

The background of the slide features a large, faint watermark of the ALSTOM logo. The logo consists of the word "ALSTOM" in a bold, sans-serif font, with a stylized circular emblem containing a crosshair pattern positioned behind the letter "O". The background is a dark blue with vertical stripes and abstract white lines.

# **CO<sub>2</sub> Capture in pre- and oxy-combustion**

**Dipl. Ing. Alain FÉRAUD**

**International Symposium  
Reduction of Emissions and Geological Storage of CO<sub>2</sub>  
Paris 15-16<sup>th</sup> September 2005**

The ALSTOM logo is displayed at the bottom of the slide. It features the word "ALSTOM" in a bold, blue, sans-serif font. The letter "O" is replaced by a red circle with a white outline, and a white crosshair pattern is visible within the circle.



# Contents of Presentation

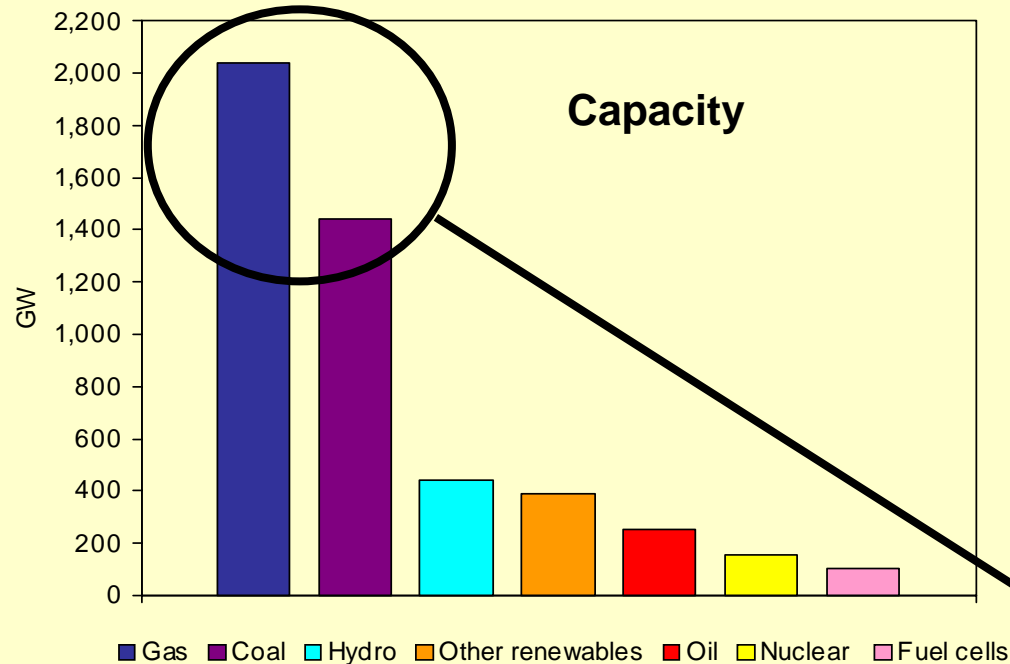
**ALSTOM**

- **Introduction**
- **Carbon Management Strategy**
- **CO2 capture : Pre-combustion Technology**
- **CO2 capture : Oxy-combustion Technology**
- **Conclusion**



# Long Term Energy Market

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**IEA projections of  
global power station  
build to 2030**

IEA World Energy Outlook 2003

- **Different needs world-wide**
  - uneven access to modern energy
- **Growth of Renewable Energy but ....**

**Continuing reliance  
on fossil fuels**

- especially China and India



# Environmental Implications - `long term`



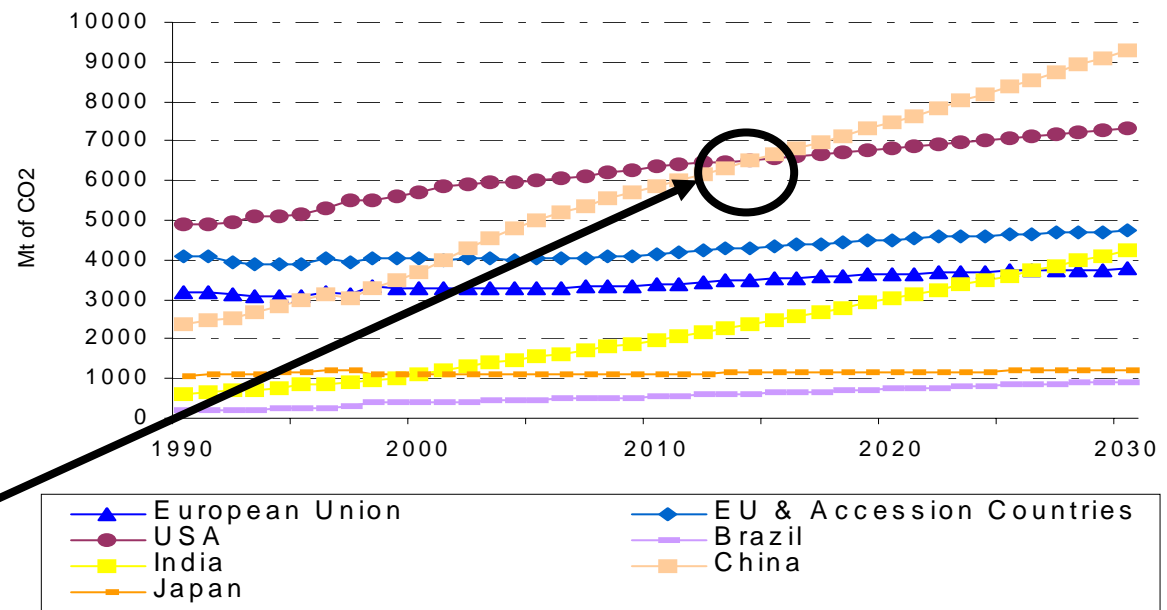
## ● Environment

- Longer term : Factor 4 GHG reductions by 2050 (France)

### Forecasted CO<sub>2</sub> Increases

Source: EC/EEA, 2004

- Importance of engaging Emerging Market Economies



China will overtake US as biggest CO<sub>2</sub> emitter by 2012

Importance of Environment as a Driver



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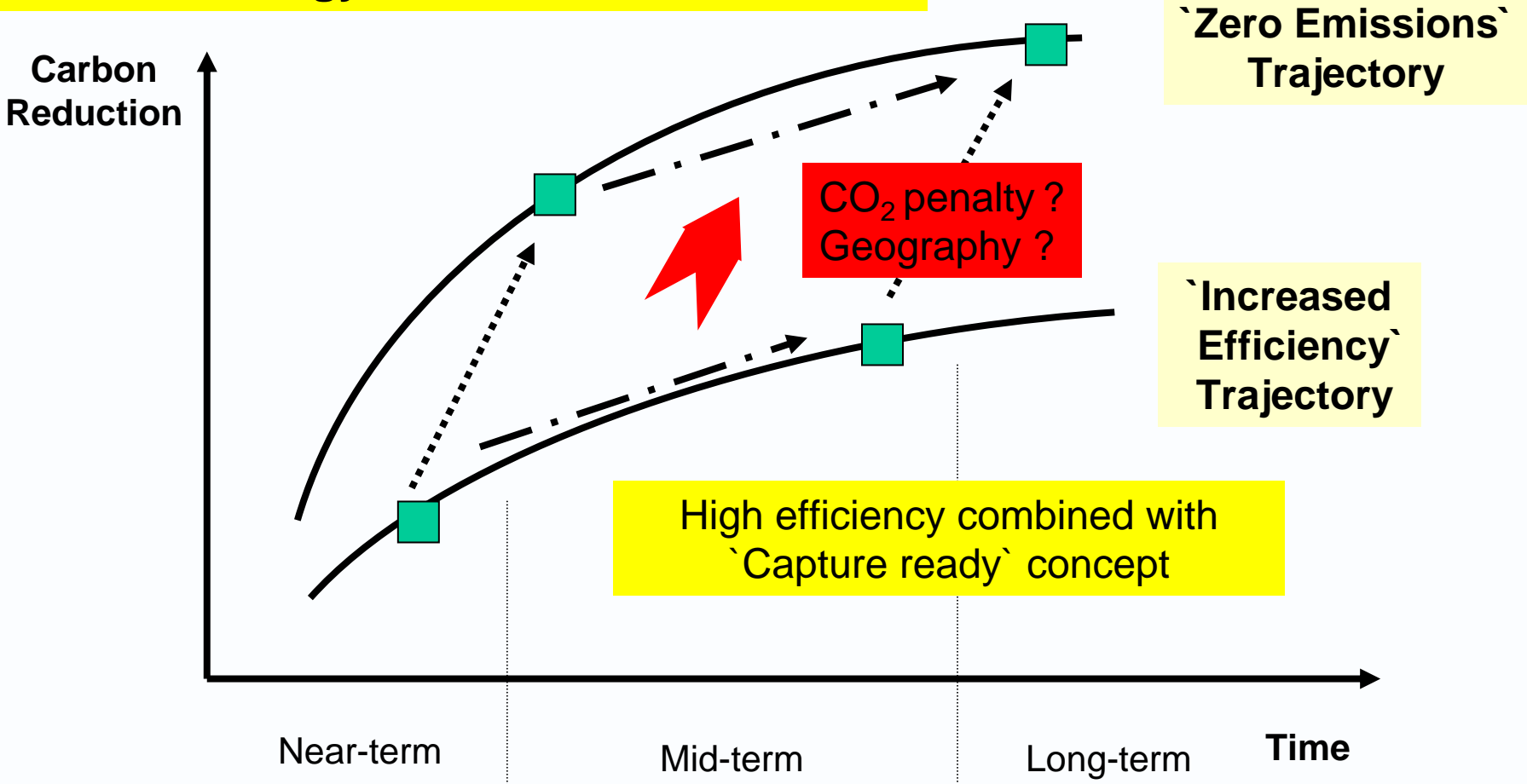
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# Strategic Trajectories

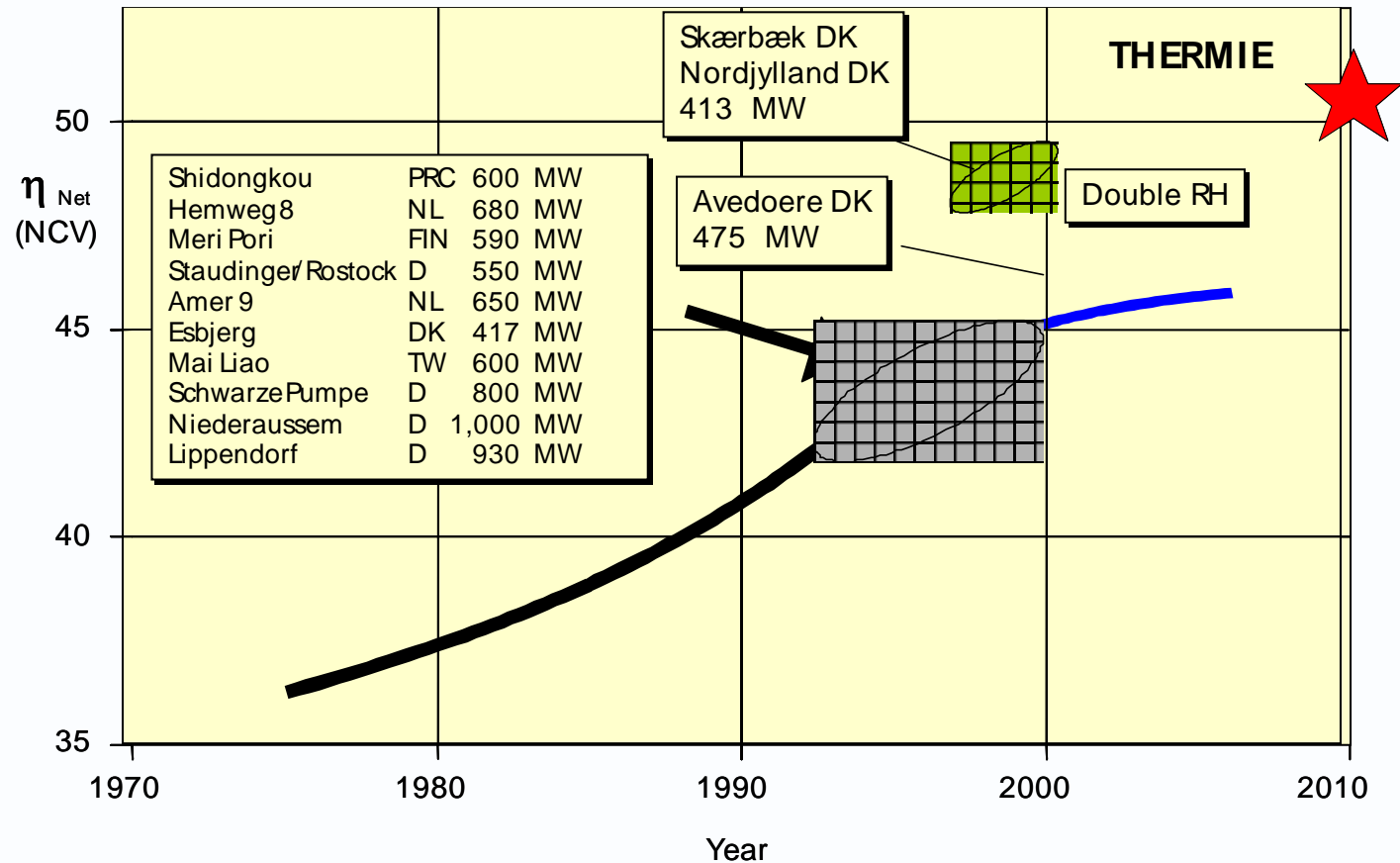
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## Flexible strategy to cover uncertain future





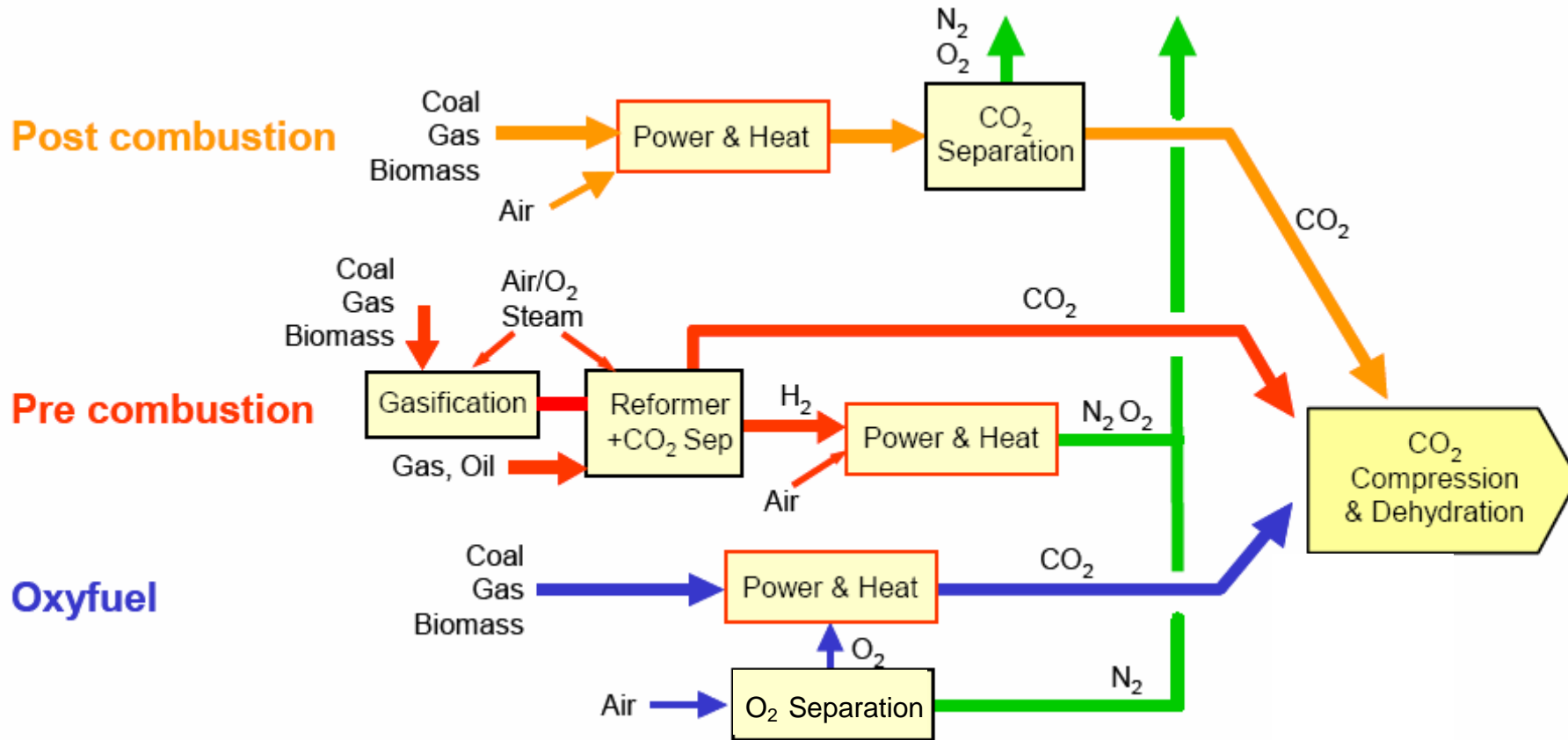
# Constant efficiency improvements



towards 50 % efficiency in 2010



# Technology Options for CO<sub>2</sub> Removal



From Bolland (2004)



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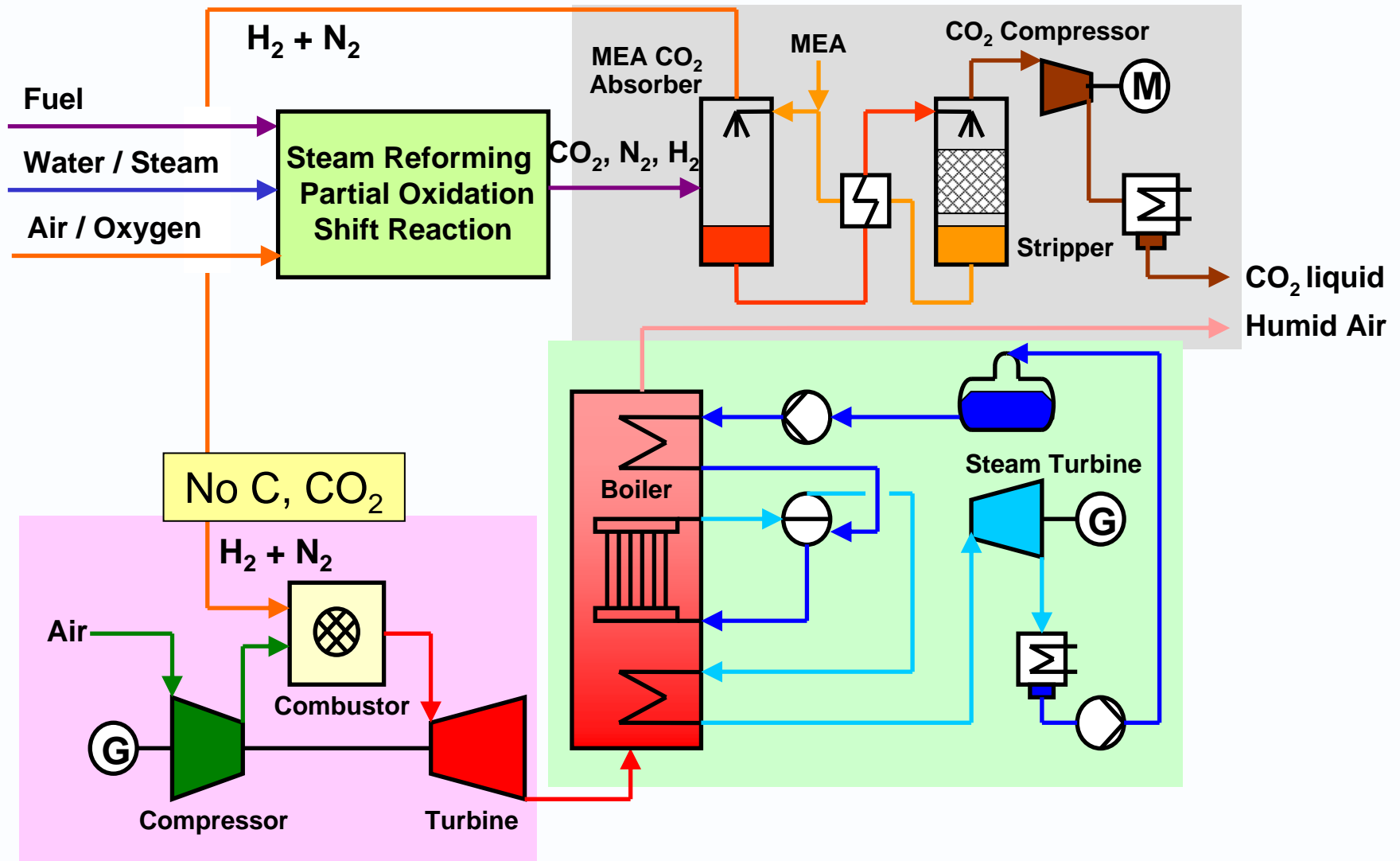
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# Pre-combustion capture

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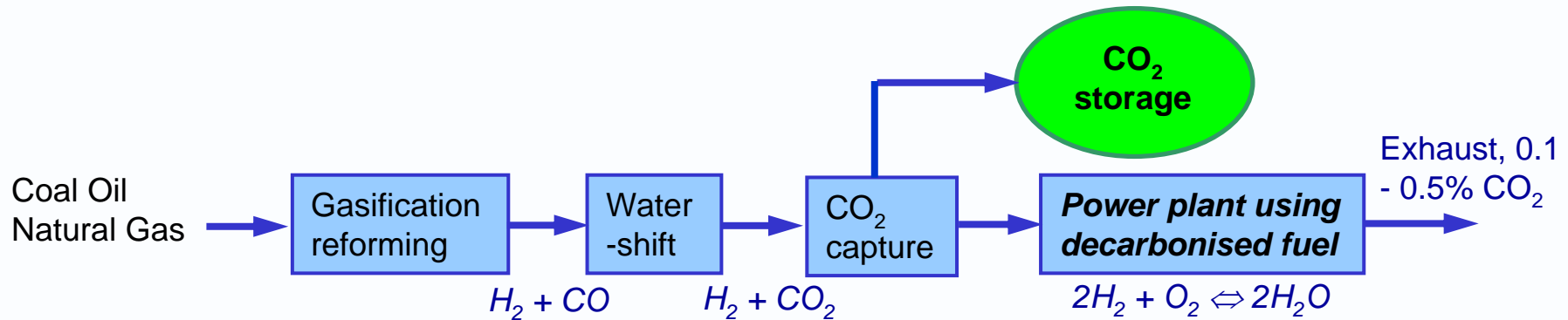
# Pre-combustion capture

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- Pre-combustion capture is proven technology
- Burning H<sub>2</sub>-rich synthesis gas requires only changes in the gas turbine combustor,
  - main challenge is low NOx combustion
- Requires a chemical plant in front of the gas turbine, high investment cost
- Max. 90 – 95% capture
- Applicable to coal based IGCC plants also
- **Shortest Term to Market: Easiest to realize**



# ENCAP WP2.3: H<sub>2</sub> Combustion



ENCAP: pre-combustion carbon capture.

- Goal: Develop lean-premixed H<sub>2</sub> burner.
  - Advanced EV burner
  - fuel-flexibility (NG/oil/H<sub>2</sub>/syngas)

**Axial fuel injection (independent of NG LPM system).**





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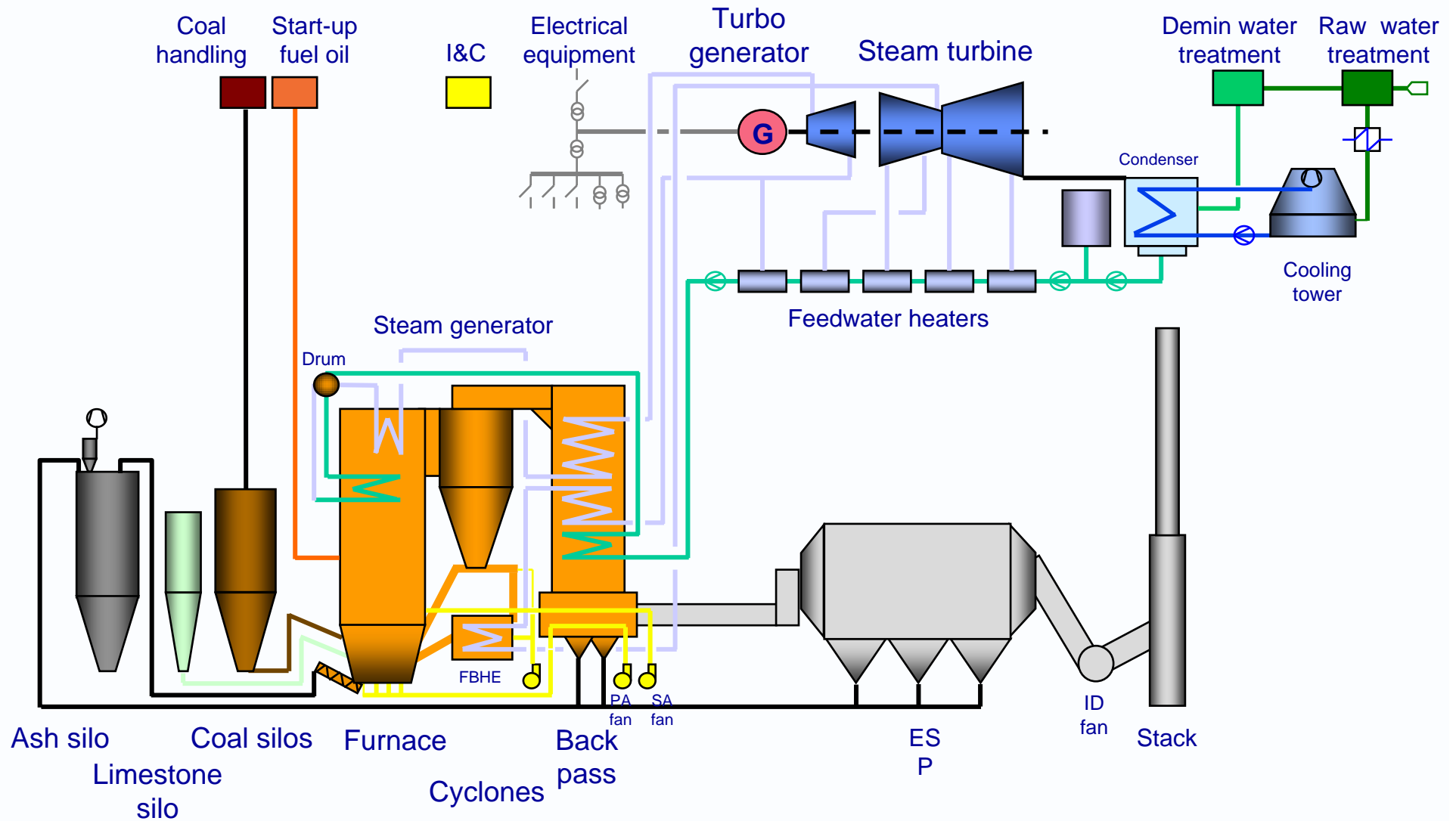
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# Circulating fluidised bed boilers

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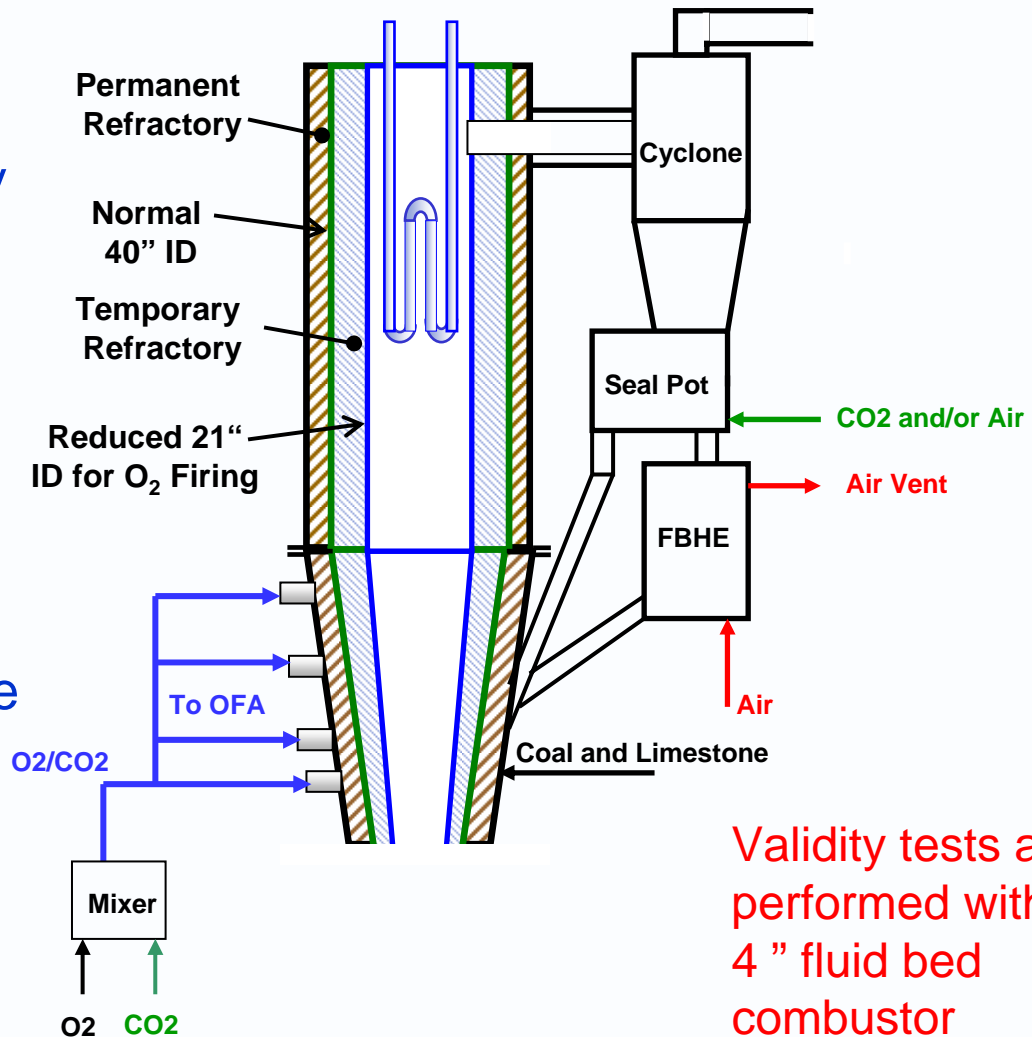




# CFB Oxy-firing 3 MWth Multi-use Test Facility

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- ❑ Reduced furnace ID from 40" to 21"
- ❑ Installed an O<sub>2</sub>/CO<sub>2</sub> supply infrastructure
- ❑ Installed additional heat absorption surfaces
- ❑ Replaced some furnace components for service at elevated oxygen content
- ❑ Modified FBHE to minimize re-carbonation of the circulating solids



Validity tests are performed with our 4" fluid bed combustor

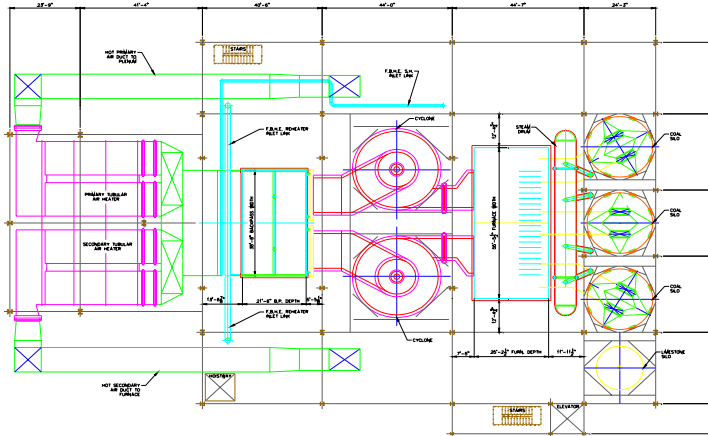


# O<sub>2</sub> Fired CFB 200 Mwe Steam generator



## CFB air-fired

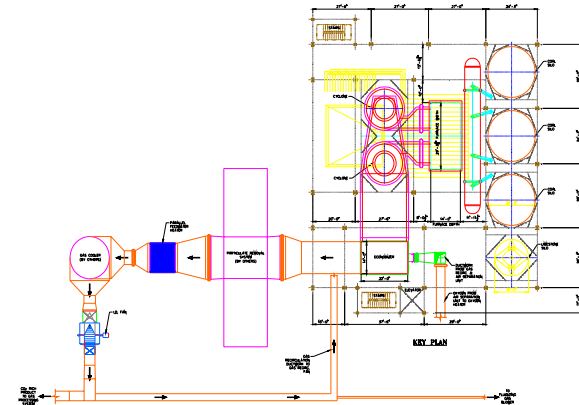
33.5 m



67.0 m

## CFB oxy-combustion

35.4 m



32.3 m

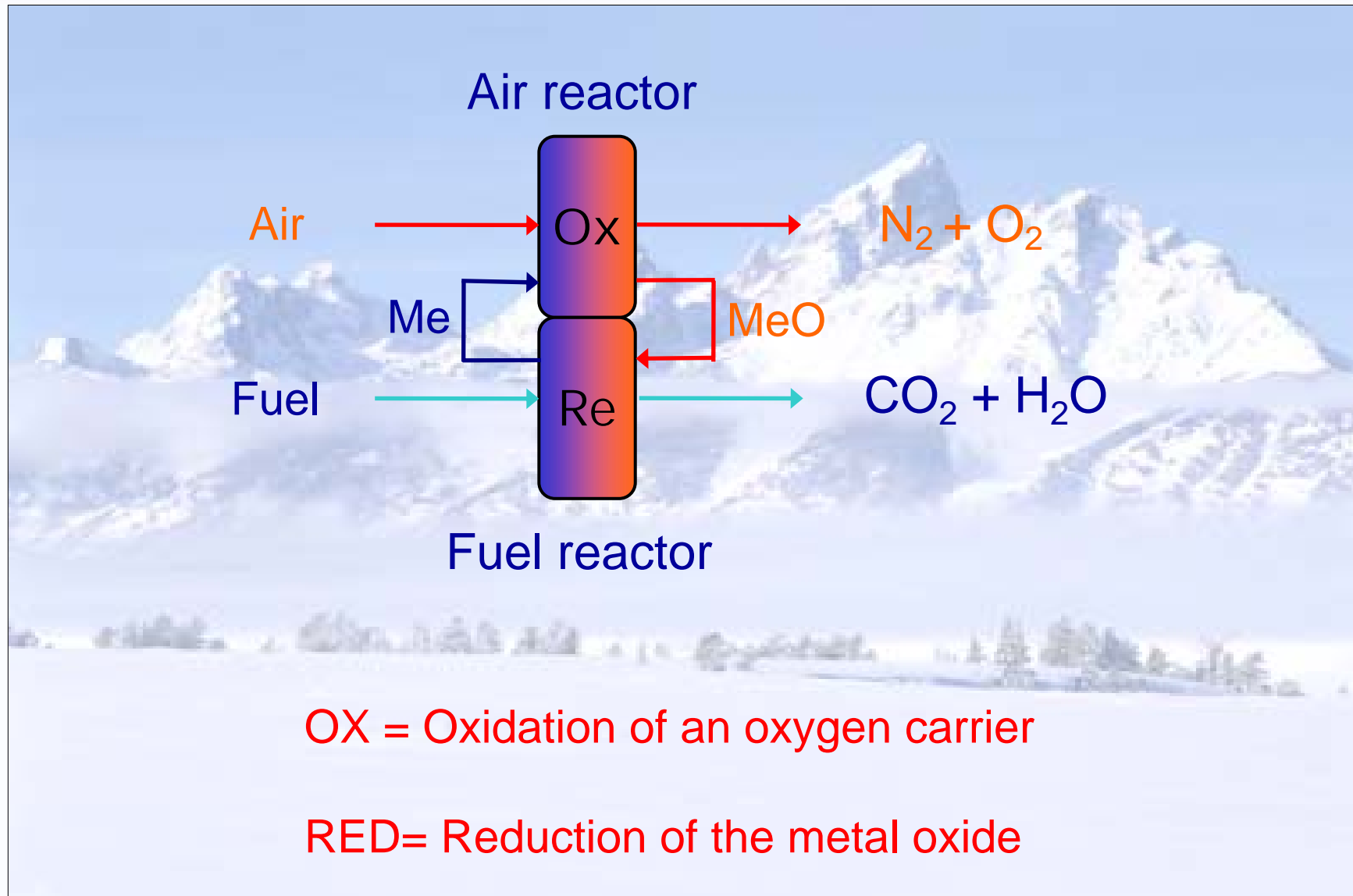
Footprint (%)

100

51



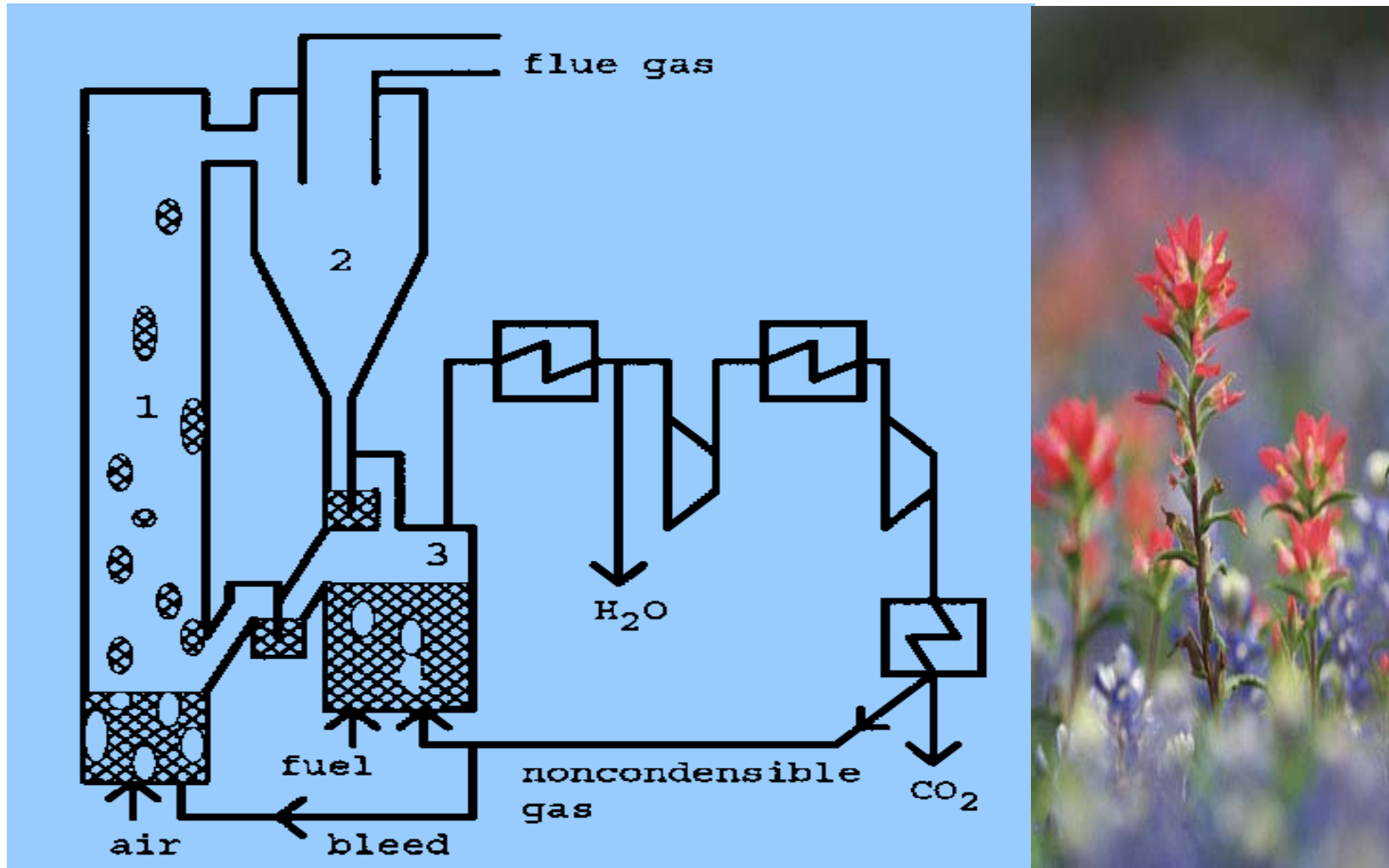
# Chemical Looping Combustion





# ENCAP WP 4.2 : Chemical Looping Combustion

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# ENCAP WP 4.2 : Chemical looping testing

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**Pilot CLC 10 kW  
Chalmers University**





# CLC features



## □ Process characteristics

- ✓ 100% CO<sub>2</sub> capture
- ✓ No Air Separation Unit for oxygen production
- ✓ No energy penalty for oxygen production and for CO<sub>2</sub> separation

## □ Process design requirements for Fluidized Bed CLC

- ✓ Reactive and hard oxygen carrier (Fe, Ni, Mn, Cu...with various supports)
- ✓ Sufficient solids flow , typical of CFB hydrodynamics
- ✓ No gas mixing between the two reactors



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## CO2 Mitigation Message

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- **All measures will be required**
  - different solutions in different parts of the world
- **Broad approach necessary**
  - energy efficiency, renewables, fossil with CCS, nuclear
- **No one single winning technology for fossil with CCS**
  - pre-combustion, oxy-firing, post-combustion
- **Development of energy technology will be essential**

**Clean use of fossil fuels : the key to a sustainable energy future**



*Thank you !*

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