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Chemistry of olivine and its influence on biomass gasification

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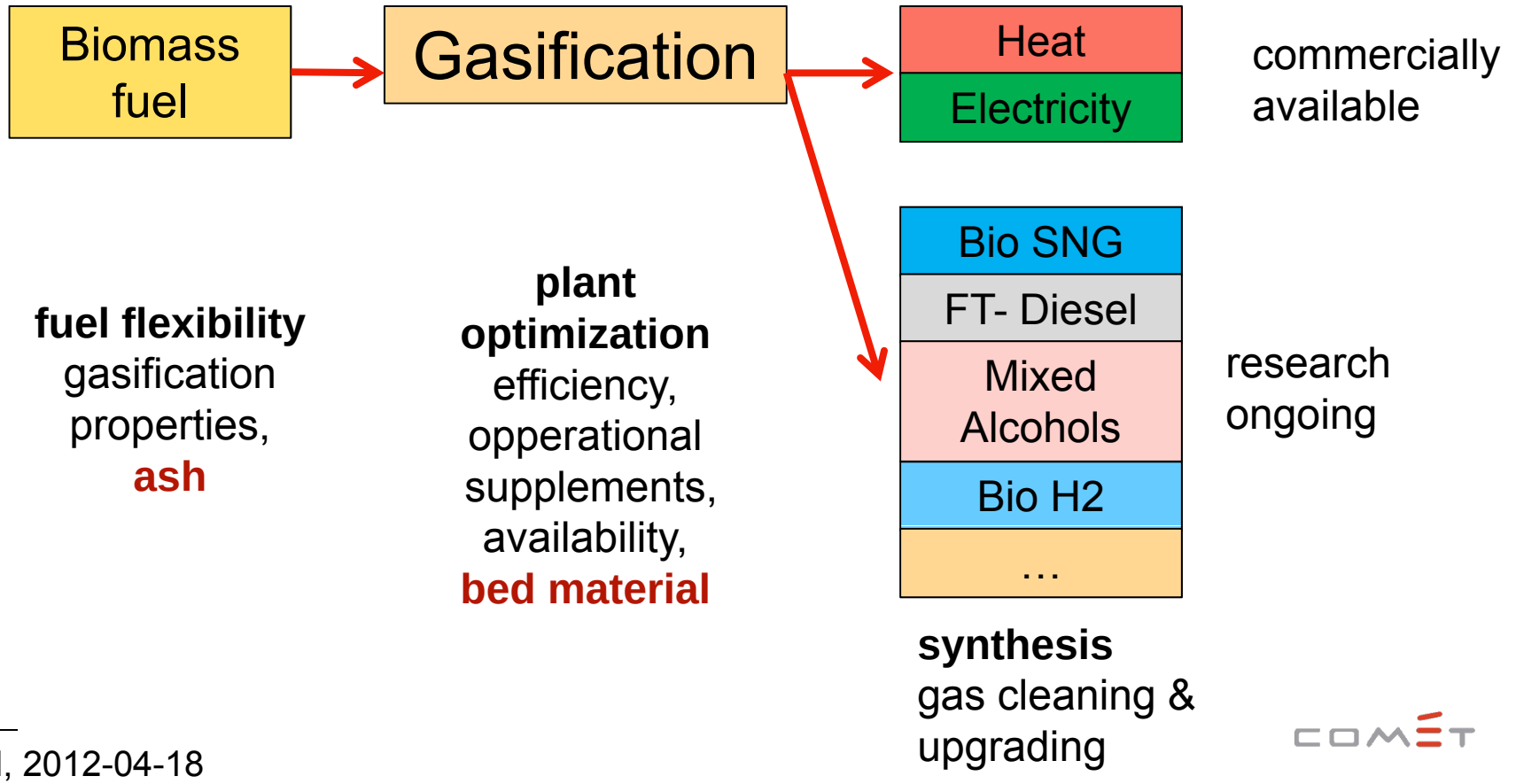
COMET

Competence Centers for Excellent Technologies

Content

- Biomass steam gasification in DFB
- Analyses of olivine from an industrial scale plant
- Comparison of fresh and used olivine in a 100 kW pilot plant

Biomass steam gasification in DFB plants

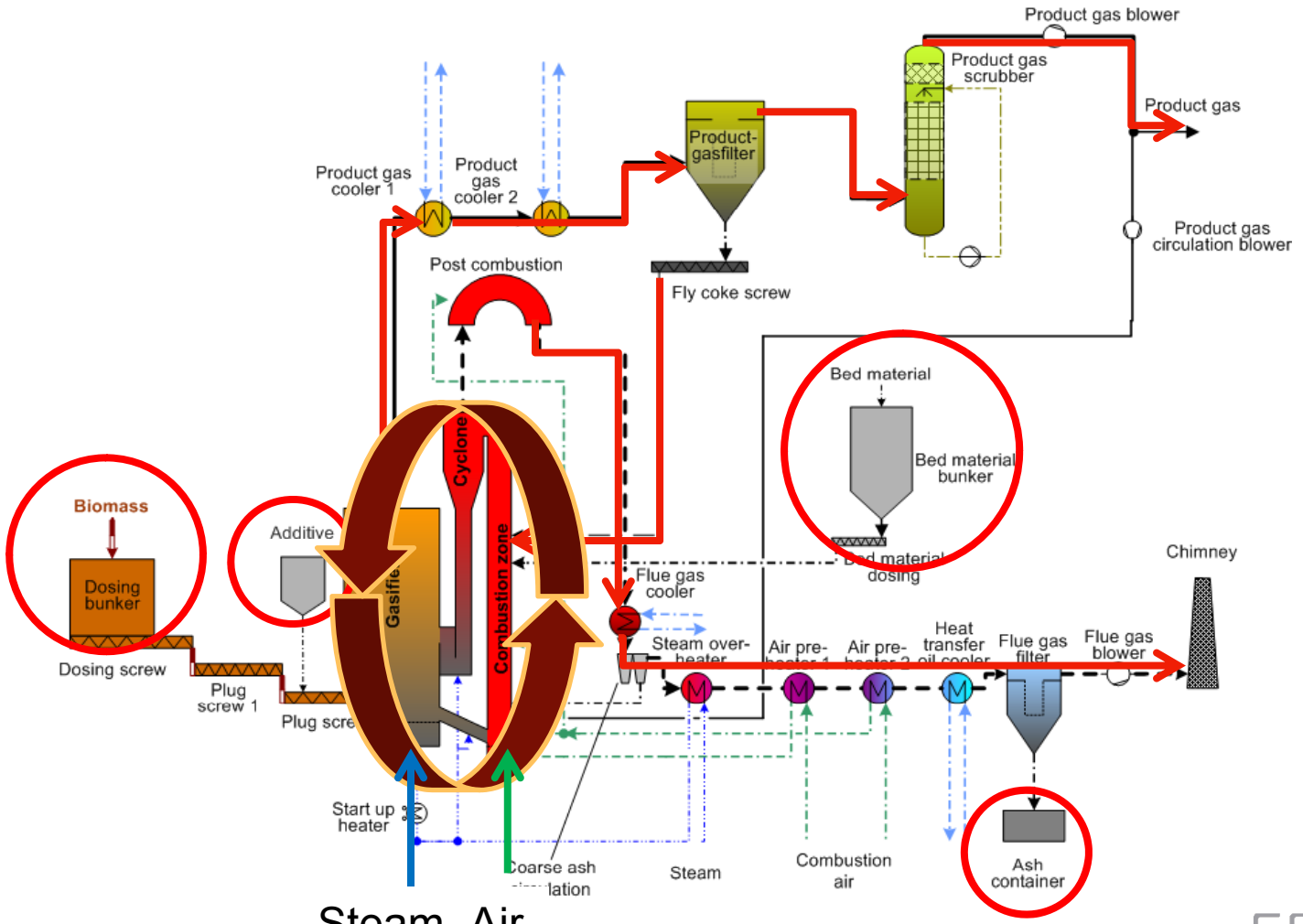


Key figures of the DFB plant in Güssing & other plants

	Unit	Güssing
Fuel power	MW	8
Electrical power	MW	2.0
In operation since		2002
Fuel		Wood residues
Bed material		Olivine
Temperature of gasifier	°C	850
Temperature of combustion zone	°C	~900
Availability	%	~81 (2011)

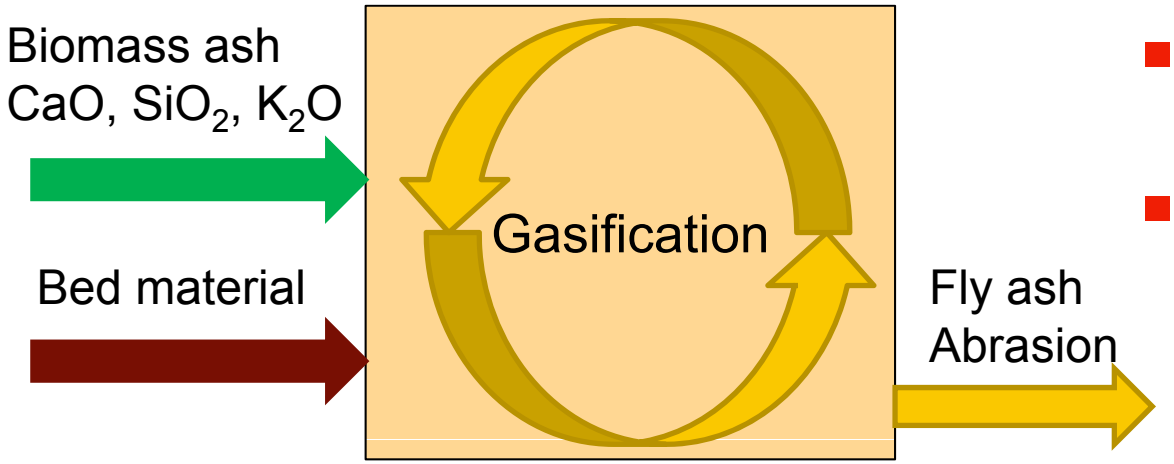
Location	Start up	Fuel input (MW^{th})	Product (MW)
Oberwart/AUT	2007	8.5	2.8_{el}
Villach/AUT	2010	15	3.7_{el}
Ulm/GER	2011	11.5	5_{el}
Götheborg/SWE	Late 2012	32	$20_{hydrogen}$

Biomass Steam Gasification in DFB Plants



Why olivine?

- Natural mineral
  - $(Mg, Fe)_2SiO_4$
- High abrasion resistance
- Positive catalytic effects on tar reduction compared to quartz sand
  - Calcination improves catalytic activity
- Low agglomeration tendency



- Operation time: 7000 h+/year
- Retention time of bed material: ~150 h

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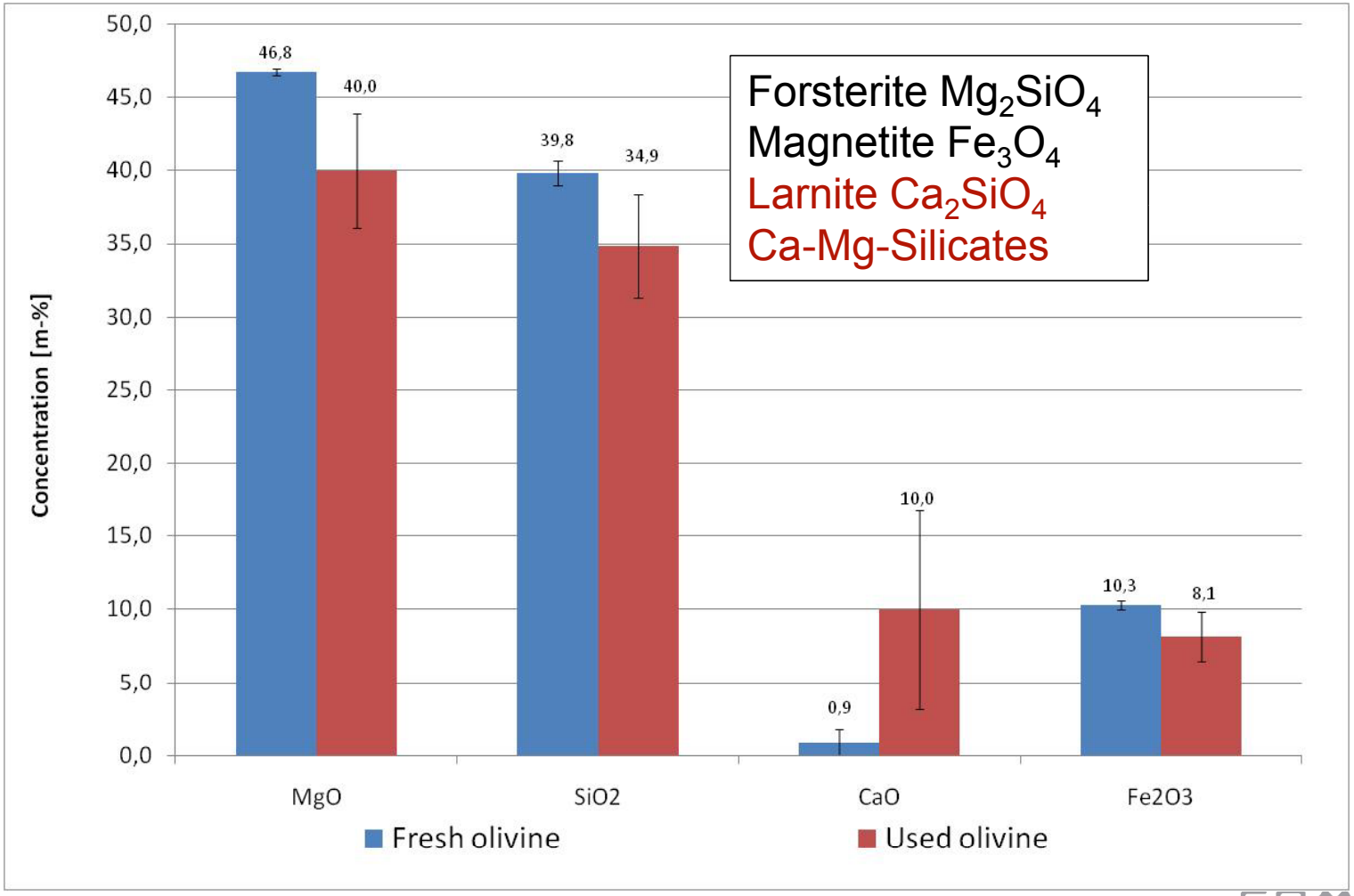
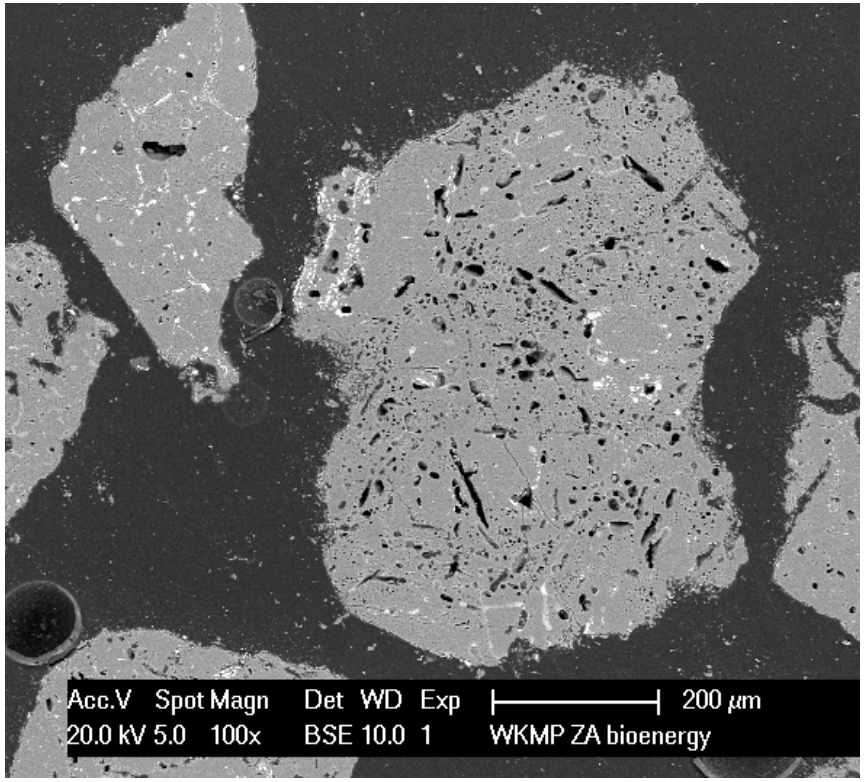
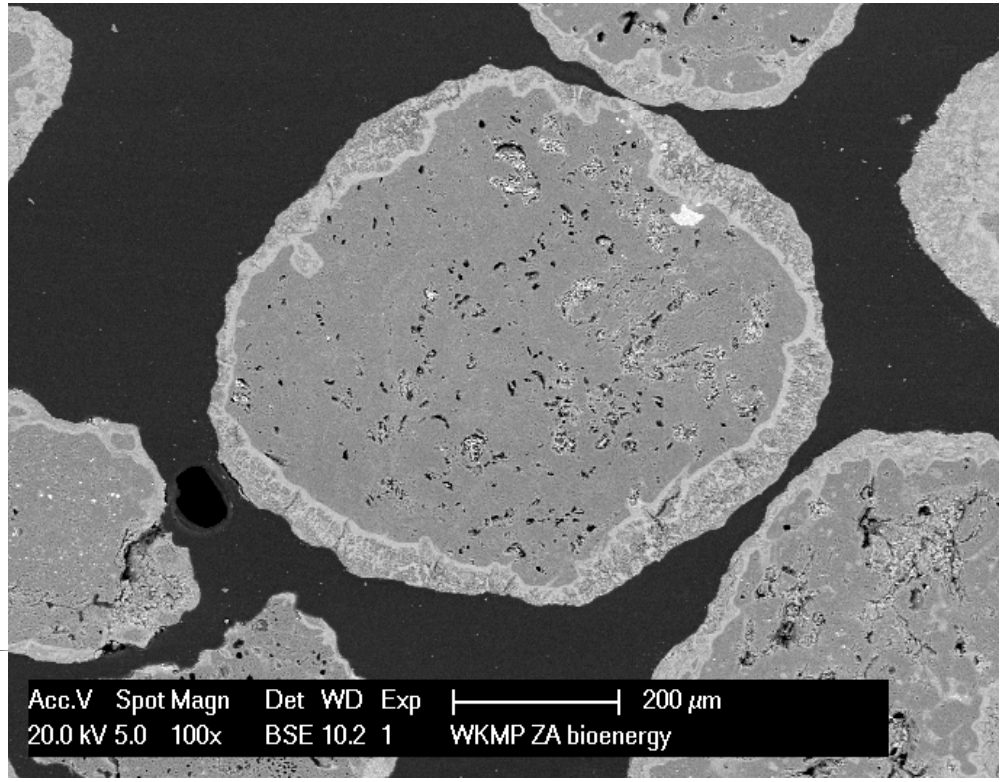
Analyses fresh – used bed material
Main elements

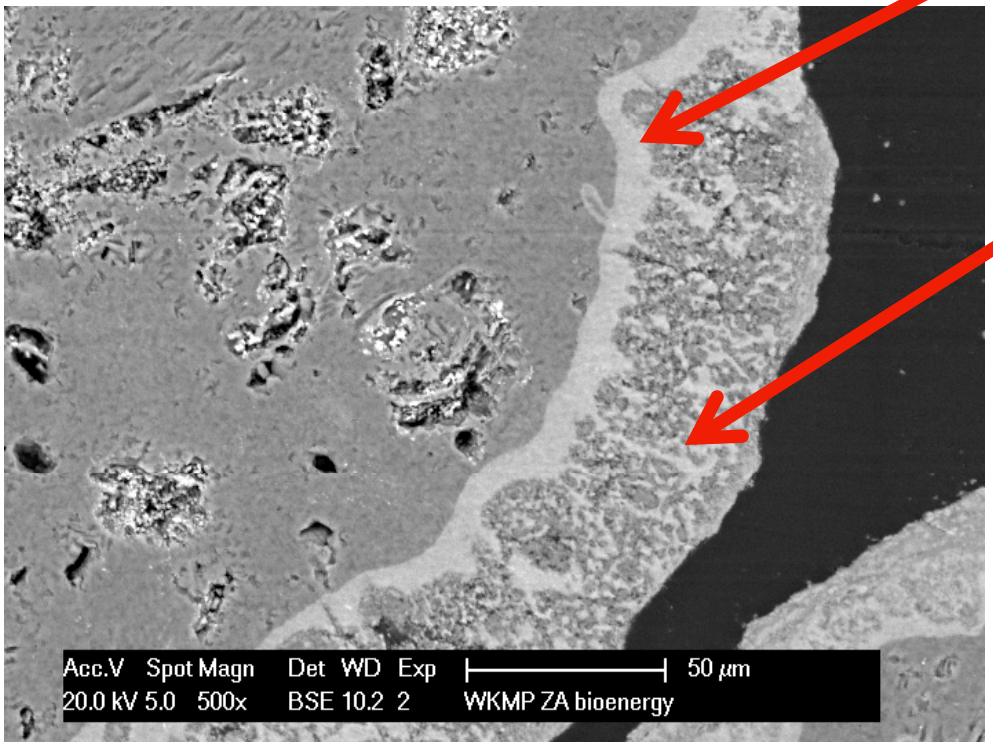


Comparison fresh olivine – used Olivine



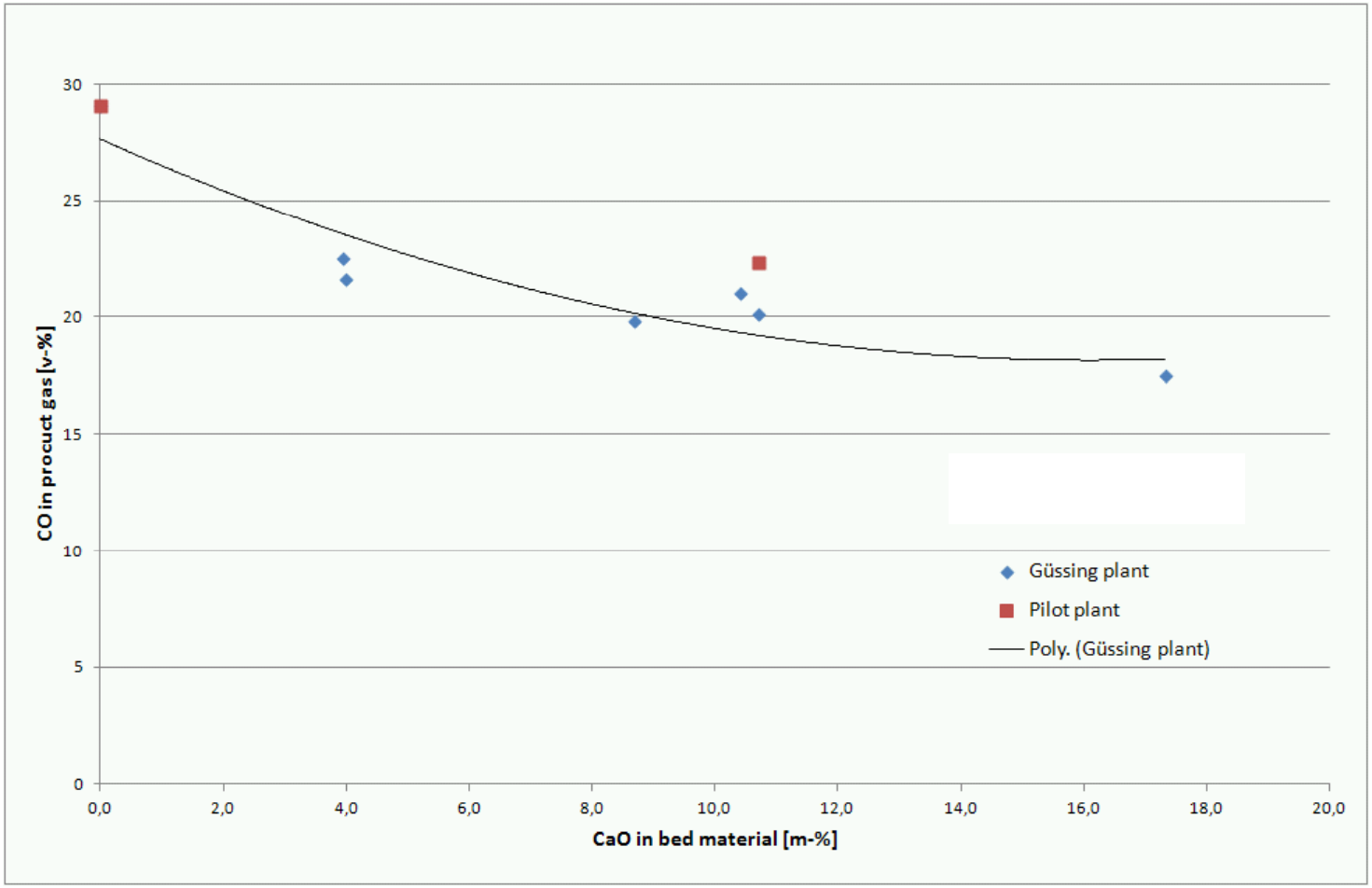


Used olivine
Detail



- Inner layer
  - Homogenious
  - CaO, SiO_2
- Outer layer
  - Inhomegenious
  - CaO, SiO_2, MgO

Calcium content bed material vs. CO-content in product gas



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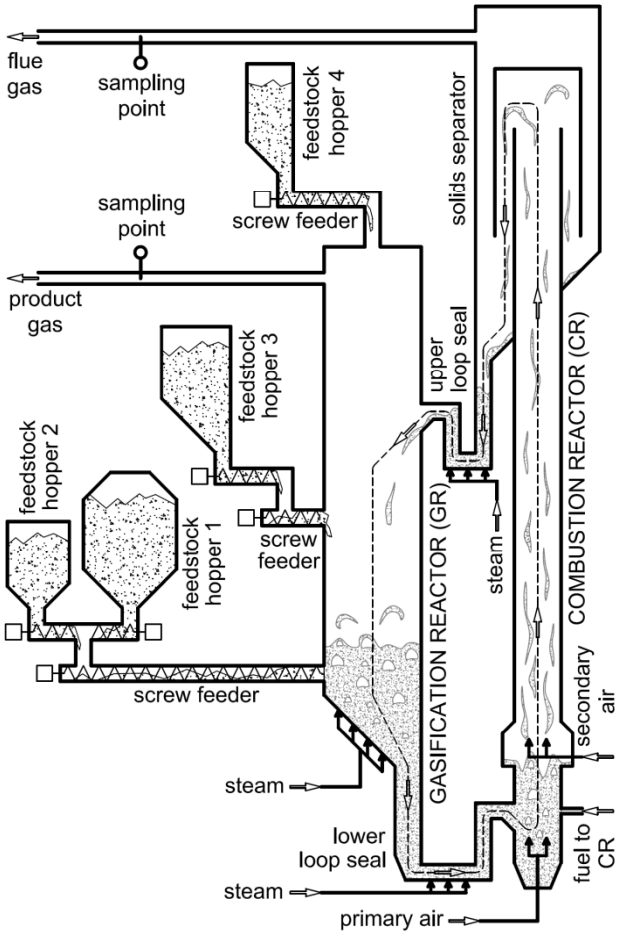
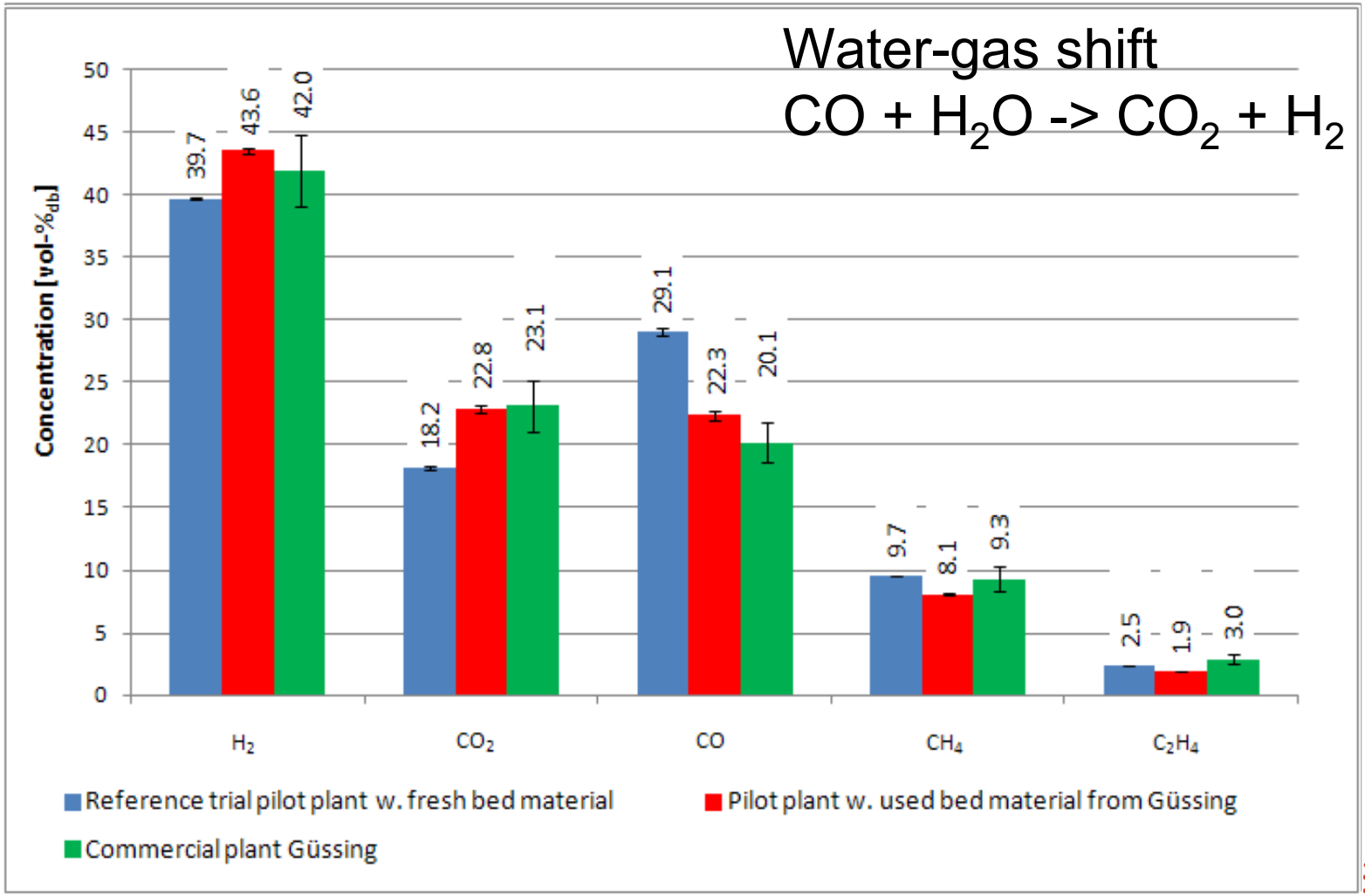
Trials in a 100 kW pilot plant at VUT
What is the influence of the layer?

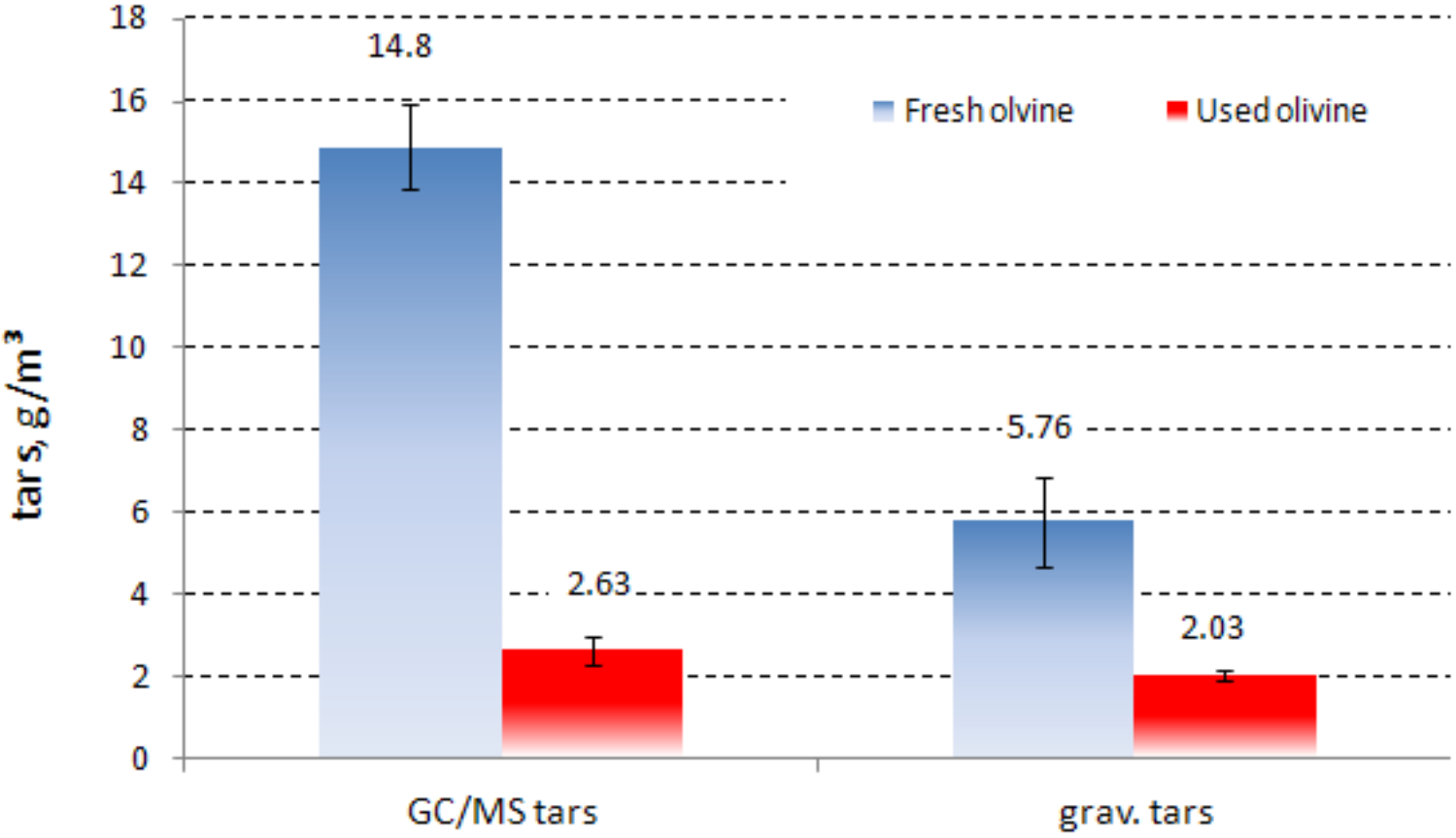


- Comparison of fresh and used olivine under same operation conditions
  - Temperature
  - Fuel
  - Steam/carbon
  - Particle size bed material
  - …

Comparison fresh – used olivine
Product gas composition



Comparison fresh – used olivine
Tar analyis



Conclusion

- Olivine is modified in industrial scale plants
  - Calcium rich layer
- The water-gas shift reaction is enhanced by the layer
  - Higher H_2, CO_2, lower CO in the product gas
  - Lower energy demand for gasification
- Positive effects on tar reduction
  - Tar reduction from 60-80%
- Results of the 100 kW pilot plant are in accordance with industrial scale plant

References

- Kirnbauer, F.; Hofbauer, H. Investigations on Bed Material Changes in a Dual Fluidized Bed Steam Gasification Plant in Güssing, Austria. *Energy Fuels* **2011**, *25*, 3793–3798. DOI: 10.1021/ef200746c
- Kirnbauer, F.; Wilk, V.; Kitzler, H.; Kern, S.; Hofbauer, H. The positive effects of bed material coating on tar reduction in a dual fluidized bed gasifier. *FUEL* **2011**, 95, 553-562. DOI: 10.1016/j.fuel.2011.10.066

Thank you for your attention!

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FUTURE ENERGY TECHNOLOGY
Dual Fluidized Bed Systems

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Biomass Steam Gasification in DFB plants