Potential use of (gasification) char as activated carbon

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outline

Brief information on institution and presenter

Basics in thermochemical conversion

The floating-fixed-bed technology

Activated char from gasification

- starting situation
- activation setup
- first findings

Summery

Marcel Huber
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personal introduction

DI Marcel Huber

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Maximilianstr. 2, 6020 Innsbruck

Education

1991 - 1996	Higher education as mechanical engineer
1999 - 2003	Studying process and environmental engineering at MCI

Professional background

1997 - 2000	Quality manager at a dozer producing company
2001 - 2003	Quality manager at automotive company
2004 - 2008	Junior researcher at MCI
2009 - now	Senior researcher and RND project manager at MCI
2015 - now	Head of research cluster renewable energy at MCI

Technology & life sciences

the entrepreneurial school

Entrepreneurial school

Based on a purely public ownership

Founding in 1996

University of Innsbruck is a founding member

9 higher education study programs

Around half are technical studies

Bachelor and Master programs

Management courses

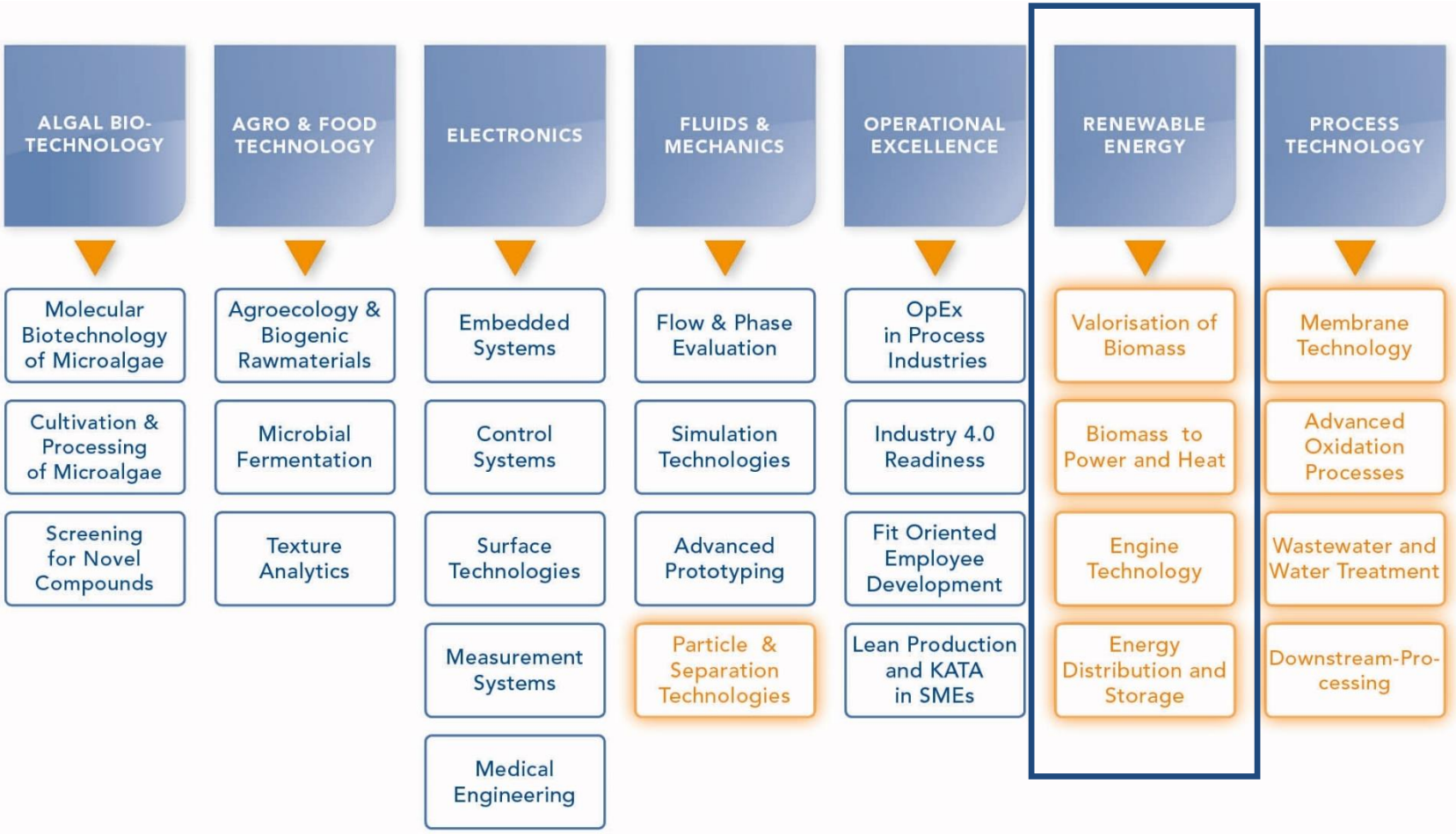
3.000 students

100 partner universities

5 locations in Innsbruck

Technology & life sciences

research structure



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Technology & life sciences

research areas renewable energy

BIOCHAR
closing cycles
sustainable

STORAGE OF ENERGY
development and testing
of new storage technologies

ENERGY
develop engines
for high efficiency

STORAGE
storage of biogenic residues
while maintaining quality

CONVERSION
convert residues
in producer gas

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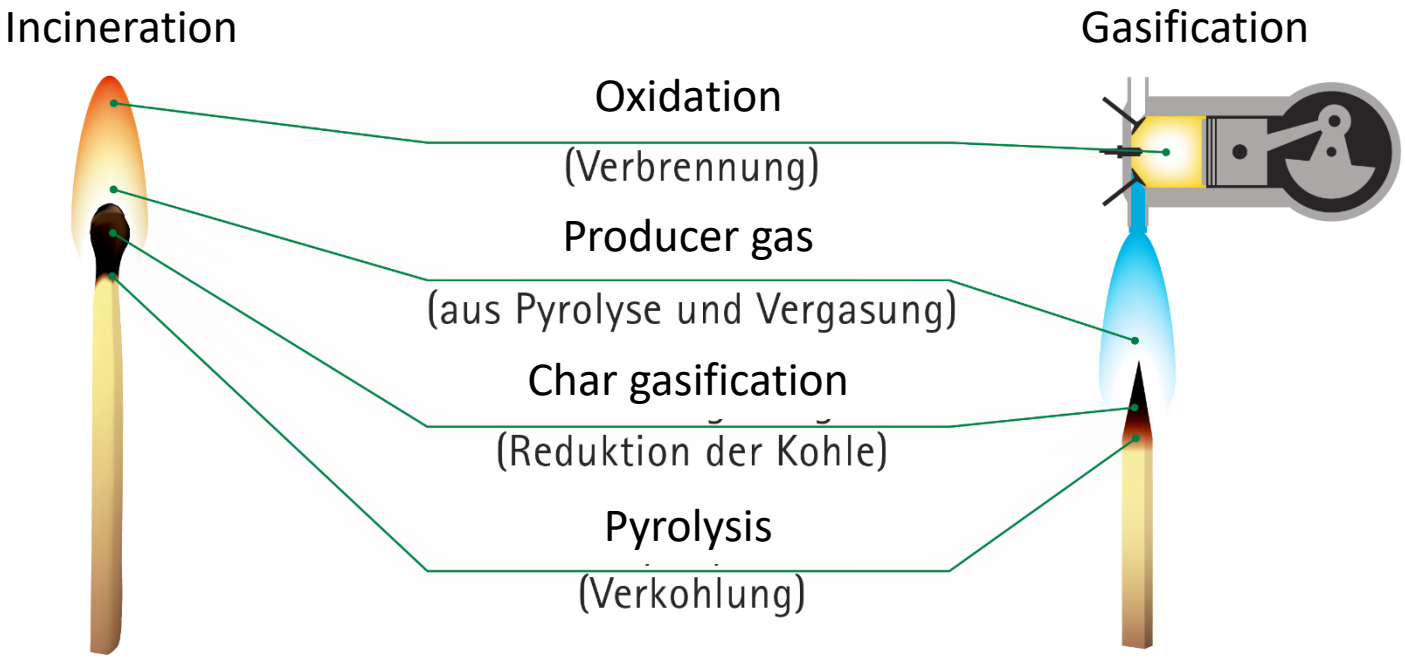
basics in thermochemical conversion

difference between incineration and gasification



Source: ÖMBV & MCI

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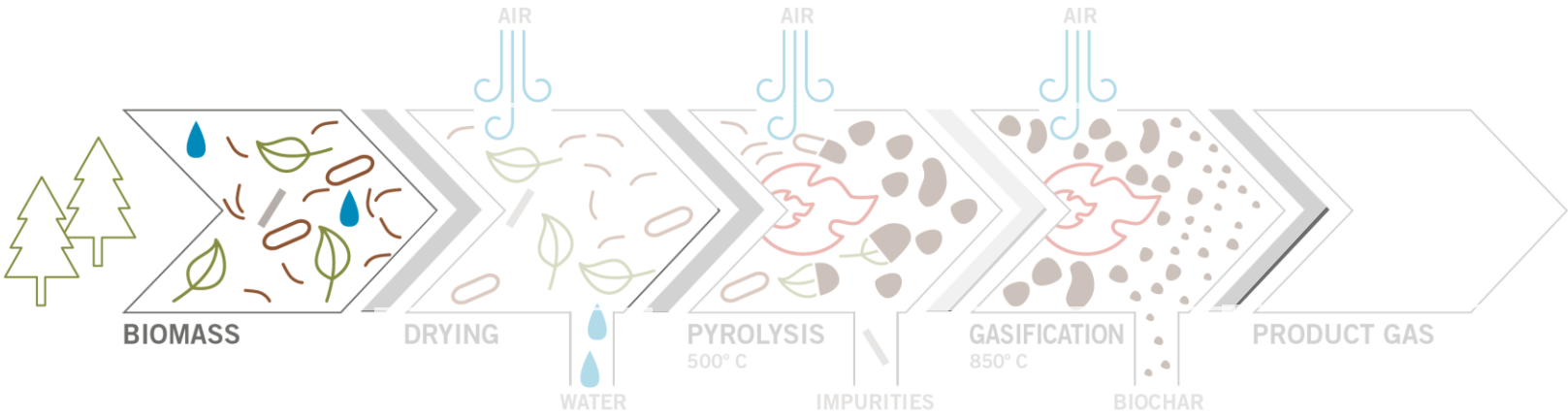
basics in thermochemical conversion

A completely staged approach



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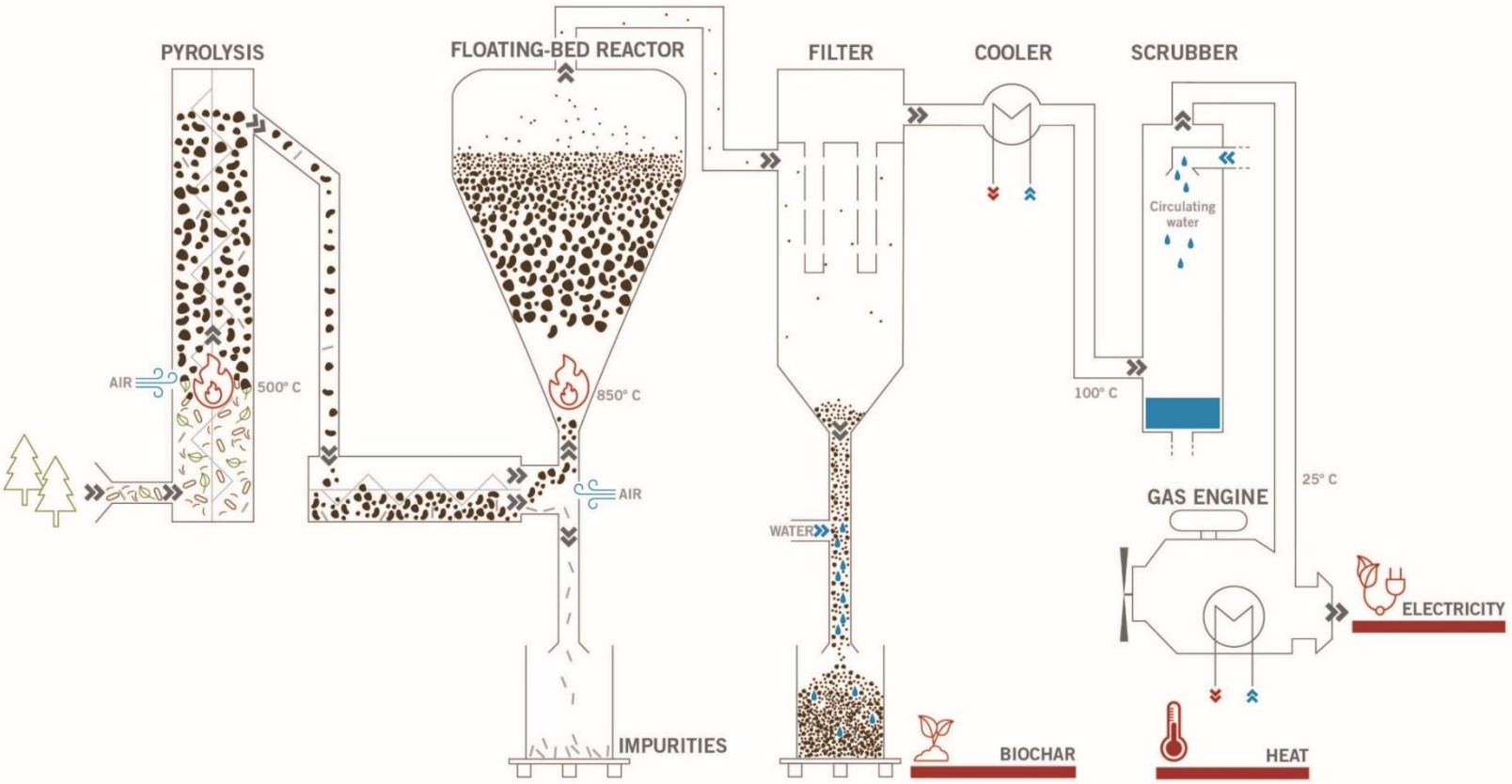
the floating-fixed-bed gasification technology



Source: www.syncraft.at

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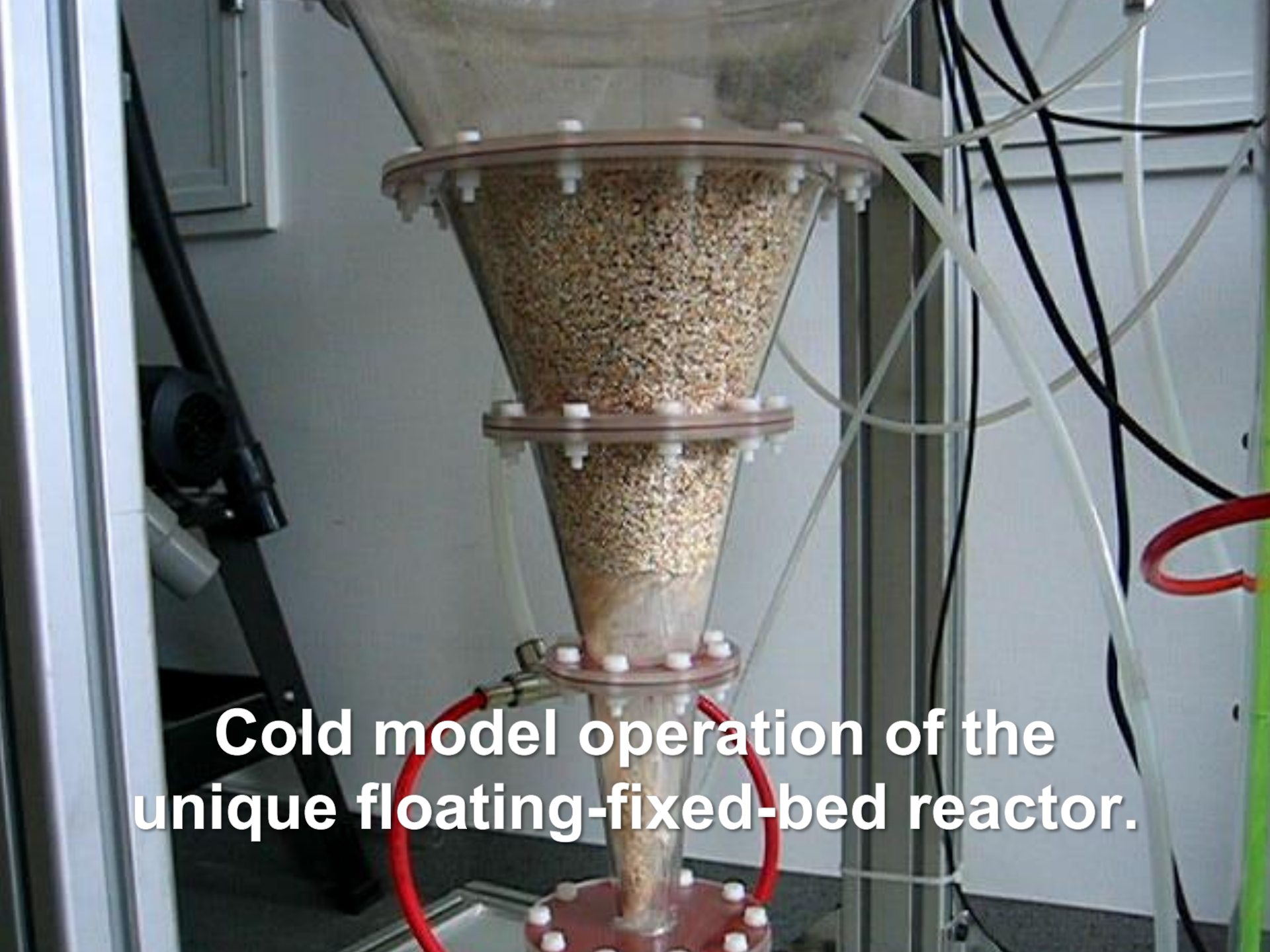
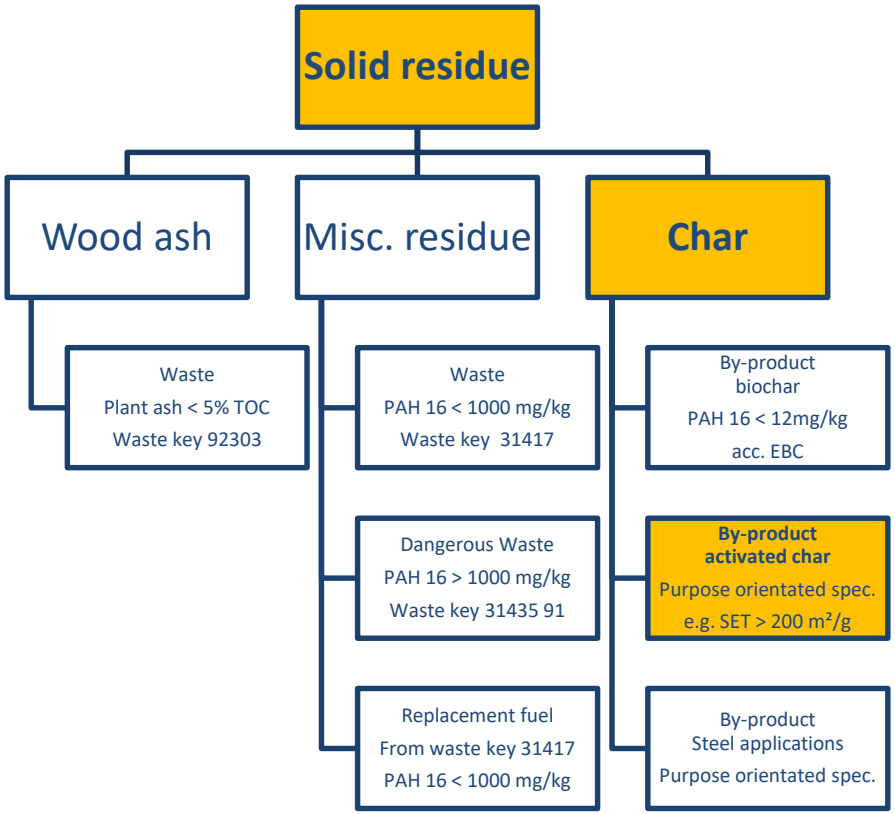

Cold model operation of the
unique floating-fixed-bed reactor.

activated char from gasification

different solid residues from gasification



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activated char from gasification

starting situation – market related

Annual global production of **charcoal 40 Mio. tons**. **200 Mio. tons of wood** are used therefore. In energy terms these are **15,000 TWh.**

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activated char from gasification

starting situation – actual production

Source: GEO

Globally dominating charcoal production technology

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activated char from gasification

starting situation – actual production

Source: Donau Carbon

Production from e.g. coconut shells at temperatures between 700 – 1,000°C to reach a surface S_{BET} from (300) 600 – 1,500 m²/g

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activated char from gasification

starting situation – gasifier char performance

Table 2. S_{BET} values of char collected from different biomass gasification plants in South Tyrol, Italy.

	Feedstock	Technology	Gasifying agent	Nominal power	T (°C)	S_{BET} (m^2/g)
A	wood chips	downdraft	air	45 kWel 120 kWth	~650	352.41
B	pellets	rising co-current	air	180-190 kWel 220-240 kWth	~700	127.67
C	wood chips	downdraft	air	100-150 kWel 200-250 kWth	~650	77.90
D	wood chips	downdraft	air	300 kWel 600 kWth	~800	281.23
E	wood chips	dual stage gasifier	air	50 kWel 80 kWth	~900	586.72

Source: Baratieri et al.; 2016

Temperature, residence time, fuel and process related!
Measurement of “real” temperature?

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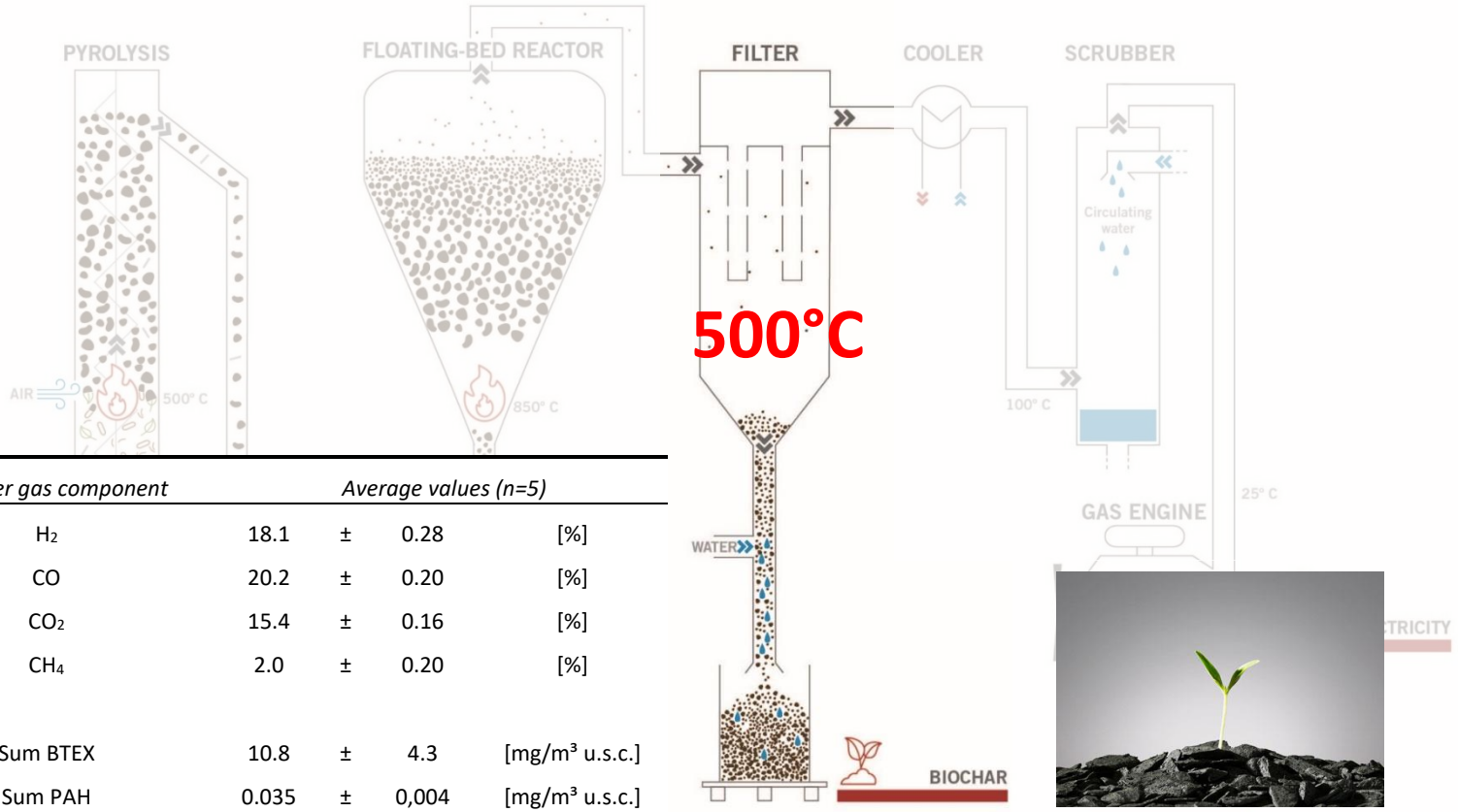
activated char from gasification



Producer gas component	*Average values (n=5)*			
H_2	18.1	±	0.28	[%]
CO	20.2	±	0.20	[%]
CO_2	15.4	±	0.16	[%]
CH_4	2.0	±	0.20	[%]
Sum BTEX	10.8	±	4.3	[mg/m³ u.s.c.]
Sum PAH	0.035	±	0,004	[mg/m³ u.s.c.]
Grav. Tars	15.3	±	2.9	[mg/m³ u.s.c.]

Source: Hofmann et. al.

CHAR

by-product due to:
PAH 16: 3,2 – 11,3 mg/kg
S_{BET}: ~ 350m²/g

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activated char from gasification

Further activation tests - setup

Strictly tubular reactor, filled with charcoal, mounted in a muffle oven and spilled by activation gas at a certain temperature for a set period of time

activated char from gasification

Further activation tests – first results

Sample	T	t	S_{BET}
	°C	min	m^2/g
Char Schwaz not activated	0	20	319
Char Schwaz activated	800	20	360
Char Schwaz activated with KOH	450	20	379
Char Hatlerdorf not activated	0	20	218
Char Hatlerdorf activated	800	20	249
Char Hatlerdorf activated with KOH	450	20	432
Char Schwaz unactivated	0	0	331
Char Hatlerdorf activated	900	20	634
Char Hatlerdorf activated	800	60	353
Char Hatlerdorf activated with KOH	550	20	466
Char Hatlerdorf activated with KOH	450	60	384

Activation gas CO_2 one some KOH pre-treated samples from different operating floating-fixed-bed gasifiers

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Summery & outlook

- Char / Charcoal is a global high volume product
- Till 2050 almost all carbon related processes (steel, etc.) must be driven by a CO_2 neutral form of carbon
- Char from gasification shows considerable high potential to act as activated char; even at untreated state
  - Pollutants on the char, like PAH, have to be considered before thinking of a by-product / activated charcoal product
- Further activation of gasification char shows good potential
- Systematic investigations in cooperation between UNIBZ & MCI already started; Interreg project targeted 2017 ff.; project partners welcome

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Summery & outlook

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Many thanks for your attention

Questions?

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