

Storage as the weak link of the biomass supply chain

2nd Africa-EU Renewable Energy Research & Innovation Symposium
23-26 January 2018
Maseru, Lesotho



Sabrina Dumfort, MSc
Sabrina.dumfort@mci.edu



Prof. Marco Rupprich, PhD
Marco.rupprich@mci.edu

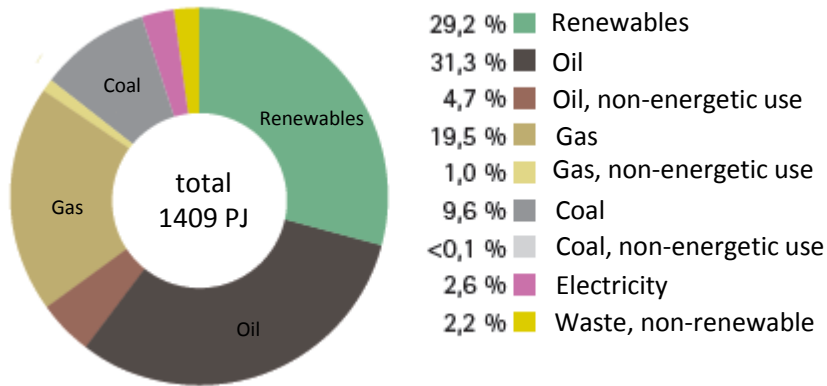
Management Center Innsbruck
Department for Environmental, Process & Energy Engineering
Research Field Renewable Energy

Overview

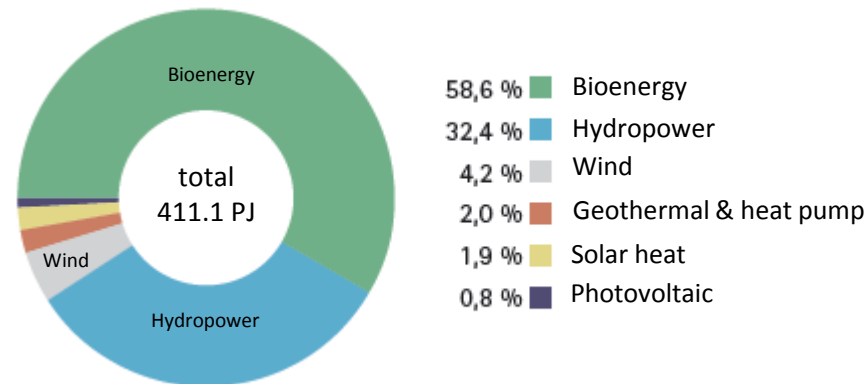
1. Introduction
 - Bioenergy in Austria
 - Renewable Energy Research at MCI
2. Biomass storage
3. Methods
4. Results
5. Outlook



Bioenergy in Austria



Gross domestic energy consumption in 2015

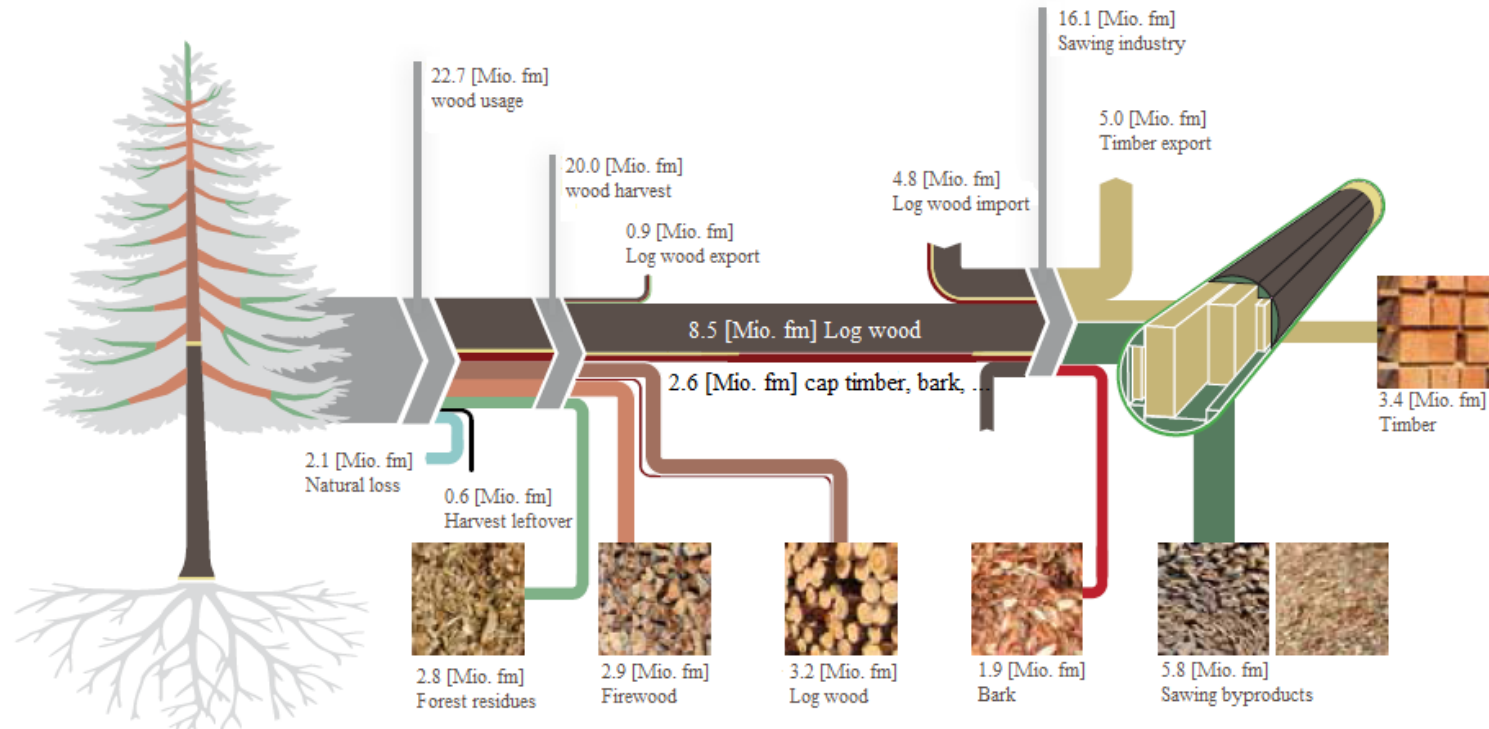


Gross domestic renewable energy consumption in 2015

Bioenergie Atlas Österreich, Österreichischer Biomasseverband, 2016

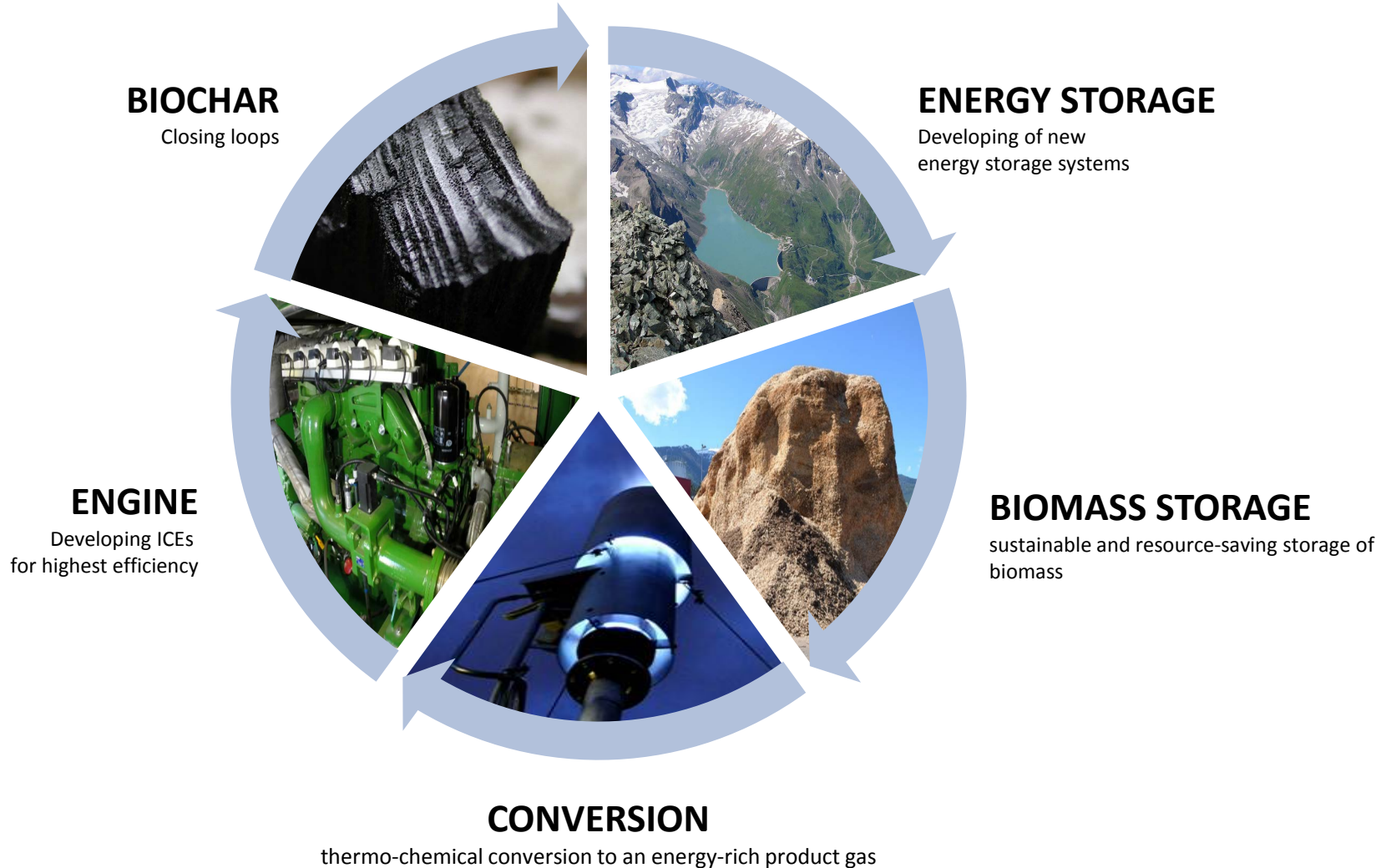
Bioenergy in Austria

- Traditionally, biomass in Austria is used for heat production consuming 82 % of the bioenergy production.
- The most important source of raw material for the biomass sector are Austria's forests.
- Growing stock in domestic forests has been on the rise throughout the past few decades and has reached a record high of 1.135 billion solid cubic metres (2014).



Source: Holzströme in Österreich 2014, klima:aktiv energieholz, Österreichische Energieagentur, FHP

Renewable Energy Research at MCI



Difficulties during biomass storage



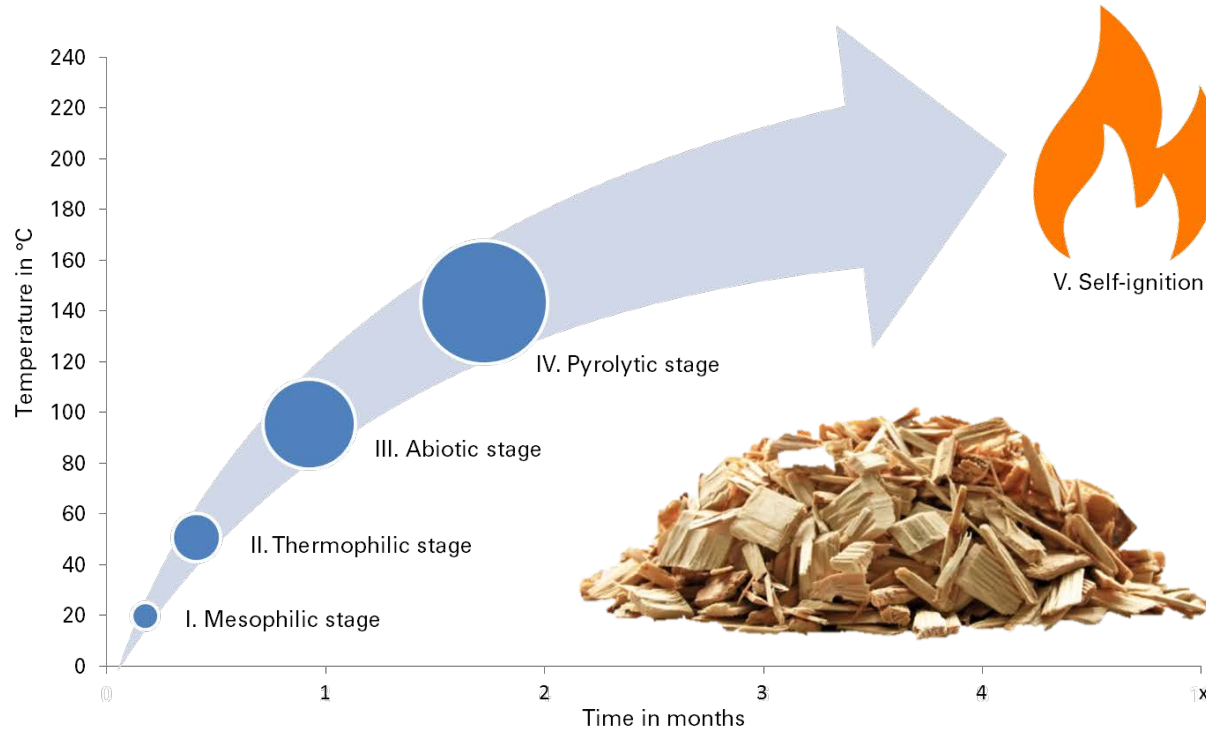
CHALLENGE

- microbial degradation
- annually loss amounting 10-40 % dry matter
- self-ignition of stored piles

AIMS

- quantification of the dry matter loss
- definition of counteractions
- describing the self-ignition process

Difficulties during biomass storage



Stage I - II

- High metabolic activity of microorganism due to favorable conditions.
- Degradation of the main wood components and heat production.

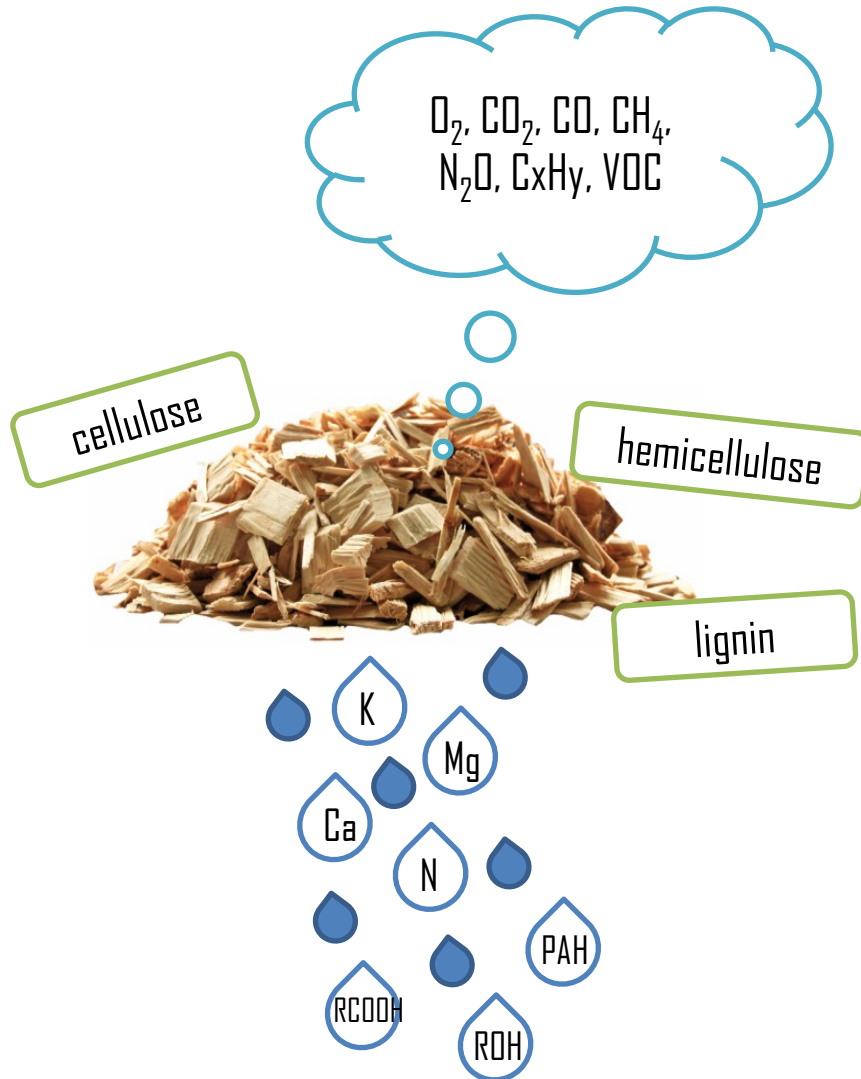
Stage III - IV

- Further heat production through oxidation and condensation processes.
- Pyrolytic degradation due to high temperatures and anaerobic conditions

Stage V

- Due to temperatures above 200°C and a sudden oxygen availability self-ignition occurs.

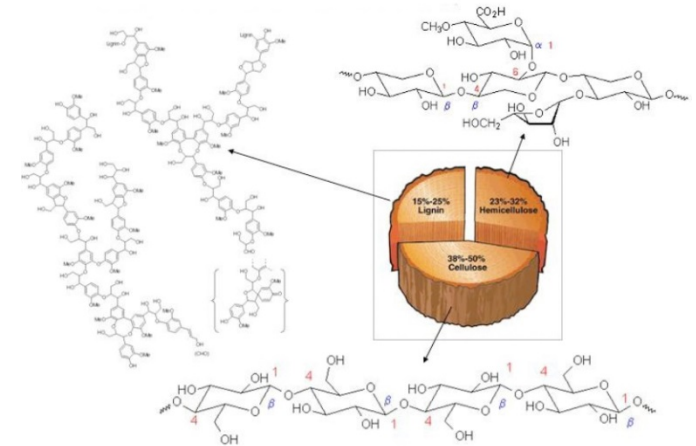
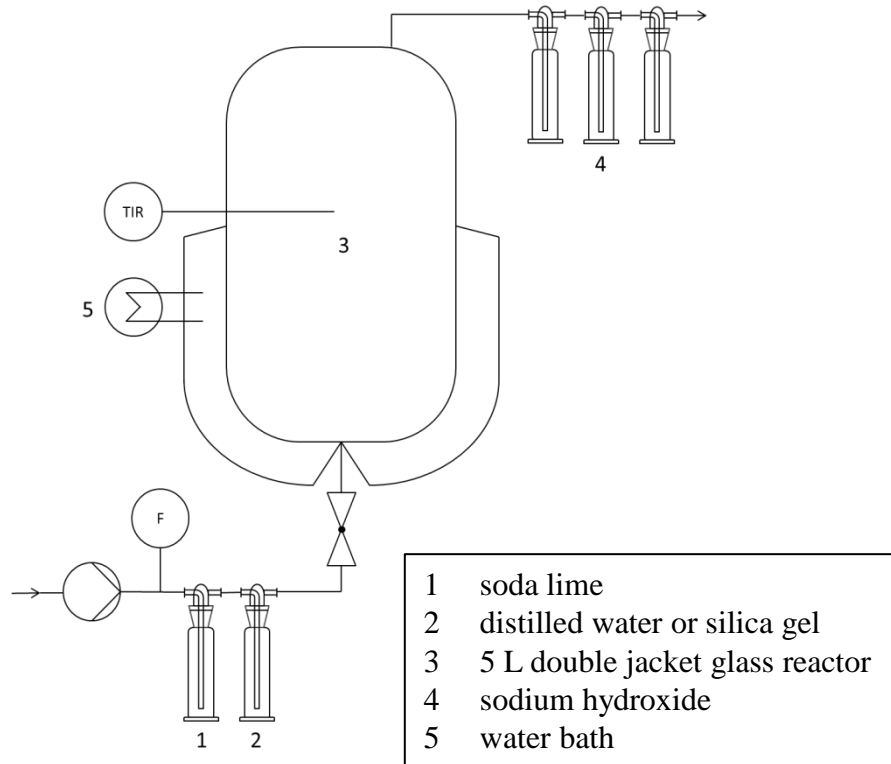
How do overall conditions affect the degradation?



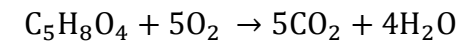
- Investigation of the degradation process in laboratory scale.
- Overall conditions such as temperature, moisture content, particle size distribution, ...
- To investigate the self-heating process knowledge about solid, liquid and gaseous products is essential.

Respirometric tests

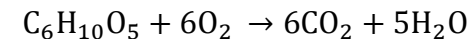
- the microbial activity can be determined by the respirometric tests
- CO_2 is determined over time \rightarrow the biomass loss can be calculated



Degradation of Hemicellulose:



Degradation of Cellulose:



Respirometric tests



Test conditions:

- Quality: forest residues
- Water content: 20 %, 30 %, 46 %
- Particle size: fine, medium, coarse
- Additives: 5 %, 10 % CaCO_3

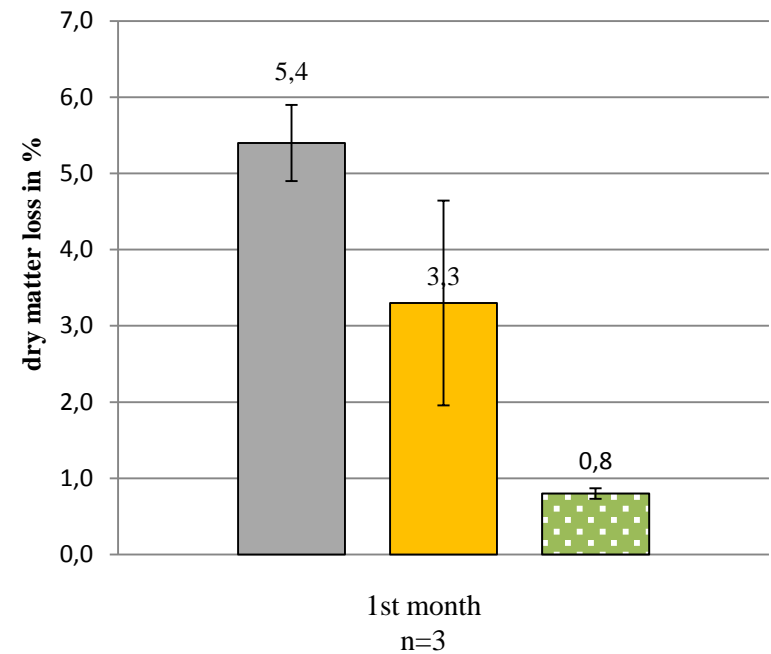
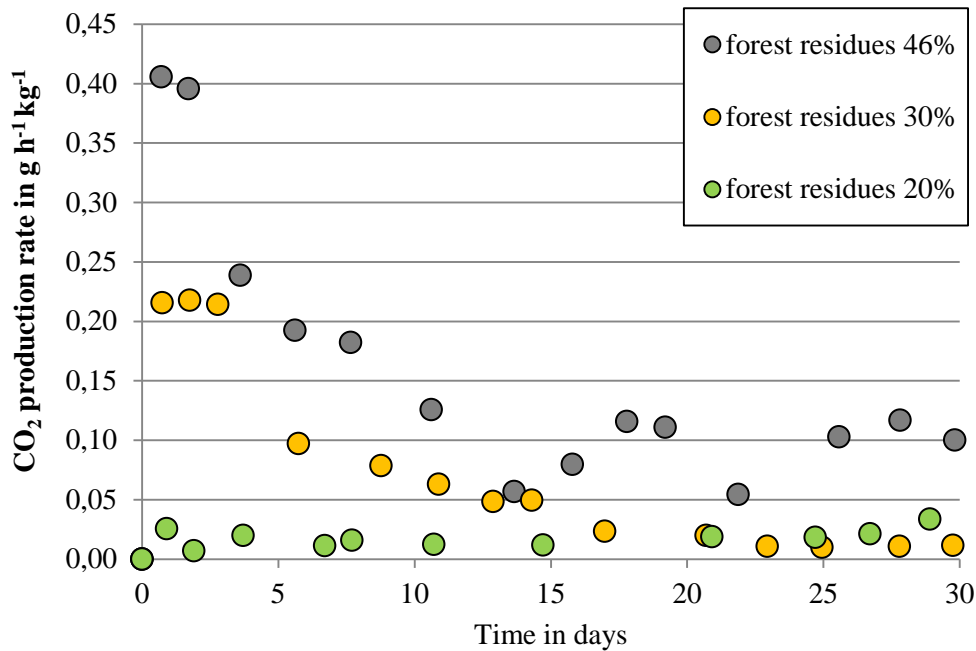


Tests have been conducted at 20 °C and 40 °C.

Microbial activity of forest residues

Test conditions:

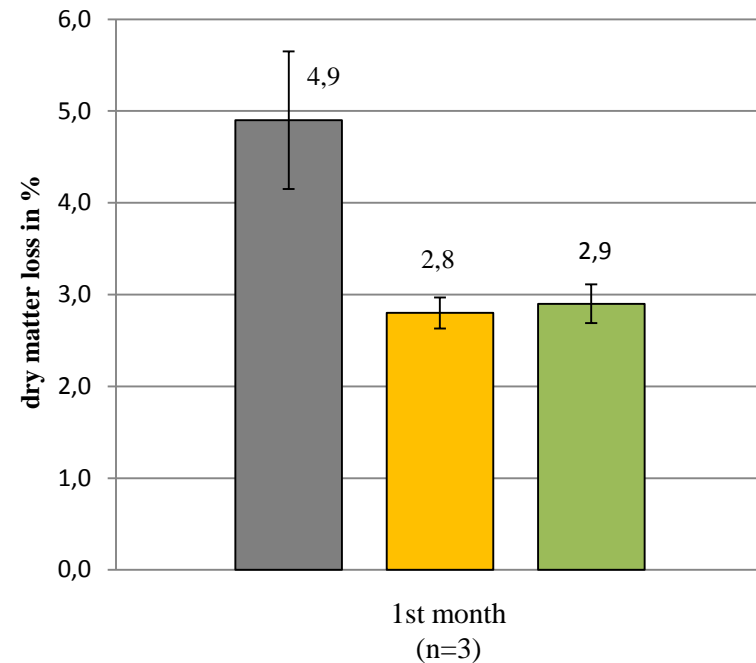
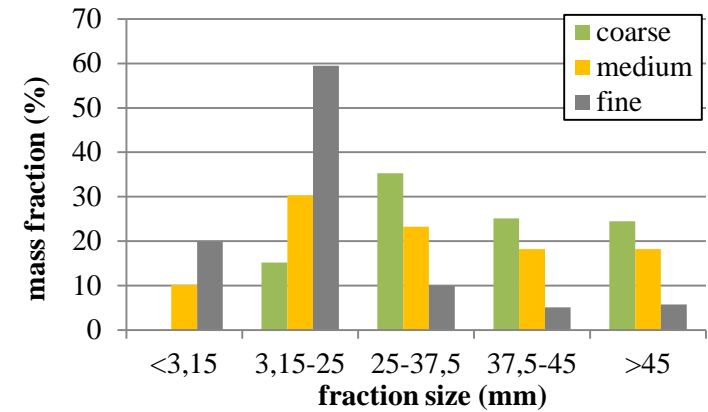
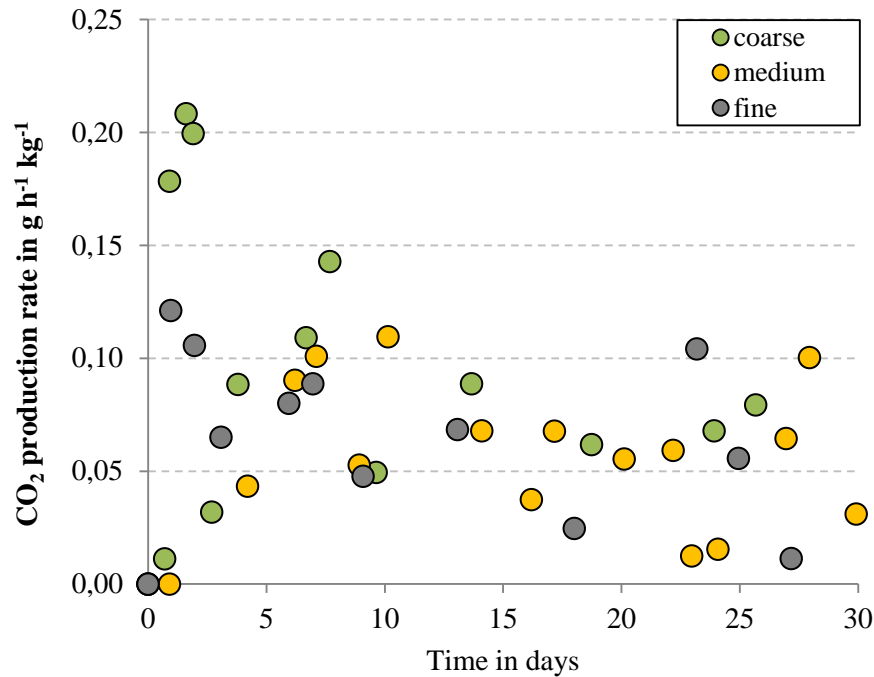
Biomass: forest residues
 Temperature: 20 °C
 Water content: 20 %, 30 %, 46 %



Microbial activity of forest residues

Test conditions:

Biomass:	forest residues
Temperature:	20 °C
Water content:	49 %
Particle size:	fine, medium, coarse



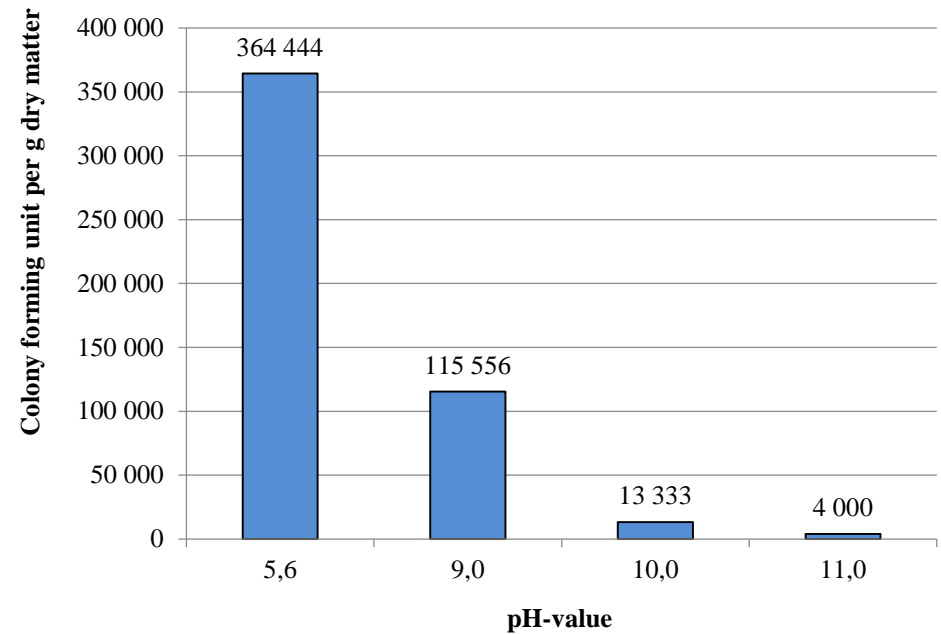
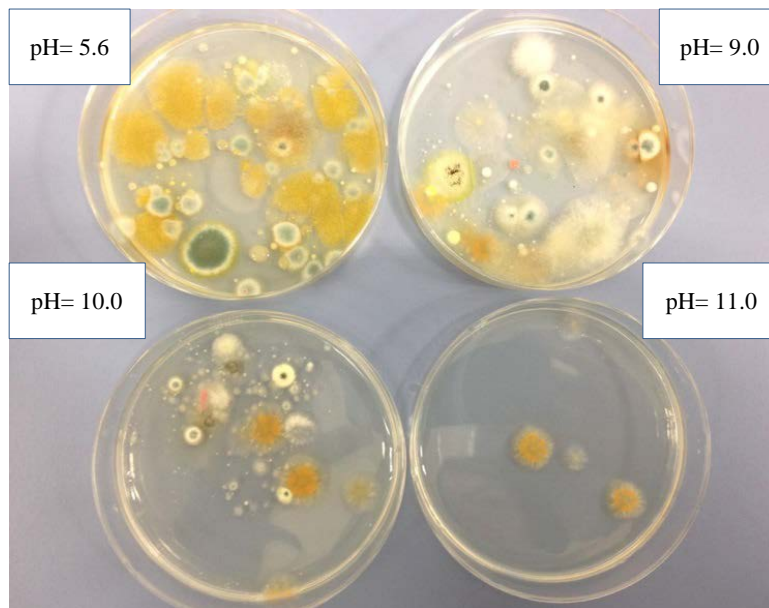
Microbial activity of forest residues

Colony forming units of fungi at pH values

- 5.6
- 9.0
- 10.0
- 11.0

DG18-Agar

Incubation for 7 days



Microbial activity of forest residues

Test conditions:

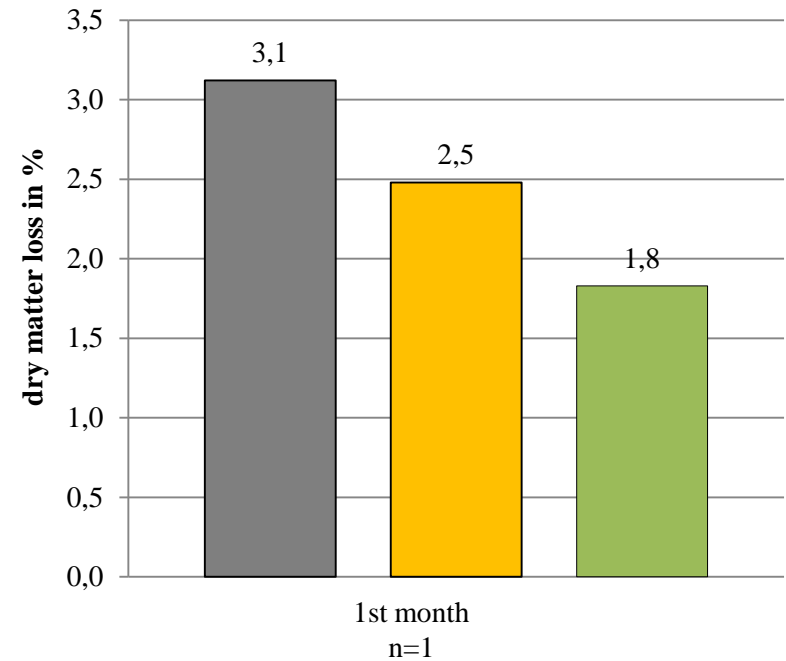
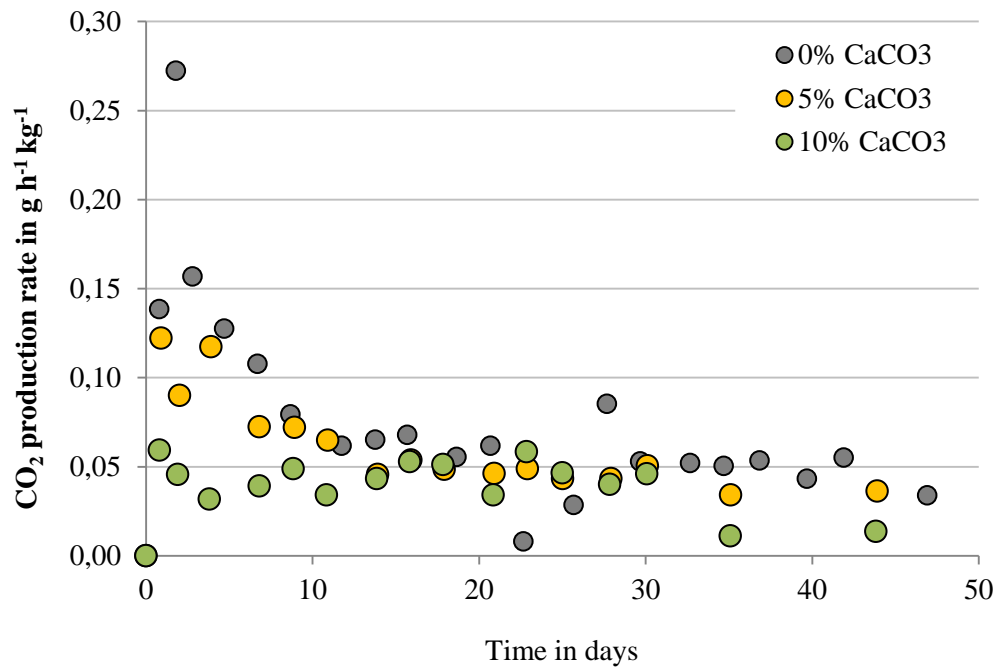
Biomass: forest residues

Temperature: 20 °C

Water content: 49 %

CaCO ₃ :	0 %	→	pH= 6.9
	5 %	→	pH= 7.9
	10 %	→	pH= 8.7

first results promising,
however further
experiments are
necessary

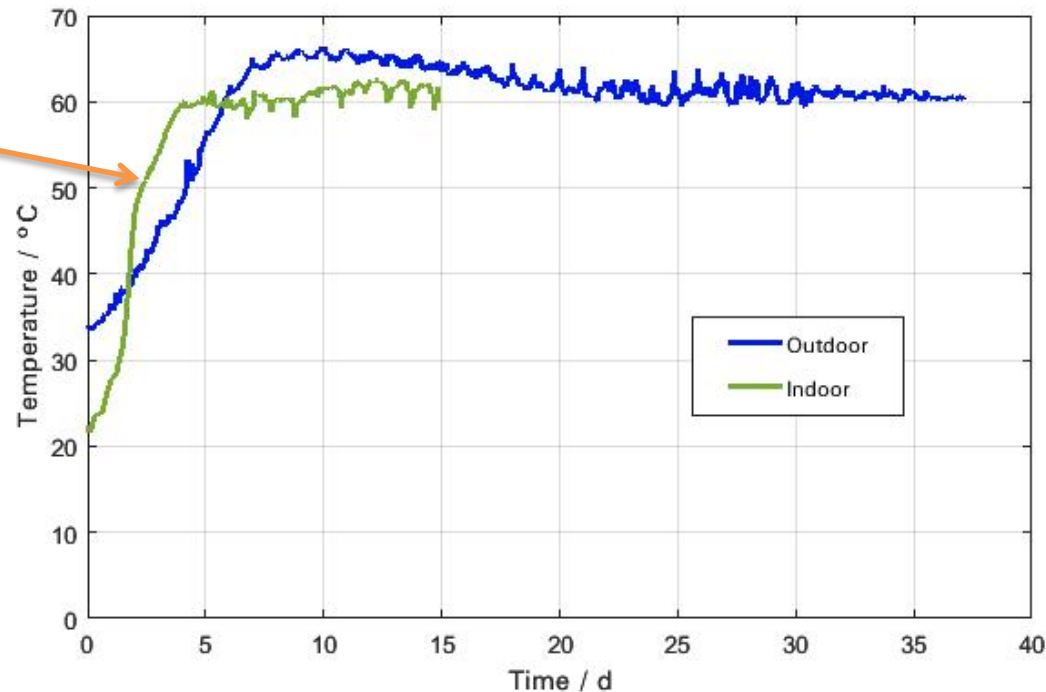


Temperature measurement

The temperature of forest residues has been measured in two woodchip piles (indoor and outdoor) consisting of about 1,000 cubic meters.

water content: 50 %
measurement month: August
mean ambient temperature: 15 °C

high microbial activity within the first days



Summary

- Respirometric tests provide a good method to determine microbial activity.
- The microbial increases with increasing water content. Drying does inhibit wood degradation significantly.
- The fine material content does have an influence on the wood degradation.
- Increasing the pH value to a minimum of 9 inhibits fungal growth.

What comes next?



- Further respirometric tests will be conducted under varying conditions with different test material.
- Further respirometric tests will be conducted with different additives.
- Soil-block decay tests are conducted to determine wood degradation by chemical and thermal gravimetric analyses.
- Gasification and combustion experiments with woodchips and alkaline additives.

