

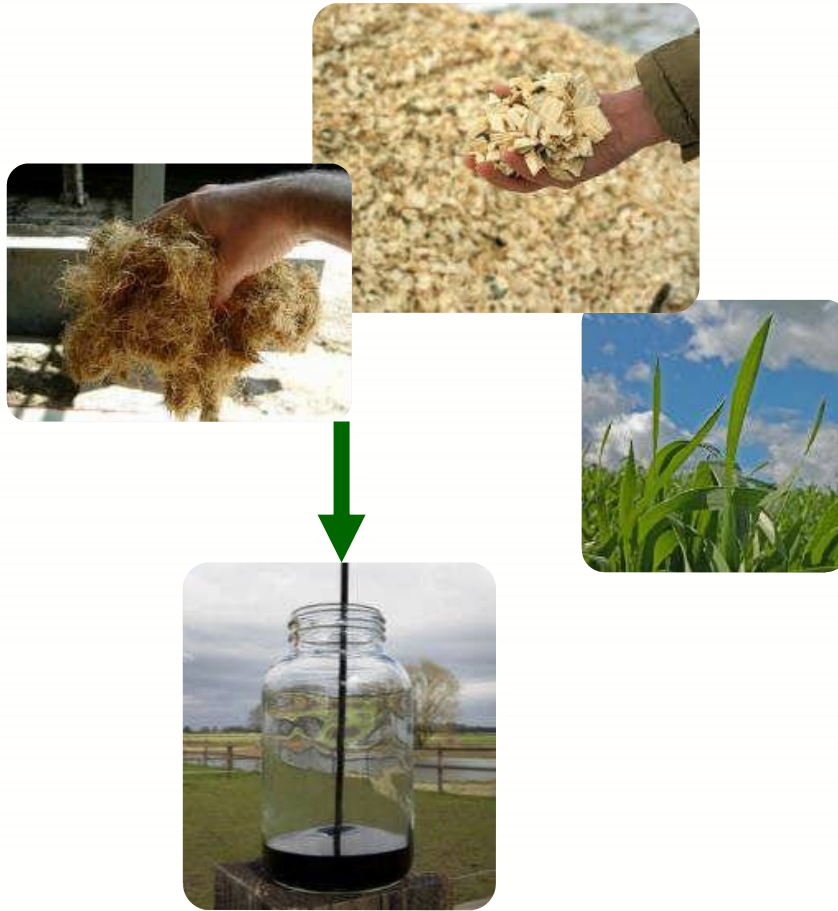


# First commercial scale pyrolysis oil production at Empyro in Hengelo, NL.

BEON vergadering, 15 juni 2016



# What is pyrolysis?



Thermal cracking of organic material in  
absence of oxygen

Main product:  
liquid bio-oil

Process conditions  
 $T = 400 - 600\text{ }^{\circ}\text{C}$   
 $P = \text{atmospheric}$

Works with most lignocellulosic  
(=inedible) feedstocks.

*e.g. Wood chips, EFB, Sugar cane bagasse, straw, corn stover, etc..*



***Pyrolysis oil, the sustainable alternative***

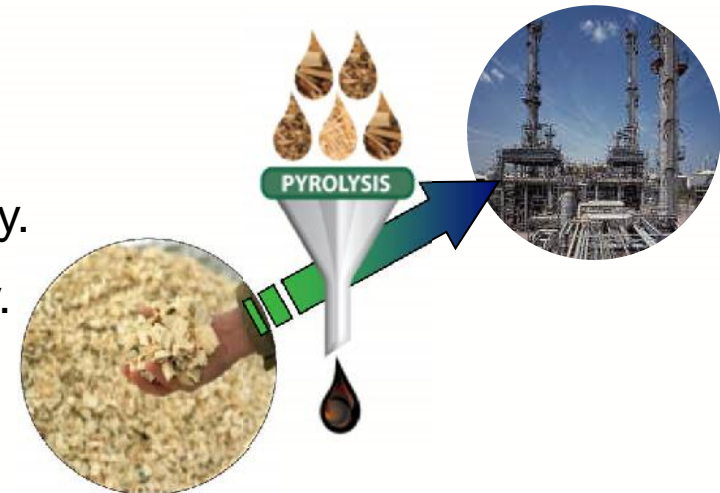




# Why pyrolysis?

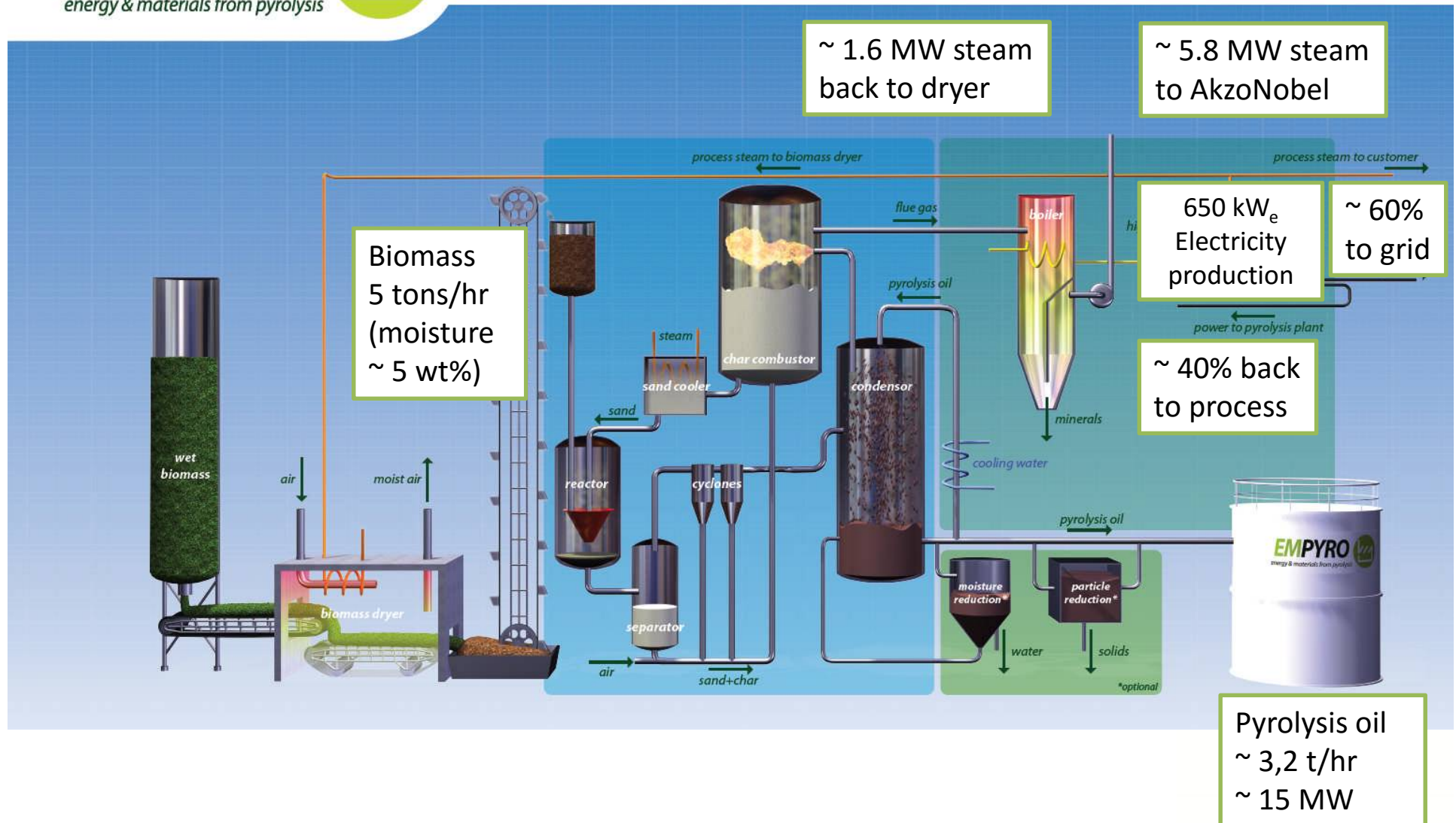
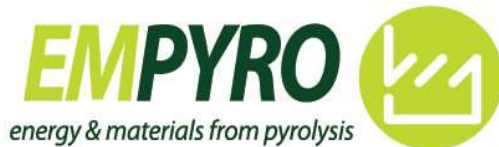


- *Decoupling in biomass resource, location, time and scale*
- Works with many biomass feedstocks.
- Increase in energy density with a factor of 4 – 20.
- Yields a tradable, homogeneous, liquid product.
- Very high overall efficiency
- Existing fossil fuel infrastructure can be used.
- Pyrolysis is the missing link between agriculture and (petro-) chemical industry.
- Starting point for the Biobased economy.

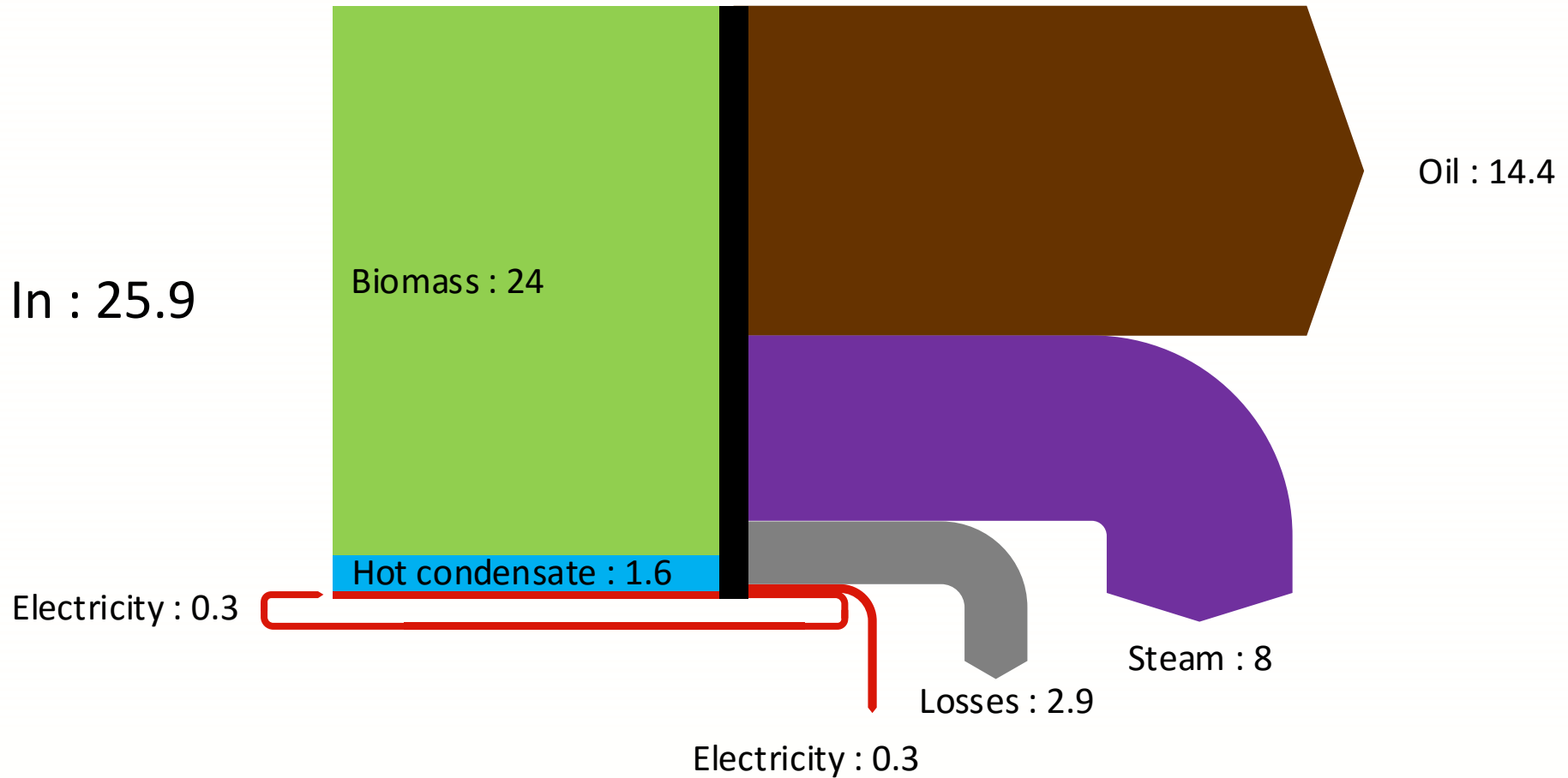


***Pyrolysis oil, the sustainable alternative***

# Key Process Figures



# Energy Balance (MW)



Overall Efficiency : 85 %



*Pyrolysis oil, the sustainable alternative*



# Empyro Project Status

## Process Performance

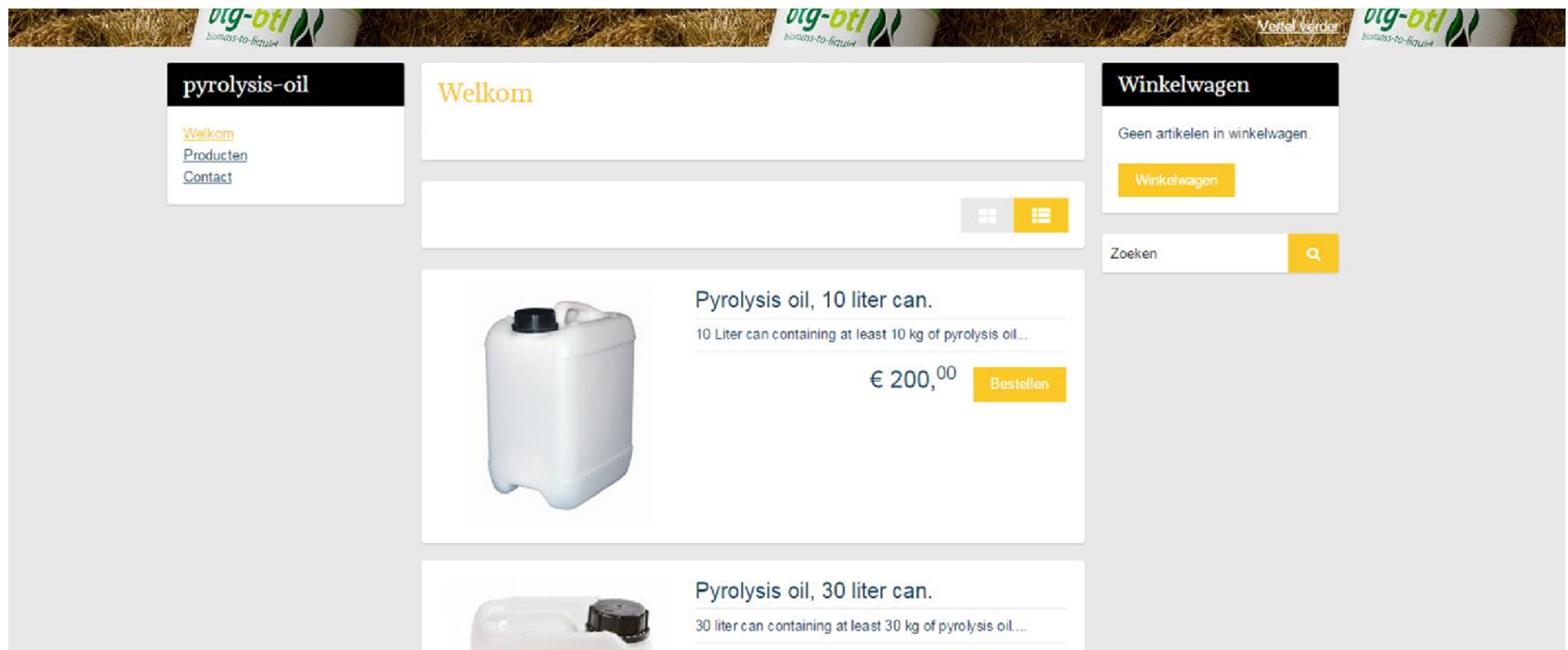


- Scale up successful
  - Our modified RCR (Rotating Cone Reactor) performs very well
  - Yield better than expected: 68-70% based on 5% wet biomass in
- Some start-up challenges ('teething troubles') as was expected but Empyro uptime gradually increasing
- Process is stable and easy to control (only one operator during the night shift)
- Oil quality has been excellent from the first batch and remained highly constant since
- May 2016: 3,5 million liters of oil produced at Empyro!

***Pyrolysis oil, the sustainable alternative***

# Pyrolysis Oil Webshop

- ❑ Let's accelerate development of more pyrolysis oil applications!
- ❑ Pyrolysis oil produced at Empyro can be obtained by contacting us or through our webshop.
- ❑ Order several liters or several hundred tons











# Modular construction



- Our pyrolysis plants consists of modules or skids which are transported like standard shipping containers.
- These are constructed, assembled, tested and then disassembled in the workshop.
- These skids are then transported to any site in the world.
- On site a foundation is required on which the skids are reassembled to form a freestanding structure. Empyro was erected in 8 days!.

**Modular pyrolysis skid**

Benefits of this modular construction approach include:

- Allows quality control
- Allows project control
- Strongly reduces project risks.

*Pyrolysis oil, the sustainable alternative*



# Pyrolysis Oil Application

## Industrial Steam Generation at FrieslandCampina

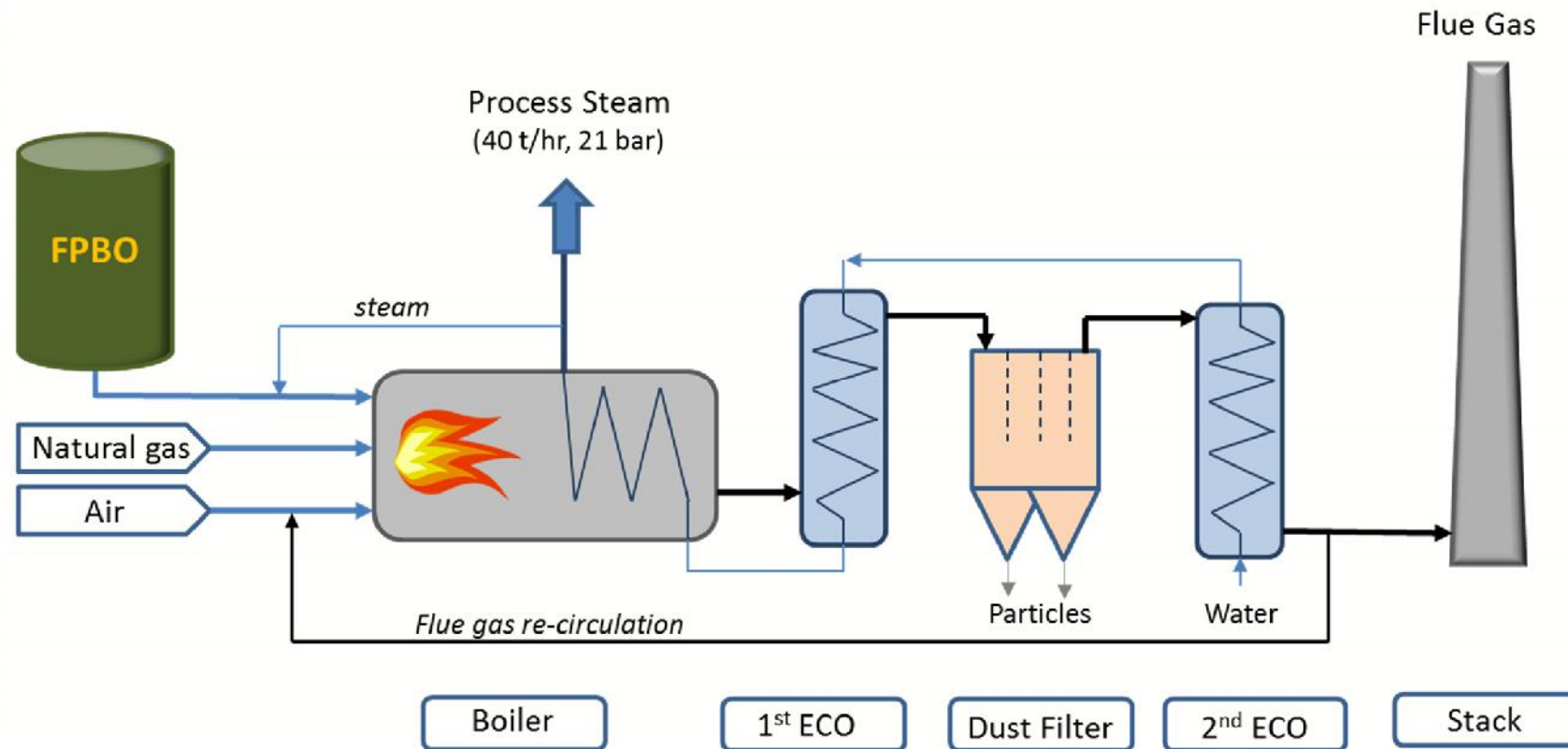


*Pyrolysis oil, the sustainable alternative*



# Pyrolysis Oil Application

## Industrial Steam Generation at FrieslandCampina



*Schematic drawing of Process Steam Boiler at FrieslandCampina*



**Pyrolysis oil, the sustainable alternative**

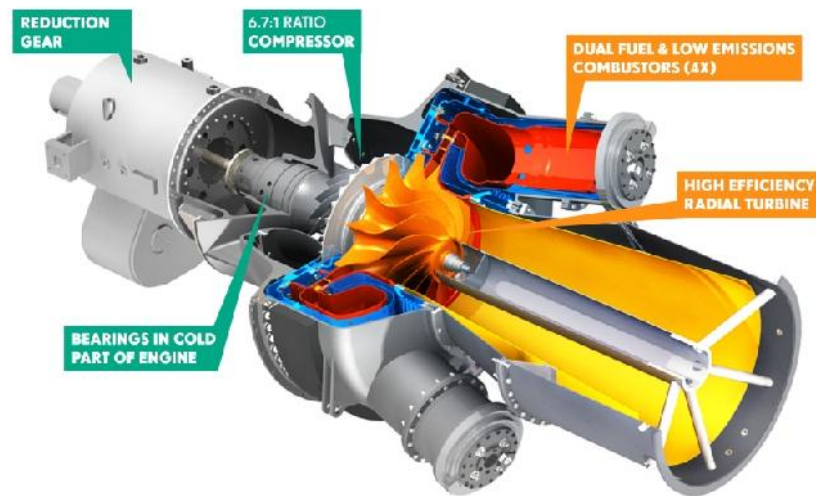




# Pyrolysis oil application

## Gas turbine for heat and power

Developments together with Opra Turbines for a 1.9 MWe / 4.5 MWth scale



**OPRA** TURBINES **1.9MW OP16 GAS TURBINE ENGINE**  
A COMBINATION OF SIMPLICITY AND HIGH PERFORMANCE

Opra Turbines

[www.opraturbines.com](http://www.opraturbines.com)



*Pyrolysis oil, the sustainable alternative*



# Pyrolysis oil

## In the biobased economy

1. Pyrolysis installations collect local biomass and convert this into pyrolysis oil

2. Once in liquid form shipping biomass becomes affordable

4. Existing infrastructure is used for further processing and distribution.

Biomass Collection  
Fast Pyrolysis  
Conversion

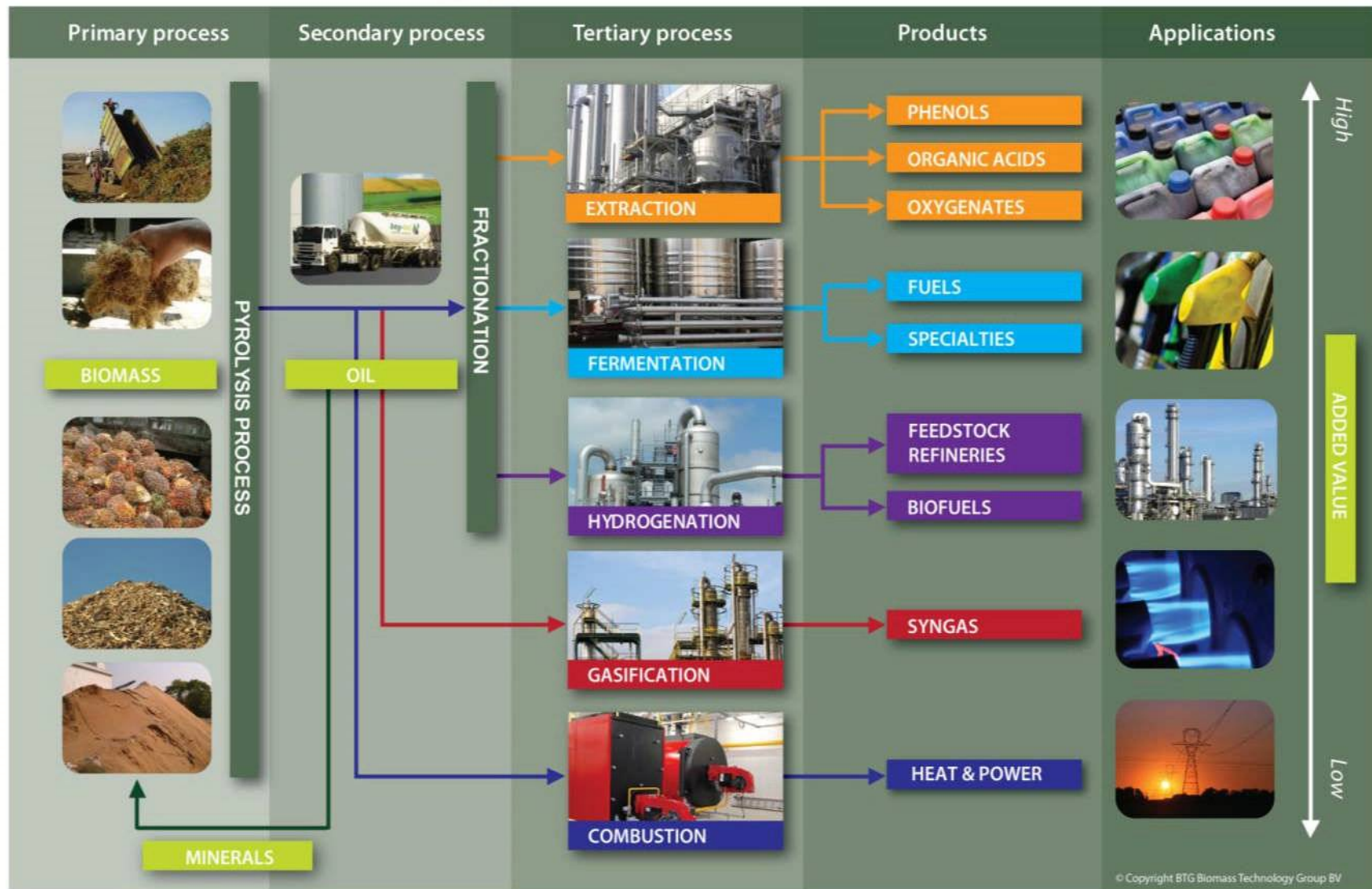
Power & Heat  
Production

Biorefinery

3. Further processing takes place at a central biorefinery.



*Pyrolysis oil, the sustainable alternative*



***Pyrolysis oil, the sustainable alternative***



# Pyrolysis oil in Overijssel

- ❑ Concentration on (larger) industrial steam consumers.
- ❑ Application of pyrolysis oil possible with sufficient SDE support.
- ❑ Total volume of about 50,000 tons of pyrolysis oil in the province (approx. 1PJ)



***Pyrolysis oil, the sustainable alternative***

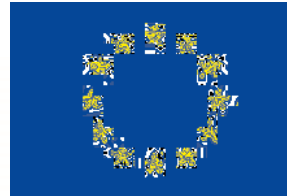
# Summary

- ❑ Mechanical issues at Empyro but production is steadily increasing.
- ❑ Empyro shows excellent oil yield, oil quality and process stability.
- ❑ Over three million liters of pyrolysis oil produced so far.
- ❑ Pyrolysis oil is currently being fired at FrieslandCampina at a rate of up to 3 tons/hour



***Pyrolysis oil, the sustainable alternative***

# Empyro Project enabled by:



***Pyrolysis oil, the sustainable alternative***





**btg-btl**  
biomass-to-liquid



**btg-btl**  
biomass-to-liquid



**Visiting address**  
Josink Esweg 34,  
7545 PN, Enschede  
The Netherlands

**Contact**  
T +31 (0)53 486 1186  
F +31 (0)53 486 1180  
E [office@btg-btl.com](mailto:office@btg-btl.com)

**Follow us:**  
[btg-btl.com](http://btg-btl.com)  
[youtube.com/BTGBioliquids](https://youtube.com/BTGBioliquids)  
[twitter.com/BTG\\_BTL](https://twitter.com/BTG_BTL)