The effects of co-firing biomass under oxyfuel conditions

Laboratory scale results

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Biomassa Meestook Symposium, Amsterdam, 27 mei 2010

Routes to reduction of carbon dioxide emissions

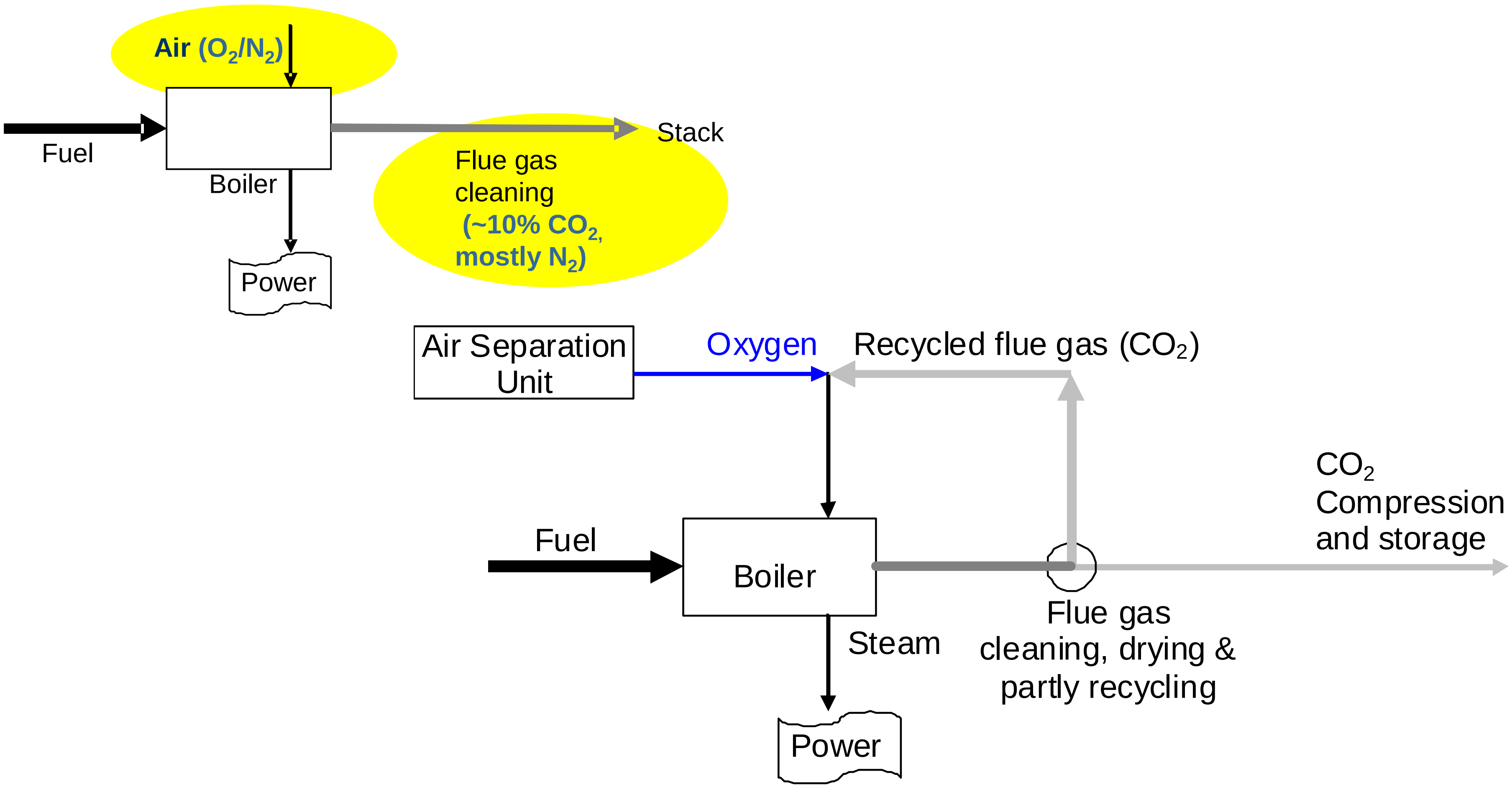
- Increased use of biomass (co - firing)
- Increased Efficiency Power plants
- **C**arbon **C**apture **S**equestration

Capture though Oxyfuel Technology

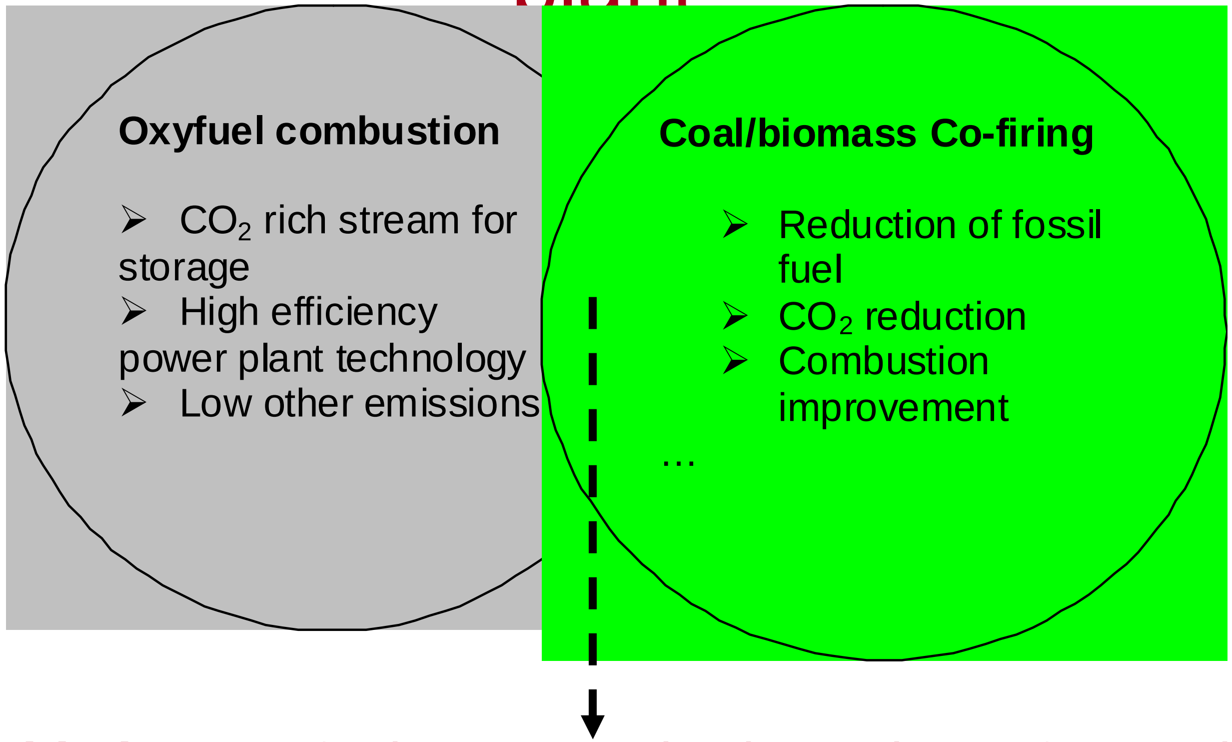
Can be retrofitted to existing boiler technology!

Concept of the oxy - combustion process

Illustrative flow sheet for oxy-fuel process, with additional unit operations for carbon capture



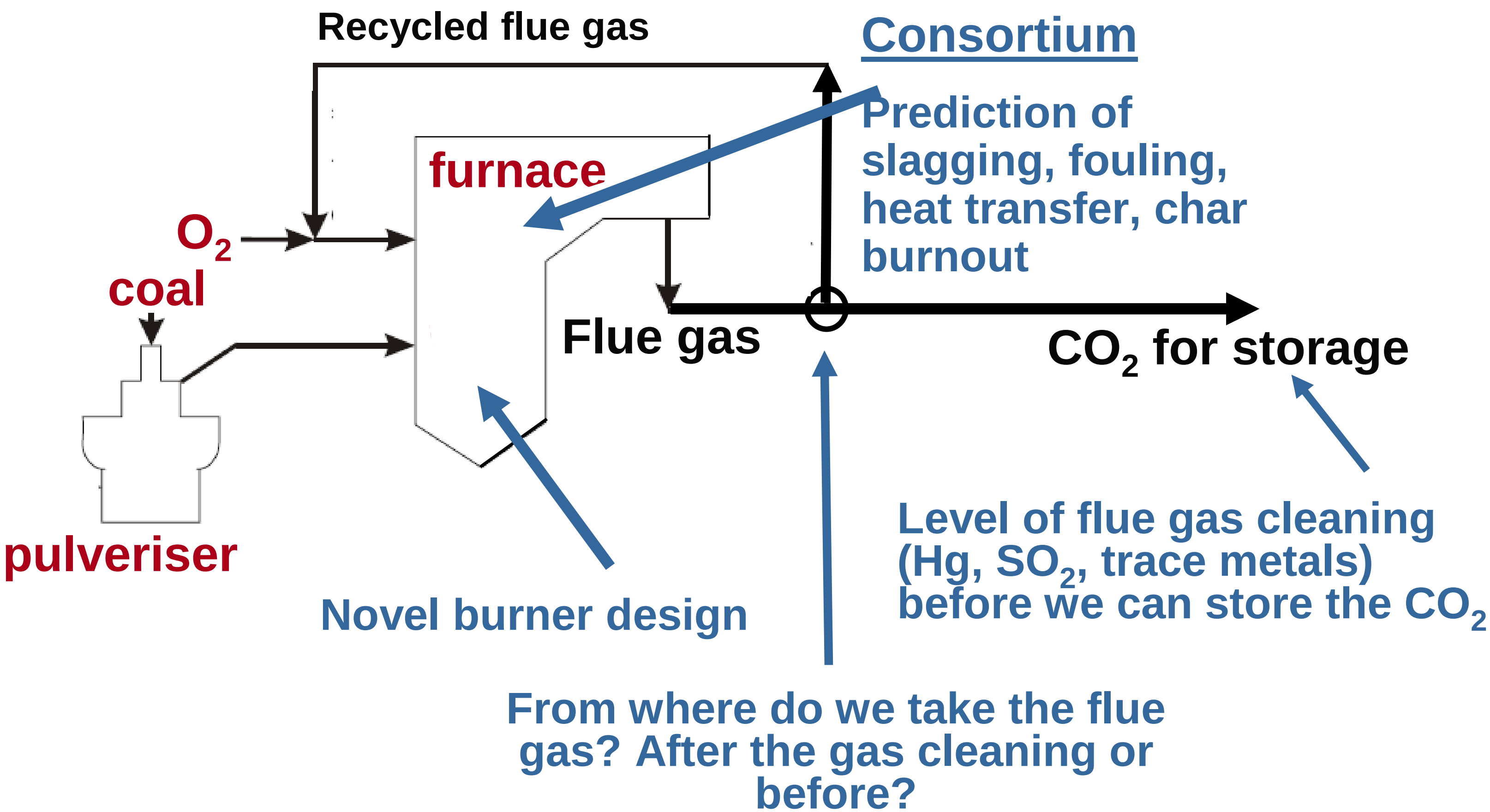
What if we add biomass into an oxyfuel power plant?



Added value: further CO_2 reduction, primary fuel savings

Cofiring / oxyfuel addressed by the Zero Emission Platform (ZEP) of the EU

Key issues & technical challenges for near term application to existing boilers



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Translation into research objectives

How do we cover this lack of knowledge?

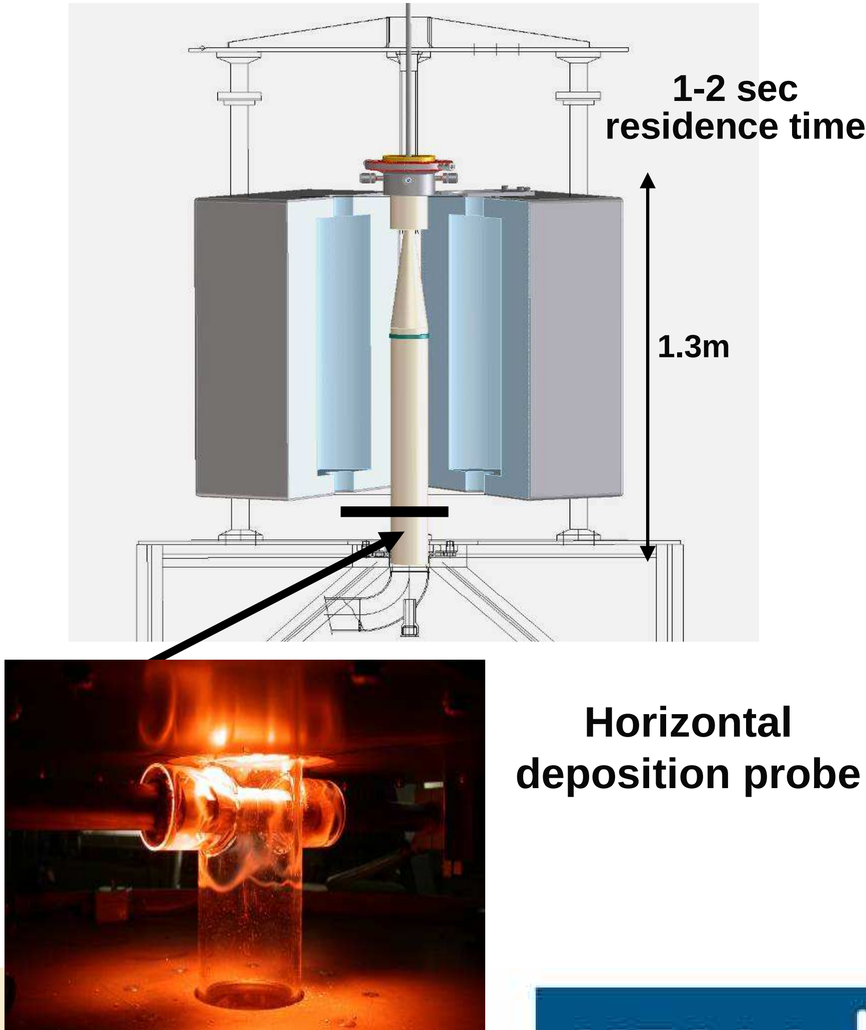
- Small scale test facility: cost effective fast ways of screening fuels under varying and novel combustion conditions; provides input data for models and feasibility studies

- Modelling tools: enable evaluation of tests results, identify most important process parameters ➡ <u>process design</u>

Lab-scale Combustion Simulator (LCS)

Facility to simulate pulverised-fuel combustion conditions

- **Scope of tests:** observe the deposition behaviour of coals & blends
- **Fuels:** Russian coal, South African coal, Lignite, blends with 20% w/w biomass - cocoa residues, wood, olive kernel
- **Conditions**: combustion under air (standard) and oxyfuel (CO_2/O_2) conditions
- **Parameters**: fuels & blends (25% dry biomass in blend), temperature profile



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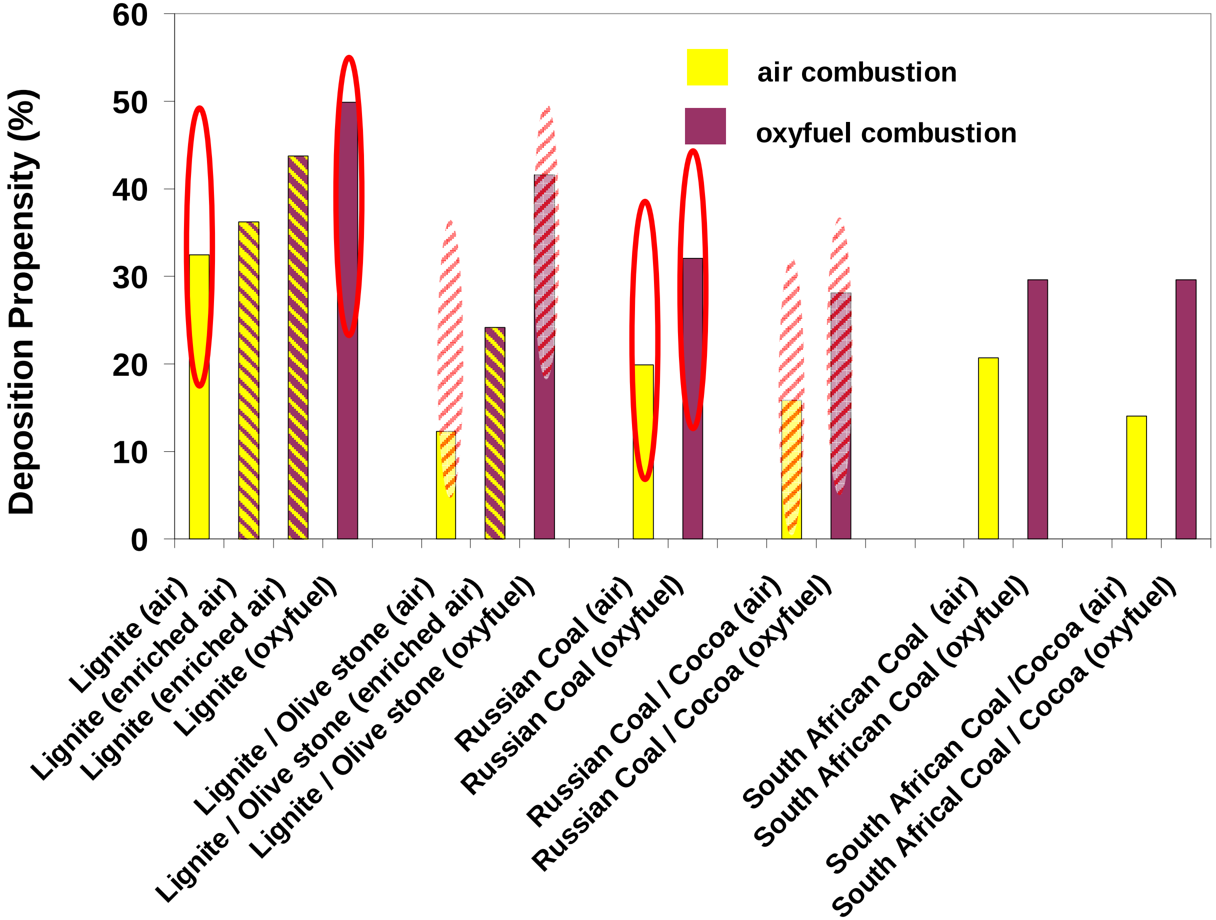
Results (1): Ash deposition behaviour



Negative oxyfuel effect compensated by blending with biomass

Chemical composition of all ash samples: no significant differences between air/oxy (however existent)

Crystallographic analysis:

No differences between air/oxy

Results (2): Particle sizes of deposited ash

Larger particles form under oxyfuel & fall directly in sensor and increase the deposit

High O_2 % may create local temperature peaks ➡ ash melt ➡ particle agglomeration & particle size increase

However particles not always (significantly) larger

What else alters the deposition behaviour then?

Parameters affecting ash deposition

1. Different Ash composition ➡variations in viscosity and slagging behaviour, promotes fouling & deposition
2. Physical gas properties of CO_2 / O_2 gas different from air (density, viscosity, heat capacity) ➡ affect heat transfer and flow field (velocity vectors)

Help from modeling tool: Ash Deposition Predictor

ADP model results (preliminary):

Deposition affected by ash particle size and by ash viscosity, also gas streamlines affect deposition

ADP proves valuable for the retrofitting of power plants

Summary and Conclusions

- Increased local deposition and heat transfer resistance (fouling) observed in oxyfuel tests due to

(a) Shift to larger ash particle sizes from air to oxyfuel combustion

(b) Varying ash viscous properties and reactor flow fields

- However: no different chemistry in boiler, no corrosion risks, **co firing compensates** increased deposition

- Using a model tool for retrofit design

(a) Predict ash deposition behavior

(b) Matching temperature profiles in air vs. oxyfuel

(c) Control heat transfer via flue gas in the boiler

Thank you!

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Acknowledgments: The work was carried out with partial financial support of the RFCS projects BOFCOM and ECOSCRUB