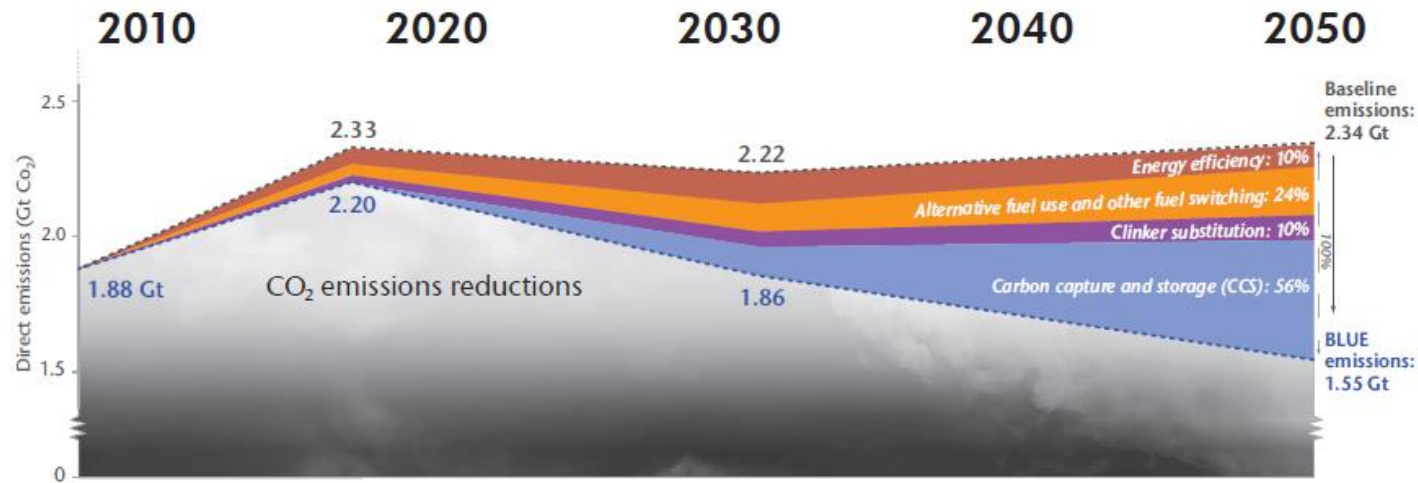
- All low-carbon roadmaps require a significant reduction of CO₂, also in the cement sector.
- Correspondingly and according to CEMBUREAU roadmap approx. 60% of cement plants in the EU will have to be equipped with CCS technology by 2050.
- Based on the need to develop this breakthrough technology, ECRA is investigating its technical and economic feasibility in its CCS research project.



IEA Cement Technology Roadmap - CO₂ reduction options



Cement Technology Roadmap 2009
Carbon emissions reductions up to 2050

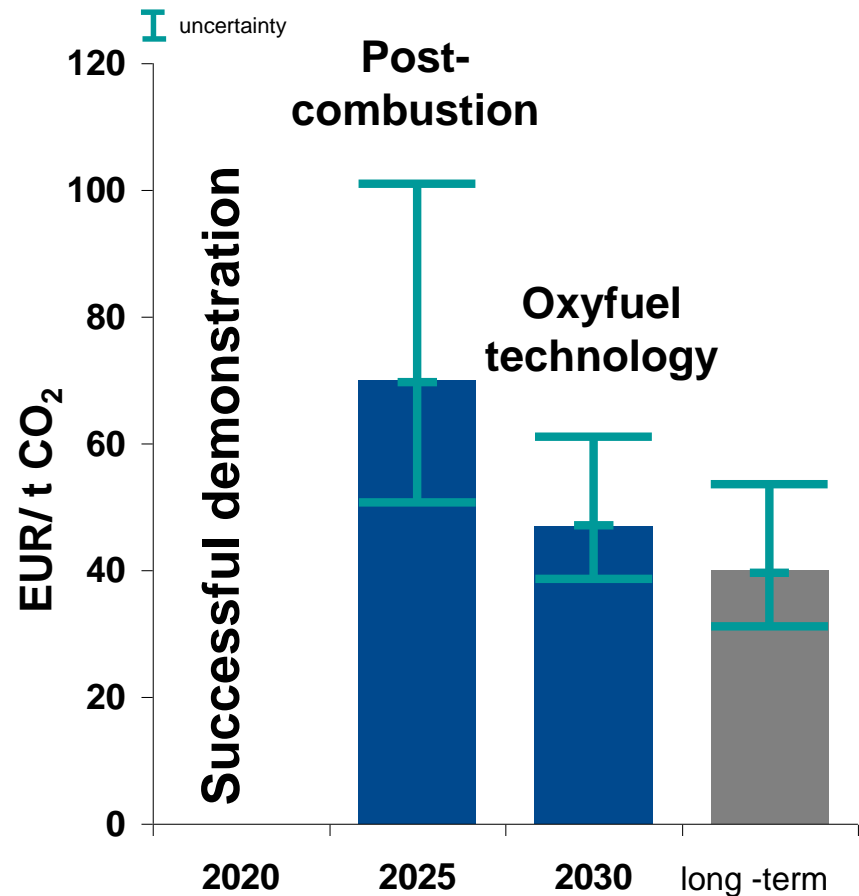


IEA target for 2050: 50 % of all cement plants in Europe, Northern America, Australia and East Asia apply CCS

Source: IEA

Challenges of carbon capture

- Significant increase of production costs
- Currently, the legal and economic conditions of these technologies would impair the competitiveness of cement production.
- CO₂ storage or reuse strategy and infrastructure
- **Oxyfuel** still requires piloting and demonstration
- **Post-combustion** requires further development of high performance capture materials to reduce energy demand

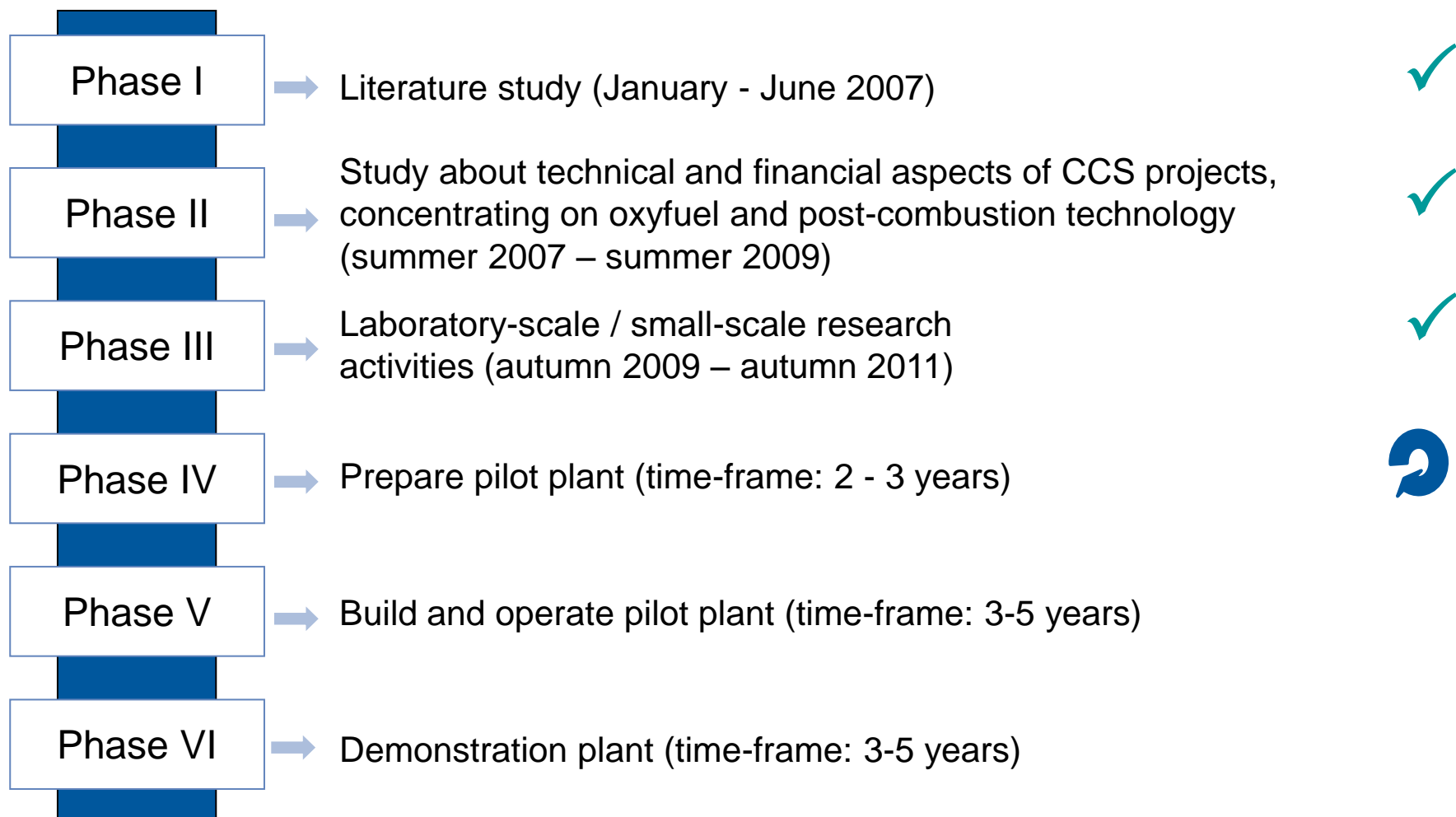


European Cement Research Academy

- The cement industry in Europe: a highly innovative sector, underlined by the establishment of ECRA in 2003.
- Members of ECRA: 47 cement manufacturers, associations and technology providers from mainly European but also non-European countries.
- Internationally recognised European research body in cement and concrete technology.
- Collaboration in R&D of technology providers and cement manufacturers to bring innovative products and improved manufacture processes to the market.
- Interrelations with associations to communicate the cement industry's activities.



ECRA's approach towards carbon capture



ECRA's decision for oxyfuel technology

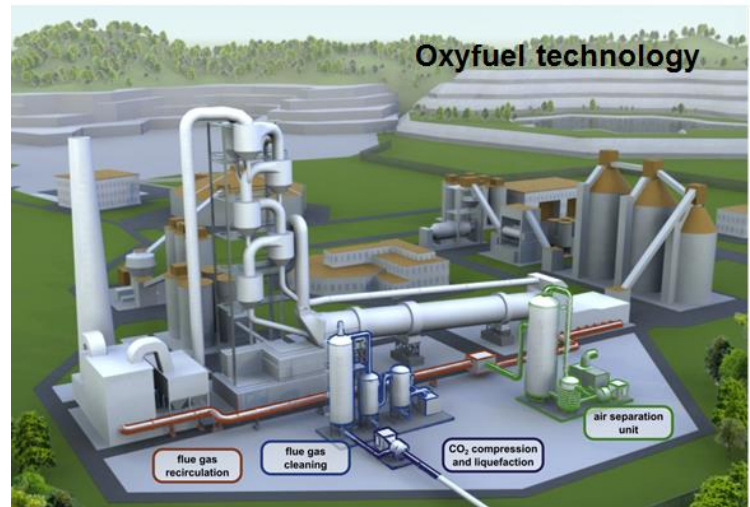
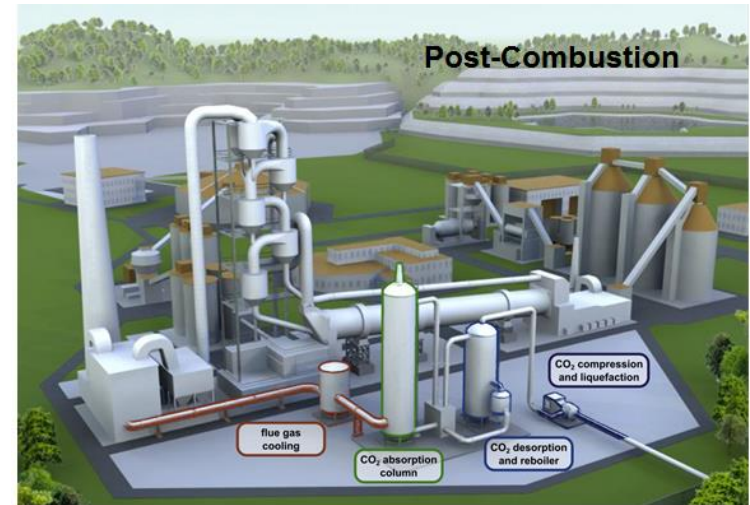
Postcombustion Technology:

ECRA decided not follow this route with own research, but to engage in the HeidelbergCement Brevik investigations

Oxyfuel Technology:

Combustion with pure oxygen instead of air in combination with flue gas recirculation to increase the CO₂ concentration.

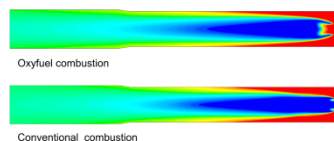
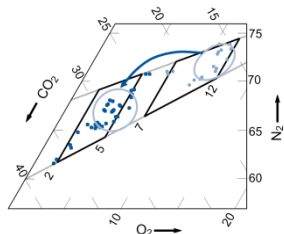
- Requires process and design adaptations.
- Within the ECRA project a complete design for an oxyfuel clinker burning process has been developed



Oxyfuel technology has been investigated in detail

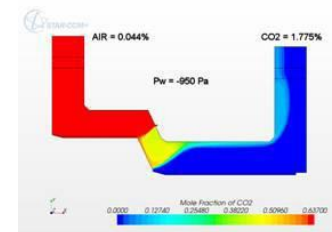
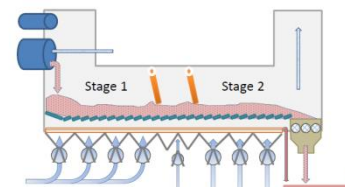


Plant operation and false air reduction

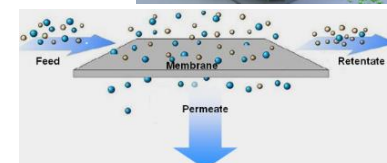
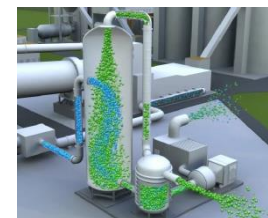


Burner design

Cooler design

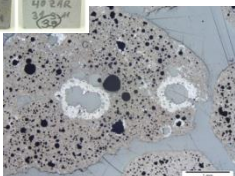


Future oxygen supply systems

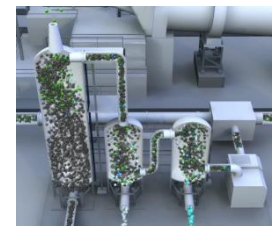


Source: Beilstein J. Org. Chem.

Refractory durability and material conversion



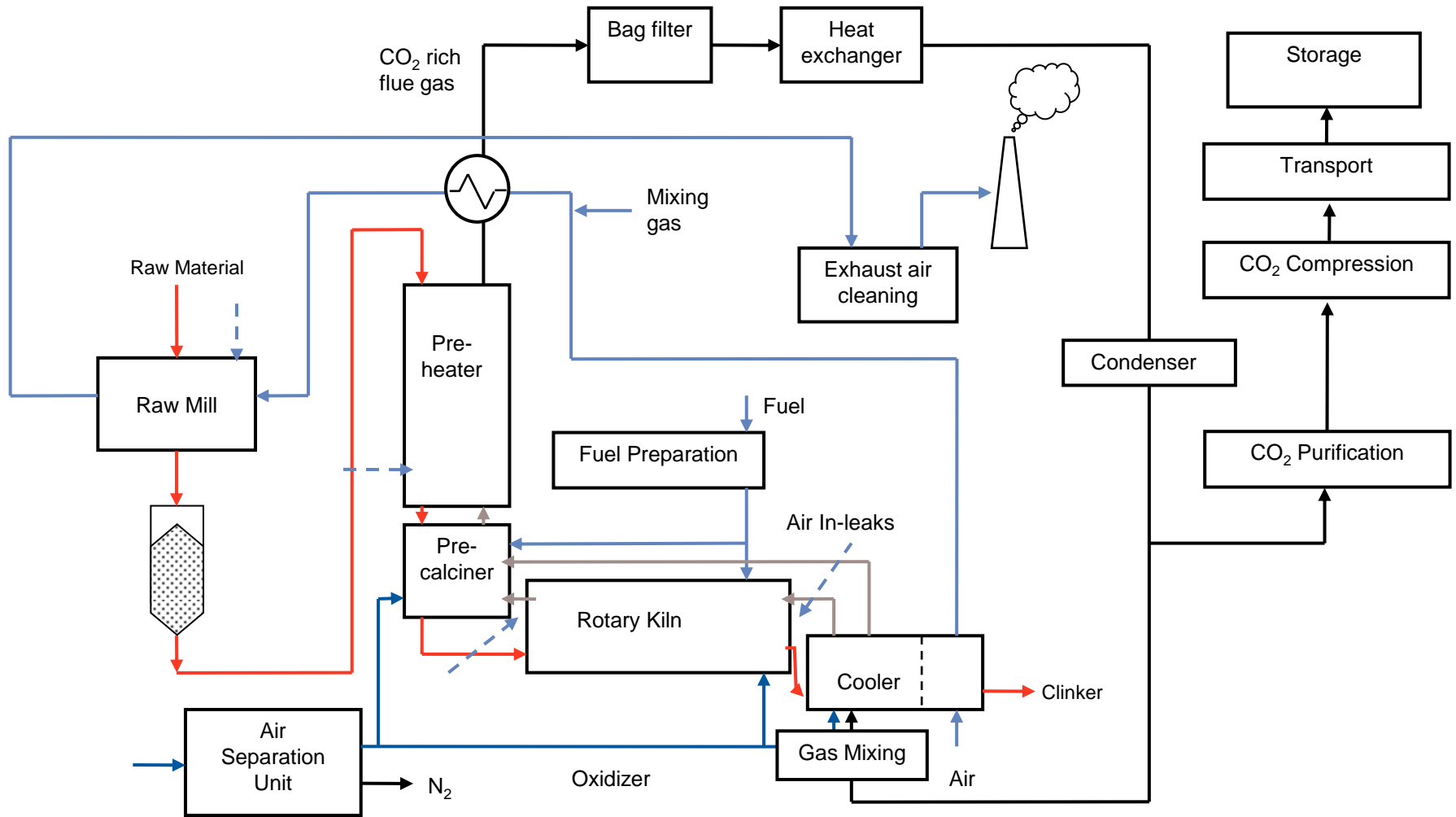
CO₂ conditioning unit



CO₂ reuse



ECRA's general layout of an oxyfuel cement plant



Concept of the oxyfuel pilot kiln

■ Design

- Blackfield: Retrofitting an old existing plant has been proven more feasible than “Brownfield” option

■ Production capacity: 500 - 1500 tpd

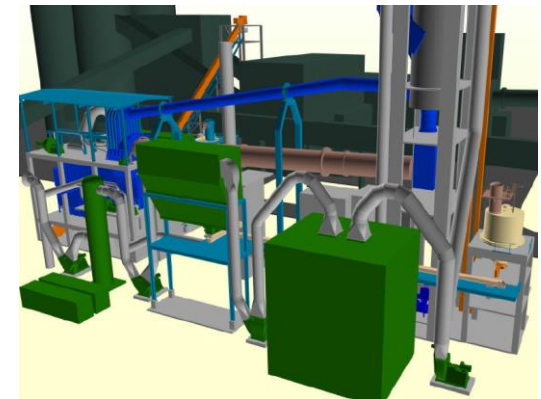
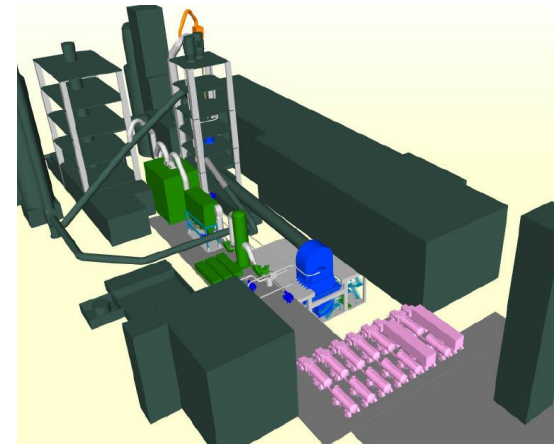
■ Feasibility

- Technological risk medium to low
- „New“ units (e.g. condenser) can be adapted from other industries

■ Expected project costs: 60 – 90 mio. €

■ Time schedule

- Engineering and construction: 20 – 24 month
- 1-2 years project period



source: ThyssenKrupp Industrial Solutions

Site selection process for the oxyfuel pilot plant

- Several plant audits have been carried out by ECRA experts.
- A ranking of seven potential sites has been carried out.
- Opportunity studies for potential sites in different European countries have been carried out by ThyssenKrupp Industrial Solutions.
- Brown-field as well as black-field projects have been evaluated
- 2 possible options:
 - simple vs complex case (0/100% AF)
- Currently potential sites in Austria and in Italy are under investigation.



Questions from the Organizer

- ***What are the technology innovation needs?***

- From many studies and roadmaps carbon capture has turned out to be the only breakthrough technology for a significant CO₂ emission reduction
- The Oxyfuel technology is readily developed and needs to be demonstrated
- Question of CO₂ storage and/or use to be clarified

- ***How to make the low-carbon innovation happen?***

- ECRA is currently searching for an appropriate plant/location for a demonstration project
- With 60-90 Mio.€ the project (CAPEX and OPEX) is so large that it cannot be covered by a cement company => significant funding is needed

- ***How could Innovation Fund help?***

- Support with regard to financing details/instruments
- Funding (???)



Questions?



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