CHALMERS

Oxygen Carrier Aided Combustion for improved fuel conversion in FB plants with simultaneous recycling of alkali compounds.

HTC/KME conference 12 – 13/3, Gothenburg

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improbed

e·on

Swedish Energy Agency

Solid fuels characterization and future fuels

What kind of fuels can we expect to be present in the future energy system?

Can we handle more complex solid fuels in existing plants?

Coal

Biomass

Waste

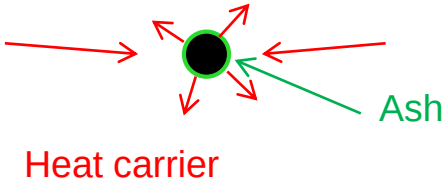
Increasing heterogeneity/complexity

Oxygen Carrier Aided Combustion (OCAC)

Idea

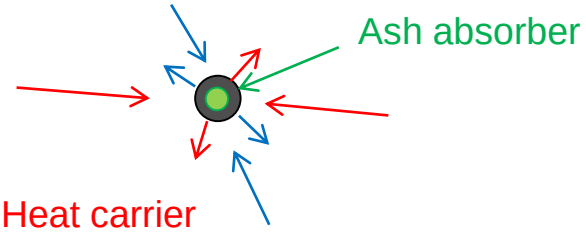
Multifunctional use of the bed material in fluidized bed combustion: addition of an oxygen-carrier

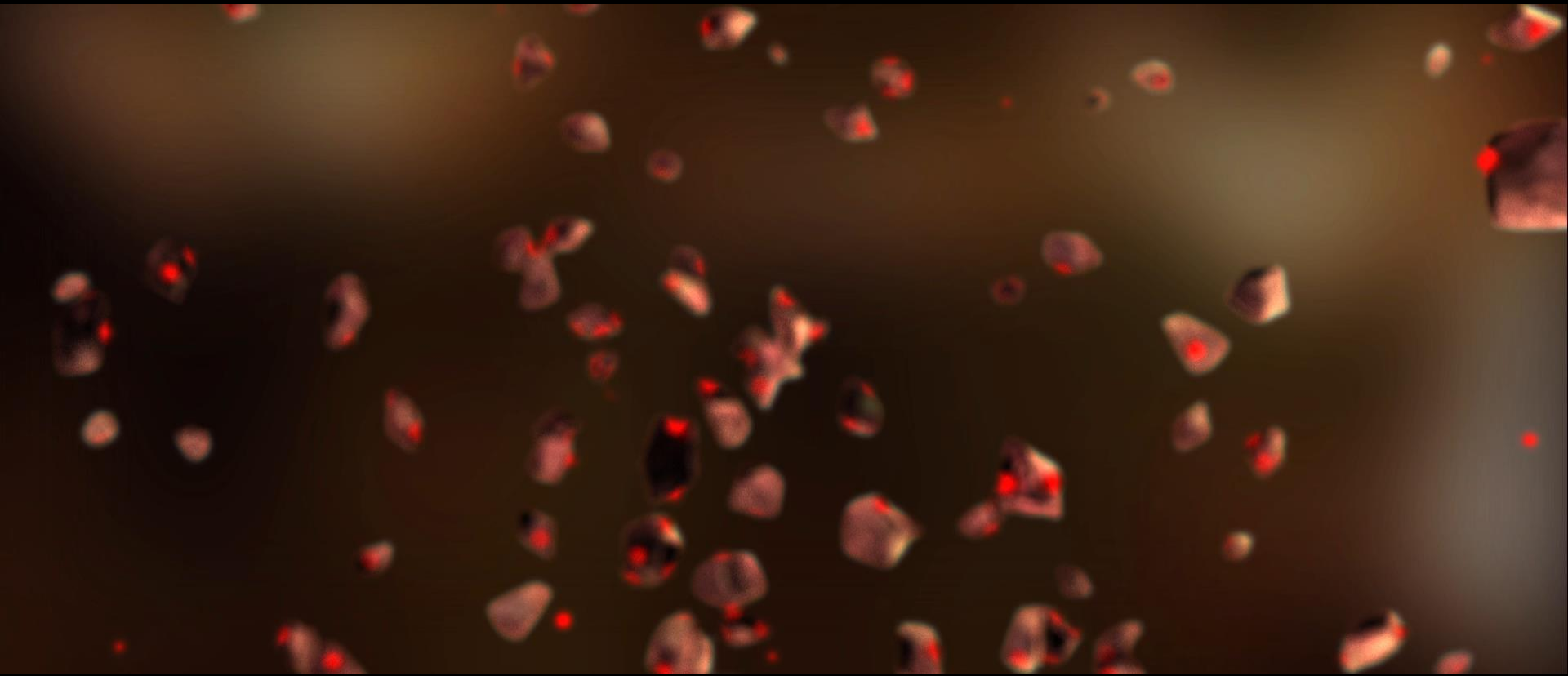
Silica-sand is a conventional material for combustion of high-volatile fuels with a "single function"

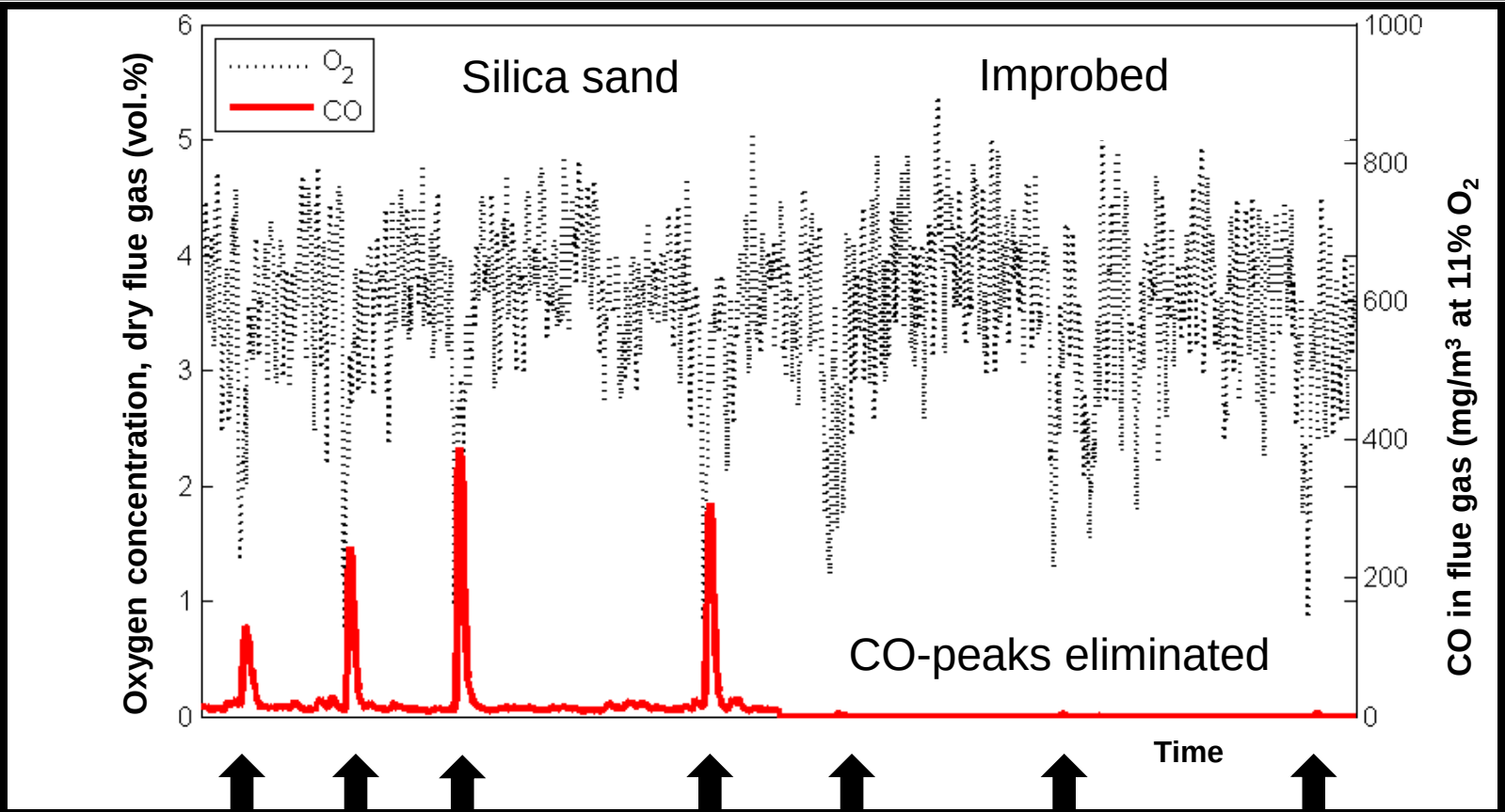


Metal-oxides provide several functions with synergy effects. They exist as natural ores.

Oxygen transport and buffering

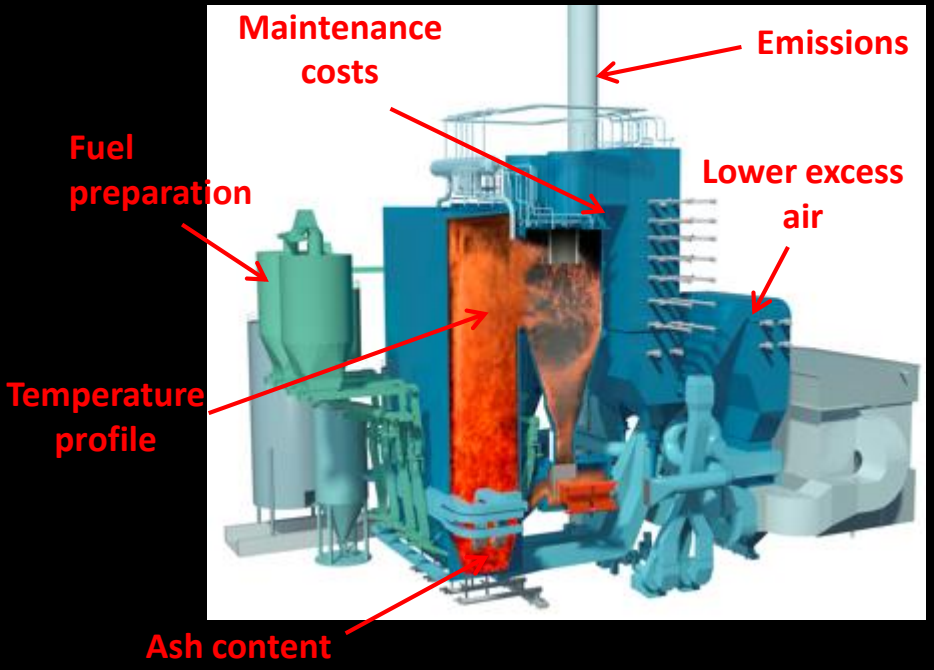






Feed in of wood chips, corresponding to 9 x actual load

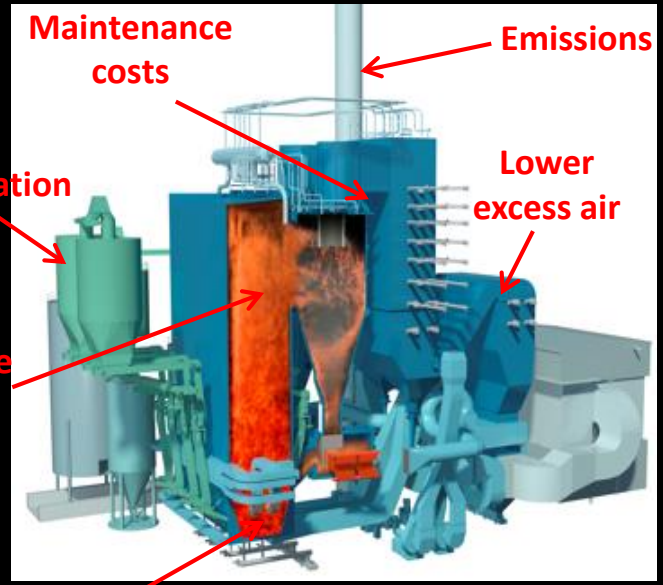
Possibilities of improvements in FB combustion systems



Desired improvements

- Targets from 5 different boiler owners

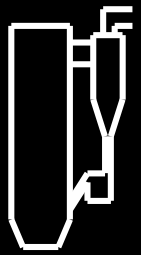
- Less corrosion
- Improved combustion efficiency (gaseous) and boiler load
- Increased operation window
- Lower maintenance costs (e.g. cyclone, corrosion)
- Fewer stops, related to agglomeration and sintering
- Increased fuel flexibility



No emissions of CO_2 2050 → decarbonization? → CCS?

Accelerating need for the decrease in CO_2 emissions

- Paris agreement, global warming < 2 ºC
- Scale-up is necessary for the understanding of FB-CCS techniques
- Experience is available: CCS -- small-scale, CFB -- Large Scale
- Motive: increased earnings by OCAC



Research FB-CCS
0.1 – 0.5 MW

- Test oxygen carriers on a large scale
- Lifetime
- OC–ash interaction
- Boiler prefomance
- ...

Industrial scale 50 – 500 MW_{th}

Scale-up the OCAC concept

2013 – 2014

”Proof of Concept”

2015 – 2016

Improbed is formed, patents applied for. Award by IVA, continuous operation in 75 MW_{th} boiler.

2017 – 2018

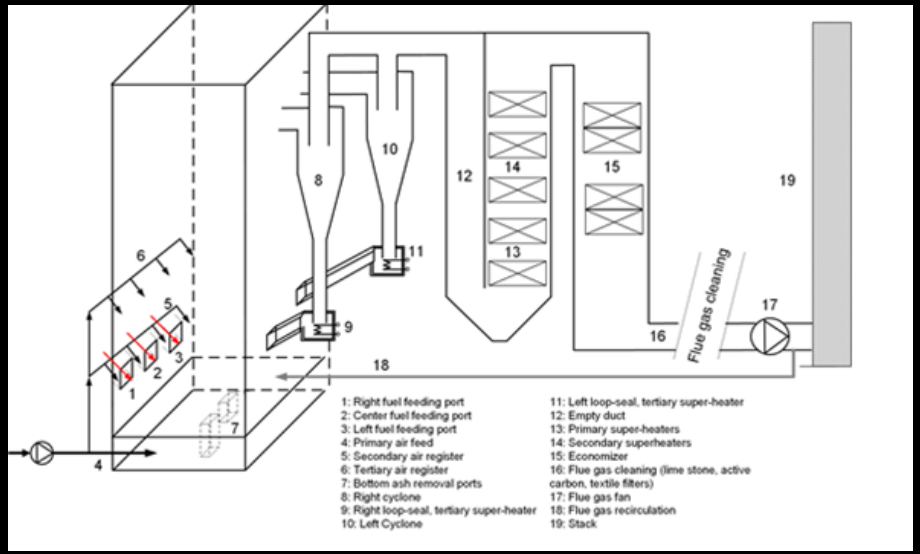
20 000 h of operation, magnetic separation, operating a 115 MW_{th} bio & waste

Present –

New financing and implementations

Industrial scale experiences

- **E.ON**: 75 MW_{th} CFB, Valmet OY, 2003
- ~ 200,000 t MSW annually
- ~ 18 – 25 wt.% of the fuel is ash
- Silica-sand consumption: 10 -13 t/day
  ~ 6 – 8 kg/MWh
- Improbed™ consumption ~ 5 t/d, ~ 3 kg/MWh
  → magnetic separation ~ 0,8 kg/MWh
- Operating time > 20 000 h

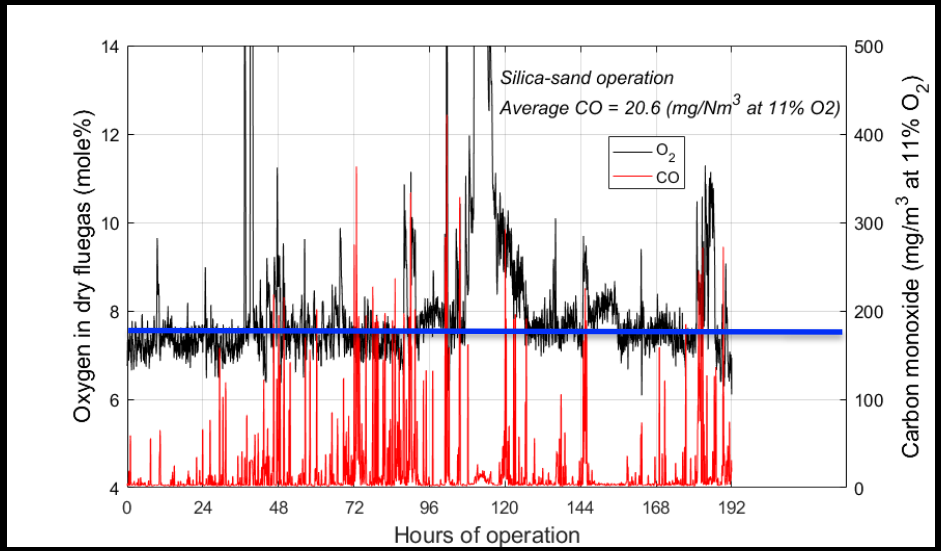


Targets

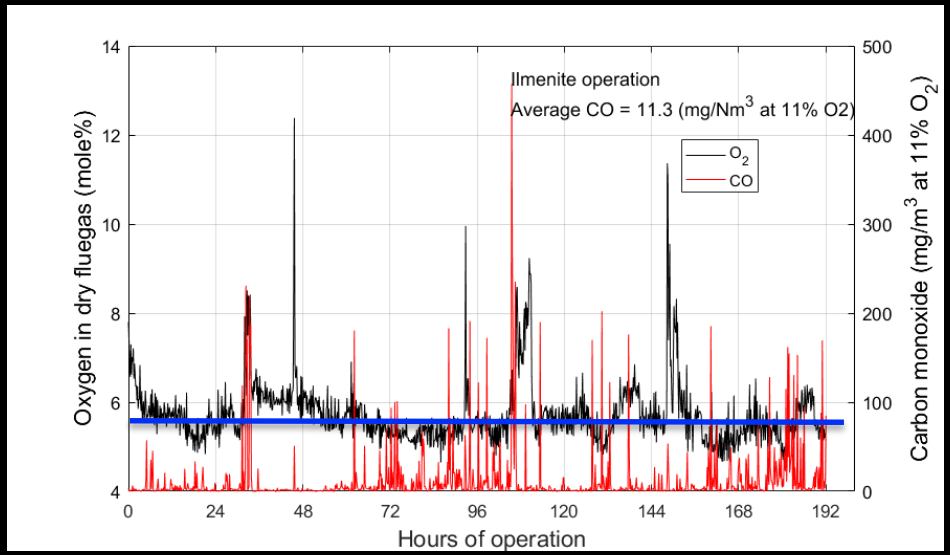
- Reduce CO issues, increased fuel load and availability, maintenance costs

O_2 and CO concentrations in the flue gases of the 75 MW_{th} MSW boiler

Silica-sand operation



Improbed™ operation



F. Lind, A. Corcoran, B-Å. Andersson, H. Thunman 12,000 hours of operation with oxygen-carriers in industrially relevant scale. VGB PowerTech 7, 2017.

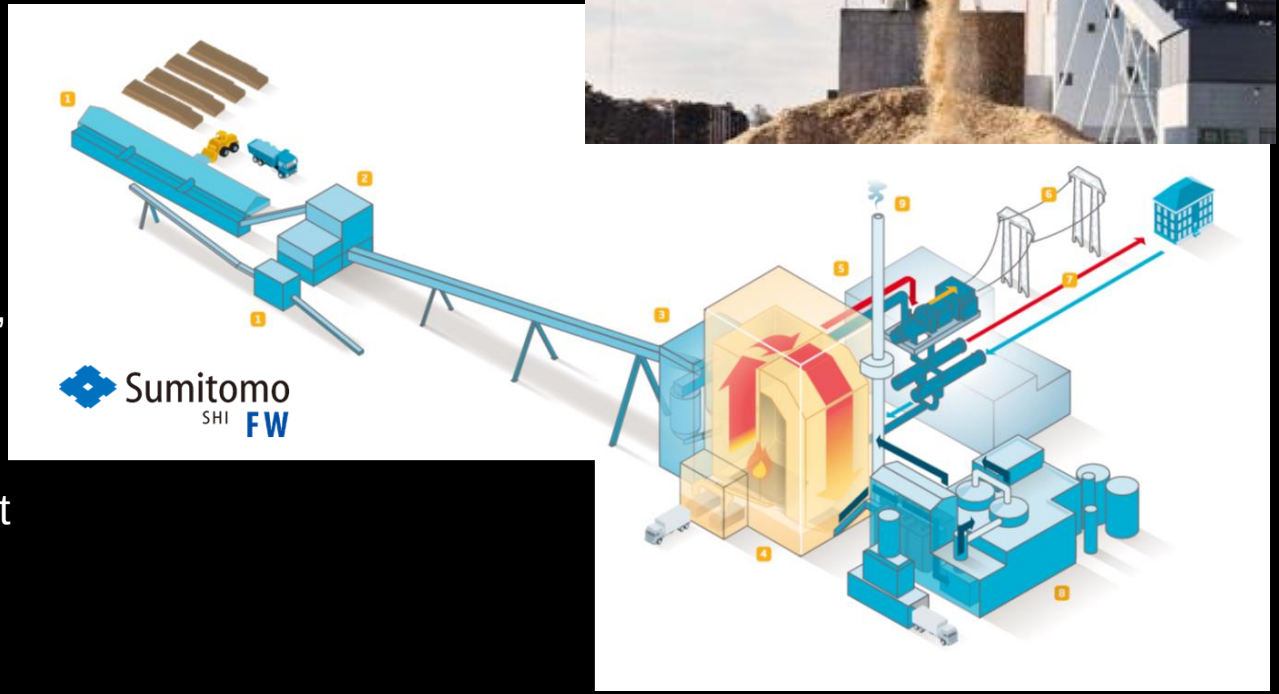
Örtofta plant 115 MW_{th}
Kraftringen Skåne Sweden

CFB, Sumitomo SHI FW 2014

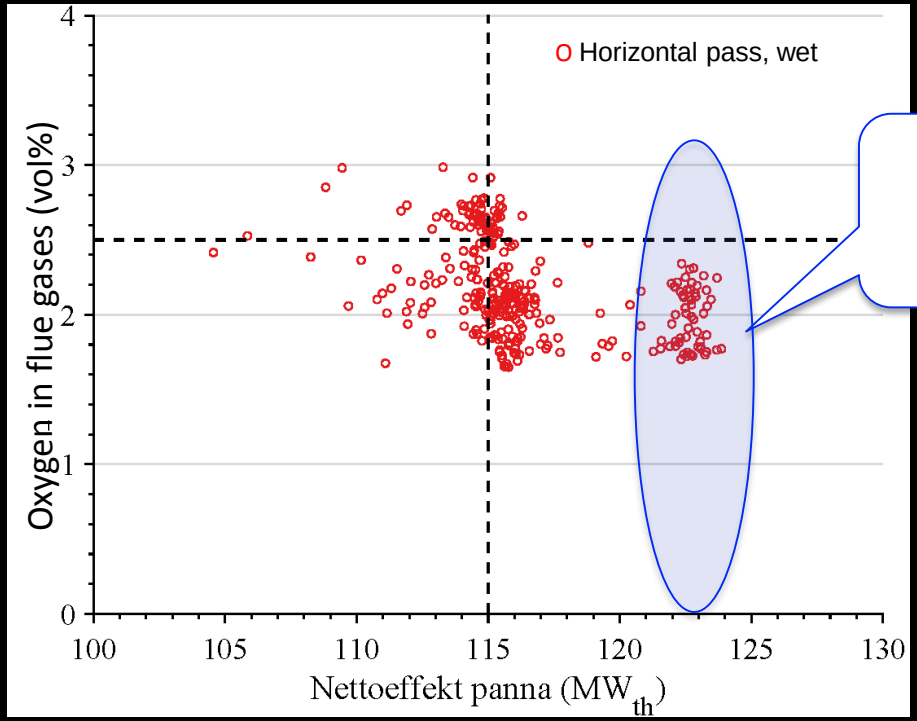
- Flue gas condenser
- 40 MWe
- Waste wood, forest residues, saw dust

Target

- Increased production of heat and power, reduced bed material consumption



Boiler load and excess air



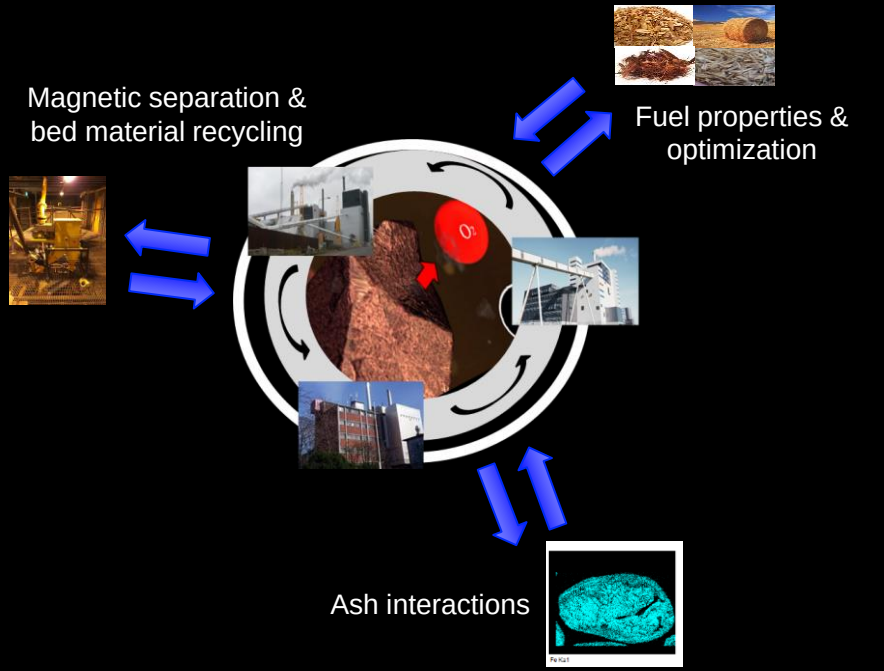
8 MW_{th} increase
7 %

Patrick Moldenhauer, Angelica Corcoran, Henrik Thunman, Fredrik Lind. A Scale-Up Project for Operating a 115 MWth Biomass Fired CFB-boiler with Oxygen Carriers as Bed Material. 5th International Conference on Chemical Looping September 25, 2018

Future work and research questions

Magnetic separation

- Lifetime of particles
- Physical and chemical effects
- Increased particle residence time in system



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