UMONS
Université de Mons

ecra
european cement research academy

From CO_2 to Energy: CO_2 Capture and reuse in the cement industry

Second ECRA Chair Scientific Event

9-10th november 2016

University of Mons

POLYTECH MONS

Introduction by **Prof. Pierre DEHOMBREUX**

Dean

Faculty of Engineering - UMONS

Presentation of the ECRA Chair and of the Event

Prof. Diane THOMAS

Academic coordinator of the ECRA Chair

Chemical and Biochemical Process Engineering Unit

Faculty of Engineering - UMONS

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Creation *on 24th April 2013*

and prolongation *on 22th october 2015*

ECRA ACADEMIC CHAIR

FROM CO_2 TO ENERGY

of the ECRA Chair

Objectives of the ECRA Chair

Centre
of scientific expertise
in the specific field of
Carbon capture in cement production and its re-use

Promotion of research and innovation through:

→ PhD theses and Post-Doc
→ Projects for undergraduated students + ECRA Award
→ Scientific communications: papers, technical reports, congress participations
→ Scientific Events, industrial visits
→ Scientific collaborations and networking

Some ECRA Chair activities

Scientific Committee Meetings

Dusseldorf

Scientific Events

Mons, 2014

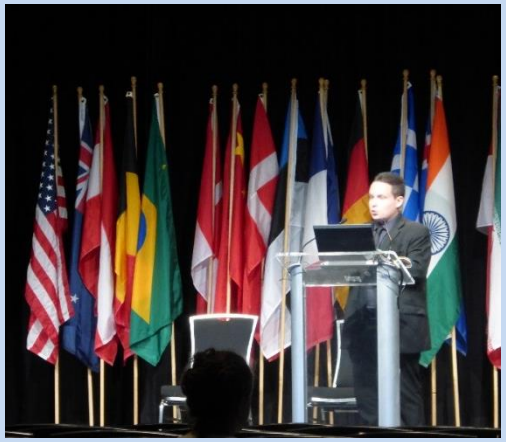
Lixhe, 2016

Visit of cement industries

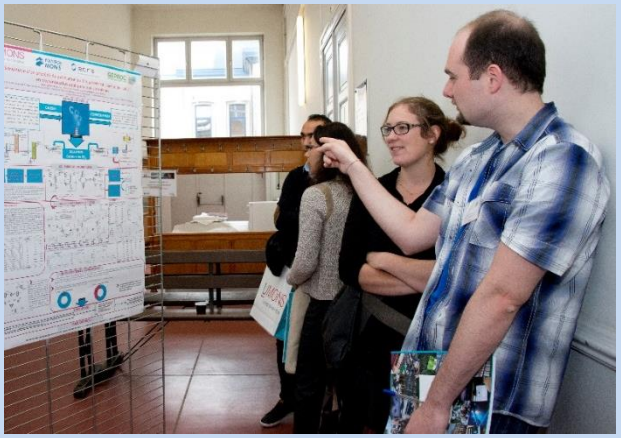
ECRA award for new graduated students

UMons, in september

External communication activities



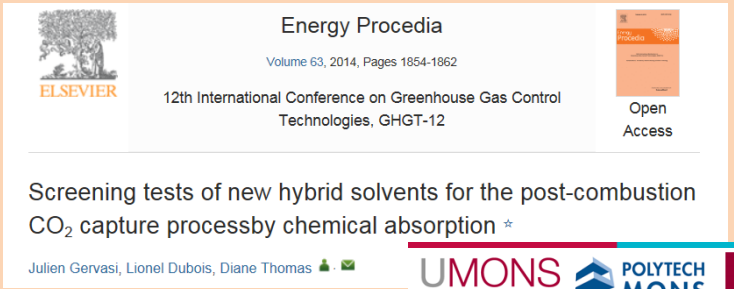
ECRA Post-doc at GHGT12 (Austin, October 2014)

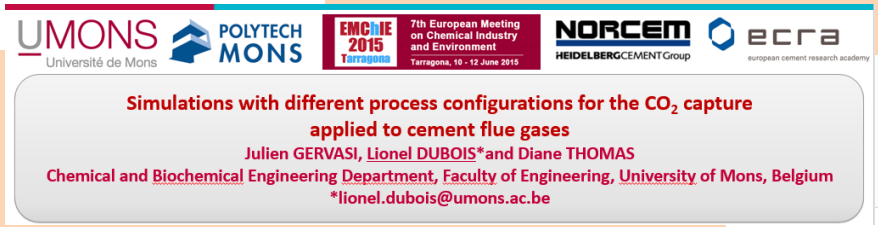


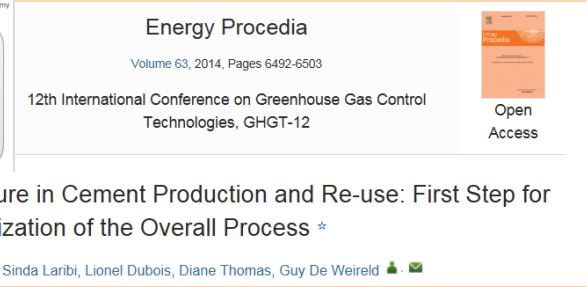
ECRA PhD student at PhD Day (Mons, October 2014)

ECRA Chair Post-doc and PhD Student (Regina, Sept, 2015)

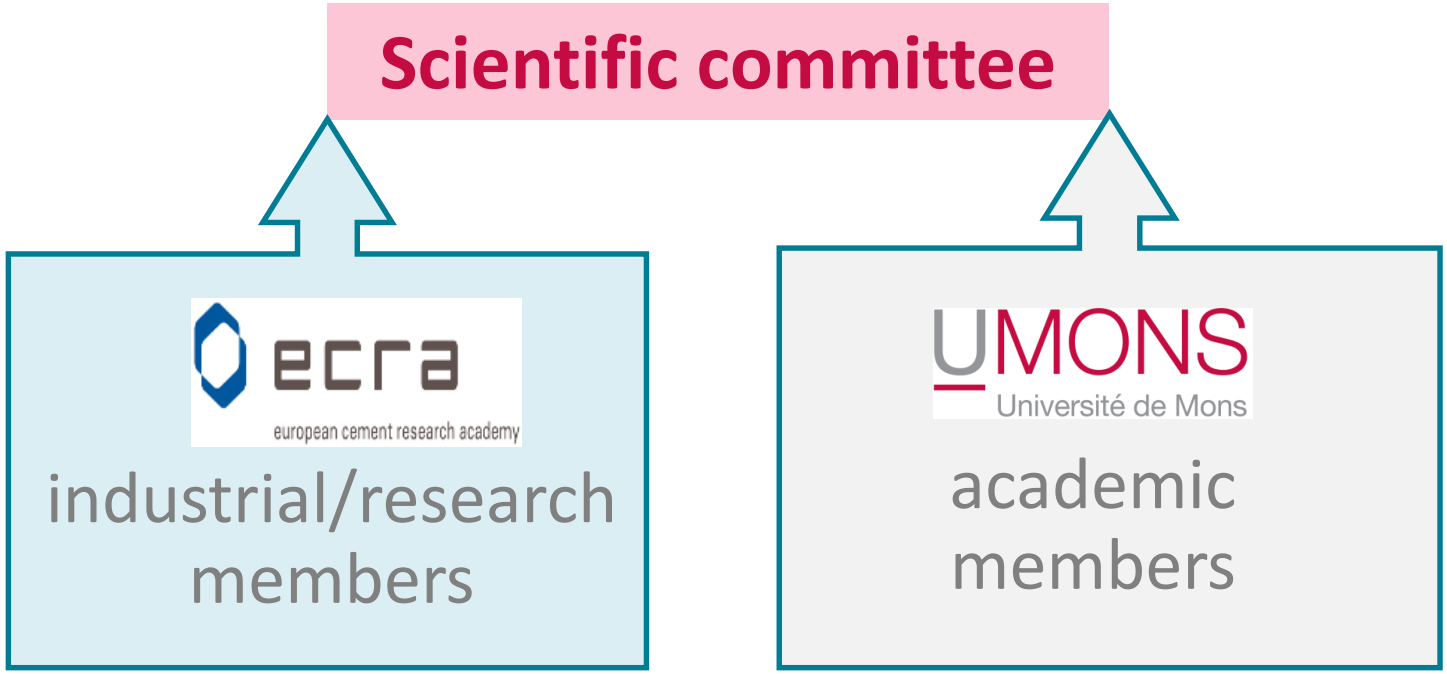
SCIENTIFIC PUBLICATIONS Examples







ECRA Chair activities management



→ Definition of the **actions** and periodical **evaluation of the progress** of the different research projects of the Chair;

→ Validation of the **program of activities,** of the **operating budgets** and of the **annual report**.

ECRA Academic Chair research team in UMONS

Academic Coordinator:

Prof. Diane Thomas

Academic Supervisors/Advisors:

Prof. Guy De Weireld

Prof. Paul Lybaert

Prof. Anne-Lise Hantson

PhD Student:

Ir Sinda Laribi

Scientific Coordinator:

Dr Lionel Dubois

PhD Student:

Ir Nicolas Meunier

PhD Student:

Ir Seloua Mouhoubi

UMONS ecra chair from CO_2 to energy

PhD Student:

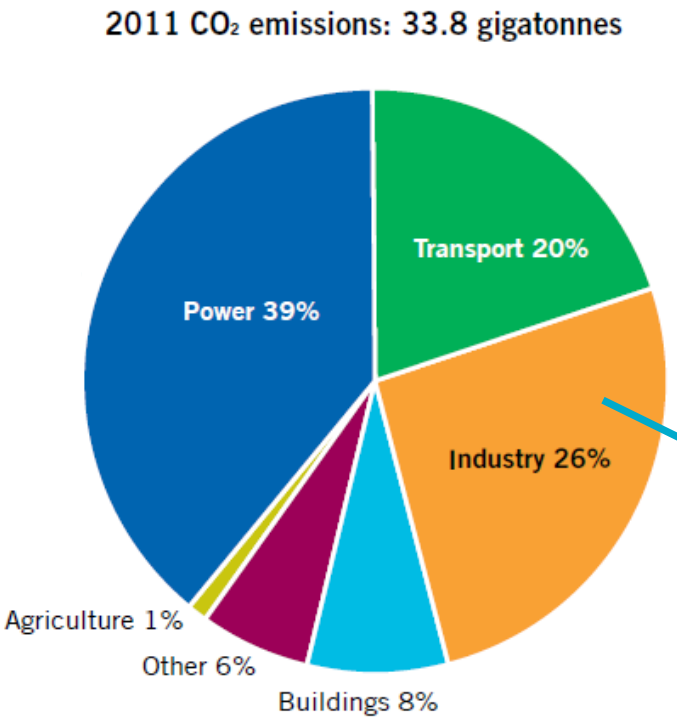
Ir Remi Chauvy

Scientific content of the Chair

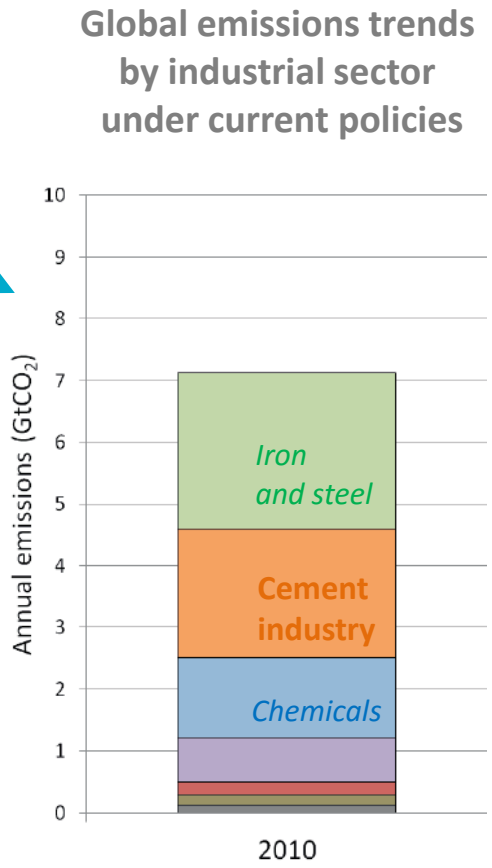
&

Link with this Event

CO_2 emissions - Key figures for the cement industry



Source: CO_2 emissions data from IEA, 2014, Energy Technology Perspectives 2014



Source: IEA (2013b), « Global Action to Advance Carbon Capture and Storage: a Focus on Industrial Applications »

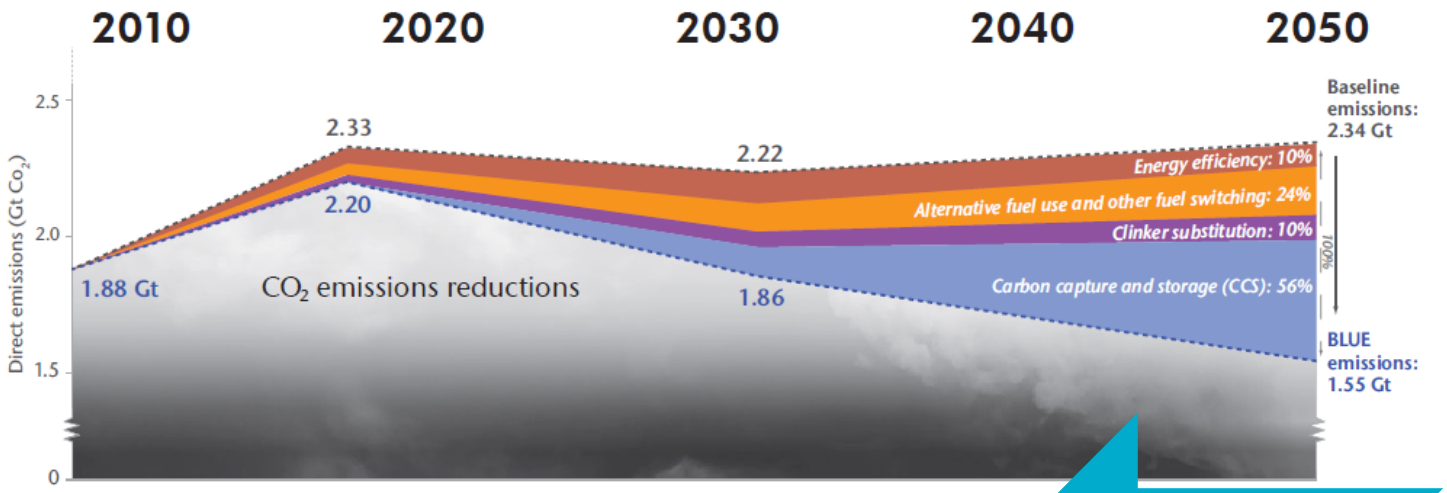
CO_2 emissions – Roadmap and actions

CEMENT ROADMAP

International Energy Agency

World Business Council for Sustainable Development

Cement sector CO_2 emissions reductions below the baseline, low demand scenario, 2010-2050



Source: https://www.iea.org

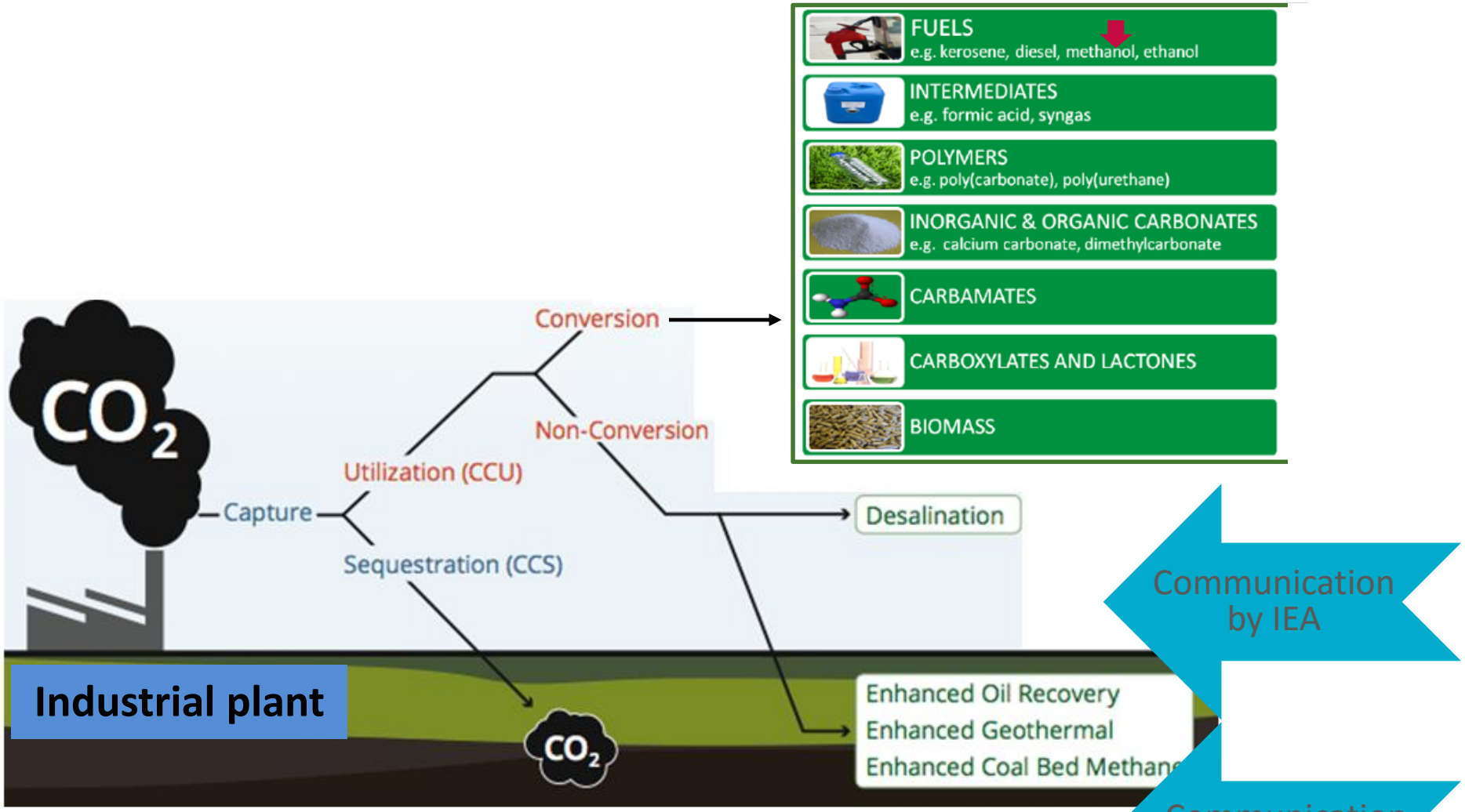
CO_2 emissions reductions

- 44% thanks to:
  - Energy efficiency
  - Alternative fuels
  - Clinker substitution
- **56%** thanks to **Carbon Capture and Storage** (CCS)

Communication by LafargeHolcim

Communication by HeidelbergC

CO_2 Capture, Utilisation and Storage (CCUS)

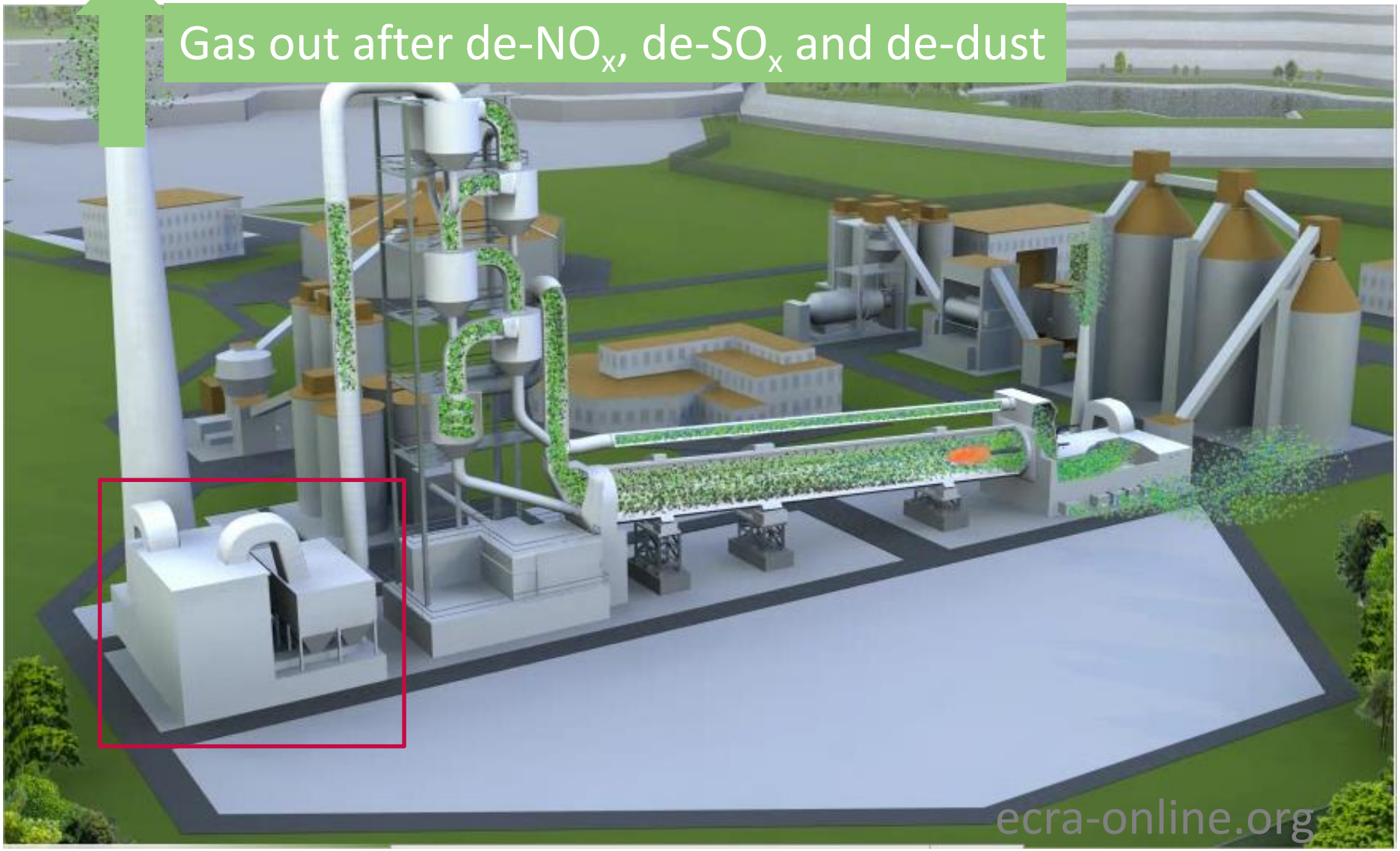


Source: The Pembina Institute with Integrated CO_2 Network (ICO2N)

Gas treatment in the cement industry

Cement flue gas composition:
(example of Norcem Brevik plant)

CO_2: 15.5-19.9 % / dust: 1.1-40.7 mg/Nm^3
SO_2: 19-461 mg/Nm^3 / NOx : 376-880 mg/Nm^3



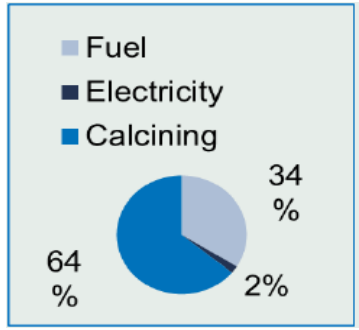
CO_2 Capture Techniques

CO_2 Capture

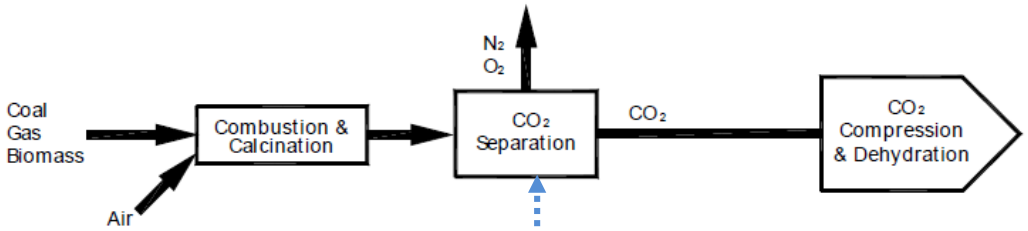
- ~~Precombustion~~

Not interesting for cement industry because most part of the CO_2 is coming from the calcination:

$CaCO_3 + heat \rightarrow CaO + \uparrow CO_2$

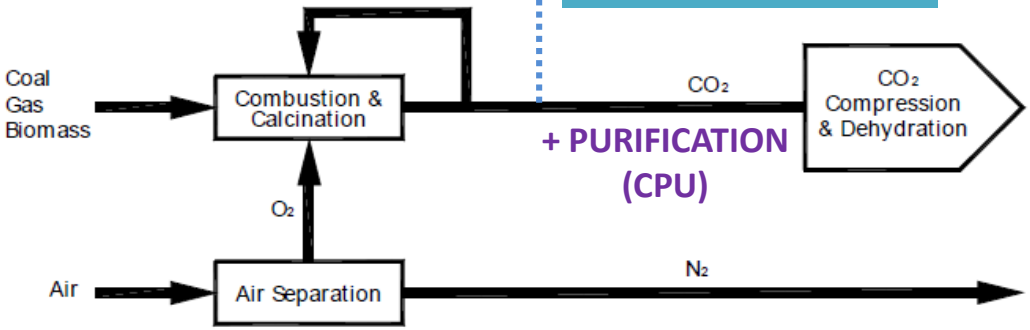


- Postcombustion



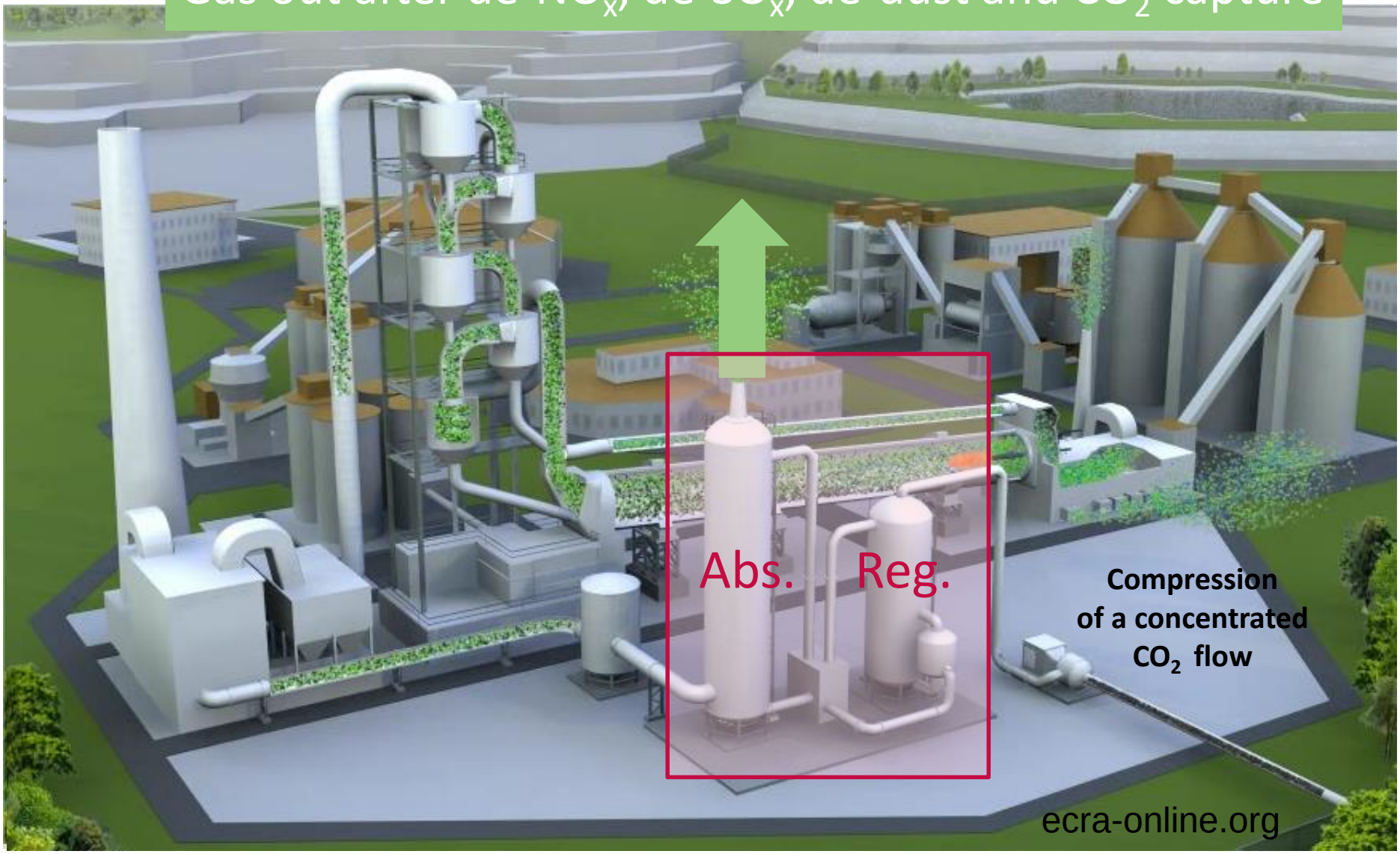
Partial oxy-fuel

- Oxycombustion



Post-combustion CO_2 Capture in the cement industry

Gas out after de-NO_x, de-SO_x, de-dust and CO_2 capture

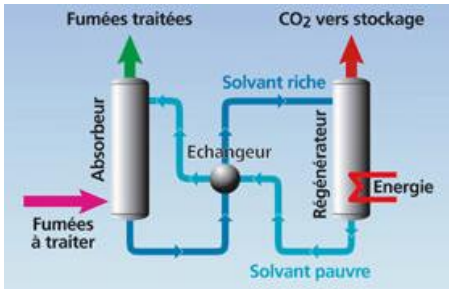


Post-combustion CO_2Capture in the cement industry

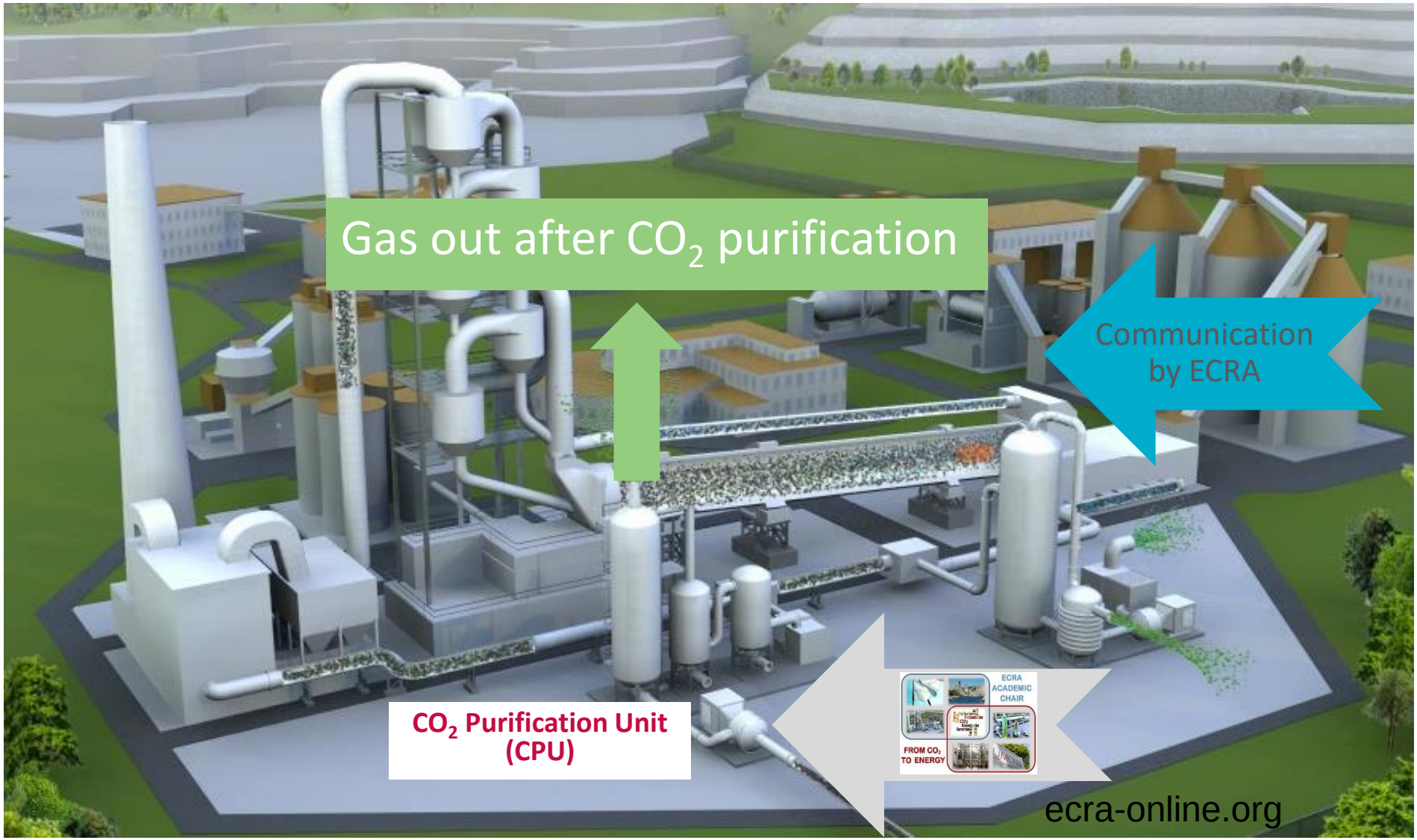
CO_2 Capture

- Oxycombustion
  - Calcium looping
- Postcombustion
  - Membrane process
  - Adsorption
  - Absorption

Communication by Polimi

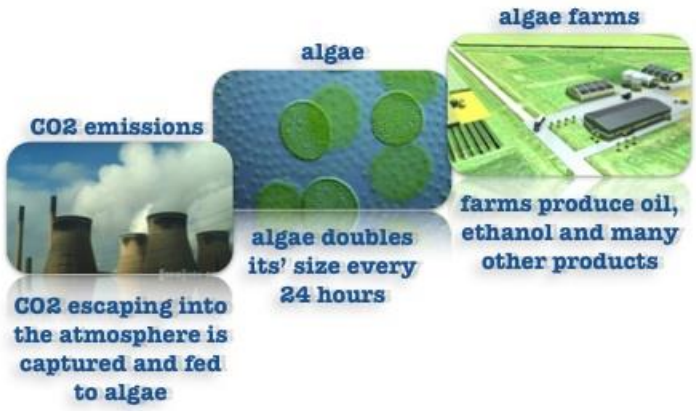


Oxycombustion CO_2 Capture in the cement industry



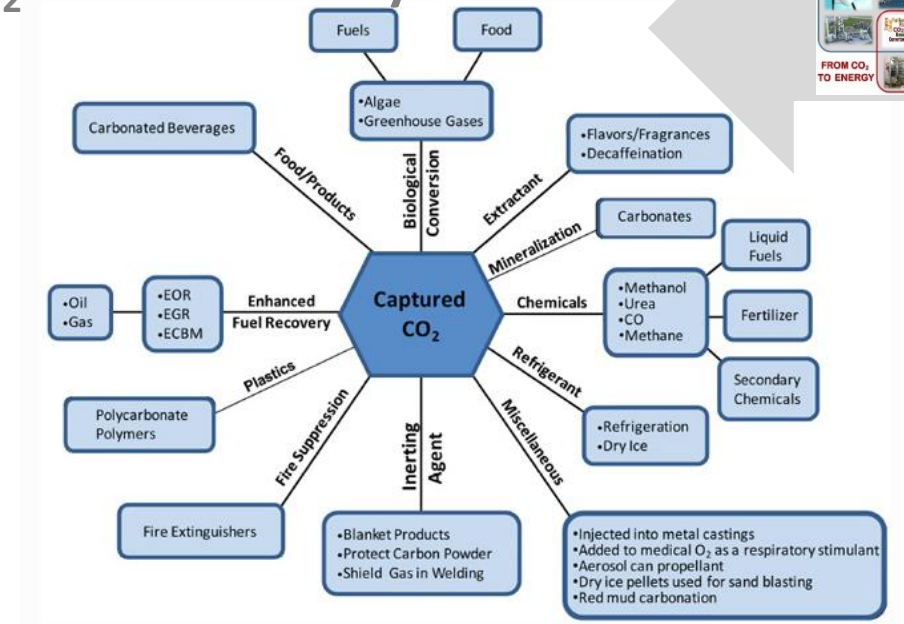
Biological CO_2 capture

Communication by AlgoSource

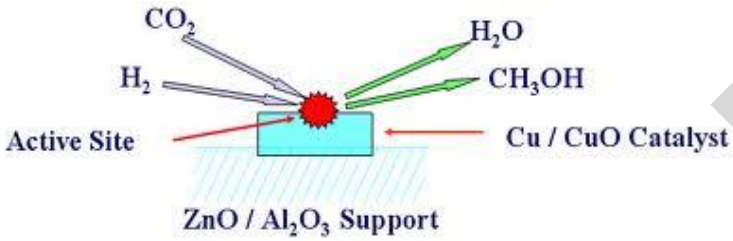


CO_2 reuse

CO_2 conversion ways



CO_2 to methanol



Communication by CRI

General framework of the ECRA Chair

Cement industry

Oxy-fuel
CO_2 capture
y_{CO2} > 70%

Partial oxy-fuel
CO_2 capture
35 < y_{CO2} < 70%

Post-combustion
CO_2 capture
y_{CO2} < 35%

CO_2 Capture & Purification

Air Products CO_2 Purification Unit (CPU)

Sour Compress. Unit

Dehydration Unit

Cryogenic Unit

Modeling and Optimization

Pressure Swing Adsorption (PSA) Adsorption Process

Modeling and Experiments (materials screening)

Absorption-Regeneration Process: *conventional solvents*

Modeling and Experiments (solvents screening)

Absorption-Regeneration Process: *demixing solvents*

Modeling and Experiments

Absorption-Regeneration Process: *other configurations*

Modeling and Technico-economic analysis

CO_2 Conversion

CO_2 Catalytic Conversion into methanol

Modeling and Experiments (effect of impurities on catalytic process)

Other CO_2 Conversion routes

Modeling and Technico-economic analysis

= Sinda Laribi's PhD Thesis

= Nicolas Meunier's PhD Thesis

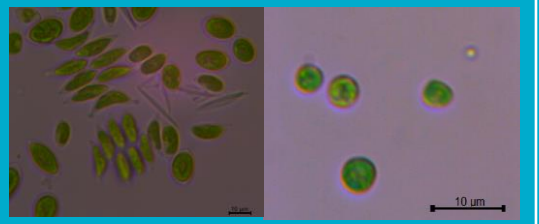
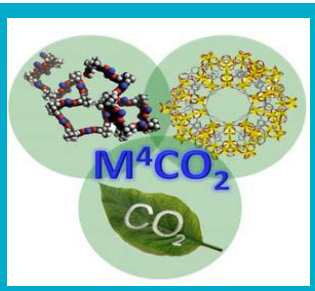
= Remi Chauvy's PhD Thesis

= Seloua Mouhoubi's PhD Thesis

= Lionel Dubois's Post-Doc

= Other works

Projects related

		
Effect of NO_x and SO_x on the cultivation of microalgae using CO_2 from cement flue gases	Energy efficient Metallic Organic Frameworks (MOF) - based Mixed Matrix Membranes for CO_2 Capture	New process for efficient CO_2 capture by innovative adsorbents based on modified Graphene Aerogels and MOF materials
FPMs project	*FP7 project*	*H2020 project*

This day… at a glance

10:00 - 11:15

Deployment of CCSU
in the industry
ECRA's and HC's projects
Lixhe and Leilac

11:30 – 12:00

Coffee Break

12:00 - 13:00

CO_2 reduction for LafargeHolcim
Ca Looping
CCUS for Engie

13:00 - 14:15

Walking Dinner

14:15 - 15:30

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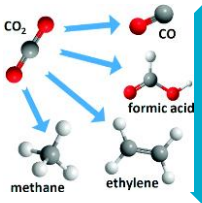
ECRA Chair projects at UMONS

15:30 -16:20



CO_2 conversion to methanol

Use of microalgae

16:20

Closing of the day

16:30 - …?

Drink

… and tomorrow

Visit of the CBR (HeidelbergCement Group) Lixhe Cement Plant

Leilac

Low Emissions Intensity Lime & Cement
A European Union Horizon 2020 Research & Innovation Project

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Thanks very much for your attention

Acknowledgments to ECRA for the funding of this Chair

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