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european cement research academy

# **ECRA's cement carbon capture project**

Martin Schneider

ECRA/CEMCAP/CLEANER Workshop  
Brussels, 17 October 2018

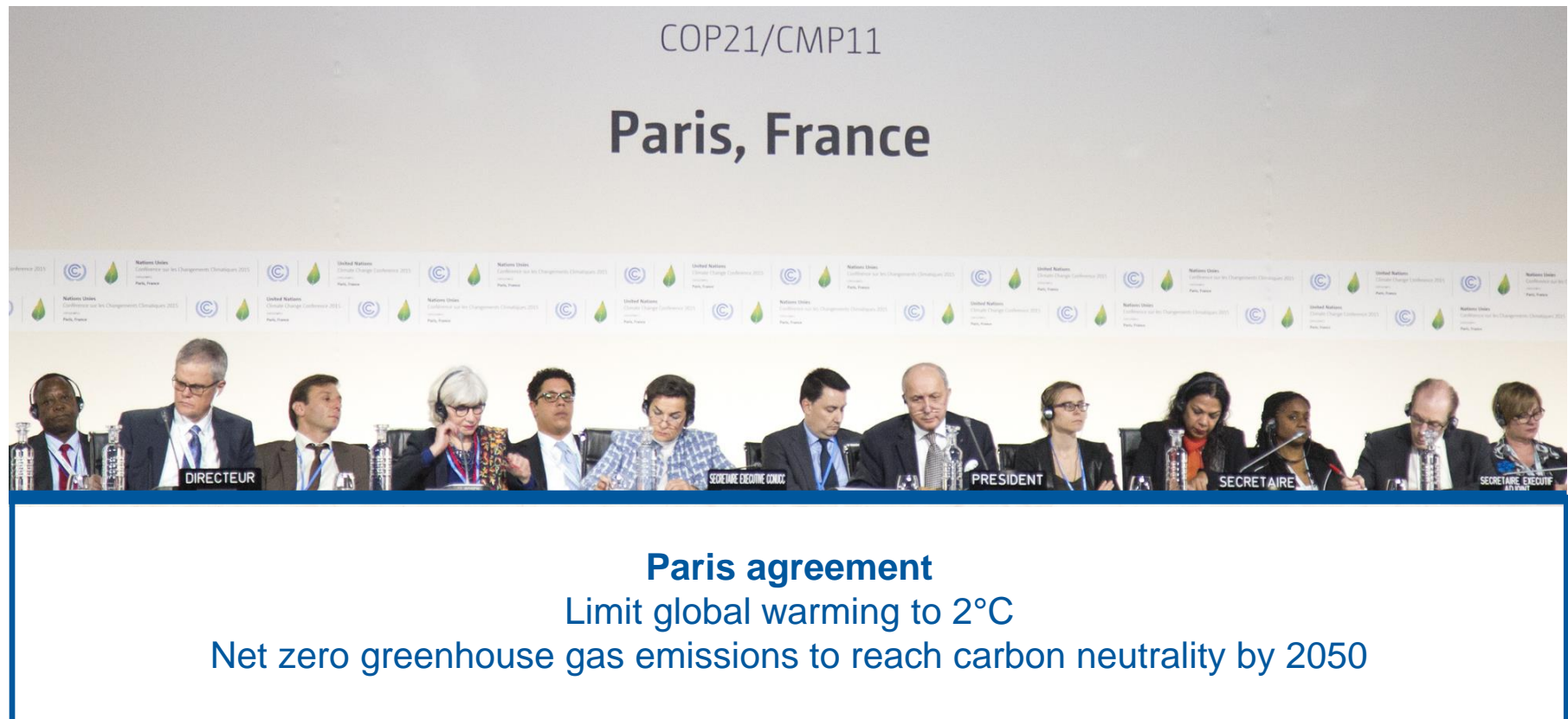
# ECRA: The European Cement Research Academy

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**ECRA is an internationally recognised European research body in the field of cement and concrete technology.**

- ECRA was founded in 2003:
  - as a platform to stimulate and undertake research activities in the context of the production of cement and its application in concrete
  - to facilitate and accelerate innovation to guide the cement industry by creating and disseminating knowledge from research.
- ECRA initiates and provides seminars and workshops teaching state-of-the-art knowledge on cement and concrete technology and communicating the latest research findings
- ECRA undertakes dedicated research projects
- ECRA focuses on issues which individual companies may not be able to tackle alone and are of major importance to the cement industry as a whole
- ECRA currently has a membership of over 45 cement producers, associations and equipment suppliers worldwide

# Climate policy context



# Technology Roadmaps of the cement industry

## WBCSD IEA Cement Technology Roadmap 2009

**Cement Technology Roadmap 2009**  
Carbon emissions reductions up to 2050

World Business Council for Sustainable Development (WBCSD) and International Energy Agency (IEA)

Development of State of Manufacturing: Trying to (CSI/ECRA-Technology P...)  
Duesseldorf, Geneva, 4 June 2009

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### Regional Roadmaps

**Existing and Potential Technology Carbon Emissions Reductions in the Indian Cement Industry**

A set of technical papers produced for the project 'Low Carbon Technology Roadmap for the Indian Cement Industry'

WBCSD, IEA, CII, IFC

**India 2013**

**Technology Roadmap**  
Low-Carbon Technology for the Indian Cement Industry

wbcsd, IEA

**The role of CEMENT in the 2050 LOW CARBON ECONOMY**

**Europe 2013**

THE EUROPEAN CEMENT ASSOCIATION

**Policy Roadmap for the Low-Carbon Egyptian Cement Industry**

**Egypt 2016**

Contract number: C31840/SEMD-2015-07-21

Egypt: Technology and Policy Scoping for a Low-Carbon Egyptian Cement Industry

**Cement Technology Roadmap Brazil 2016/17**

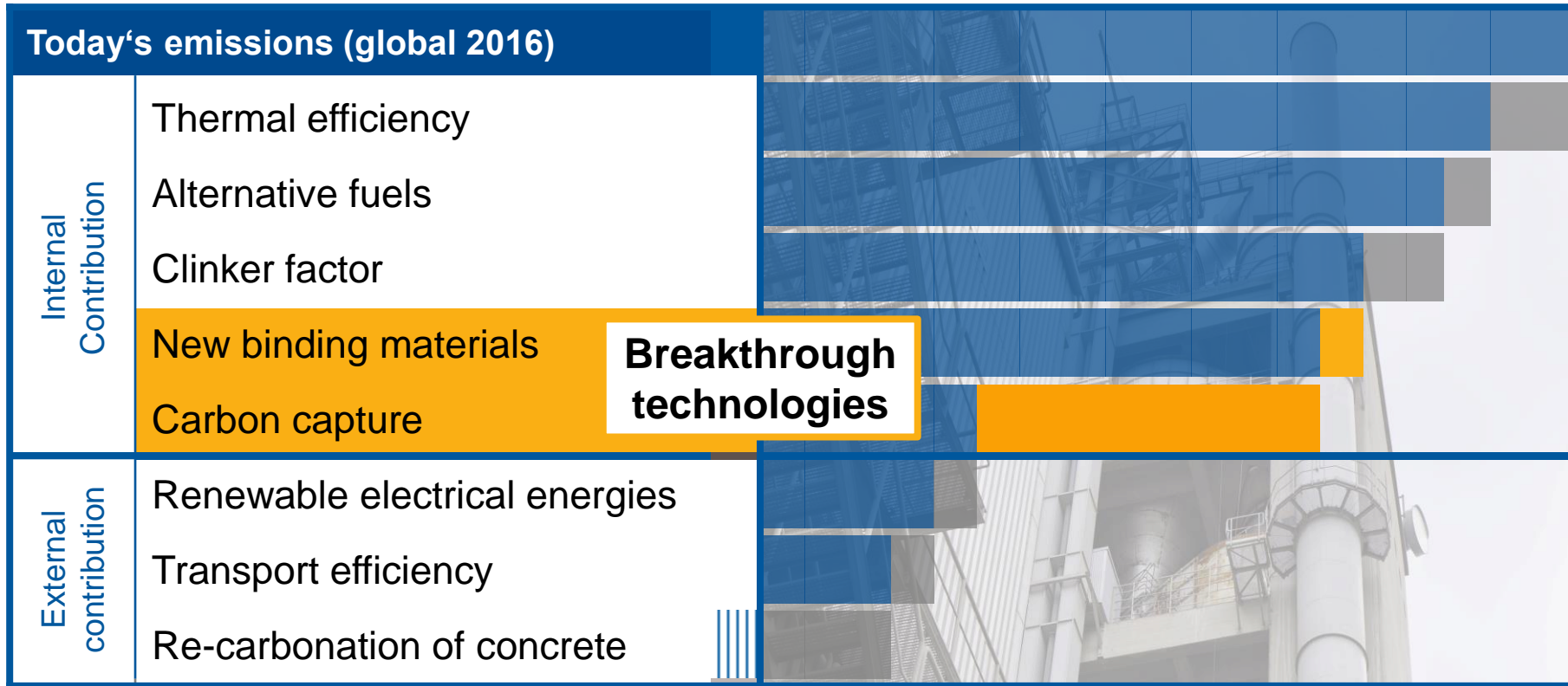
State Policies on

- Several states in Brazil are establishing state regulation
- Goal: Elaborate an internal mapping, with consensus of the industry, portraying the real potential
- Guide for decision makers
- Cooperation between CSI, SNIC, ABCP, IEA, IFC
- Timeframe: 18 months

Map of Brazil showing state policies: Target Set, Law Approved, Bill, Nothing.

European Bank for Reconstruction and Development

# Net zero greenhouse gas emissions - cement production

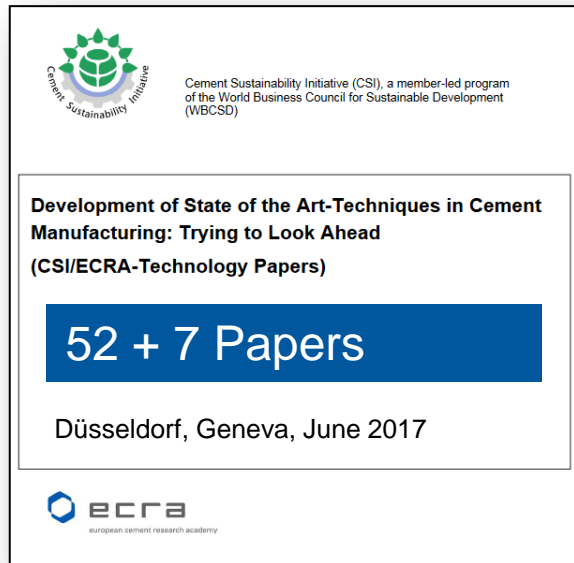


Schematic figure.









\*) Global CO<sub>2</sub> estimate is subject to data constraints.

# ECRA cooperation in EU CO<sub>2</sub> capture research projects

## CSI ECRA Technology Papers 2017

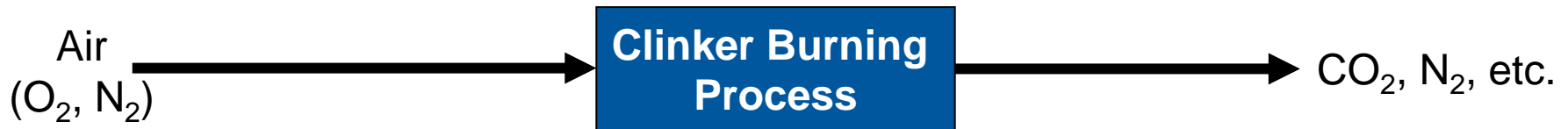


## Current R&D in capture technologies:

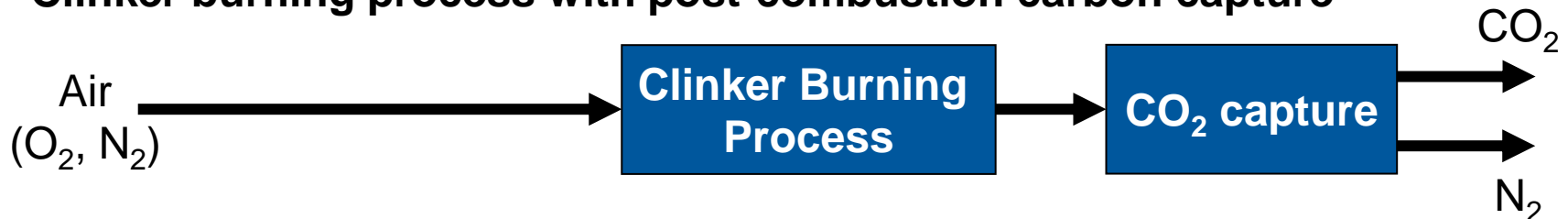
- Oxyfuel carbon capture technology  
ECRA project and:  
- Post-combustion capture technologies
  - Absorption technologies:  
  - Calcium Looping:  
  - Algae capture
- Indirect calcination:  

# CCS technologies for the cement industry

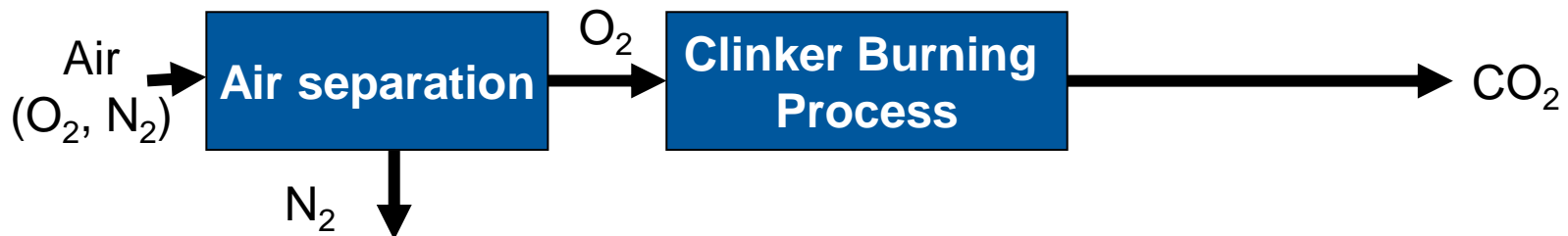
## Conventional clinker burning process



## Clinker burning process with post-combustion carbon capture



## Oxyfuel clinker burning process





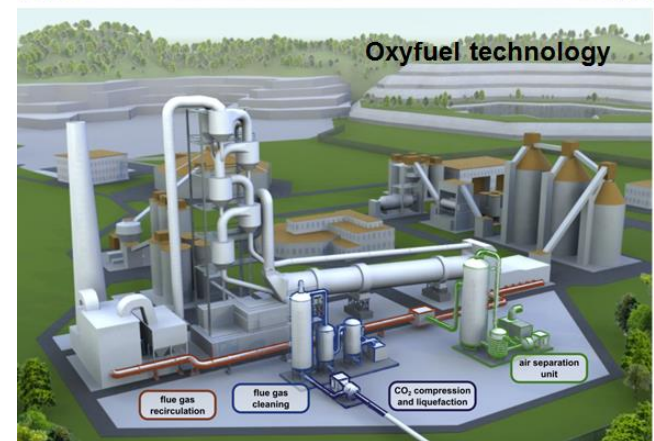
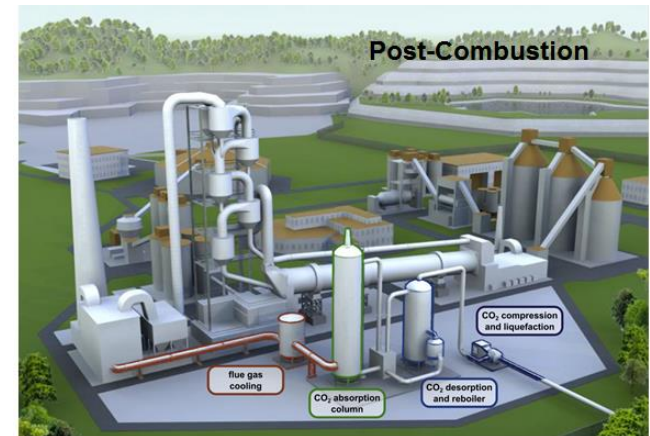
# Potential capture solution for the cement industry

**Post-Combustion:** Tail-end separation of CO<sub>2</sub> from flue gas by e.g. chemical absorption, adsorption, membranes or Ca-looping.

- A very energy-intensive technology.
- Important projects: Norcem's Brevik project (pilot testing), CEMCAP (prototype testing).

**Oxyfuel Technology:** Combustion with pure oxygen instead of air in combination with flue gas recirculation to increase the CO<sub>2</sub> concentration.

- Requires process and design adaptations.
- Important projects: ECRA (complete oxyfuel), LafargeHolcim/ AirLiquide/ FLSmidth (pilot testing of partial oxyfuel), CEMCAP (prototype testing).



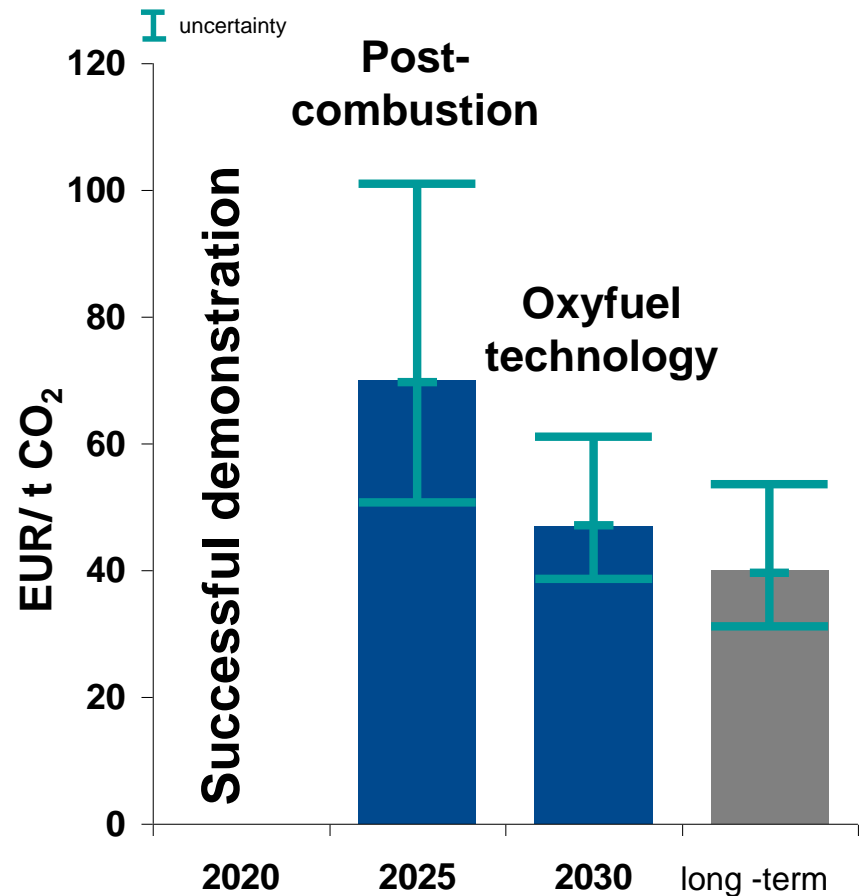


# CCS in the cement industry: Two options

Issue	Oxyfuel Technology	Post-combustion capture
Concept	Integrated concept	End-of-pipe technology
Effect on cement kiln operation	Process and material reaction is influenced	Minimal impact on existing cement kiln process
Development status	<p>Oxygen enrichment has been applied to cement kilns</p> <p>Oxyfuel technology still requires some R&amp;D, but ready for demonstration</p>	<p>Commercially available in other industry sectors</p> <p>Pilot-scale testing in cement industry initiated</p>
Time horizon for commercial application	not before 2025	not before 2020
CO <sub>2</sub> purity	CO <sub>2</sub> from the combustion (~ 85 vol.%) process is concentrated and purified in CO <sub>2</sub> purification unit (CPU)	Pure CO <sub>2</sub> stream for compression (90 -99 vol.%)
Energy demand	<p>Doubling of power demand per tonne of cement produced</p> <p>Thermal energy demand could be reduced</p>	Doubling of electrical and thermal energy demand per tonne of cement produced

# Challenges of carbon capture

- Significant increase in production costs
- Currently, the legal and economic conditions of these technologies would impair the competitiveness of cement production
- CO<sub>2</sub> storage or reuse strategy and infrastructure
- Oxyfuel still requires R&D
- Post-combustion requires further development of high-performance capture materials to reduce energy demand

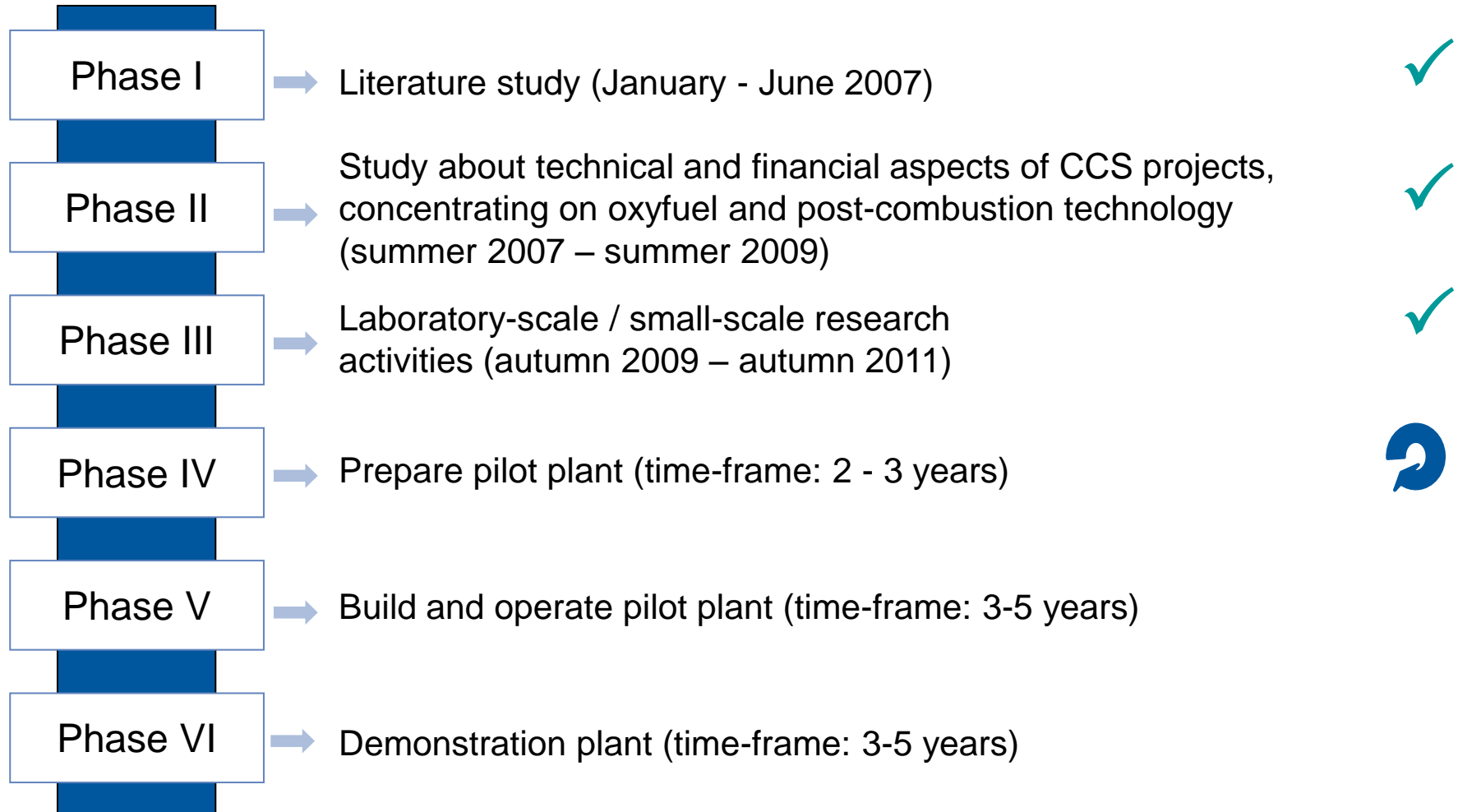


# Post-Combustion: The Norcem Project

- Testing of Post-Combustion technologies in industrial surrounding:
  - Solid sorbents
  - Amine
  - Membrane
  - Calcium Looping
- Period: 2013 - 2016
- Evaluation concerning:
  - Suitability
  - Energy demand
  - CAPEX/OPEX
  - Capture rates
- Perspective: 40 – 50% capture rate based on waste heat utilisation



# ECRA's approach towards carbon capture



# Organisation of the CCS project

## Steering Committee

Buzzi Unicem

Cimpor

HeidelbergCement

MPA

Schwenk

Titan

CEMBUREAU

CRH

Italcementi

Norcem

Secil

VICAT

CSI

LafargeHolcim

PCA

thyssenkrupp Industrial Solutions

VDZ

## External project partners

Aixergee

Danish Technical University

IKN

Praxair

Cinar

Fives FCB

IrishCement

Refratechnik Cement

## Cooperations

University of Mons

Norcem Projekt

CEMCAP



Quelle: Springerprofessional

# ECRA cooperation in EU CO<sub>2</sub> capture research projects



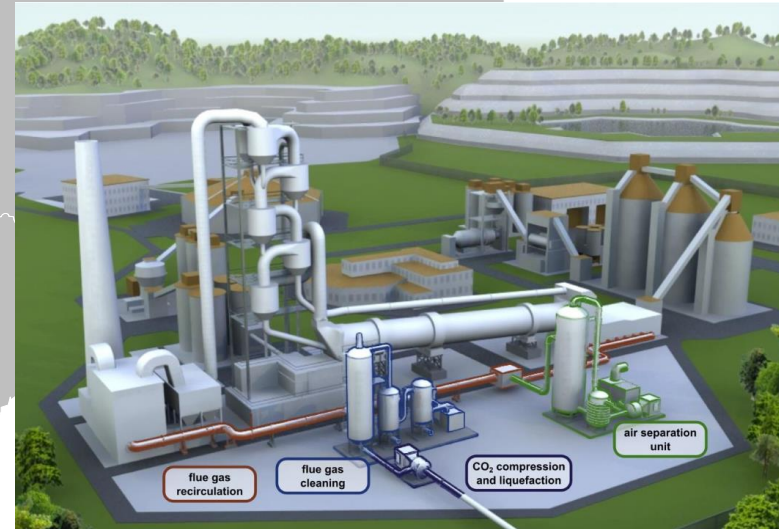
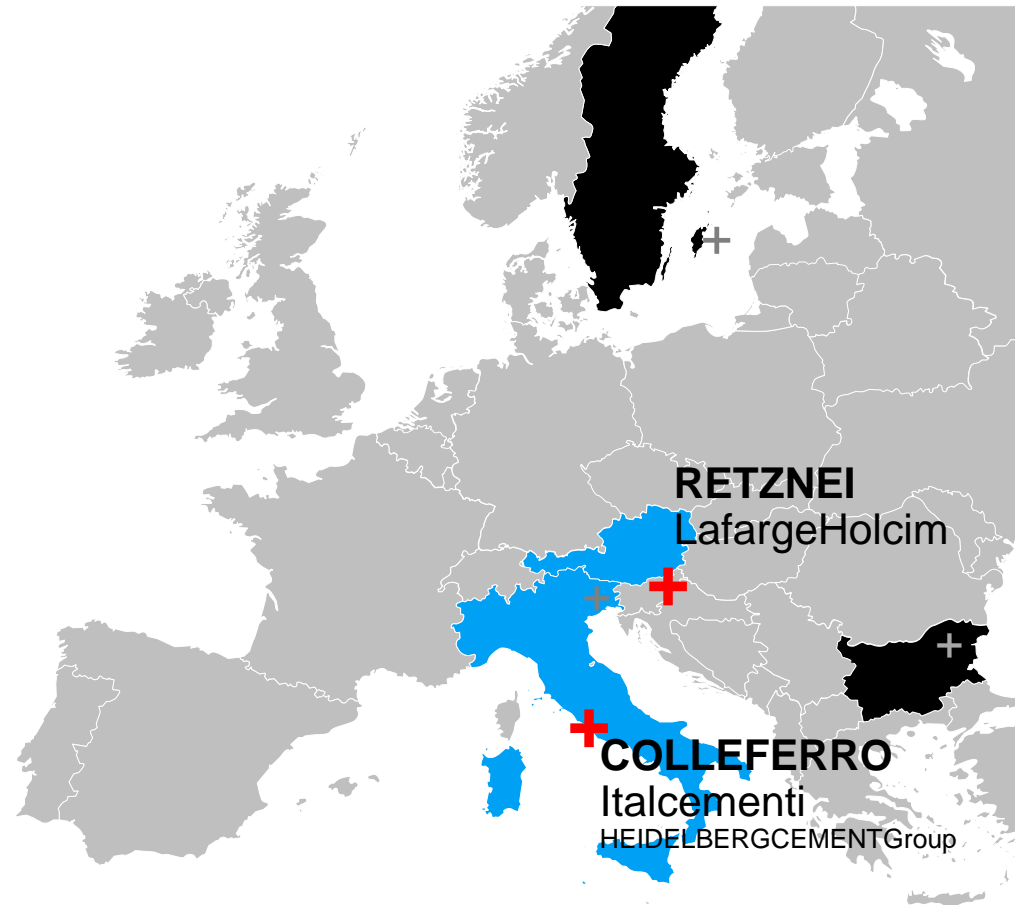
- Oxyfuel carbon capture technologies for the cement industry based on ECRA project
- 2016 to 2018: Testing of key technologies under cement industry conditions
- Successful demonstration of key oxyfuel technologies; advancement to technological readiness level (TRL 6)

## Next step:

Demonstration of a complete oxyfuel capture system prototype in a cement plant (TRL 7 and 8)



# Two cement plants are identified for the oxyfuel project



Industrial-scale carbon capture project  
ECRA press release January 2018  
<https://ecra-online.org/press-releases/>

Project in two phases to ensure oxyfuel prototype plant operation under different local and plant-specific conditions

# ECRA CCS Project: Current status and upcoming activities

- Site selection process for oxyfuel pilot project completed
- Required budget around 80 Mio. €
- Cement industry committed to sponsor a significant amount to the budget
- Significant funding from European or national funding schemes required
- Additional work packages assigned



## Industrial-scale oxyfuel kiln for carbon capture in the cement industry

### Project outline and proposal for funding

The European Cement Research Academy (ECRA), based in Düsseldorf, has a membership of over 40 leading cement producers, relevant equipment suppliers and cement associations worldwide. ECRA supports and conducts research activities on the production of cement and its application in concrete.

According to different abatement scenarios put forward in the roadmaps of the International Energy Agency and CEMBUREAU, the cement industry is expected to contribute to CO<sub>2</sub> mitigation globally by a set of several measures, among which CCS plays a key role. Against this background, ECRA has been working on carbon capture research since 2007 in a long-term project designed to examine the capture of CO<sub>2</sub> as a prerequisite for its safe geological storage or its utilisation for further applications. Today ECRA is in the position to build an industrial-scale oxyfuel kiln and wants to initiate a project in order to demonstrate and test this kiln for carbon capture in the cement industry.

Different phases of ECRA's CCS project have been successfully completed and certain parts of it have been investigated within a HORIZON2020 research project ("Cemcap"). The project has now advanced to the stage where definitive steps towards establishing an oxyfuel kiln can be taken. Such kilns are intended to provide insight into the industrial-scale operation of a technology which provides a high CO<sub>2</sub> concentration exhaust gas stream for carbon capture. In this project it is also planned to process a small part of the CO<sub>2</sub> to test its further utilisation. An important outcome of the ECRA project is, that the oxyfuel technology not only can be implemented at new installations but also as a modification to existing plants, as they are representative for the European cement industry.

However, the question of how to pursue the project further is not only a technical issue. Based on opportunity studies and in-depth technical feasibility studies, the investment and costs for the test phase will amount to around 80 M EUR. However, the high costs of the project cannot be covered by ECRA or its members alone. The cement industry has committed itself to contributing 25 M EUR. To cover the remaining part of the project's budget of around 55 M EUR, ECRA is now seeking substantial funding from European institutions and national governments.

Over the past months ECRA has examined the suitability of sites which could potentially be locations for oxyfuel kilns. From the five sites which were examined in depth, two were identified as the most suitable to host the project from a technical standpoint: the Colleferro plant of HeidelbergCement in Italy and the Retznei plant of LafargeHolcim in Austria. Both companies are committed to hosting their part of the project and to dedicating their respective resources to it.

Thank you for your attention!



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