

# EXPERIENCES FROM THE LAST DECADE OF INSTALLING BIOMASS-FUELLED HEAT PLANT IN NEW ZEALAND AND NEW EMERGING TECHNOLOGIES



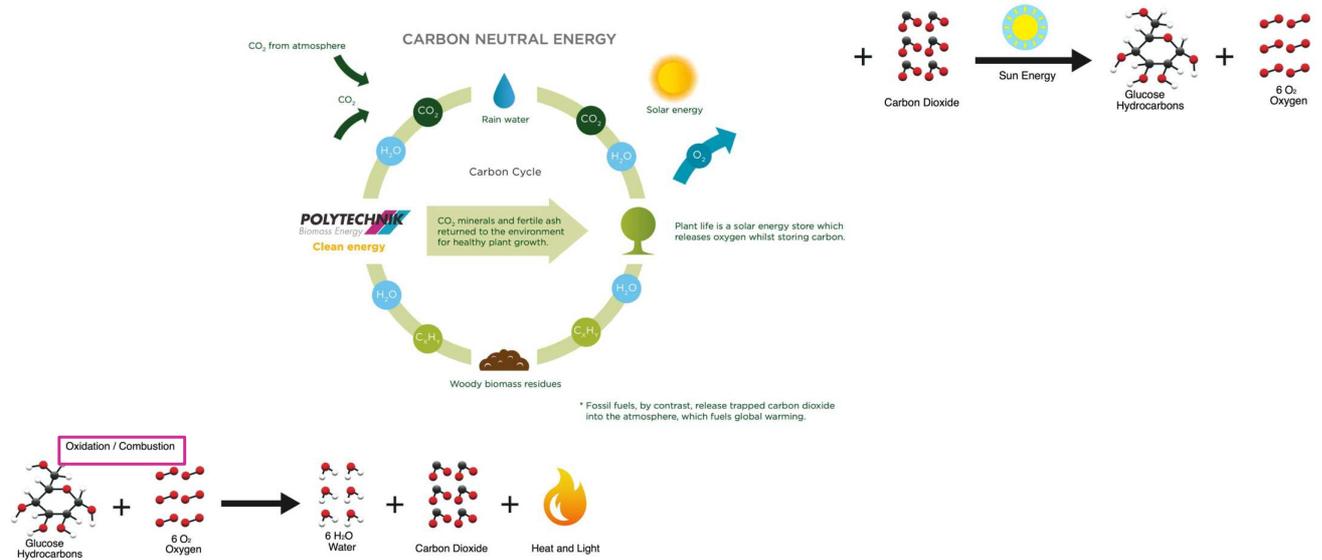
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The utilisation of biomass residues for heat, cooling, power, drop-in fuels and carbon sequestration

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## Biomass Energy

Wood + Biomass – Most sustainable building material – Utilising sun energy via biomass residues



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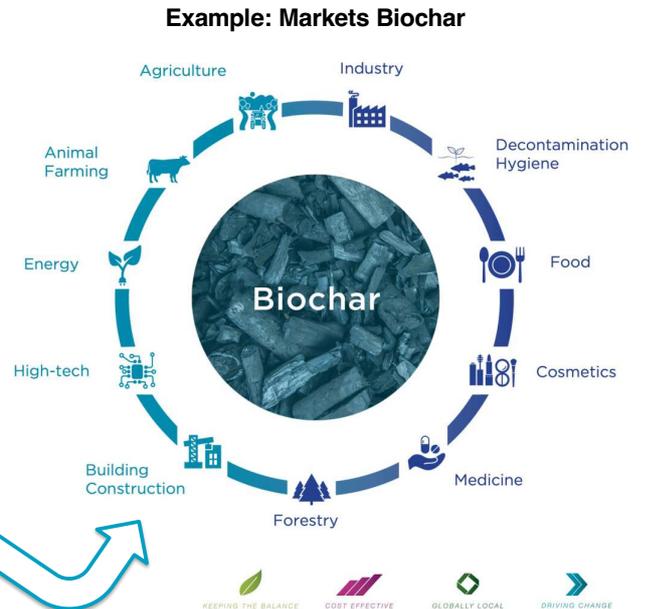


## Woody Biomass Residues

Carbon Cycle – Technologies, Applications and Products



Technologies	Application	Products
Combustion	Heat	Hot water
Gasification	Cooling	Steam
Torrefaction	Power	Thermal oil
Carbonisation	High-value products	Electricity
		Fertiliser
		Syngas / Oils
		Biomethane
		Drop in fuels
		Carbon storage
		Biochar



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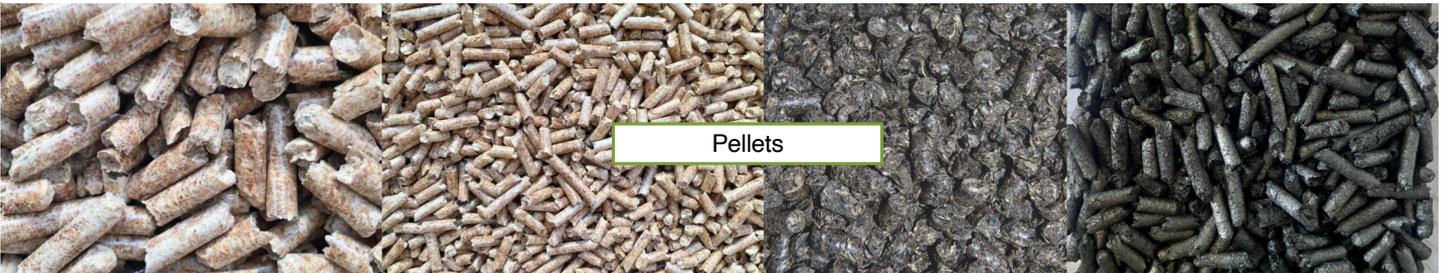


# BIOMASS RESIDUES



## Biomass Feedstock

Energy-dense and uniform biomass fuels





Hogged residues



Shredded residues



Shavings and peelings



Sawdust

**Biomass Feedstock**

Forest residues and high ash-content biomass residues



**Biomass Feedstock**

Construction and demolition wood



## Biomass Feedstock

Challenges and considerations on energy systems

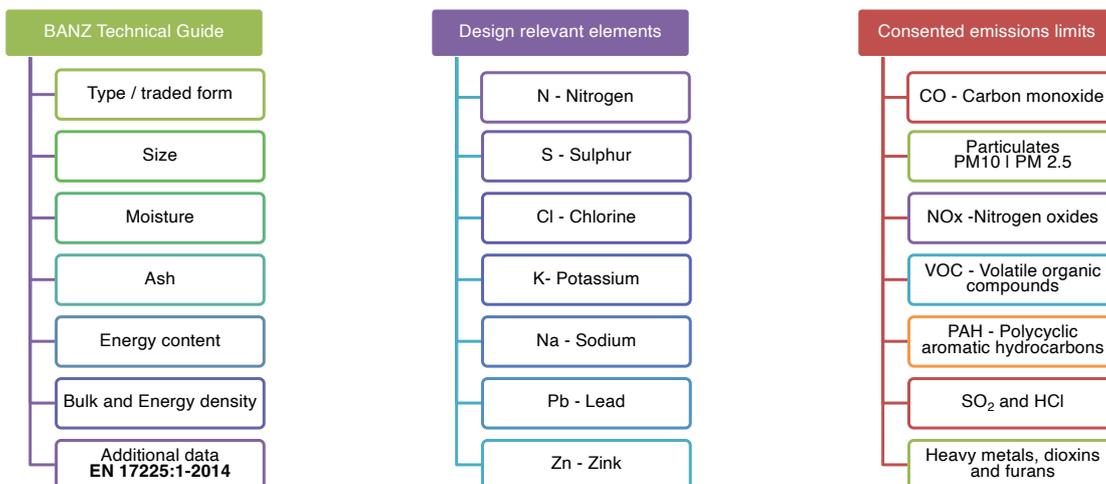


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## Biomass Residues

Design relevant data - Fuel and related emissions

When tailoring a wood energy system to an application, the understanding of feedstock and local requirements is most important.



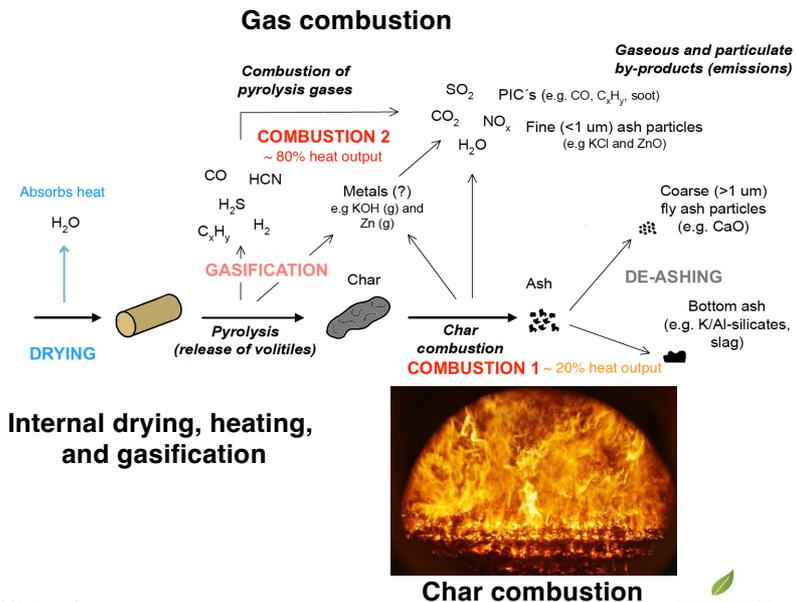
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# BIOMASS COMBUSTION

## Biomass Combustion

5 Steps: Drying → Heating → Gasification → Combustion → De-ashing

### Biomass Residues



**De-ashing**



**Char combustion**

## Biomass Combustion

Energy content biomass – Impact of ash/dirt and water on fuel storage volume and transport weight



**750 kWh per m<sup>3</sup>**  
**2,330 kWh per tonne**

Moisture: 35.8 % wb  
Ash: 23.5 % db  
GCV: 9.93 MJ/kg = 2.75 MW/t  
NCV: 8.40 MJ/kg = 2.33 MW/t  
Bulk density = 321 kg/m<sup>3</sup>  
Fines (<3.35 mm): 36.4 %

Wet vs. dirty

-15% less energy per volume  
-47% less energy per weight



**640 kWh per m<sup>3</sup>**  
**1,230 kWh per tonne**

Moisture: 68.0 % wb  
Ash: 3.2 % db  
GCV: 6.48 MJ/kg = 1.80 MW/t  
NCV: 4.41 MJ/kg = 1.23 MW/t  
Bulk density = 517 kg/m<sup>3</sup>  
Fines (<3.35 mm): 17.6 %



**710 kWh per m<sup>3</sup>**  
**2,120 kWh per tonne**

Moisture: 52.6 % wb  
Ash: 2.8 % db  
GCV: 9.52 MJ/kg = 2.64 MW/t  
NCV: 7.63 MJ/kg = 2.12 MW/t  
Bulk density = 336 kg/m<sup>3</sup>  
Fines (<3.35 mm): 11.2 %

Wet vs. dry

-28% less energy per volume  
-52% less energy per weight

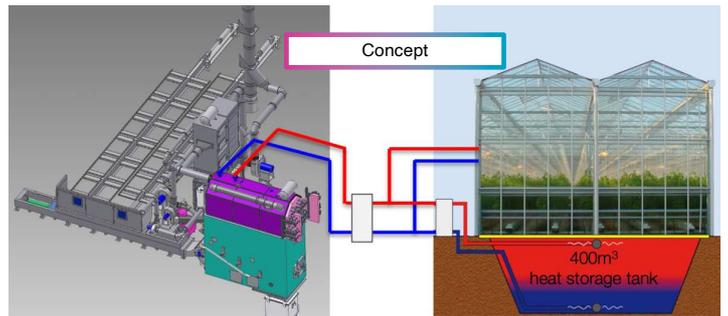


**980 kWh per m<sup>3</sup>**  
**4,380 kWh per tonne**

Moisture: 15 % wb  
Ash: 0.4 % db  
GCV: 17.28 MJ/kg = 4.80 MW/t  
NCV: 15.78 MJ/kg = 4.38 MW/t  
Bulk density = 224 kg/m<sup>3</sup>  
Fines (<3.35 mm): not tested

## Biomass Combustion – Industrial Heat

Hot water heater for flower growers – South Island





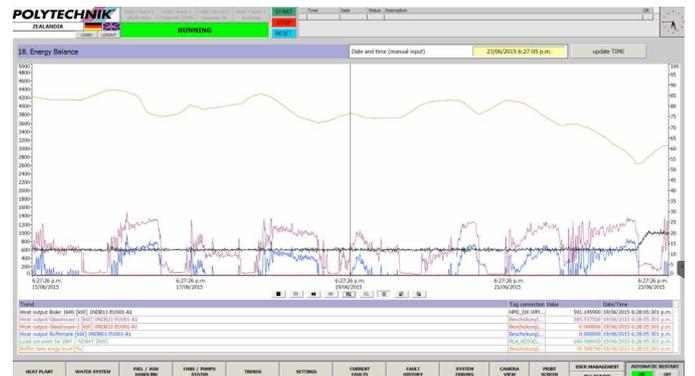
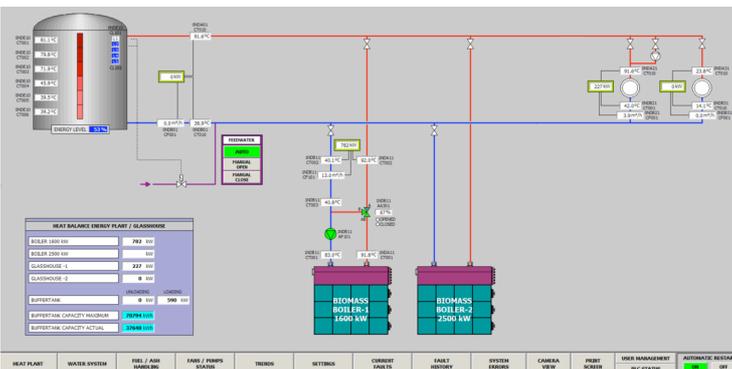
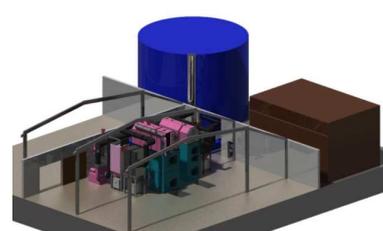
**Biomass Combustion – Industrial Heat**  
Hot water heaters in the Horticulture Industry - Australia



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**Biomass Combustion – Industrial Heat**  
Hot water heaters in the Horticulture Industry – South Island



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Hot water heaters in the Horticulture Industry - South Island



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**Biomass Combustion – Industrial Heat**  
Steam boiler for the Wood Processing Industry – South Island



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## Biomass Combustion – Industrial Heat

Thermal oil heater for the Wood Processing Industry – North Island

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## Biomass Combustion – Industrial Heat

High-temperature Hot Water Heater for the Wood Processing Industry – South Island

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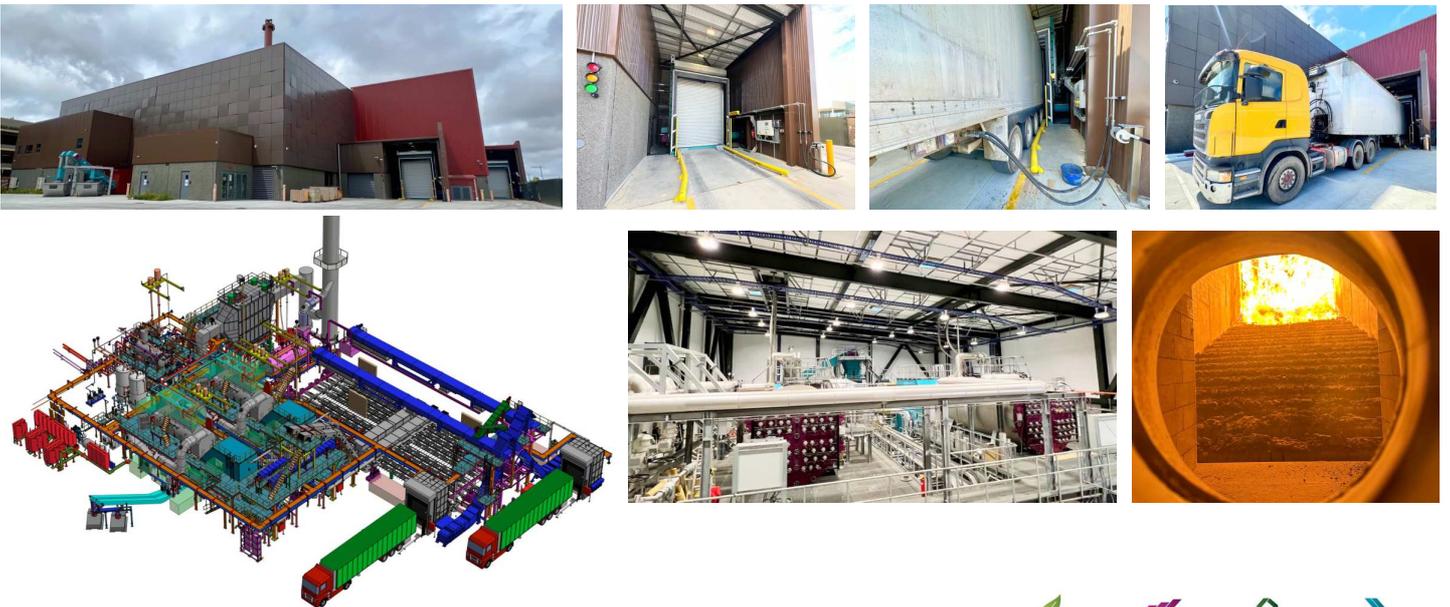
**Biomass Combustion – Industrial Heat**  
 Steam boilers and hot water for hospitals – Seismic Importance Level 3



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**Biomass Combustion – Industrial Heat**  
 Steam for a hospital – Seismic Importance Level 4



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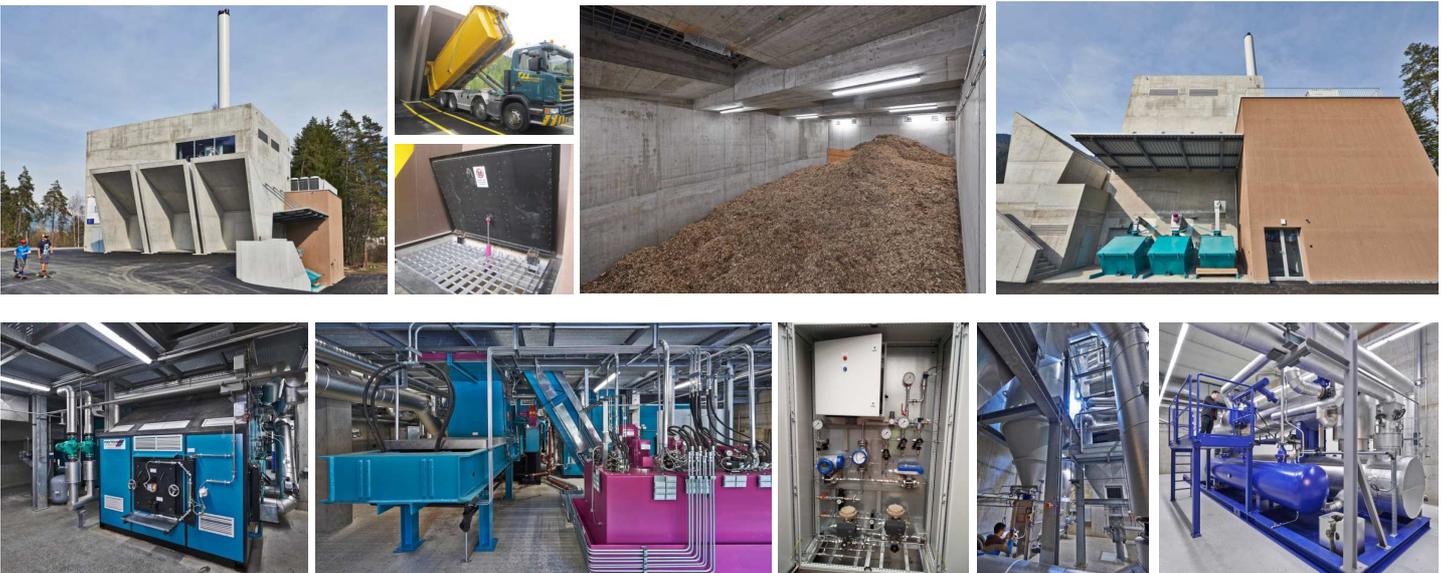
**Biomass Combustion – Industrial Heat**  
 Steam boiler plant



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**Biomass Combustion – Co and Tri-Generation**  
 Thermal oil boiler with ORC utilising C&D wood



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## Biomass Combustion – Co and Tri-Generation

Steam boiler plant with absorption chiller and steam turbine utilising C&D wood

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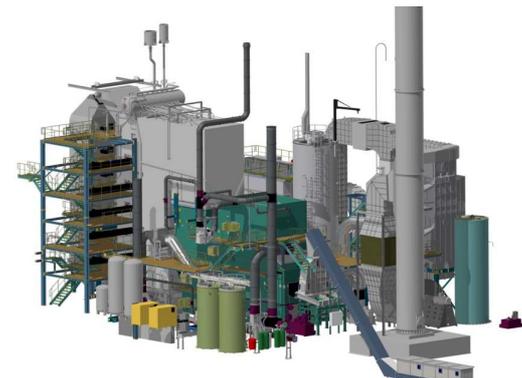
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## Biomass Combustion – Co and Tri-Generation

Steam boiler plant with steam turbine utilising C&D wood

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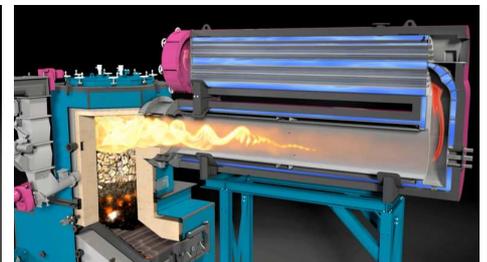
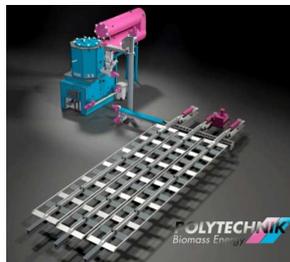
# GASIFICATION



**Biomass Gasification**  
Polytechnik's HELD System

**POLY H.E.L.D.® is the combustion technology of the future.**

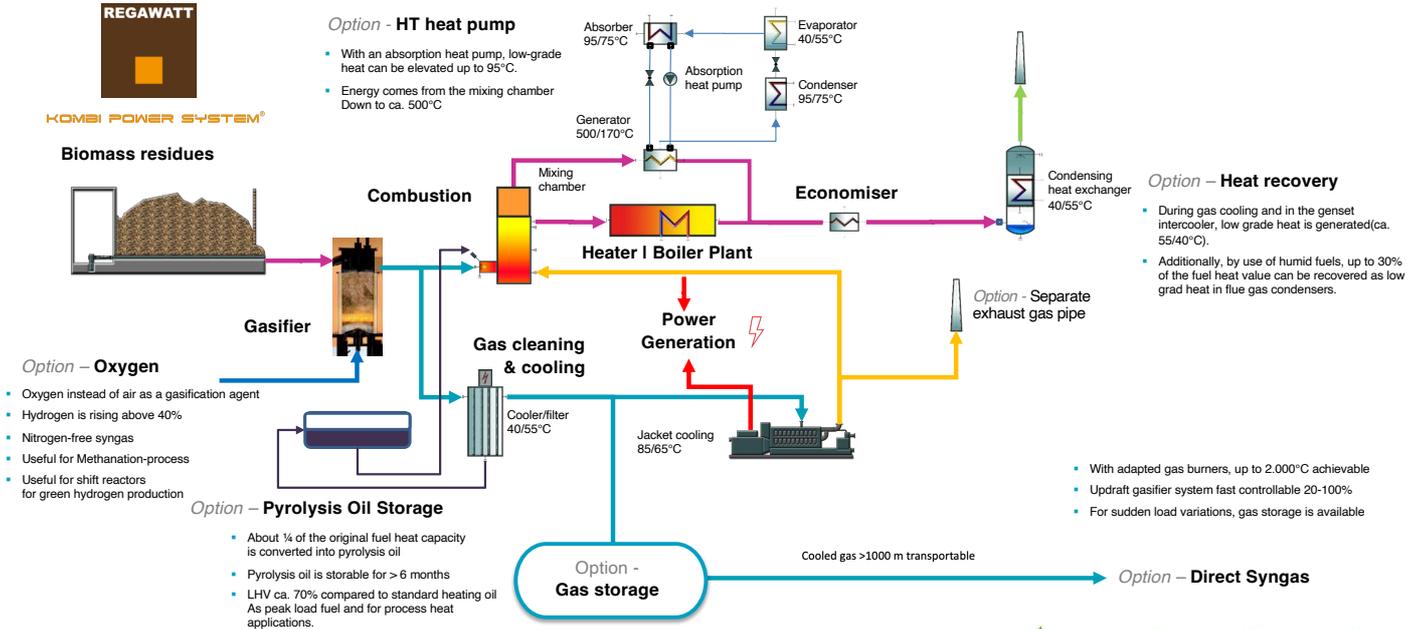
A combustion system with extreme air staging, designed as a counter-current fixed-bed gasifier with, very low-emissions and highly efficient combustion of various biomass residues.



- Fuel flexibility:  
Wood chips up to M45, straw pellets, agricultural residues, etc.
- **Efficiency: > 92%** = 5% higher when compared to conventional combustion!
- Particulates < 20mg/Nm<sup>3</sup> without any emission control system!
- NO<sub>x</sub>: 25% compared to conventional combustion
- Operating range: 25 to 100%

## Biomass Gasification

Process options



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## Biomass Gasification

Reference sites



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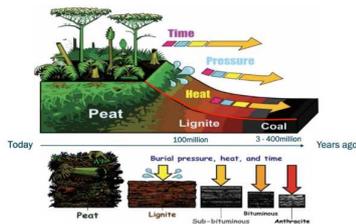




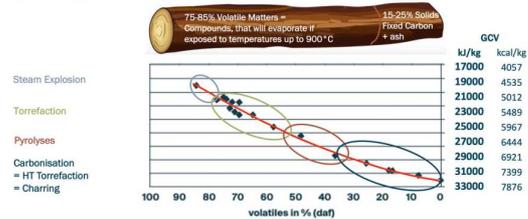
**Torrefied Biomass**

Torrefied biomass can be used as a direct replacement for fossil fuels (drop-in fuels).

Coal is made of biomass in million of years



...or within minutes  
by technology and temperature



Source: Michael Wild, Wild & Partner LLC

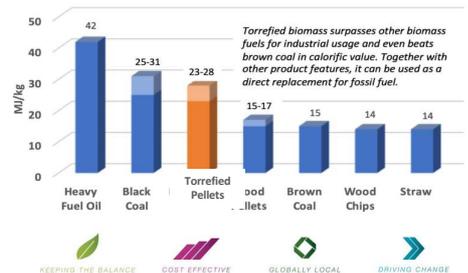
Torrefaction = slowly heating biomass at low temperatures (250 to > 300°C) in a limited oxygen environment. The product has fewer volatiles and a higher carbon and energy content than thermally untreated biomass.



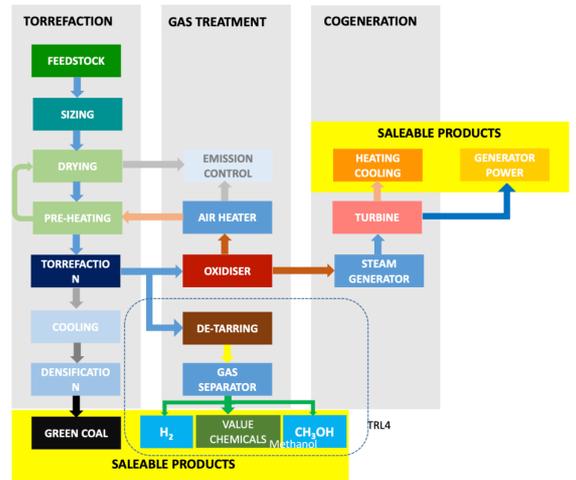
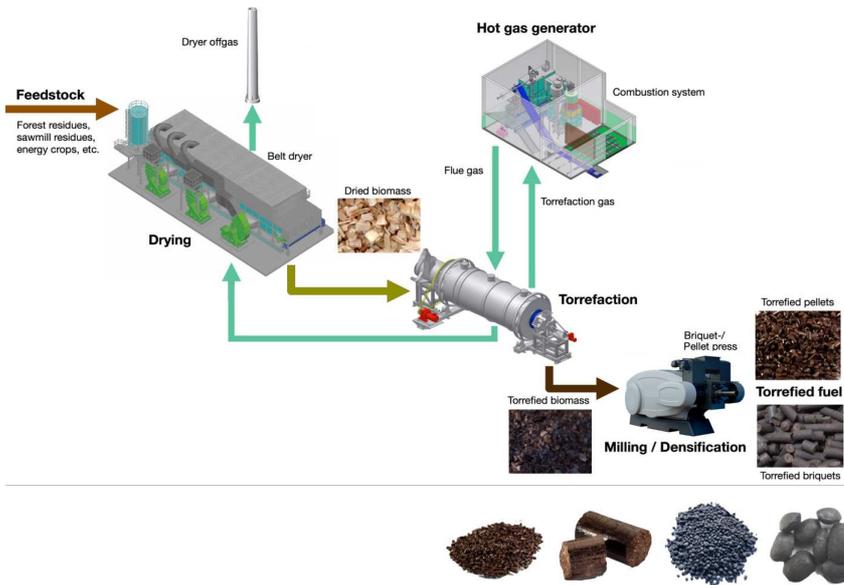
Different carbonisation levels - different products

**Typical values of torrefied and densified biomass**

- Carbon content: 55 to 75%
- Volatiles: 35 to 65%
- Chlorine and Sulphur content: minus 80 to 90% from raw material
- Bulk density: 550 to 800 kg/m<sup>3</sup>
- Moisture content: 5%
- Calorific value: 23 to 28 GJ/tonne



# Torrefied Biomass Process



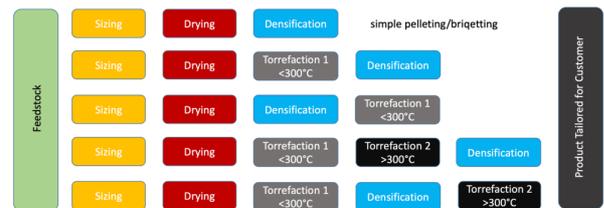
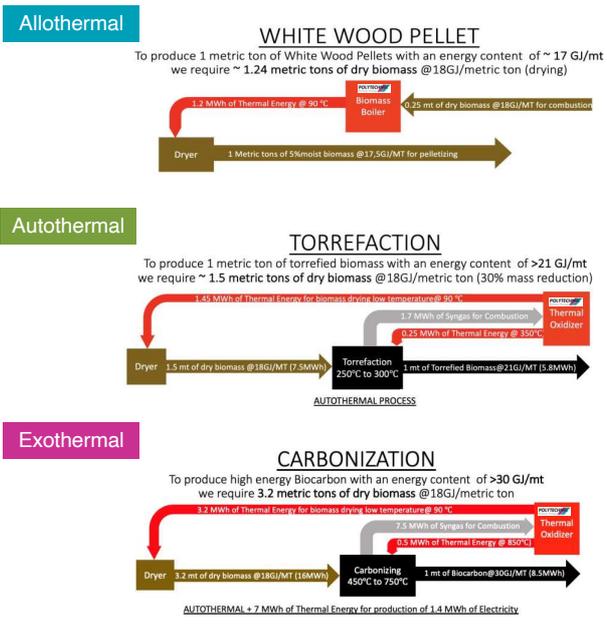
Source: Michael Wild, Wild & Partner LLC



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# Torrefied Biomass

White pellets, torrefied pellets, and carbonised pellets



Biomass, once torrefied will have a bulk density of <150 kg/m³ and is prone to form plenty of fines <500microns



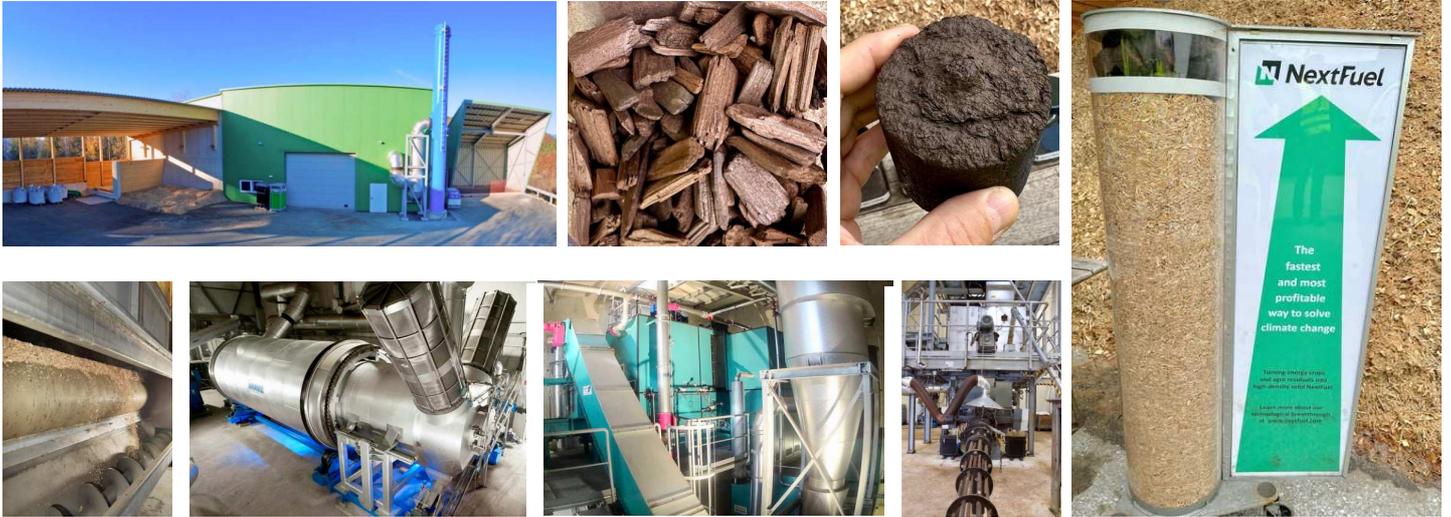
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Source: Michael Wild, Wild & Partner LLC

## Torrefied Biomass

8,000 t/a demonstration plant operational since 2011

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The ACB (Accelerated Carbonized Biomass) pilot plant in Austria, with a capacity of 1 t/h, has been operational since 2011. The Austrian Research Institute for Chemistry and Technology (of), an Austrian consortium consisting of ANDRITZ, Polytechnik and Wild & Partner developed the process.

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## Torrefied Biomass

Europe's biggest torrefaction plant (60,000 t/a of torrefied product) will be commissioned in 2024

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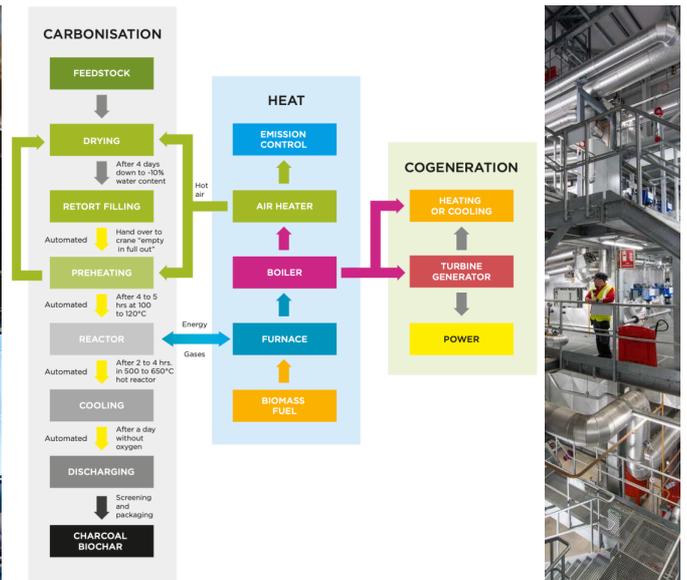
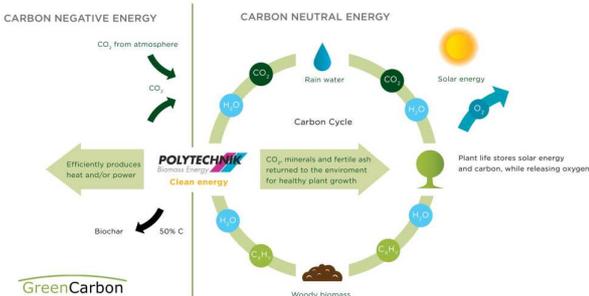
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# CARBONISATION

*Biomass Carbonisation Process*



**Biomass Carbonisation**  
Feedstock



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**Biomass Carbonisation**  
Feedstock



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## Biomass Carbonisation

3,000 tonnes per year demonstration plant in Germany

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## Biomass Carbonisation

Biochar Products

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*Polytechik Biomass Energy*

*New Zealand's leading experts in biomass combustion, gasification, torrefaction, and carbonisation*

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**DON'T TURN AROUND,  
DON'T LOOK BACK.**

**KEEP MOVING FORWARD,  
KEEP PUSHING.**

**THE POT OF GOLD IS AT THE  
END OF THE RAINBOW,  
NOT THE BEGINNING.**

-ZIAD K. ABDELNOUR

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