Biokenaf project
thermochemical conversion tests

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Experimental work of BTG in Kenaf project

WP 5: thermochemical conversion

> Goal: evaluation of suitability of kenaf for thermo-chemical energy applications

> D12: quality characteristics and energy potential as a biofuel for thermochemical conversion processes (month 12 - 40)

> Equipment
  – ash fusibility test
  – combustion device
  – gasifier (fluidized bed)
  – rotating cone reactor (pyrolysis)

> Samples
  – kenaf whole crop
  – core fiber produced after bast fiber removal

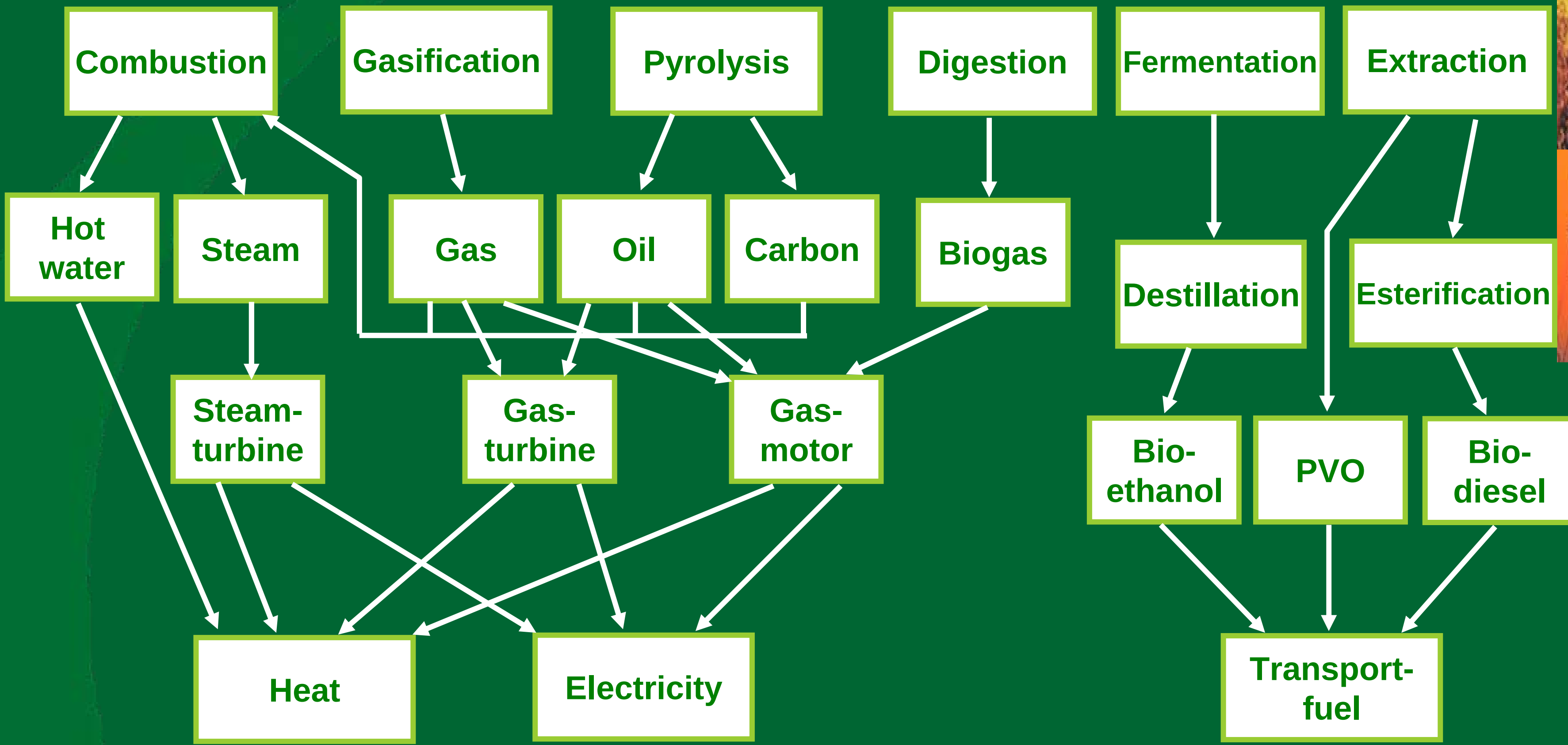
Introduction

Overview of presentation

- Activities presented in Catania (July 2005)
  - Feeding of whole plant and core material
  - Ash behaviour
  - Gasification experiments
  - Combustion experiments
- Activities presented in this presentation
  - Pyrolysis experiments

Introduction

Overview conversion-technologies



Introduction

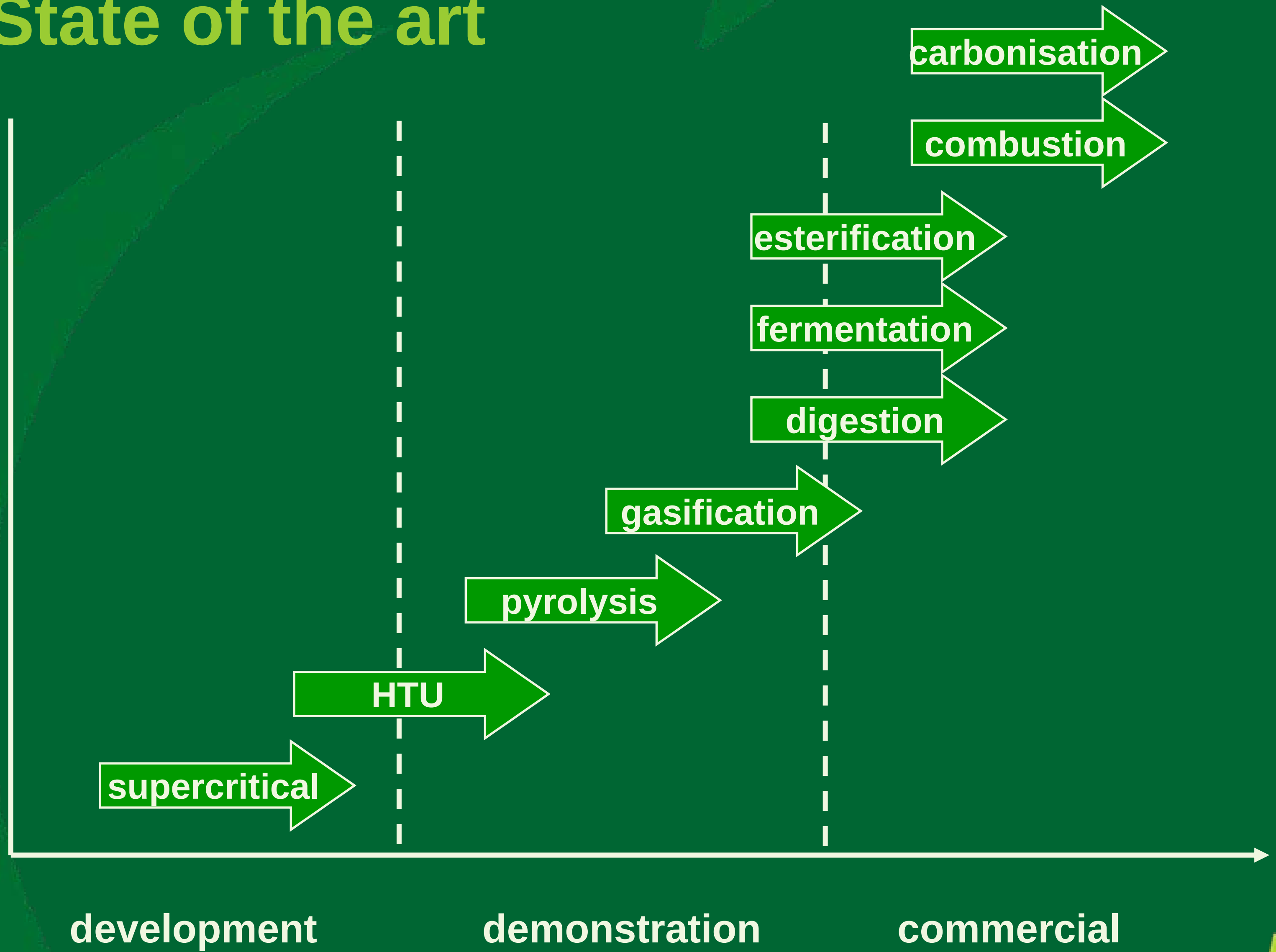
Thermochemical conversion

biomass ($CH_{1.4}O_{0.6}$)

- **combustion** (excess O_2) → $CO_2 + H_2O$
- **gasification** (sub stochiometric O_2) → $CO + H_2 + CO_2$
- **pyrolysis** (without O_2) →
  - char (solid)
  - pyrolysis oil (liquid)
  - non condensibles (gas)

Introduction

State of the art



Introduction

Pyrolysis - example

- BTG 2 t/hr commercial plant under construction in Malaysia
- Bio-oil for co-combustion in power plants
- Research is being carried out to upgrade bio-oil to transport fuel by water removal and hydrotreating

Feeding

Kenaf properties and preparation

> Bulk density

> Particle size and size distribution

> Flow properties

	Bulk density [kg/m3]	Particle S & D	Flow properties	Moisture $[wt\%]_{wb}$
Core	**120**	**+**	**+**	**16.4**
Whole plant	**60**	**- -**	**- -**	**15.7**
Whole plant milling	**80**	**-**	**-**	**15.7**

Feeding

Kenaf properties and preparation

Milling →

Pyrolysis

Experimental set-up (new for Kenaf)

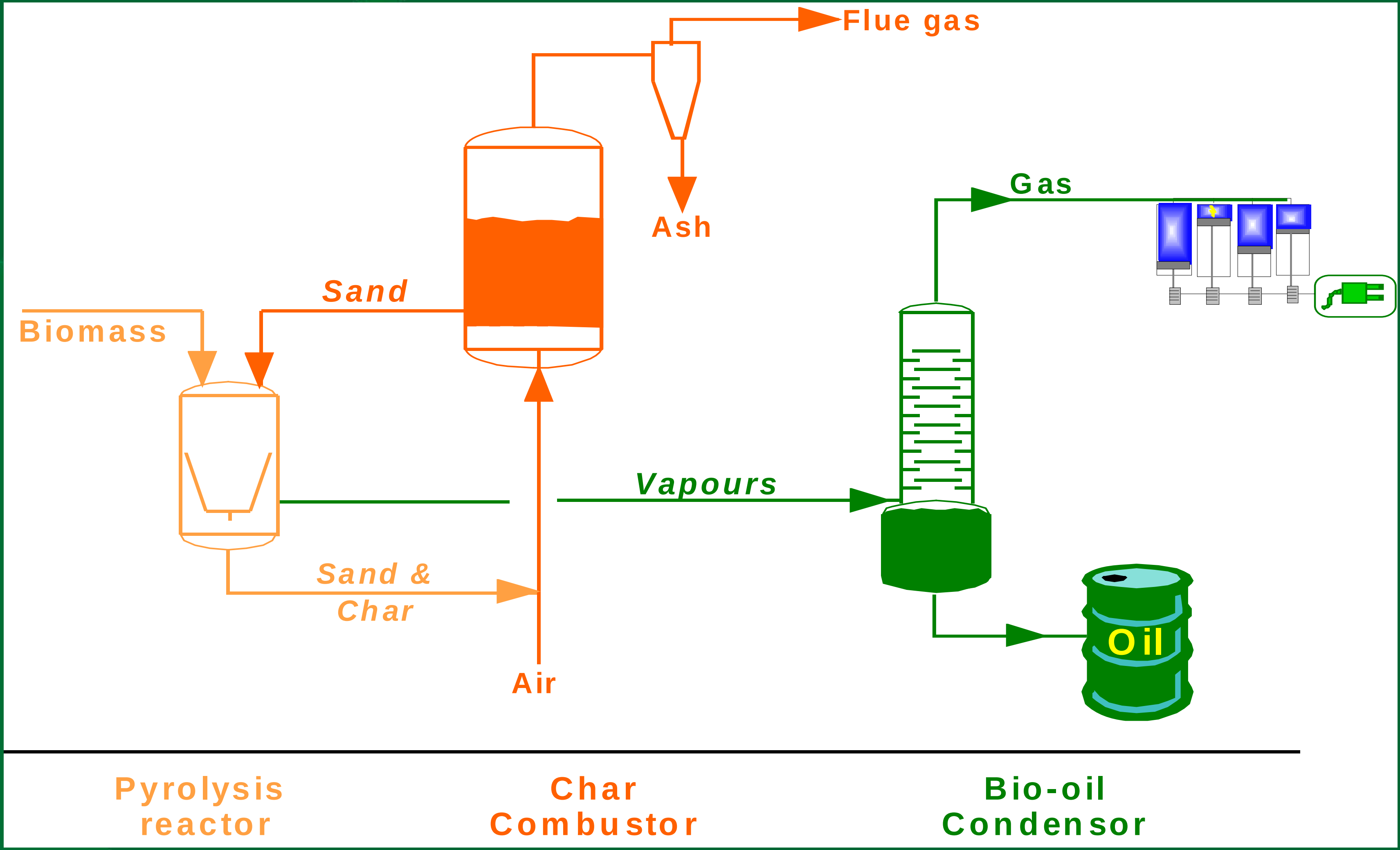
Feeding system

Pyrolysis reactor system (placed in hotbox)

Bio-oil condensing system

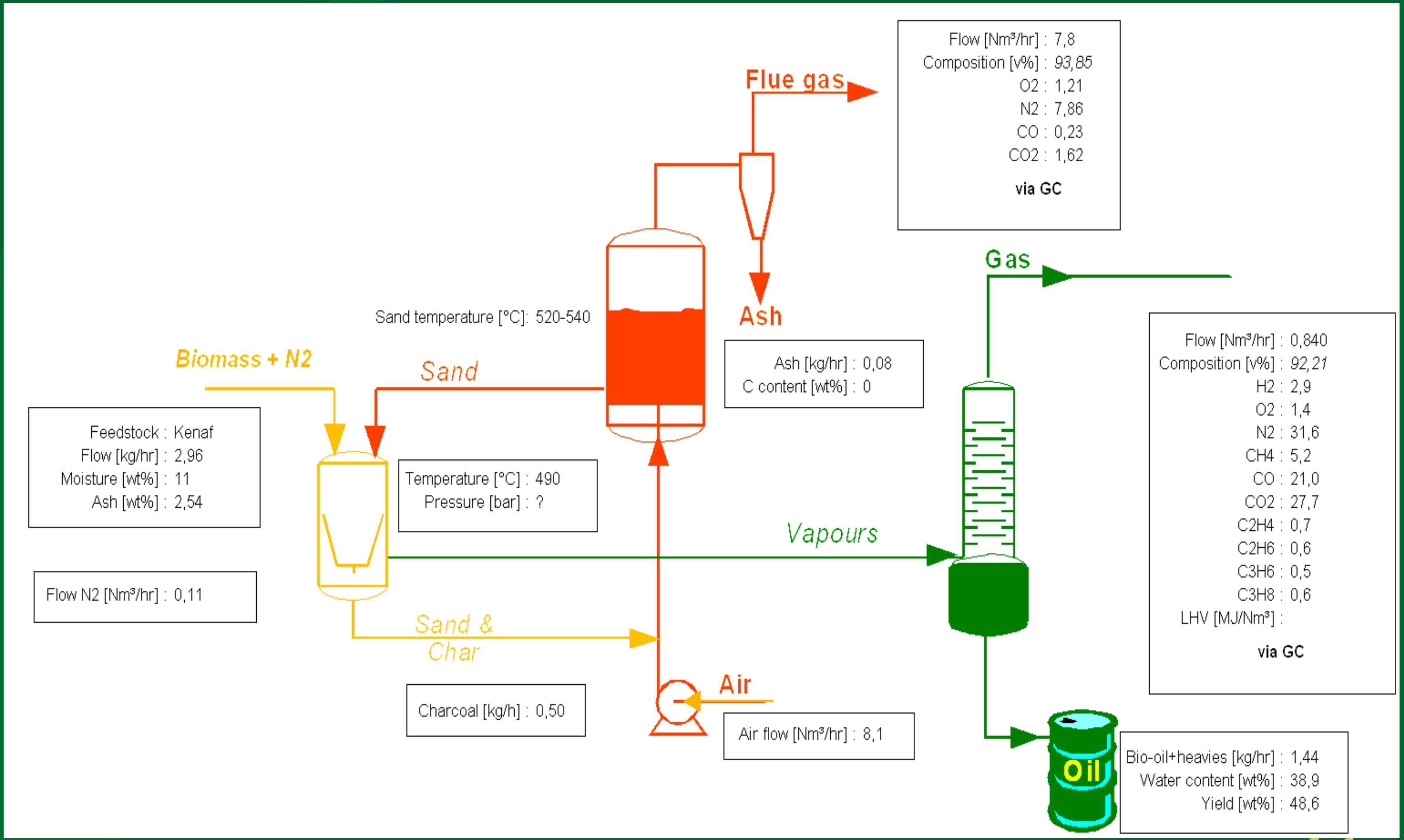
btg

Pyrolysis
Flow scheme



Pyrolysis

Results: measurement data



Pyrolysis

Results: mass balance

	Overall	Biomass
IN (kg/hr)		
Biomass	2,96	2,96 (100%)
Air	10,47	
Nitrogen	0,14	
Total, in	13,57	2,96 (100%)
OUT (kg/hr)		
Bio-oil	1,44	1,44 (49%)
Heavies	0	0
Ash	0,08	0,08 (3%)
Pyrogas	1,20	
Combugas	10,92	
Charcoal		0,50 (17%)
NC gasses		0,87 (30%)
Total, out	13,63	2,89 (98%)

Results: bio-oil yield and quality

> Total bio-oil yield is 49%
  - comparable / higher than other herbacious crops (about 45 - 55 wt%)
  - lower than wood (about 70 wt%)

> High water content in bio-oil (38 wt%) and strong phase separation
  - water orginating from water in feedstock and
  - water formed during reaction and catalysed by minerals

Pyrolysis

Conclusions

> Whole plant needs additional pre-treatment to allow stable and trouble free feeding

> Compared to wood design of feeding system needs modifications (larger volumes)

> Pyrolysis needs additional drying and/or post-treatment to obtain a one-phase oil (pyrolysis as such is no problem)