Thermo-Catalytic Reforming TCR® – Pyrolysis research on a wide range of feedstocks

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Potential of biowaste

Residual biomass in Germany

Sustainability restrictions

Food or fuel

Biogenic residues

Biowaste[1]

4 Mio. Mg/a

Garden and park waste[2]

4,5 Mio. Mg/a

Straw[3]

8 - 13 Mio. Mg/a

Hay[4]

0,6 - 0,9 Mio. Mg/a

Sewage sludge[5]

1,9 Mio. Mg DM/a

Source: [1]UBA 2011, [2]Destatis 2010, [3]Zeller et al., 2011, [4]Simon et al., 2008, [5]UBA, 2012

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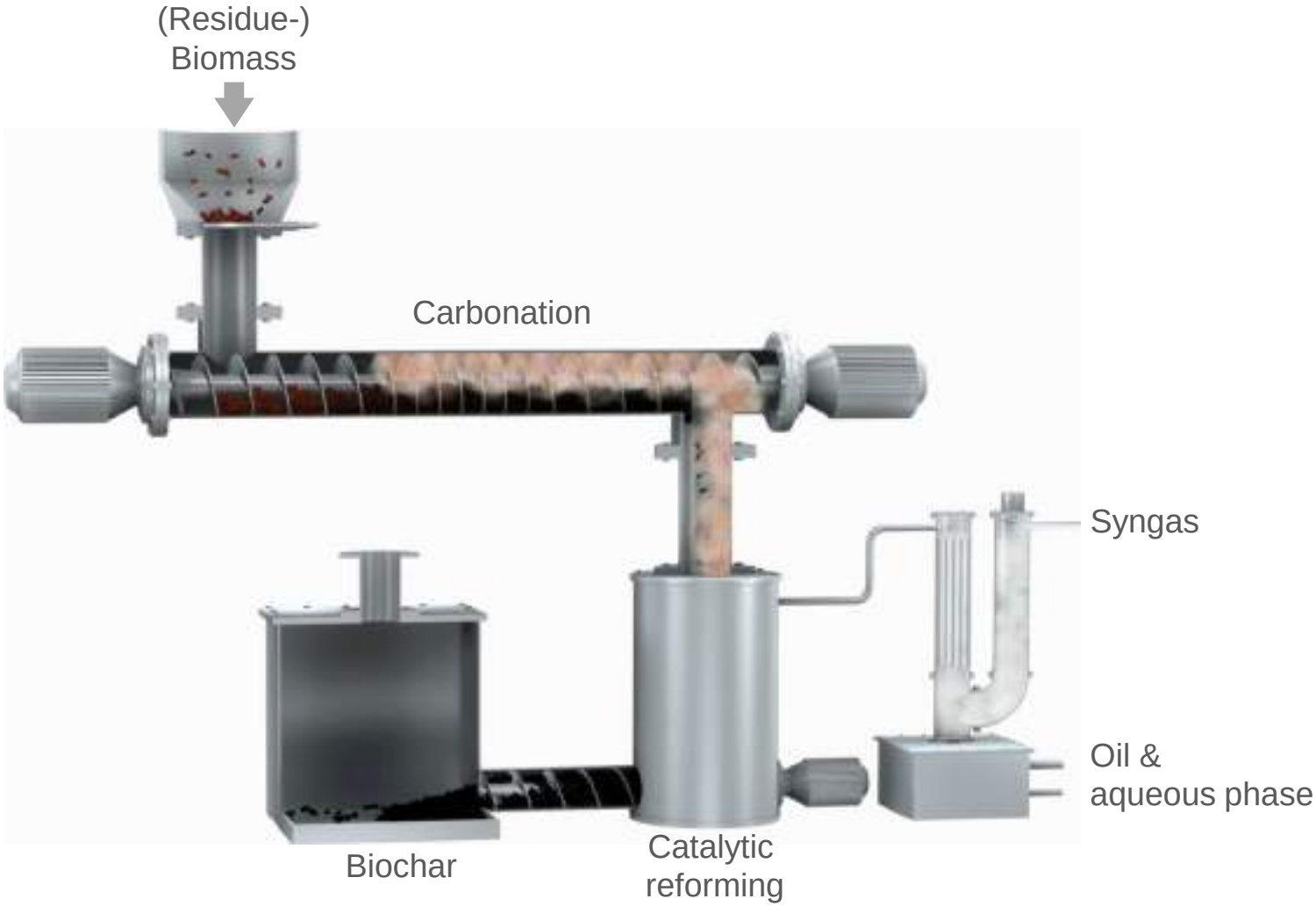
A key element of the Biobattery

Thermo-Catalytic Reforming TCR®



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TCR ® Animation

YouTube Video: https://www.youtube.com/watch?v=dharbD50LGg

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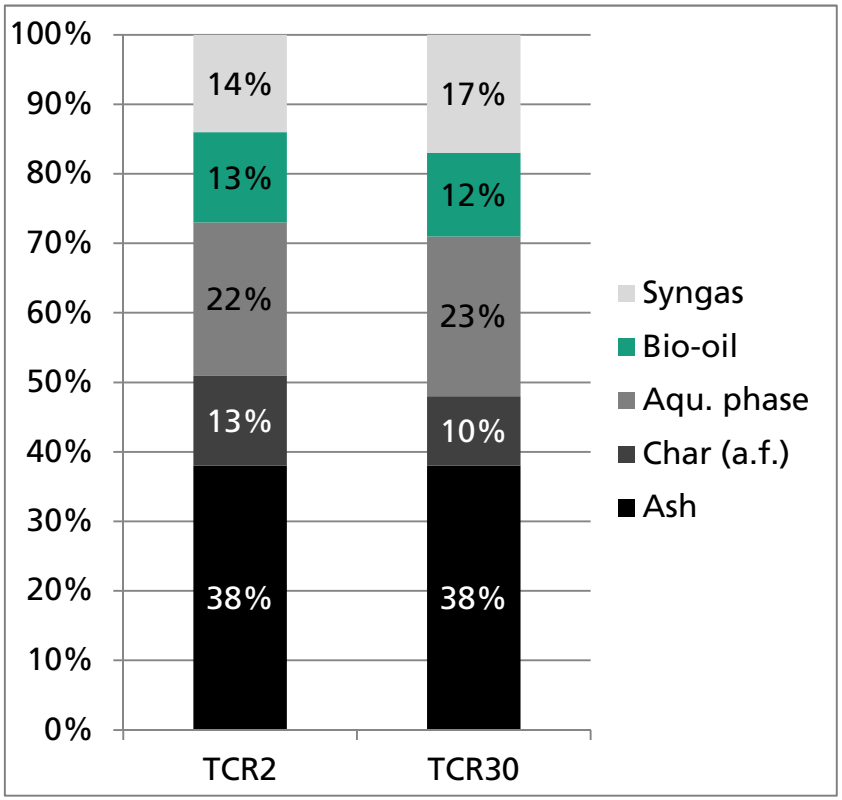
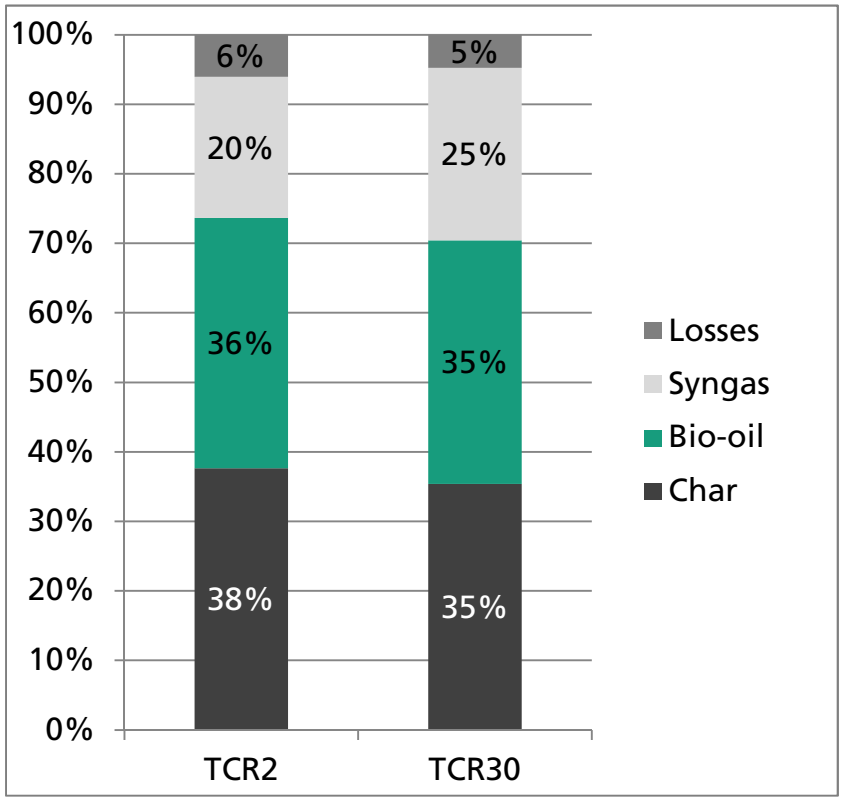
Thermo-Catalytic Reforming TCR®

Energy and Mass Balance (for sewage sludge)

MASS BALANCE



ENERGY BALANCE



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Thermo-Catalytic Reforming TCR®

Various applications – Bio-oil

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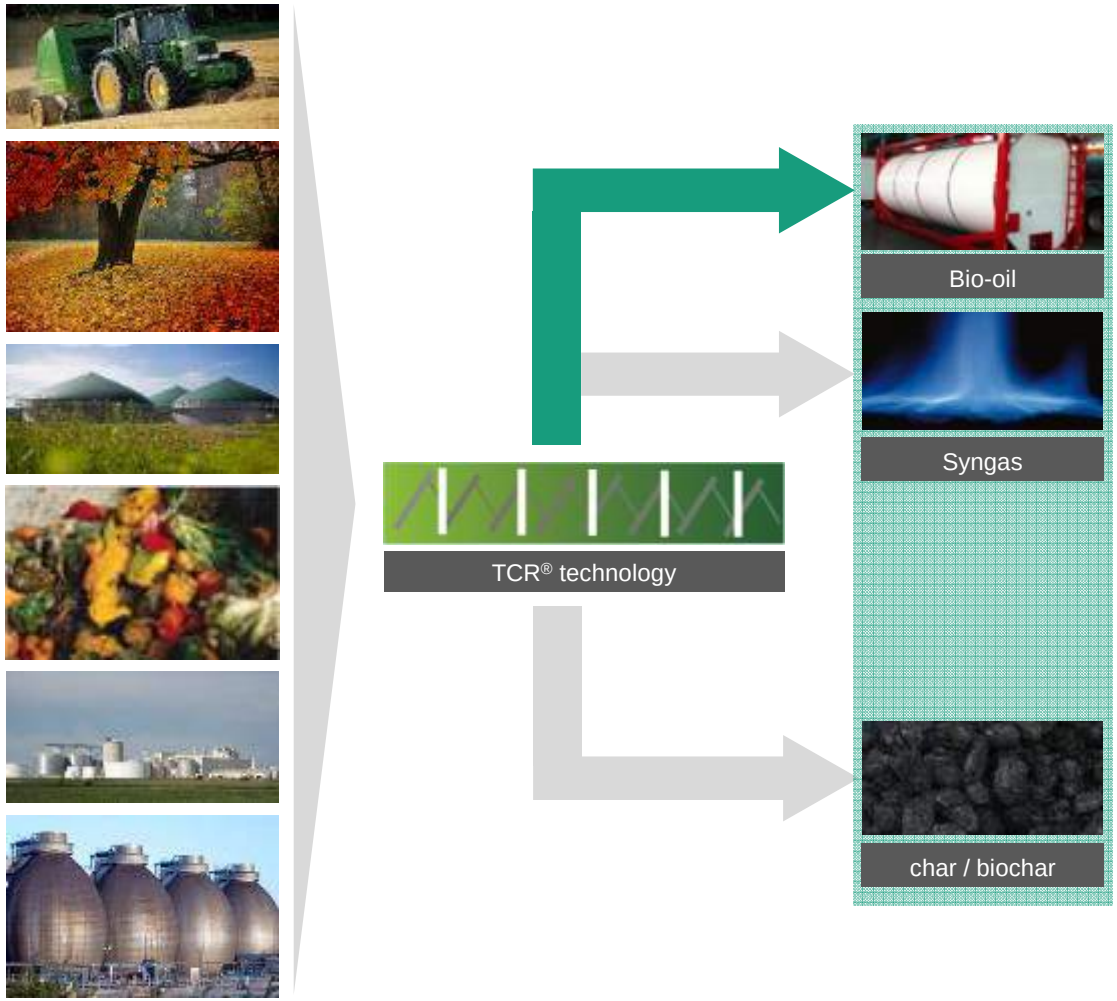
Thermo-Catalytic Reforming TCR®
Various applications – Bio-oil



High quality, engine-ready

- Low acid number
- High calorific value
- Miscible with common fuels
- No tar issues
- Low Viscosity
- Thermal stability

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Thermo-Catalytic Reforming TCR®
Product utilization – Bio-Oil

Crude Oil

- CHP Engine
- Dual Fuel Engine (with Syngas)
- Fuel Blends

Up-graded Oil

- Green Diesel
- Green Naptha and Jet Fuel
- Green Chemicals

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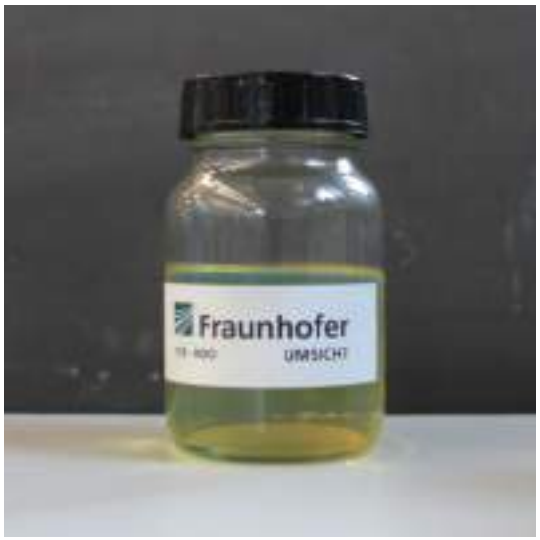
TCR®-Fuels

Primary Oil



Hydrated Primary Oil

Hydrated Primary Oil Fractions

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Results HDO

Anlaysis Diesel Fraction

Standard Value				Reference Product	TCR®-Product
Diesel EN 590				Diesel B7	Fractionated TCR®-HDO
min	max	Property	Unit	EN590	
51	-	Cetane number		54	43
820	845	Density at 15 °C	kg/m³	842,5	840,0
-	8	PAH	% (m/m)	4	n.a.
-	10	Sulphur	mg/kg	n.a.	19,9
55	-	Flash point	°C	67	86
-	0,01	Ash content	% (m/m)	n.a.	<0,005
-	200	Water content	mg/kg	n.a.	55
Class 1	Class 1	Copper strip corrosion (3 hours at 50 °C)	Class	n.a.	Class 1
-	460	Lubricity at 60 °C	µm	165	196
2	4,5	Viscosity at 40 °C	mm^2/s	3,3	2,855
-20 (Winter)	0 (Summer)	CFPP	°C	n.a.	-11
-	< 65	Volume at 250 °C			54
85	-	Volume at 350 °C			92,7
-	360	95 %(V/V) recovered at	°C	360	360
		Lower Heating Value	MJ/kg	42,49	42,496
		Carbon	% (m/m)	86,5	86,3
		Hydrogen	% (m/m)	13,4	13,6
		Nitrogen	% (m/m)	n.a.	< 0,5
		Oxygen	% (m/m)	0,1	< 0,5

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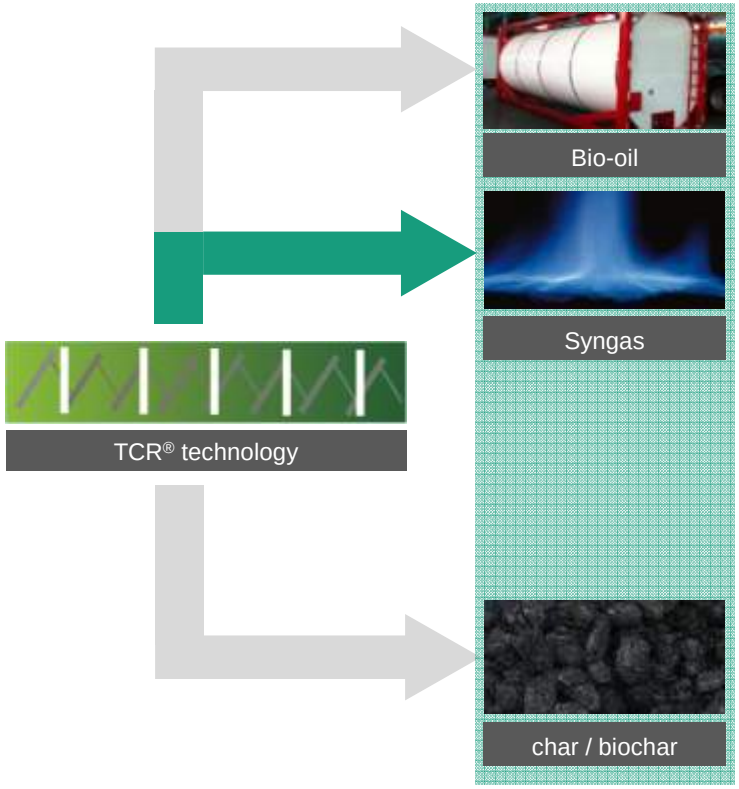
Thermo-Catalytic Reforming TCR®
Various applications – Syngas



Engine-ready gas

- Tar and dust free syngas
- Direct suitable for engines
- High hydrogen content
- Free of aromatic-compounds

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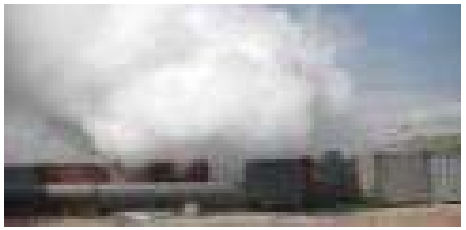
Thermo-Catalytic Reforming TCR®
Product utilization – Syngas

Energetic Use

- CHP Engine
- Dual Fuel Engine (with Biooil)
- Gas Burner (Heating)

Material Use

- Synthesis Gas
- Green Hydrogen



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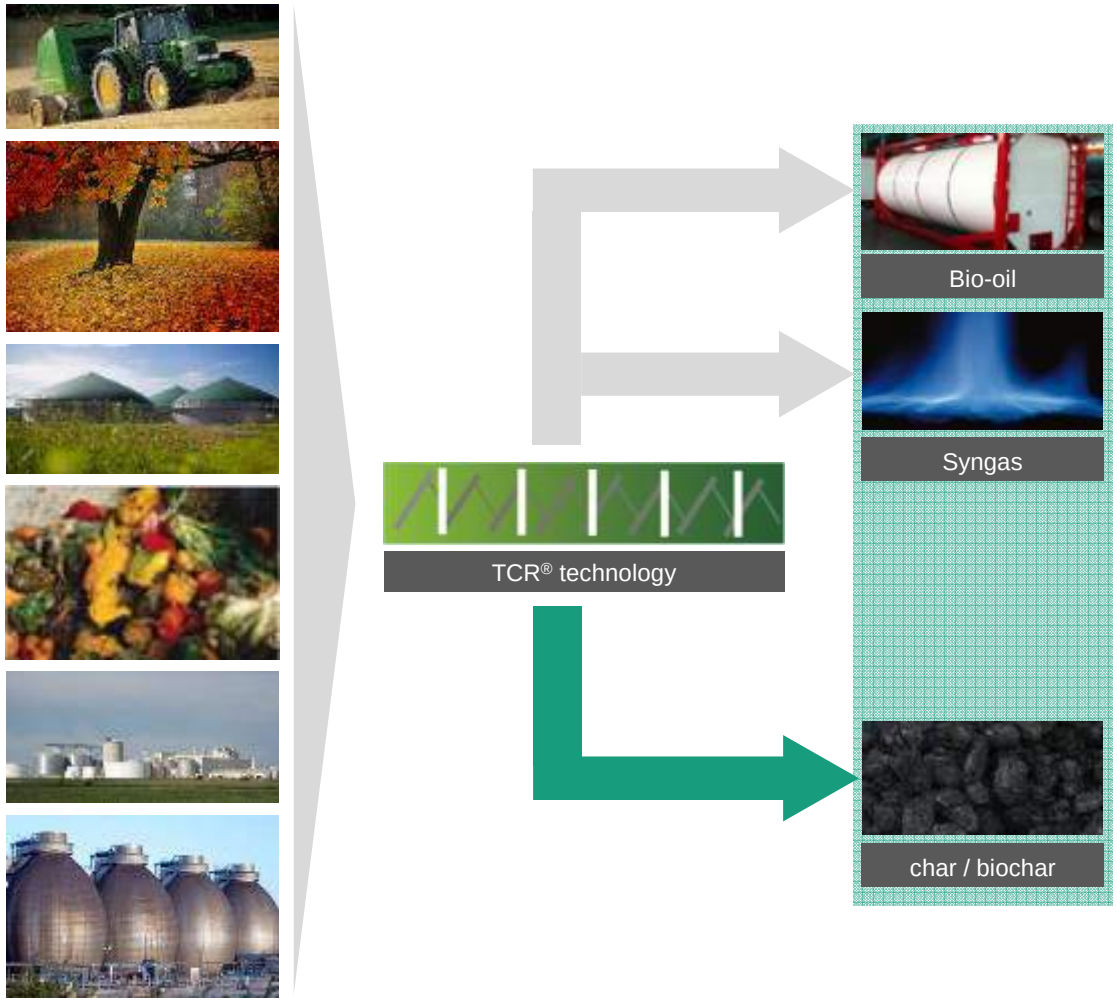
Thermo-Catalytic Reforming TCR®
Various applications – Char



Anthrazitic-like, storable biochar

- Very low H and O content
- High calorific value
- High soil stability
- Significant ash content

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Thermo-Catalytic Reforming TCR®

Product utilization – char

Energetic Use

- Co-Combustion in Power plant
- Cement Industry
- Barbecue Coal
- Distributed Combustion




Material Use

- Soil Improvement
- Animal feed additive
- Filter Material (Activated Carbon)
- Reduction in metal process




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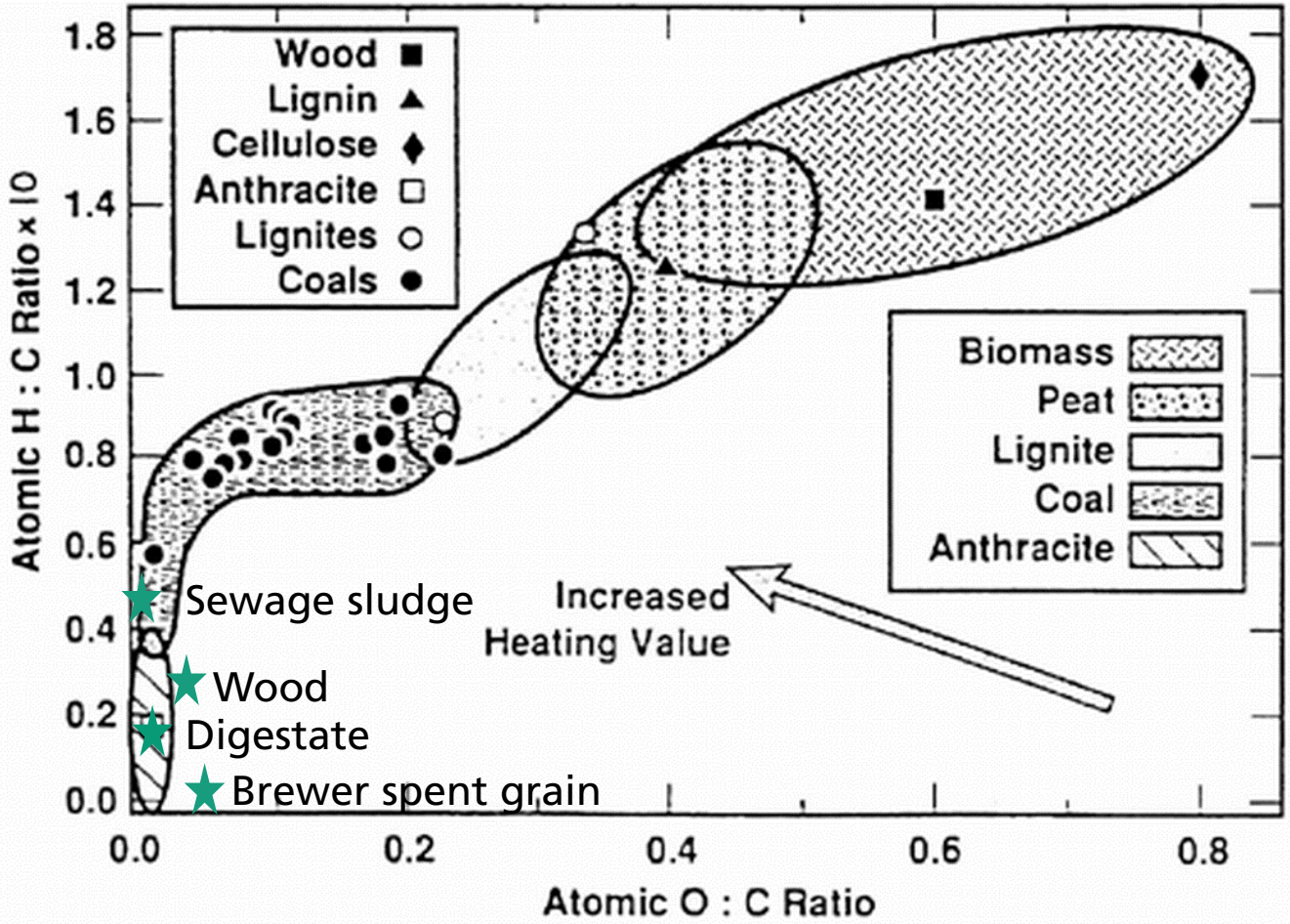
Results
Biochar characterization

Sewage Sludge		Digestate		Brewer Spent Grain		Wood	
C	**22.2 wt.-%**	**C**	**64.0 wt.-%**	**C**	**72.6 wt.-%**	**C**	**89.8 wt.-%**
H	0.9 wt.-%	H	1.0 wt.-%	H	0.1 wt.-%	H	2,2 wt.-%
N	2.0 wt.-%	N	1.4 wt.-%	N	4.6 wt.-%	N	0.3 wt.-%
S	1.0 wt.-%	S	0.5 wt.-%	S	0.4 wt.-%	S	0.1 wt.-%
O	0.0 wt.-%	O	0.7 wt.-%	O	4.9 wt.-%	O	4.5 wt.-%
Ash	**74.4 wt.-%**	**Ash**	**32.0 wt.-%**	**Ash**	**17.5 wt.-%**	**Ash**	**3.1 wt.-%**
LHV 8.2 MJ/kg		LHV 23.0 MJ/kg		LHV 26.0 MJ/kg		LHV 34.4 MJ/kg	

Results

Van Krevelen chart



Source: www.intechopen.com

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