

Pyrolyysi ja biohiili

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Macon Oy

Mikä on pyrolyysi

Pyrolyysi on menetelmä jakaa aine uusiksi yhdisteiksi käyttämällä lämpöä alhaisessa happipitoisuudessa ympäristöön.

Sana pyrolyysi tulee yhdistämällä kreikan sanat tulelle ja halkeamiselle.

Pyrolyysi on lämpöprosessi, jota käytetään pääasiassa kiinteiden aineiden muuntamiseen kaasuksi, nesteeksi ja uudeksi kiinteäksi aineeksi niiden yhdistelmiä.

Polttoainelähteet voivat usein vaihdella. Tuloksena saataviin tuotteisiin vaikuttavat useat tekijät, kuten reaktioaika, lämpötila ja reaktorityyppi (Kantarelis ym. 2012)

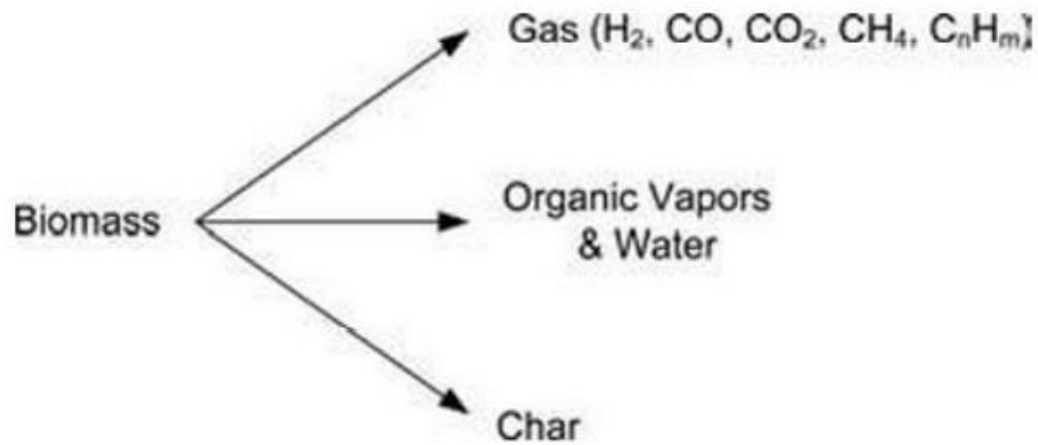
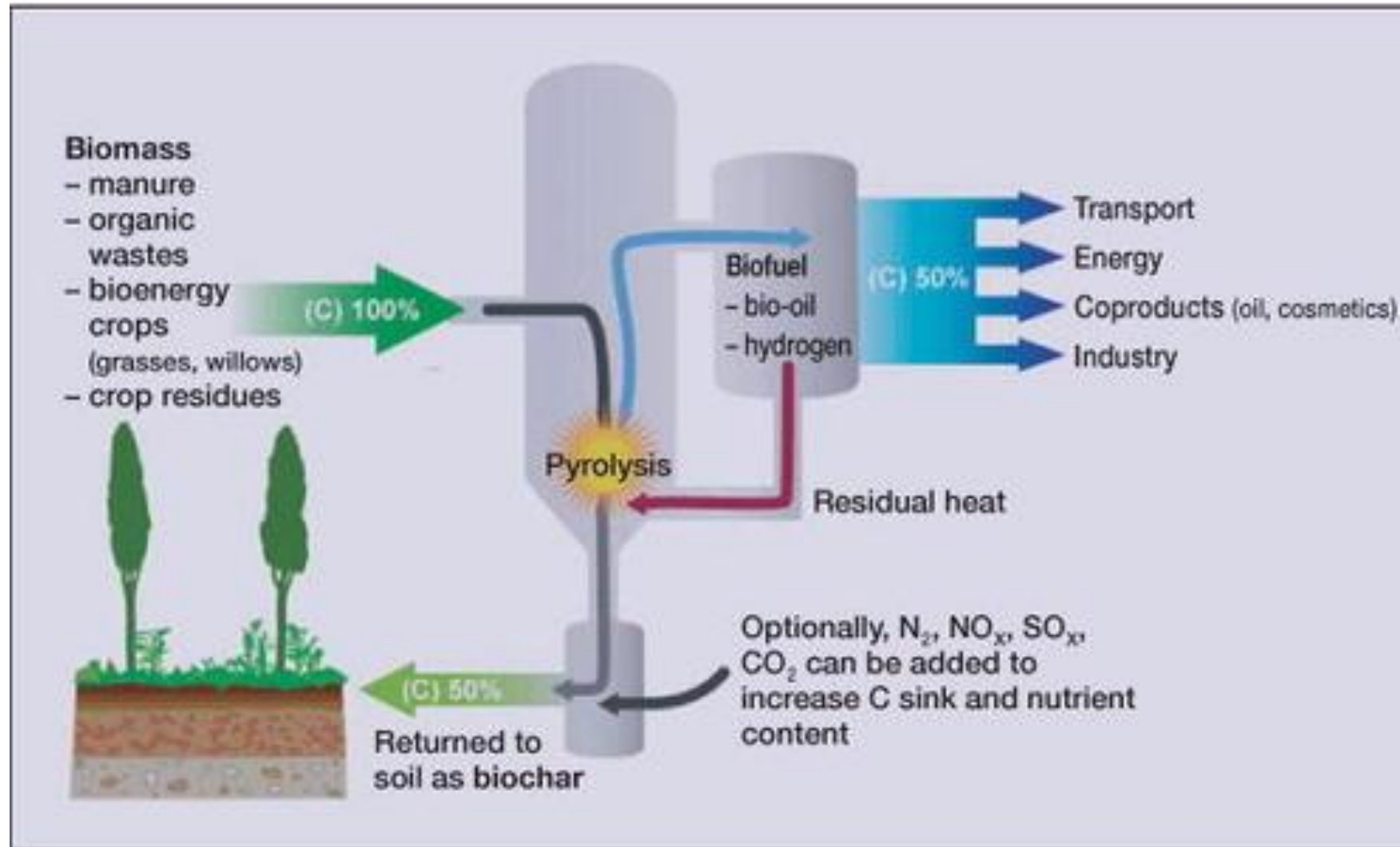
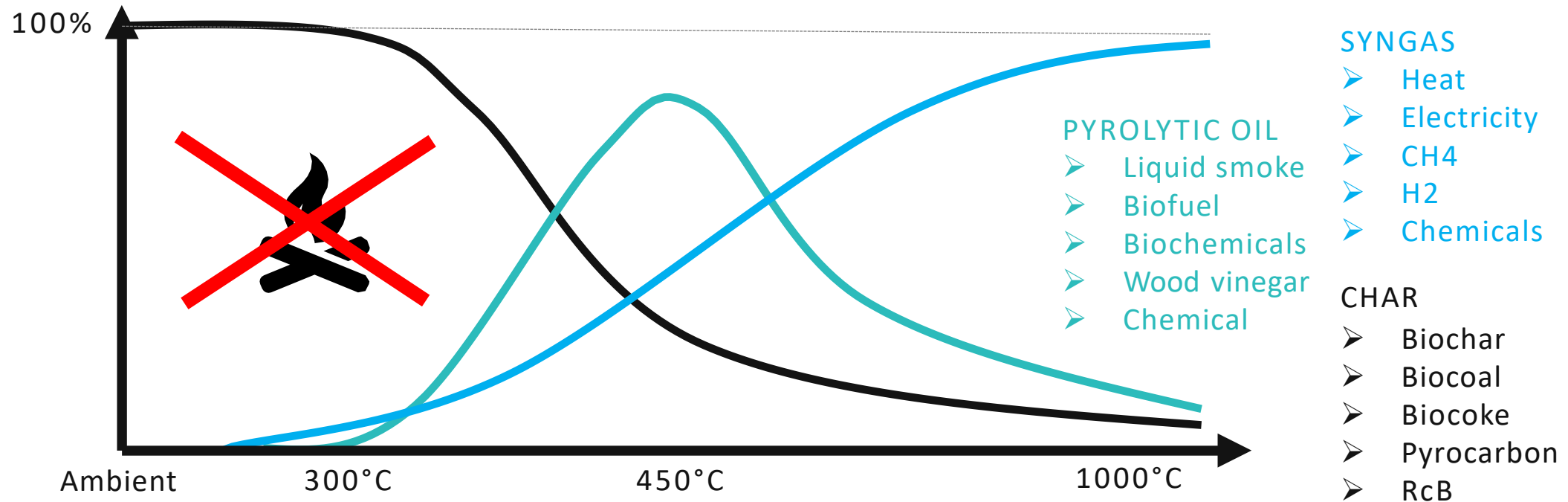


Figure 1: Thermal process depending on amount of reacting oxygen in the process



Pyrolyysin periaatteet

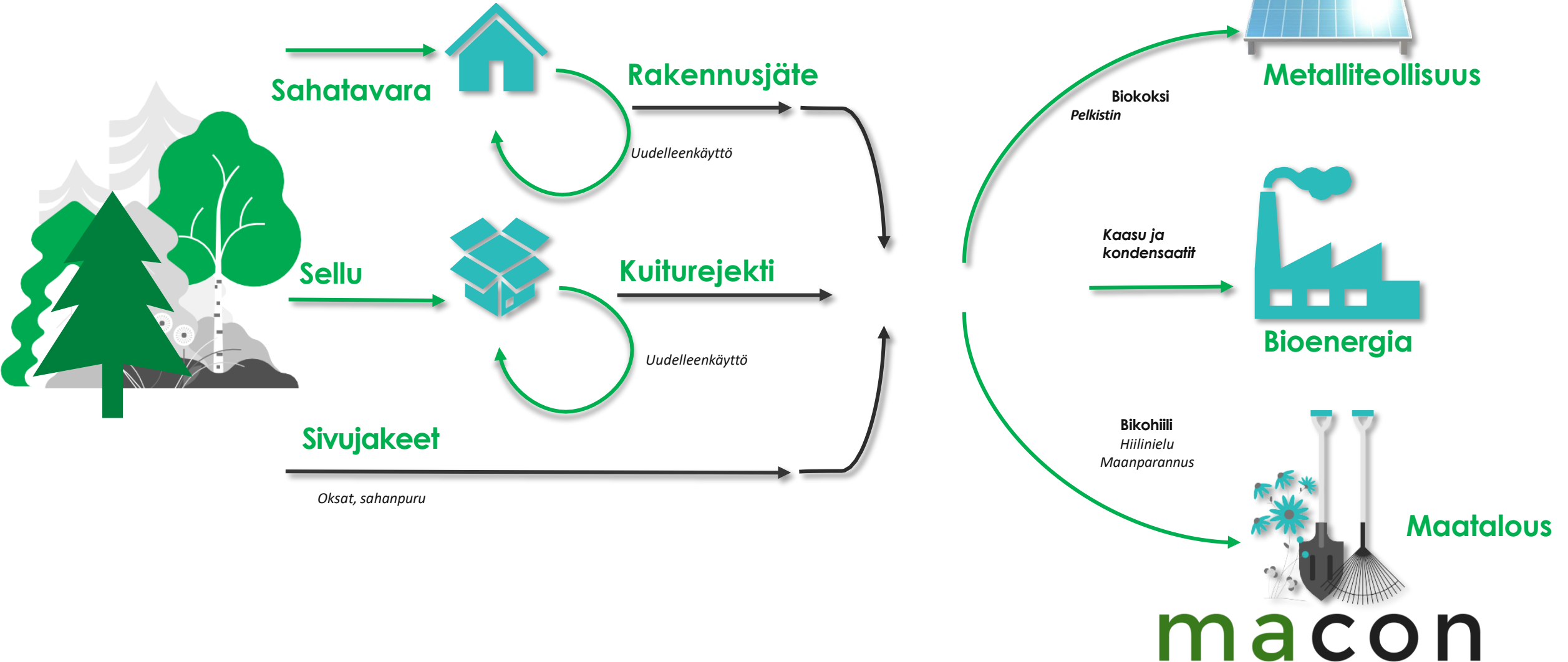
Pyrolyysituotteiden käyttökohteet



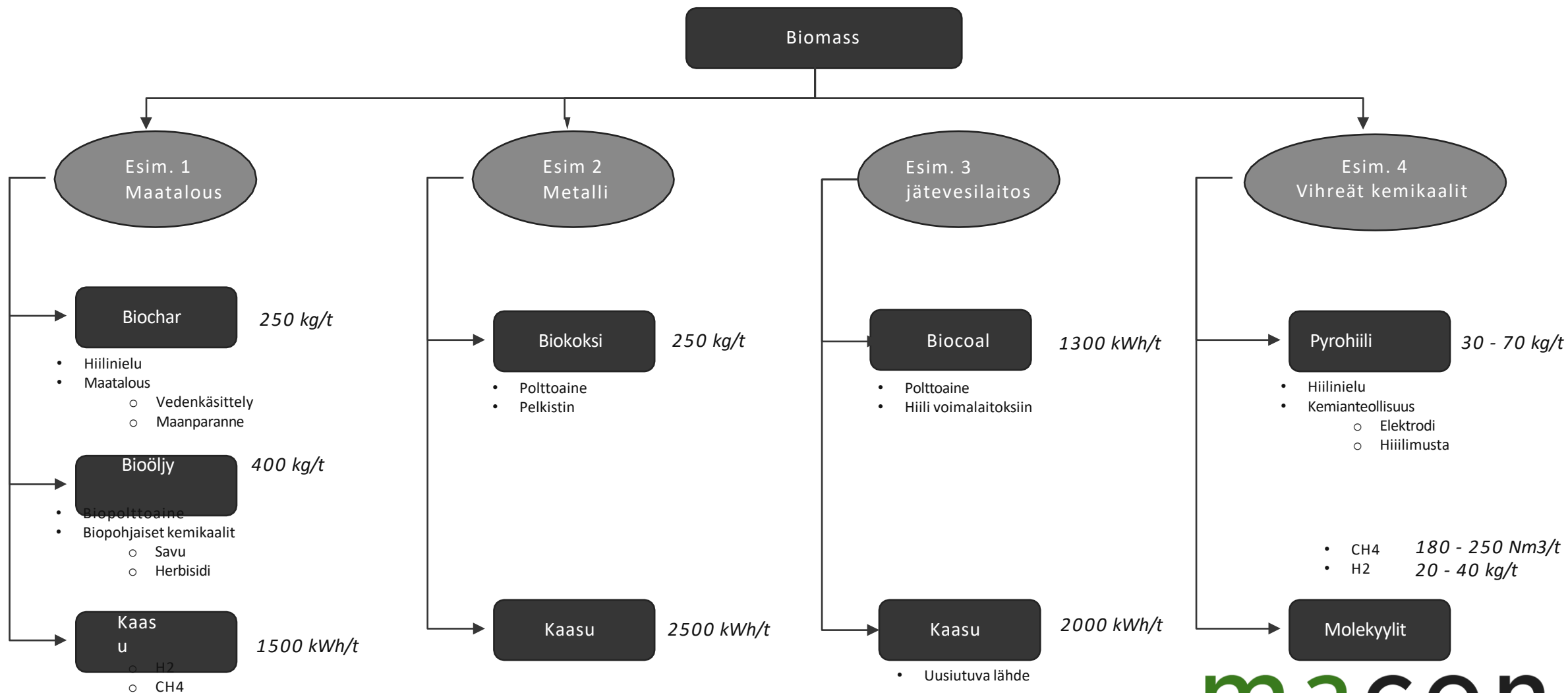
- Pyrolyysi on hiilipitoisten komponenttien terminen hajoaminen jossa happi ei ole läsnä

PUUN ARVOKETJU–SIVUTUOTTEIDEN HYÖDYNTÄMINEN

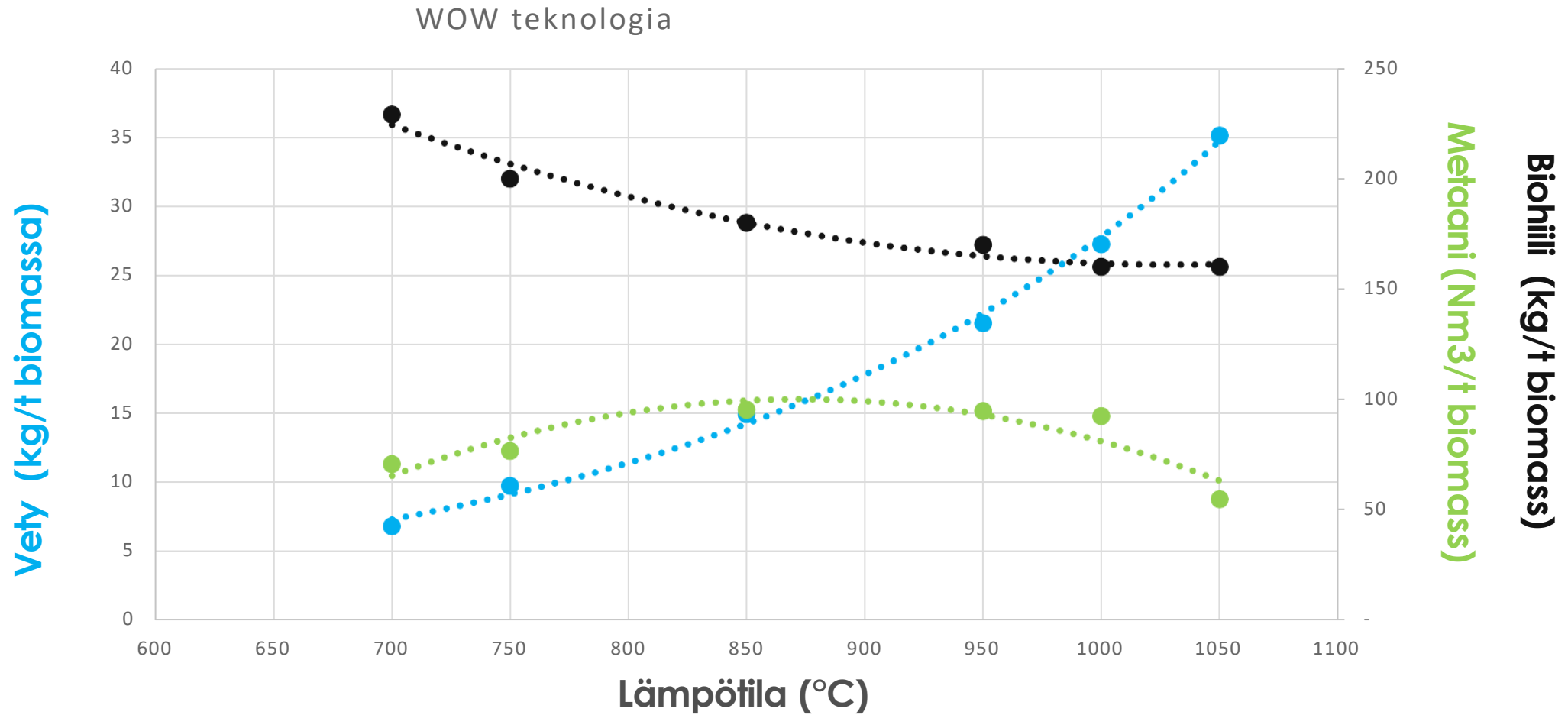
Fossiilisten raaka-aineiden korvaaminen



Esimerkkejä



UUSIUTUVIA RAAKA-AINEITA



TEKNOLOGIAT

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Waste to Carbon

A large industrial facility, likely a waste-to-carbon plant, featuring a long black container with orange safety railings and a central orange door. The facility is equipped with various pipes, tanks, and structural elements, situated in an open field under a cloudy sky.

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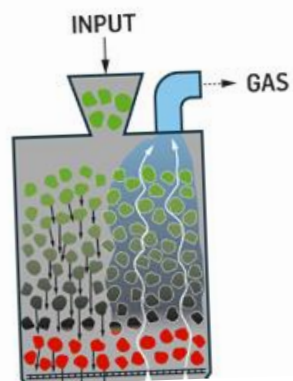
Carbon Terra®

Deutsch

English



Functionality



The Schottdorf method is neither gasification nor pyrolysis. The focus is on the production of pure biochar. The resulting gas is a by-product and can be used as an energy source.

Biogreen pyrolysis technology - Thermochemical conversion of biomass and waste

Pyrolysis process in mobile, containerised and fixed equipment

Biogreen® is innovative, patented pyrolysis process operating since 2003. Since more than a decade, our solution works for converting biomass, plastics, and waste into energy and useful products.

Biogreen pyrolysis process is based on electrically heated screw conveyor (Spirajoule®), designed for advanced thermal treatment in temperatures up to 800 degrees C and beyond. Processed product temperature is precisely controlled basing on the temperature settings. The dwell time of material inside Biogreen® reactor is regulated by screw rotation speed. Thermal conversion is performed in oxygen-free (pyrolysis) atmosphere in unique construction of equipment, which guarantees a constant quality of product obtained from the treatment.





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pyrolysis

Pyrolysis oil is a clean and uniform liquid that can be used as a sustainable alternative to fossil fuels for the production of renewable energy and chemicals. It is obtained through a process called fast pyrolysis, which transforms biomass into a liquid.





Carbon Negative, Community-Scale, and Reliable Baseload Energy

Project Sites Carbon Negative Clean Energy





Biomass Pyrolysis Technology // Biochar production equipment

We are participating:



MUSK FOUNDATION

Kuva kuvassa 

WORLD CLASS BIOCHAR PRODUCTION FACILITIES MADE IN FINLAND

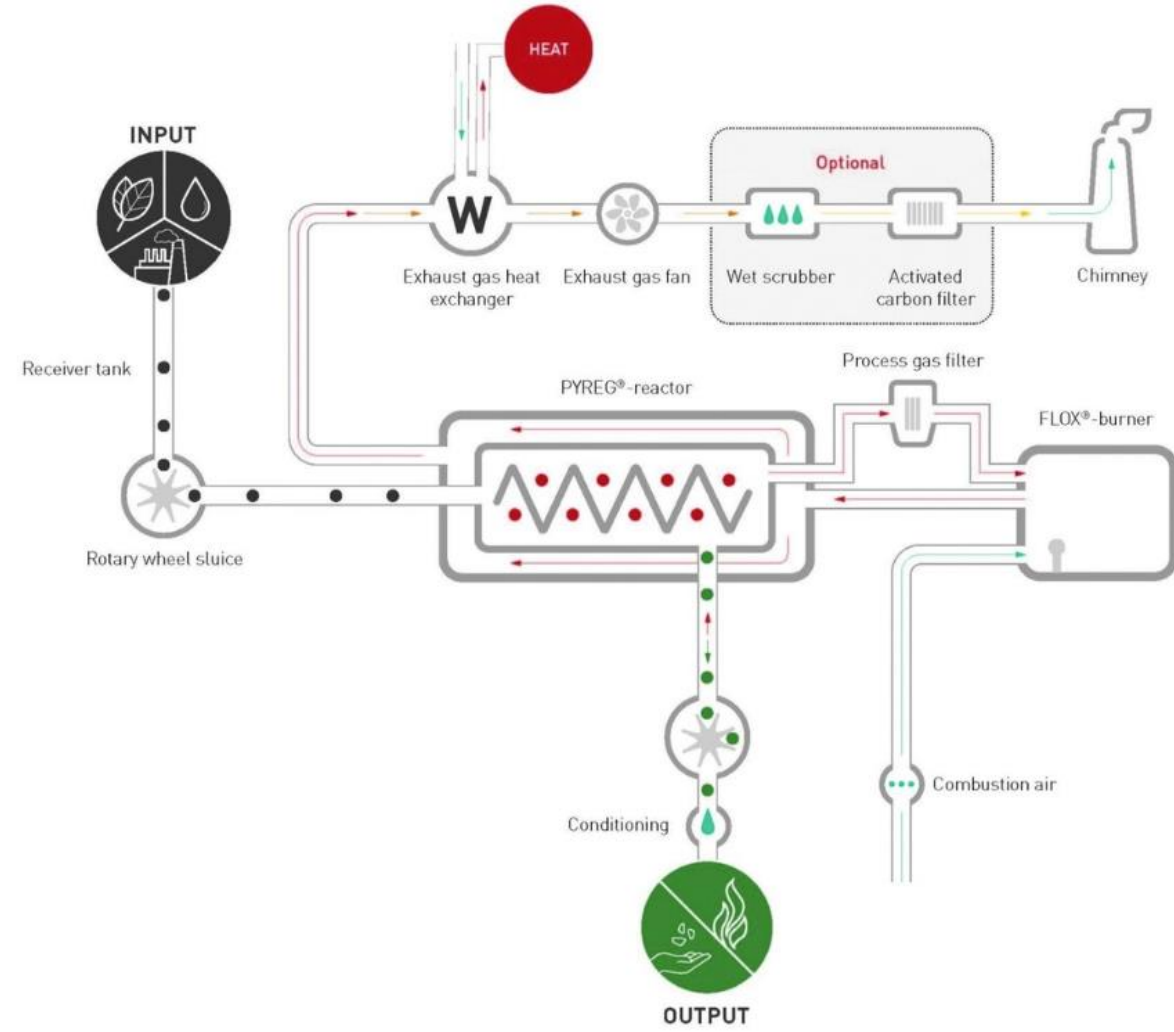
Remove CO₂ by converting waste biomass into energy



Industry-level biochar
production technology



Suitable for biogas, pyrolysis
oil, and clean energy
production



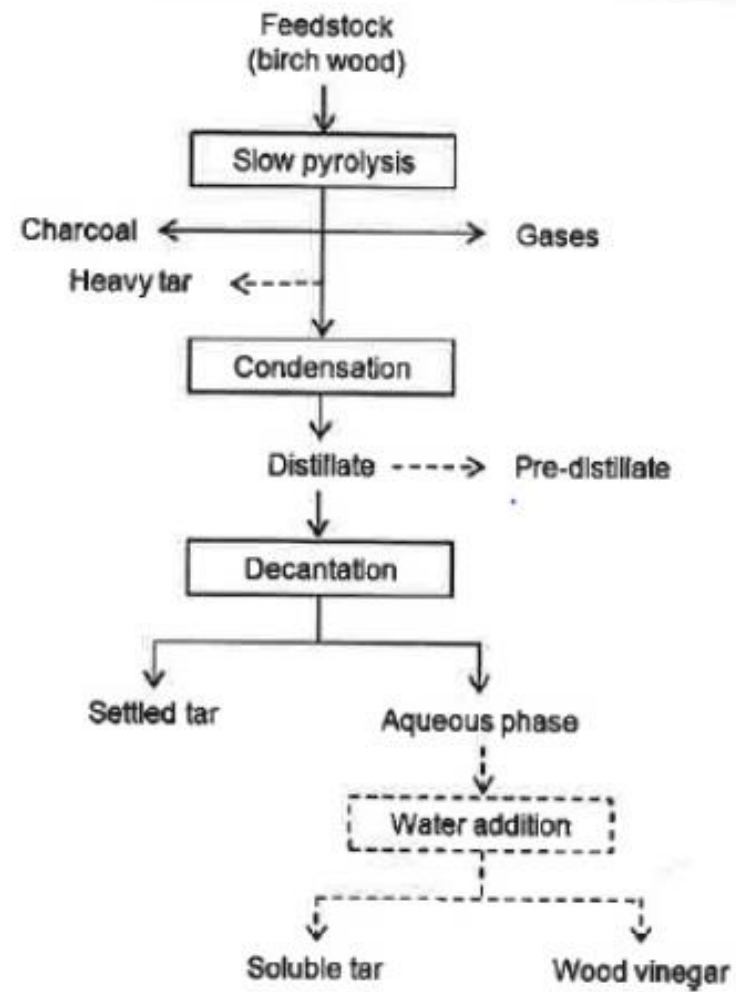


Table 1: Share of products (Kantarelis et al. 2012)(Bridgwater 2007)

Method	Temp [°C]	Vapors res time	Char [wt %]	Liquid [wt %]	Gas [wt %]
Slow	400	Hours-days	30-40	25-30	25-35
Intermediate	500	5-30 s	25-30	40-50	25
Fast	500	1-2s	12-20	60-75	13-20

Table 2: Mass and energy balance of Dry Birch wt% (Fagernäs et al. 2014)

Yield from pyrolysis of Birch	Mass balance [wt%]	Energy balance [% of total]
Initial Feedstock, dry	100	100
Products total	94	95
Char	34	56
Liquids/distillate	42	16
Gases	18	23
Energy for process/losses	6	5

Table 3: Energy and product distribution of slow pyrolysis process (Rosas et al. 2015)

Products	Yield [wt%]	HHV [MJ/kg]	Energy [MJ/kg feedstock]	Exit temperature of products [°C]	Heat losses [MJ/kg feedstock]
Char	40	12,8	5,16	322	1,67
Liquids	17	5,7	0,97	70	0,34
Gas	43	10,6	4,55	338	3,4

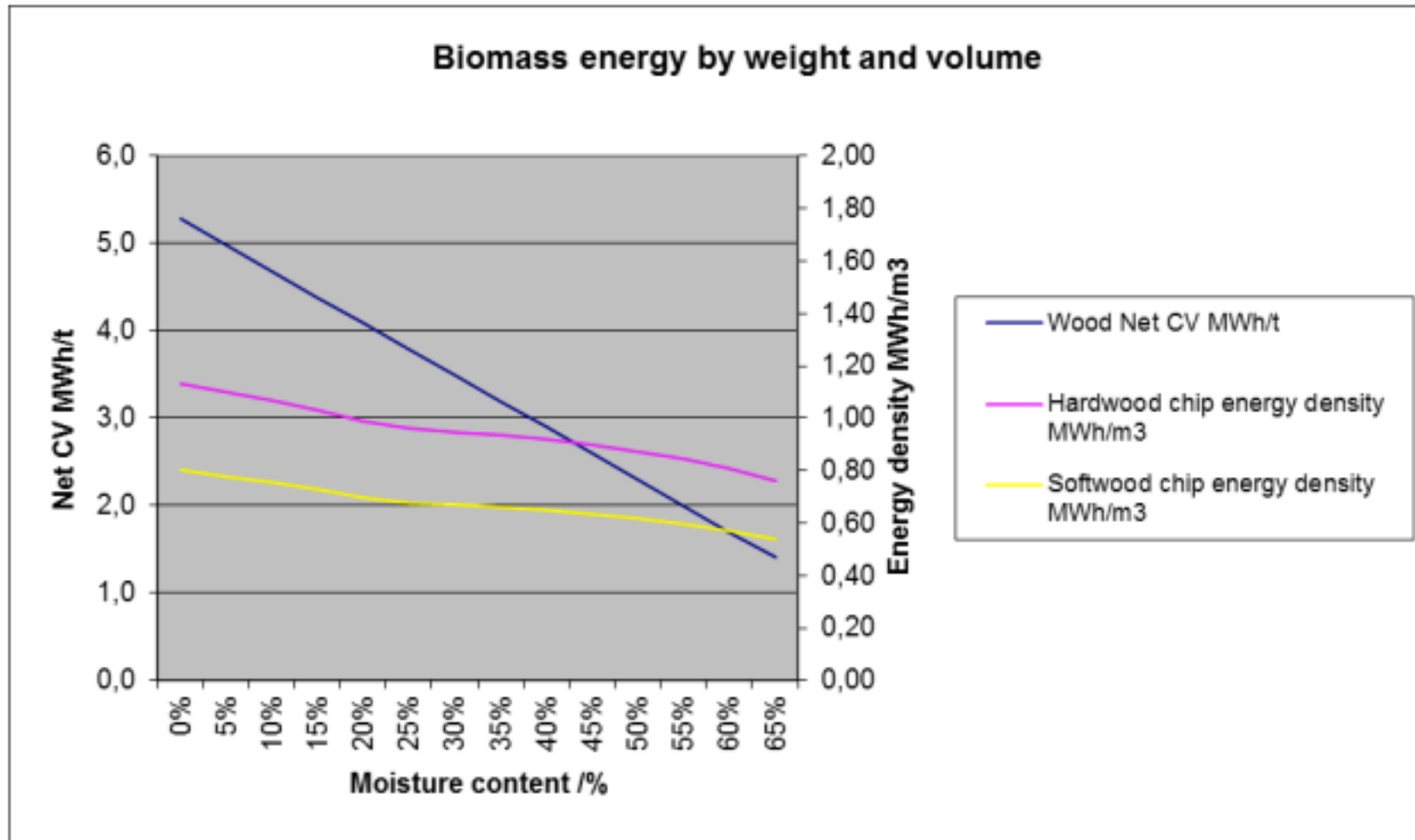


Figure 4: Energy and moisture content of biofuels (Biomass Energy Centre 2011)

Bioöljy

- Seos, jonka pääkomponentteja ovat hydroksyylialdehydit ja ketonit, sokerit, dehydrosokerit, karboksyylihapot ja eri fenoliyhdisteet.

Table 9: Temperature for chemical formation of compounds (Kantarelis et al. 2012)

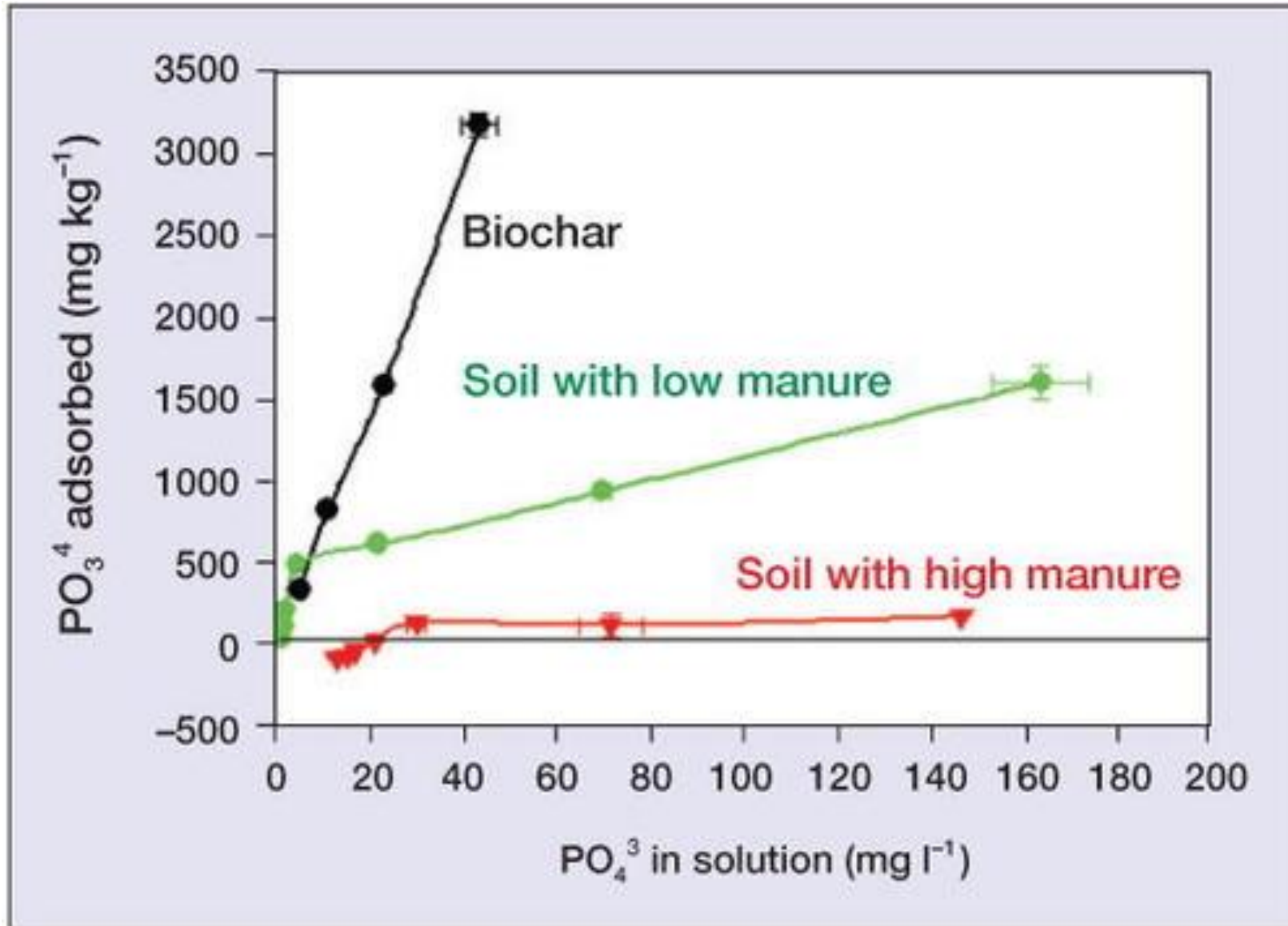
Mixed Oxygenates	Phenolic Ethers	Alkyl Ethers	Hetrocyclic Ethers	PAH	Larger PAH
400°C	500°C	600 °C	700 °C	800 °C	900 °C

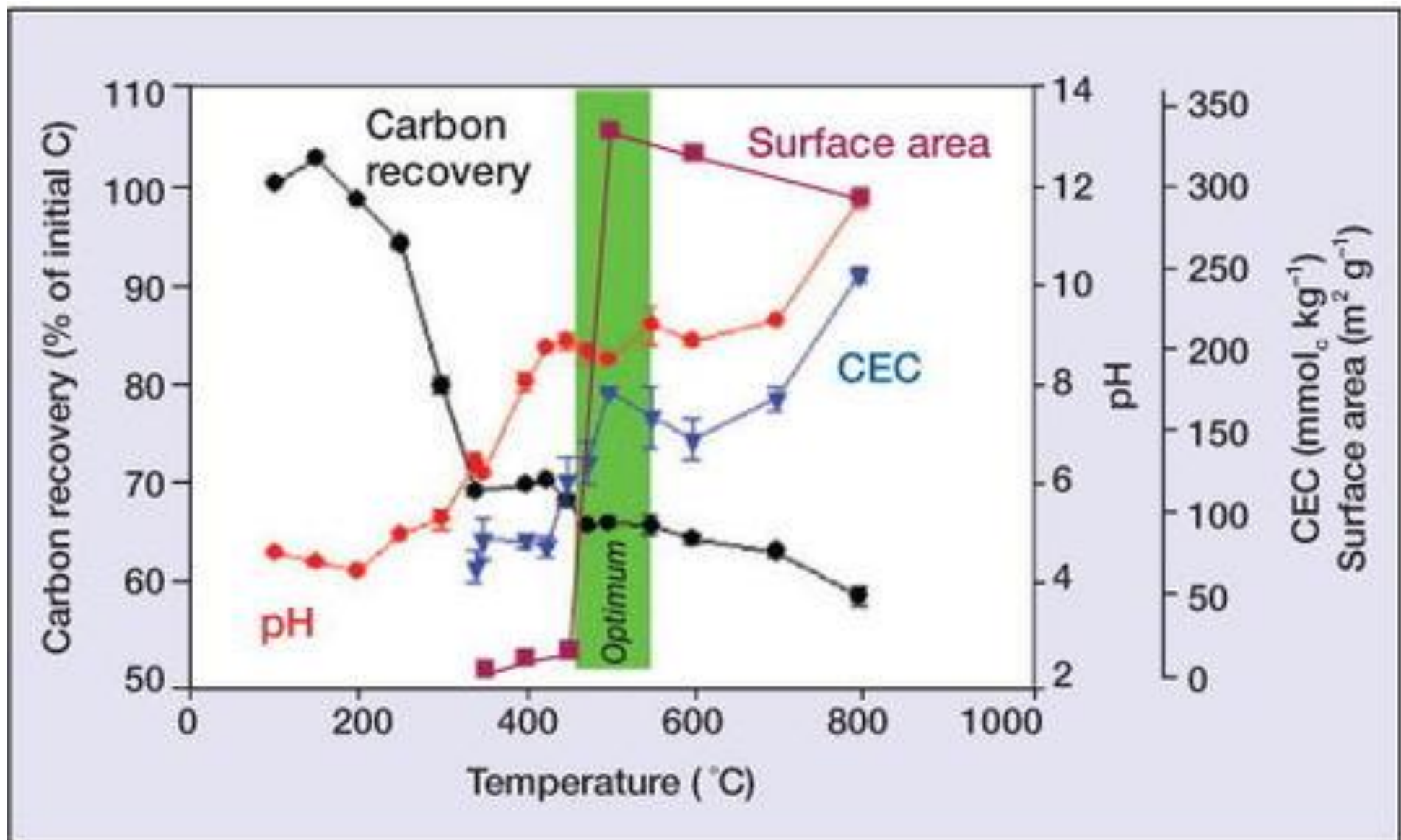
Table 10: Typical values of wood derived bio-oil (Bridgwater 2007)(Kantarelis et al. 2012)

Moisture content [wt %]	20-30
pH	2,5
Specific gravity	1,20
C [wt %]	56
H [wt %]	6,5
O [wt %]	37,5
N [wt %]	0,1
Ash [wt %]	0
LHV [MJ/kg]	13-18

Table 7: Characteristics in char from slow pyrolysis of silver birch (Fagernäs et al. 2012)

	A1	A2	B	C
Moisture content [wt%]	1,3	4,9	2,8	0,9
Ash content [wt% DM]	0,8	1,4	1,2	0,9
Volatile matter [wt% DM]	19,6	19,9	18,4	17,1
Fixed carbon [wt% DM]	79,6	78,7	80,6	81,9
Heating value, calorimetric [MJ/kg]	33,2	33,4	33,8	33,4
Heating value effective [MJ/kg]	32,5	32,6	33,1	32,3
Carbon [wt% DM]	87,1	86,4	87,2	88,0
Hydrogen [wt% DM]	3,3	3,3	3,3	2,9
Nitrogen [wt% DM]	0,3	0,1	0,2	0,2
Sulfur [wt% DM]	0,02	0,01	0,02	0,02
Oxygen [wt% DM]	9	9	8	8





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Table 12: Gas composition from slow pyrolysis of Beech wood chips (D'Alessandro et al. 2013)

Methane [vol %]	9,95
Hydrogen[vol %]	2,21
Carbon monoxide [vol %]	41,23
Carbon dioxide [vol %]	40,60
Nitrogen [vol %]	6,01
LHV [MJ/kg]	6,17

Table 14: Cost of slow pyrolysis and biochar applications (Shackley et al. 2011)

Stage in pyrolysis system	Cost of biochar [€/ ton]
Virgin Feedstock	76-347
Non-virgin Feedstock	0
Transport of feedstock	11-62
Capital cost of power plant	63-141
Operational costs	13-167
Storage of biochar	10-21
Transport of biochar	0-27
Application of biochar to soil	7



Process development status of fast pyrolysis technologies for the manufacture of renewable transport fuels from biomass

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Highlights

- Comprehensive review on current status of biomass fast pyrolysis into renewable fuels.
- Summary on the progress on semi-commercial conversion technologies.
- Detailed discussion of available technologies with focus on the commercial readiness of the thermal and catalytic pyrolysis.
- Key impediments in biomass conversion technologies at industrial scale.

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Slow pyrolysis in Brista

AN EVALUATION OF HEAT AND BIOCHAR PRODUCTION IN SWEDEN

ERIK JONSSON

Lappeenranta teknillinen yliopisto

Teknillinen tiedekunta

Energiatekniikan koulutusohjelma

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Bioöljy ja pyrolyysi

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- Käytetty kirjallisuus

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