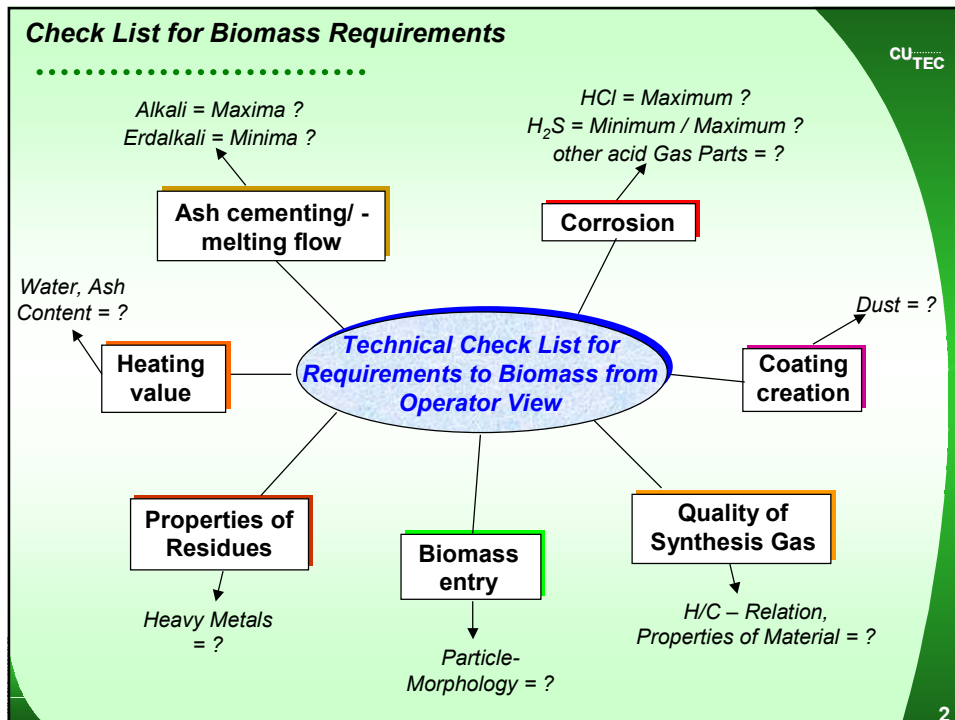


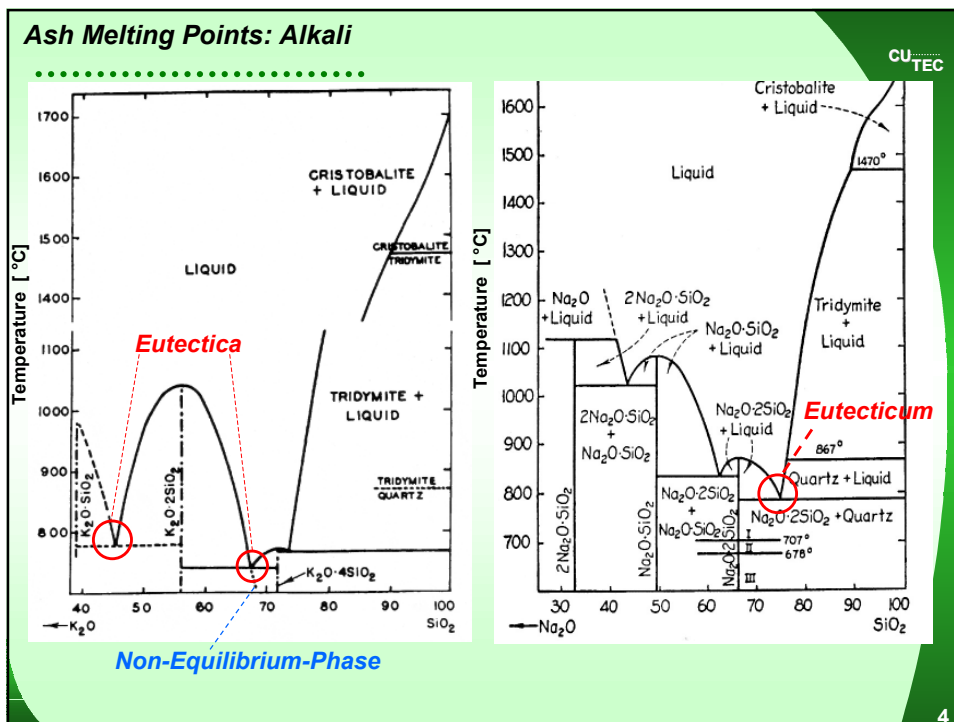
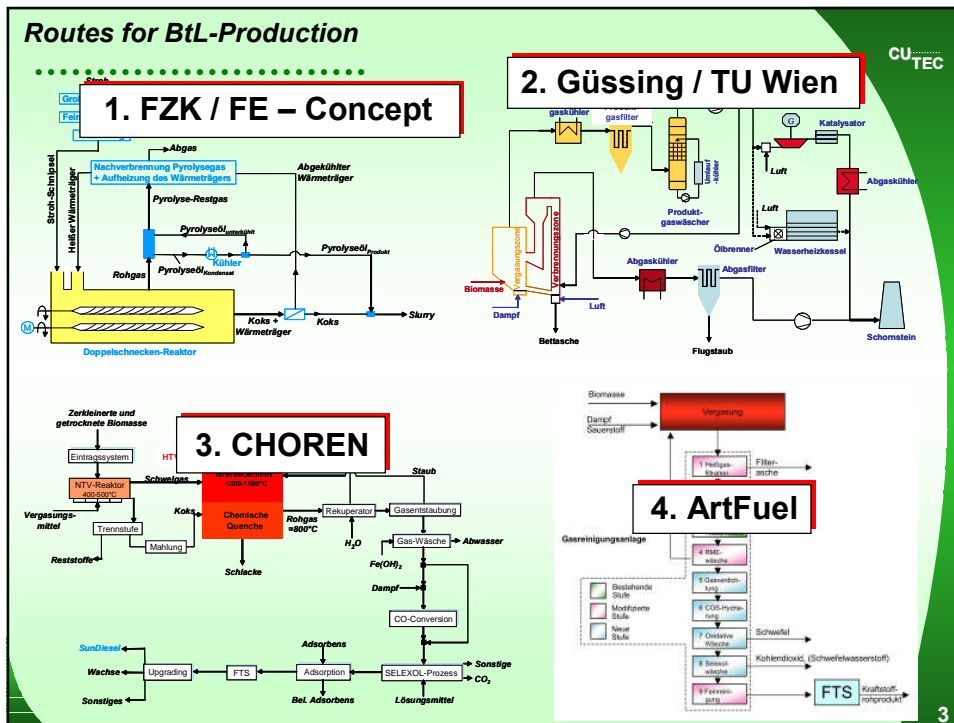
Biomass for Future BtL - Processes: Requirements and Characterisation

Dr.-Ing. Stefan Vodegel

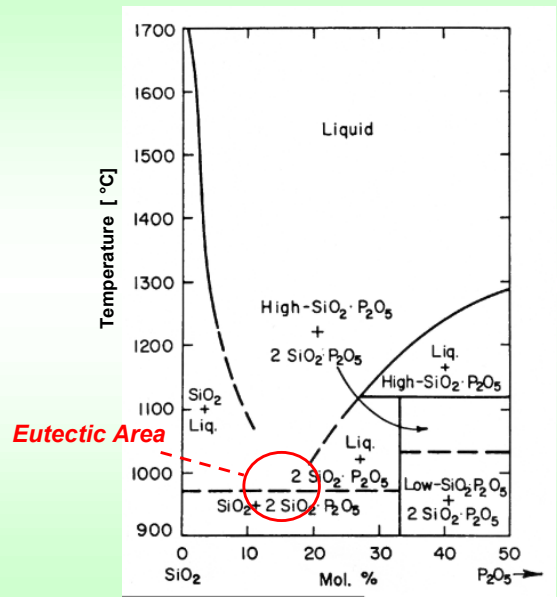
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Clausthal-Zellerfeld, 16.10.2006

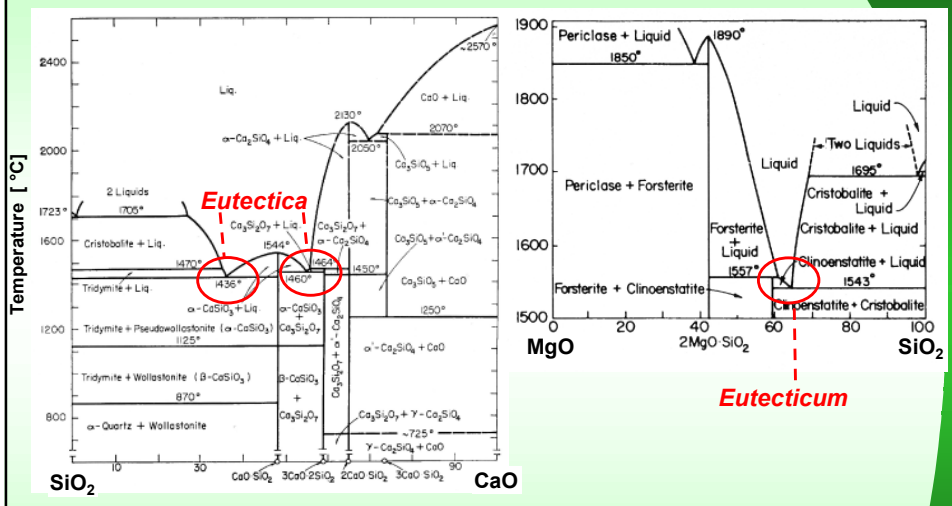




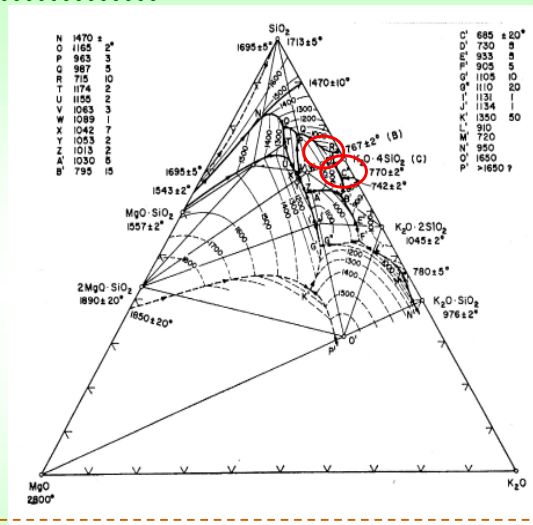
Ash Melting Points: Phosphor



Ash Melting Points: Erdalkali



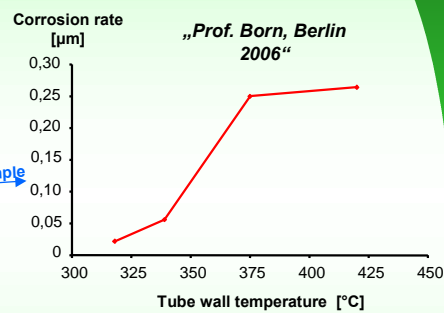
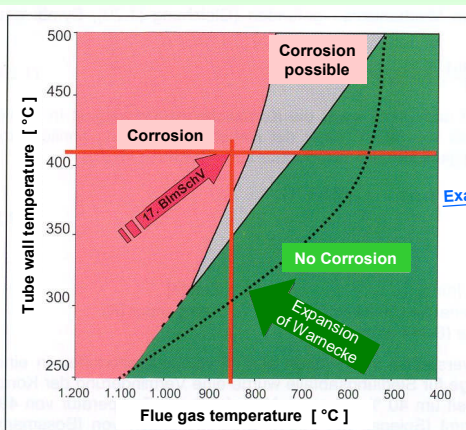
Ash Melting Points: Tri-Systems



Conclusion: K and Na decrease the melting point strongly. This effect can be wished in Entrained Flow Gasification; in Fluidised Bed Reactors CaO and MgO are necessary. A maximum level should be in the biomass.

Chlorine = Corrosion ?

Alternative 1: Steam generation in uncritical temperature area to avoid corrosion.



„Flinger'sches Korrosionsdiagramm“, common for incineration

Remark: Numbers are valid in incineration atmosphere. Under gasification conditions long term experiences have to be collected. Safety distance should be kept in the first commercial plants.

Chlorine = Corrosion ?

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Alternative 2: Using of additives in a temperature field of ≈ 800 to 900 °C.

Exp. No.:	Trace component [$\text{g}/\text{m}^3_{\text{is,dry}}$]			
	NH ₃	HCN	H ₂ S	HCl
0622-1-Wheat straw	7.44	n.m.	0.27	<0.005
0622-2-Rapse	61.0	6.10	0.47	<0.005
0622-7-Wood	0.27	n.m.	0.02	<0.005

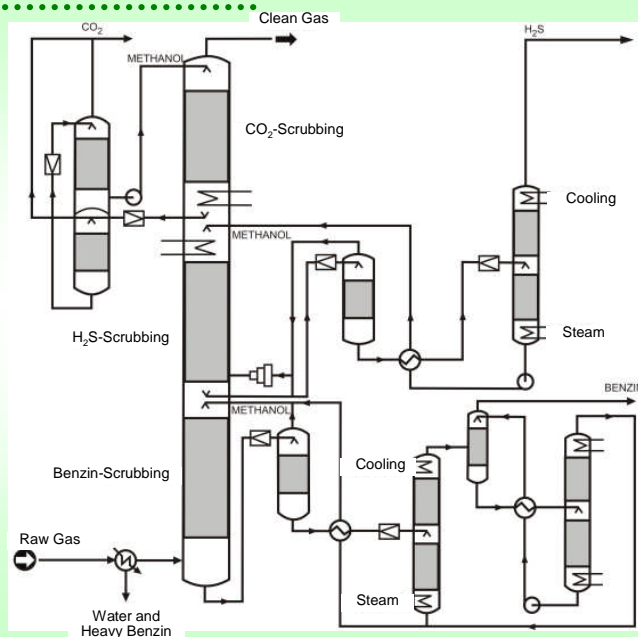
No HCl could be detected in the raw gas after using CaO

Remark: Experimental results in a Circulating Fluidized Bed, made in the EU-Project RENEW.

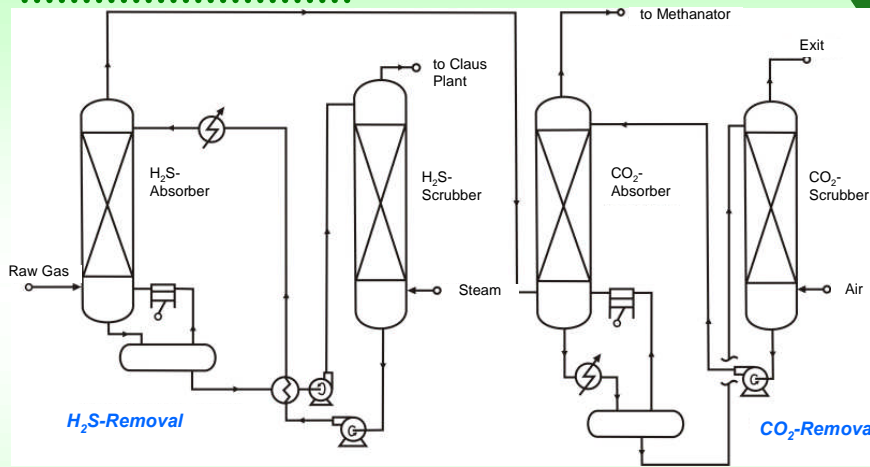
Conclusion: Cl in biomass is in principle a corrosion danger. But under the special conditions of BtL-plants (need of low-pressure steam, some heating sources and sags, using CaO in CFBs) there is a great potential to minimize corrosion.

Removal of Sulphur + CO₂-Reduction: Rectisolscrubbing

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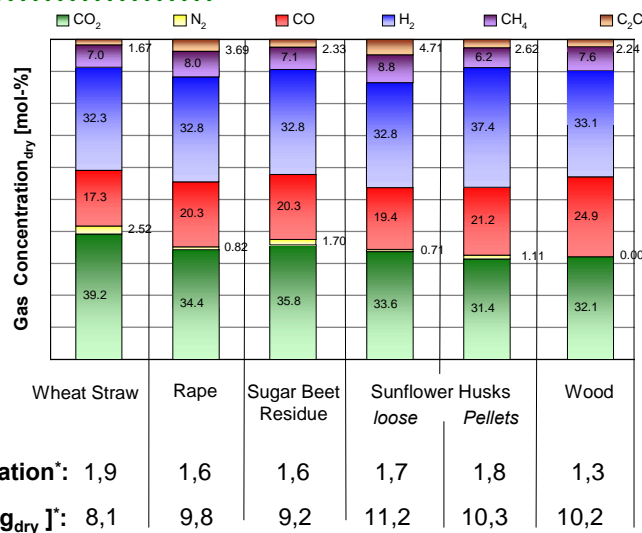


Removal of Sulphur + CO₂-Reduction: Selexolscrubbing



Conclusion: For H₂S-Removal and CO₂-Reduction in BtL Plants the alternatives Rectisol and variations of Selexol are favoured. With Rectisol to meet limits is shure; with variations of Selexol it has to be checked. The price for the biomass which can be payed will differ in the two routes.

Influence of kind of Biomass on Synthesis Gas Quality



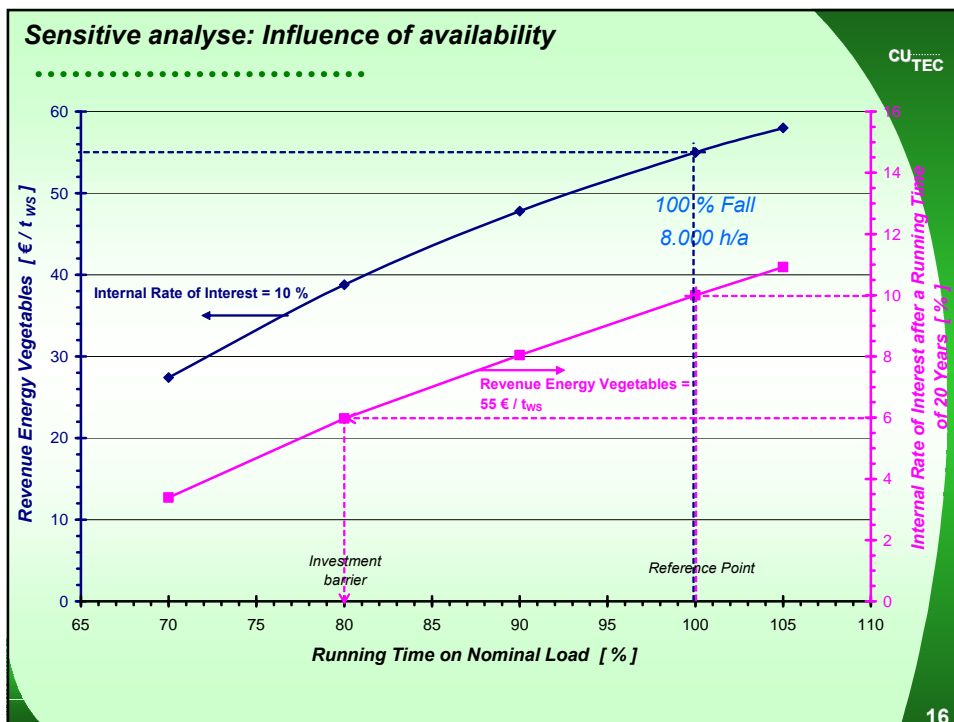
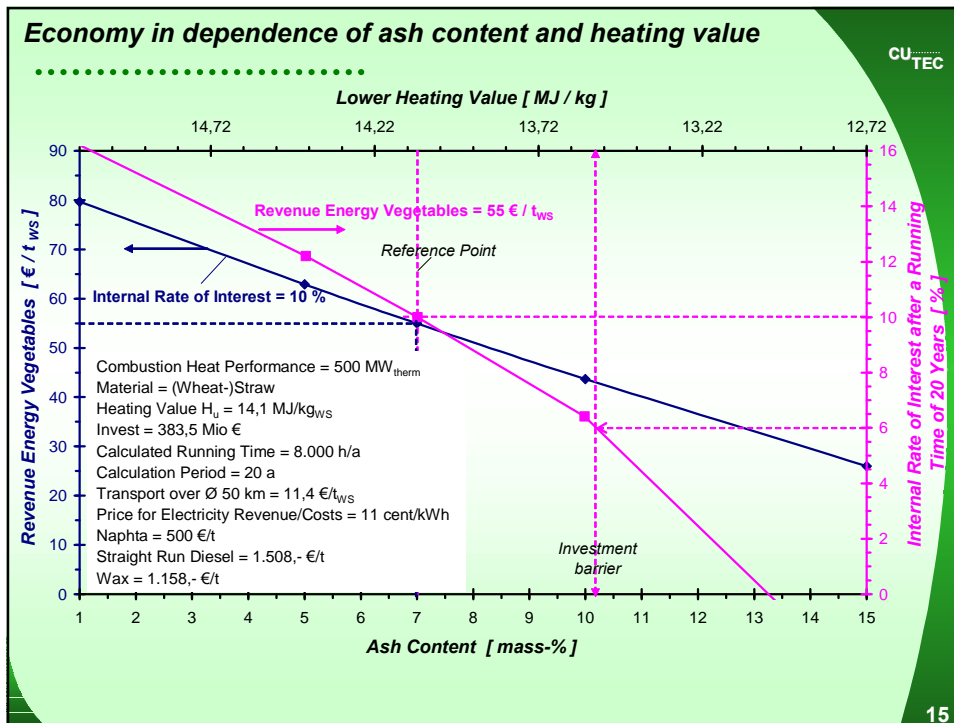
* : Experimental results in a Circulating Fluidized Bed under the same process parameters.

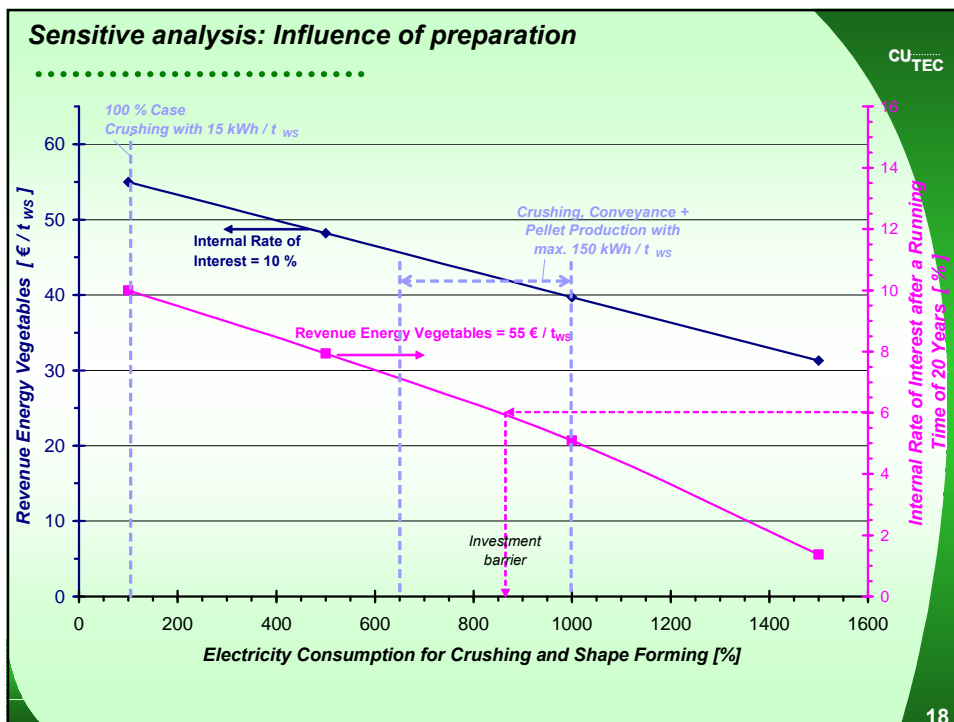
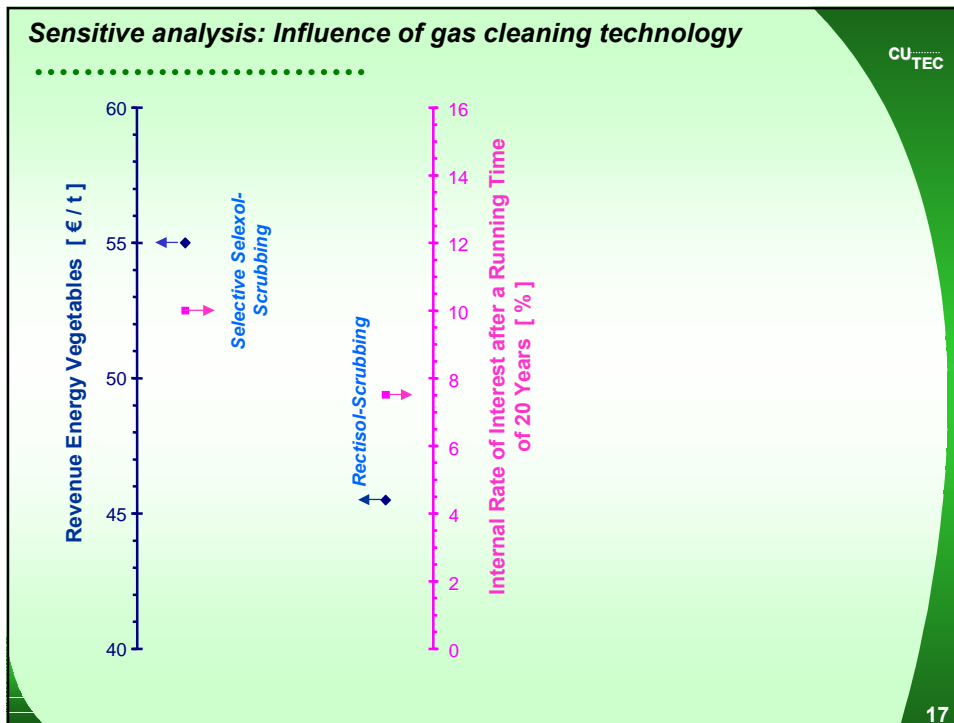
Requirements to the biomass at the entry of thermal system from the point of quality

	FZK / FE	Güssing / TU Wien
Particle dimensions [mm]	in the area of millimeters	2 to 150
Water content [mass-%]	□ 15	10 to 60
Ash content [mass-%]	$1 \leq X \leq 40^{**}$	any
Ash melting point [°C]	any	≥ 950*
Content of Cl, S, N	any	any
Content of Earth- + Alkali	any	any*
Content of Phosphor	any	any*
Other restructions	no bodes in biomass.	maybe Si-content. Still open.
Other possibilities	Carbon-containing dusts, suspensions and liquids.	Carbon-containing suspensions and liquids.
Remarks	<ul style="list-style-type: none"> - is conceived for difficult biomass. - $H_{u, Fuel}$ Entrained Flow Gasification ≥ 11 MJ/kg. ** : at the entry of the Entrained Flow Gasifier 	<ul style="list-style-type: none"> *: as long as minimal ash-melting point in the mixture is not met → CaO- and MgO-content to maximize.

Requirements to the biomass at the entry of thermal system from the point of quality

	CHOREN	ArtFuel
Particle dimensions [mm]	max. 120 * 50 * 30	Ø 50, max. □ 200
Water content [mass-%]	□ 10 to 20, max. 25	□ 35
Ash content [mass-%]	no materials with a big amount of ash like sewage sludge or turf.	any
Ash melting point [°C]	n.i.	≥ 850*
Content of Cl, S, N	n.i.	any
Content of Earth- + Alkali	n.i.	any*
Content of Phosphor	n.i.	any*
Other restructions	no fibre structure like old paper or textiles, no chips.	maybe Si-content. Still open.
Other possibilities	n.i.	Carbon-containing suspensions and liquids.
Remarks	Qualification only proved for wood in published form until now.	*: As long as minimal ash-melting point in the mixture is not met → CaO- and MgO-content to maximize.





Conclusions

- For autothermic Circulating Fluidized Bed and FZK/FE-Process is a high variability in contents of earth-/alkali proved; for Güssing-Process and Carbo-V® it is predicted.
- Corrosion danger by means of chlorine is in BtL-Plants much lower than in power plants.
- Sulphur elimination and CO₂-reduction is technical complex and expensive; Variations of Selexol- und Rectisol-Processes compete.
- MgO- and/or CaO-contents in the biomass should be maximized if solded to BtL-plants with Circulating Fluidized Bed as gasifier.
- Ash content in the biomass should be minimized from economic considerations.
- Biomass must be available over the whole year.
- Preparation of the energy vegetables has to be performed with minimal electrical consumption.

Acknowledgment

The presented theoretical results are part of the study **Anforderungen an Biomasse zur Kraftstoffherstellung aus der Sicht von Anlagenbetreibern**. The experimental results are descended from the EU-Project **RENEW**. CUtec thanks **Fachagentur Nachwachsende Rohstoffe** and **Volkswagen AG** for financing the study and the **European Union** for participating in and financing of the network project.