

PRODUKSJON OG ANVENDELSER FOR BOKULL.

Kai Toven, RISE PFI

28 April 2021

RISE PFI AS



Focus areas at RISE PFI



Biorefining and bioenergy



Fibre technology and applications



Biocomposites



Nanocellulose and carbohydrate polymers

Outline

- Produksjon av biokull
 - Om pyrolyse
 - Laborieverktøy for å utvikle pyrolyseprosesser
- Anvendelser for biokarbon
 - Pågående initiativ
 - Effekt av råstoff
- utfordringer og muligheter



Pyrolysis technologies

Mode		Conditions	Liquid	Biocarbon	Gas
Fast pyrolysis	"Thermal Liquefaction"	~ 500°C, short vapor residence time ~ 1-2s	75 %	12 %	13 %
Intermediate pyrolysis	"Carbonisation" and "Thermal liquefaction"	~ 400°C, long vapor residence time ~ minutes to hours	45 %	30 %	25 %
Slow pyrolysis	"Carbonisation"	~ 400°C, long vapor residence time ~ hours to days	35 %	35 %	30 %
Gasification		~ 800°C	5 %	10 %	85 %

- Pyrolysis – Thermal processing of biomass in absence of oxygen

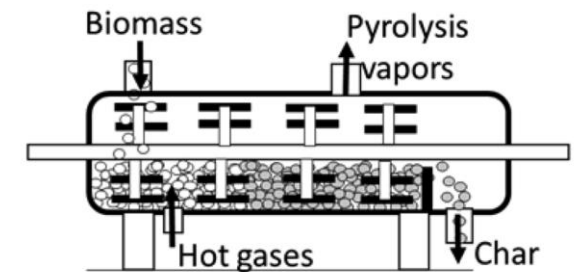
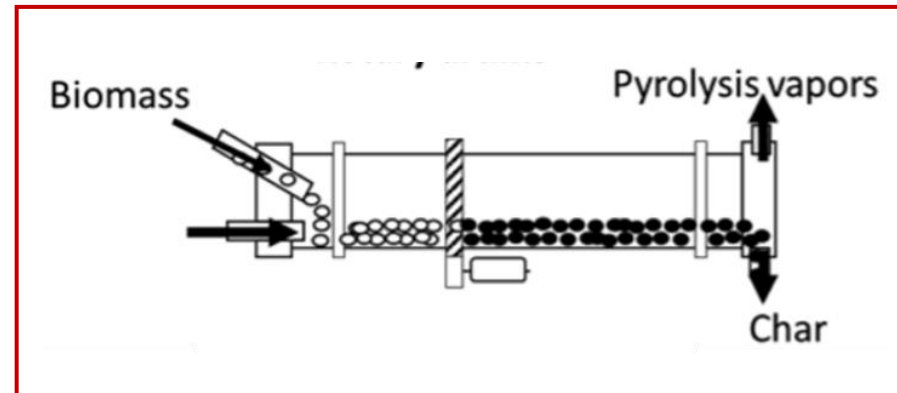
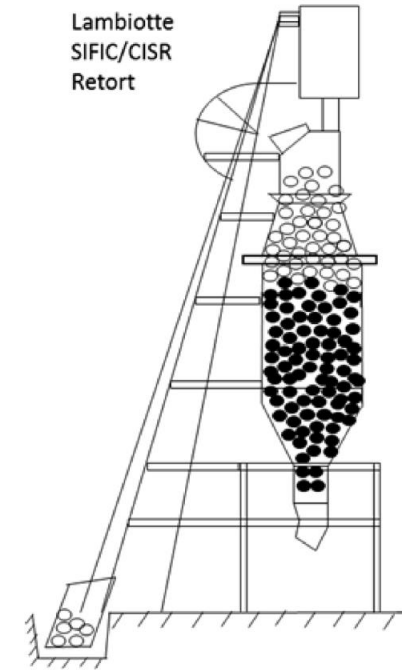
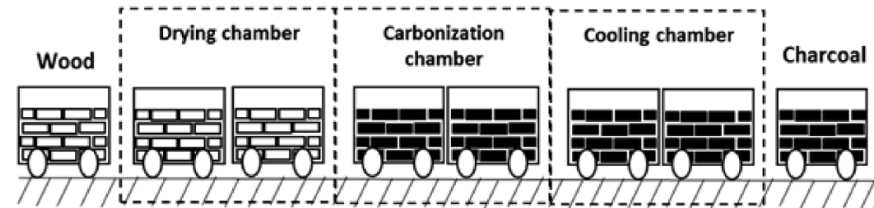
Pyrolysis technologies

Slow pyrolysis

- Industrial carbonisation process
- About 30-35% charcoal yield
- No utilisation of byproducts

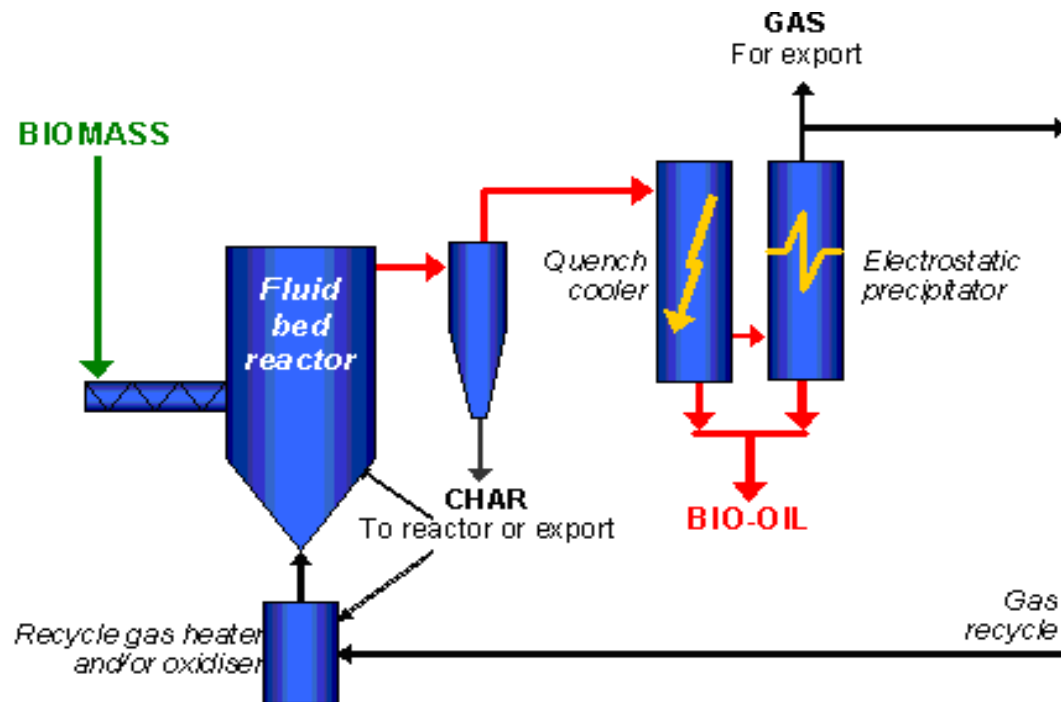
Intermediate pyrolysis

- Somewhat lower charcoal yield
- Utilize condensate byproduct



Pyrolysis technologies

Fast pyrolysis



*National Team Leaders for **IEA Bioenergy Task 34 – Pyrolysis** at the opening of **EMPYRO** in Hengelo Netherlands 20th May 2015.*

Pyrolysis technologies

IEA Bioenergy

Task 34

Direct Thermochemical Liquefaction

Task 34 Members: 2019-2021 Triennium



Axel Funke (Task 34 Leader)
 Karlsruhe Institute of Technology (KIT), Hermann-von-Helmholtz-Platz 1, D-76344 Eggenstein-Leopoldshafen, GERMANY
 Tel: +49 721 608 22391
 Email: axel.funke@kit.edu
 Web: www.kit.edu



Bert van de Beld
 BTG Biomass Technology Group bv, Josink Esweg 34, 7545 PN, the NETHERLANDS
 Tel: +31 53 486 1186
 Email: vandebeld@btgworld.com
 Web: www.btgworld.com



Linda Sandström
 RISE Energy Technology Center, Industrigatan 1, 941 38 Piteå, SWEDEN
 Tel: +46 10 516 911 23 23 85
 Email: linda.sandstrom@ri.se
 Web: www.ri.se



Christian Lindfors
 VTT Technical Research Centre of Finland Ltd, Ruukkimestarintie 2, 02330, Espoo, Finland
 T: +358 40 515 0429
 Email: christian.lindfors@vtt.fi
 Web: www.vtt.fi



Lasse Rosendahl
 Aalborg University Denmark, Department of Energy Technology Pontoppidanstræde 111, DK-9220 Aalborg
 T: (+45) 9940 9263
 Email: lar@et.aau.dk
 Web: http://www.et.aau.dk



Mr. Kai Toven
 Høgskoleringen 6B,
 NO-7491 Trondheim
 Phone: +47 952 11 704
 E-mail: kai.toven@rise-pfi.no
 Kai Toven



Benjamin Bronson
 CanmetENERGY, Natural Resources Canada, 1 Haanel Dr., Ottawa ON, K1A 1M1
 Tel: +1-613-797-3097
 Email: Benjamin.Bronson@Canada.ca
 Web: www.nrcan.gc.ca/energy/

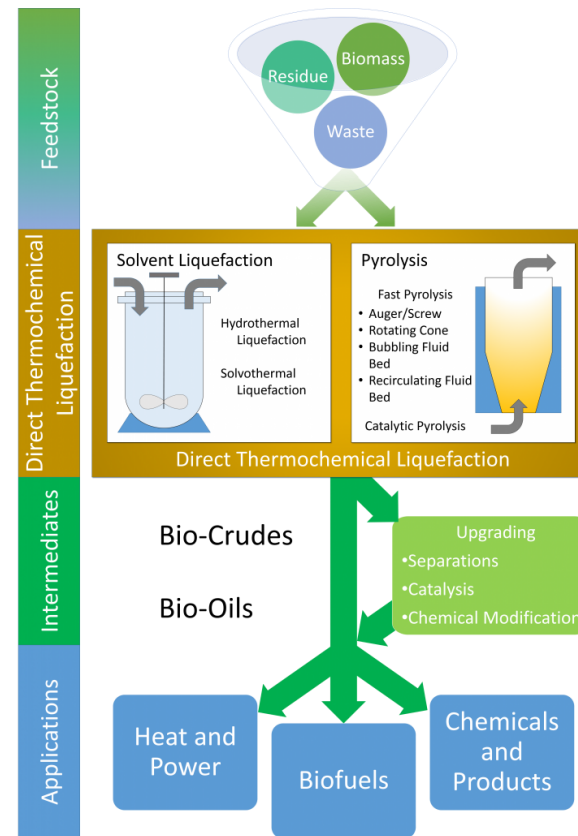


Justin Billing
 Pacific Northwest National Laboratory (PNNL), 902 Battelle Boulevard, PO Box 999, Richland, Washington, 99352 USA
 Tel: +1 509 375 5054
 Email: justin.billing@pnnl.gov
 Web: www.pnnl.gov



Paul Bennett

Scion, 49 Sala Street, Private Bag 3020, Rotorua 3046, NEW ZEALAND
 Tel: +64 7 343 5601
 Email: paul.bennett@scionresearch.com
 Web: www.scionresearch.com



RISE PFI – Tools

Tools for characterising biocarbon materials

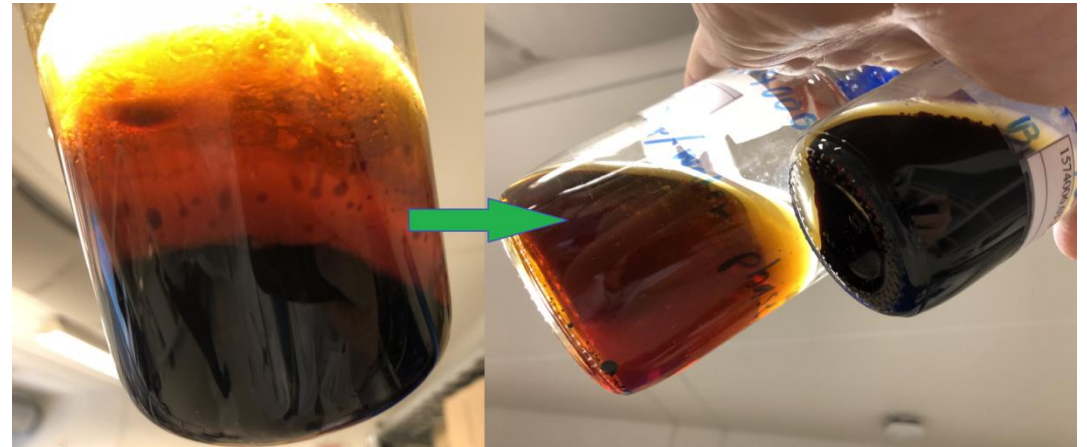
- Fuel properties
- Chemical characteristics
- Morphological characteristics
- Strength properties

Tools for characterising pyrolysis liquids

- Fuel properties
- Chemical characteristics
- Upgrading techniques

Pretreatment techniques

- Grinding
- Pelletizers and briquetting press
- Techniques for analysing strength properties of agglomerated materials



RISE PFI – Tools

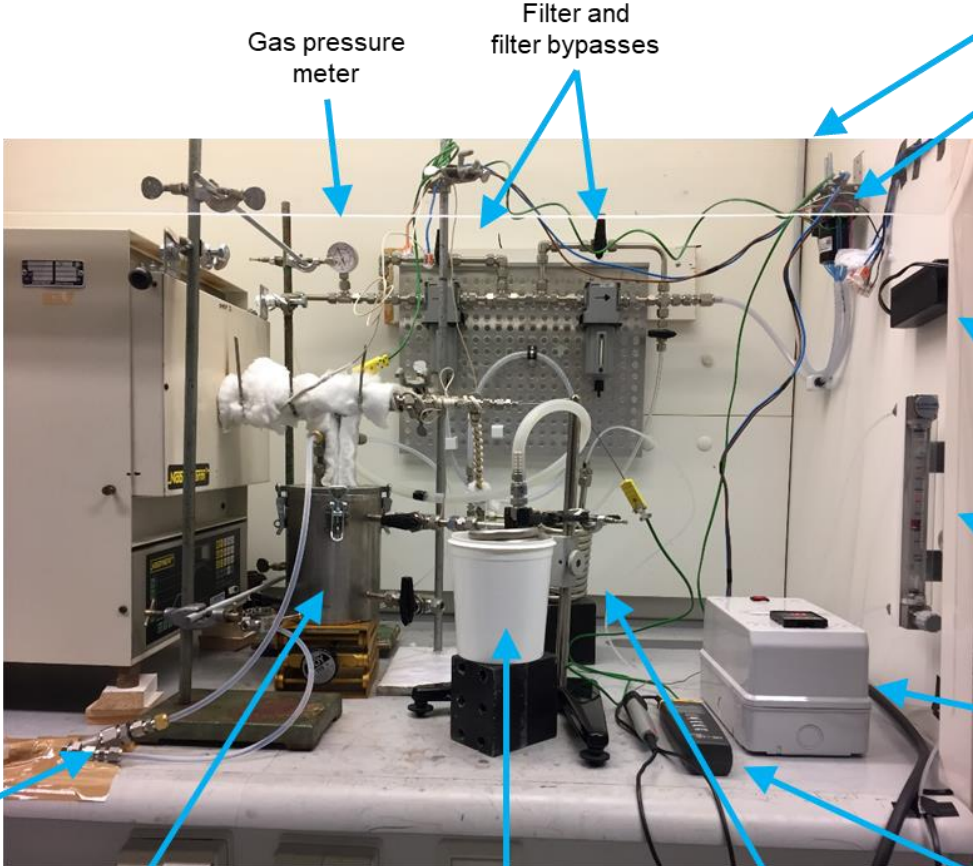
Bench scale

- Carbonisation reactors



Cooling water for the liquid collector (optional)

Liquid collector (with or without a copper cooling coil inside, with or without sample to be impregnated)



Gas pressure meter

Filter and filter bypasses

Gas exit

Gas pump

AC/DC converter (power source for the pump speed controller and the gas pump)

Gas flowmeter (N₂ inlet)

Gas pump speed controller (held in the wall, not shown)

Heater controller

Cooling coil (in a bucket with water)

Nitrogen heating coil

Thermocouple display (internal temperature box)

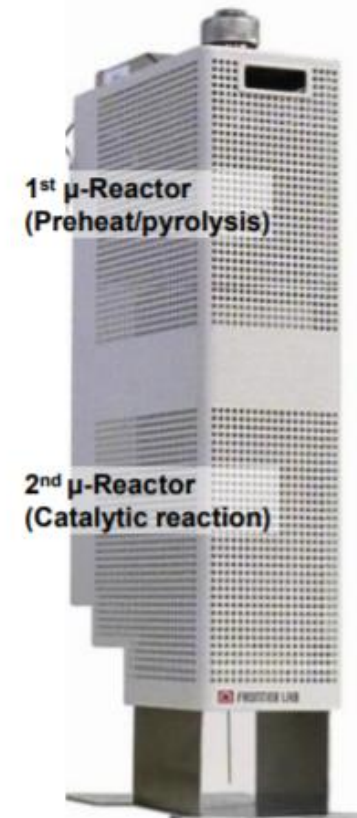
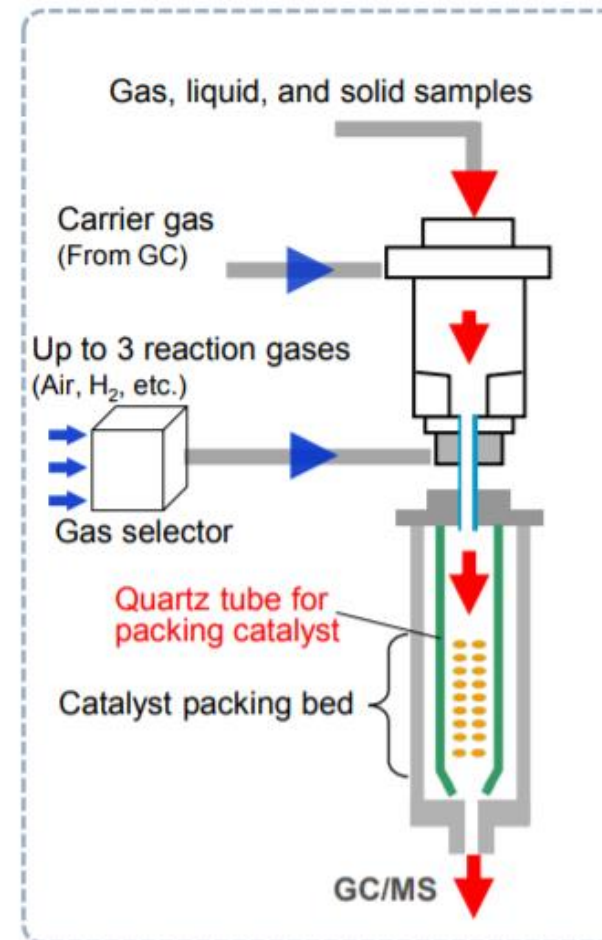
Pyrolysis Process Development Unit

- Fast pyrolysis with/without fractional condensation
- Carbonization by slow or intermediate pyrolysis with/without fractional condensation
- Catalytic fast pyrolysis
- Fast pyrolysis with direct catalytic vapour upgrading



Pyrolysis tandem reactor system with GC/MS detector

- Screening pyrolysis conditions
- Screening catalysts
- Raw material flexible reactor system



Outline

- Produksjon av biokull
 - Om pyrolyse
 - Effekt av råstoff
 - Laborieverktøy for å utvikle pyrolyseprosesser
- Anvendelser for biokarbon
 - Pågående initiativ
- utfordringer og muligheter



Biocarbon applications – Fornybart biobrensel

- Kalkholdig karbonisert biobrensel egnet for sintring av mangannalm (**BioSinter**)



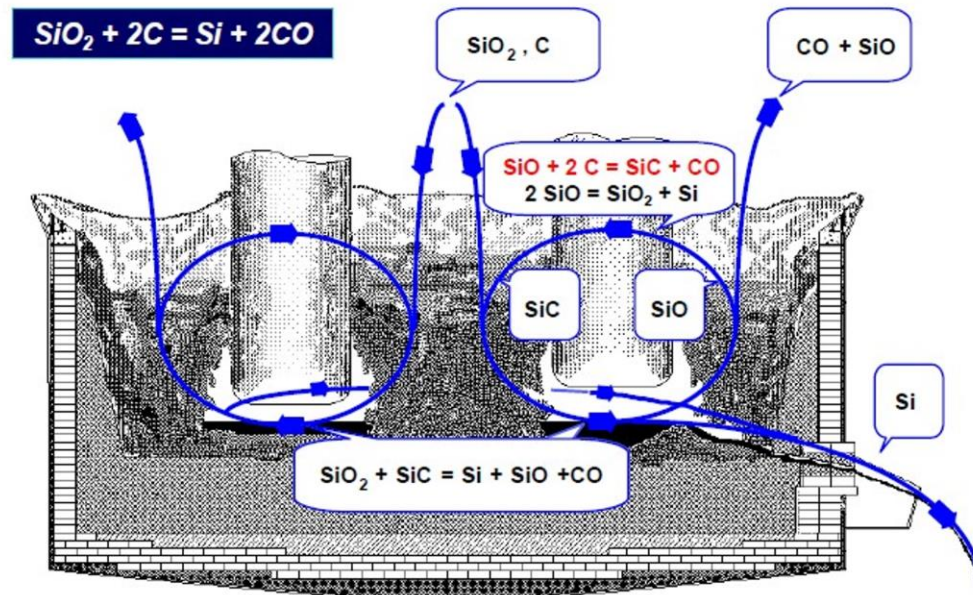
Biocarbon applications – Biokarbon som vekstmedium

- Bærekraftige jord og vekstmedier (**Decarbonize**)



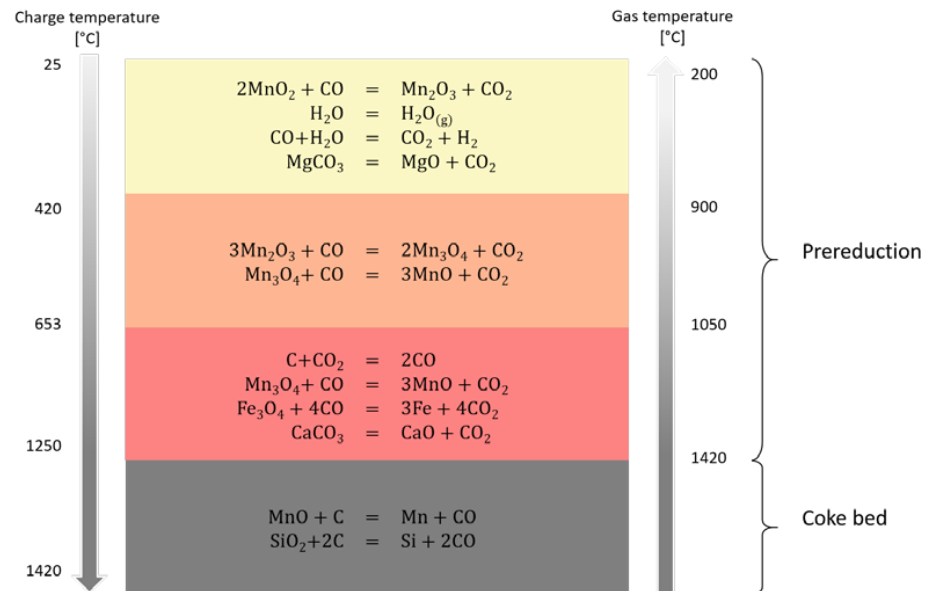
Biocarbon applications – Reduksjonsmiddel i metal produksjon

- Biobasert reduksjonsmateriale til produksjon av silisium
- Elkem har som mål at minst 40% av reduksjonsmiddelet skal være fornybart innen 2030 (PyrOpt / LiCoSi)



Biocarbon applications – Reduksjonsmiddel i metall produksjon

- Biobasert reduksjonsmateriale til produksjon av manganlegeringer
- Eramet har som mål å kutte klimagassutslipp med 43% innen 2030 (**PyroGass**)



Biocarbon applications – Oppgradering av kontaminert avfall

- Oppgradering av avfallstrevirke og katodeavfall fra aluminium produksjon basert på pyrolyse (**OPPY**)



Biocarbon applications – Nye applikajoner

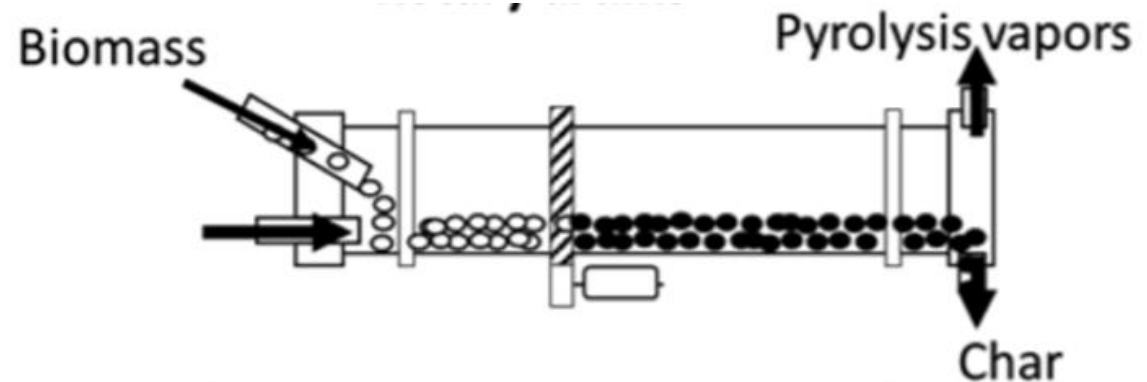
- Aktivert biokarbon
 - Luftrensing
 - Vannrensing
 - Aktive materialer
- Anodemateriale
 - Batterier
 - Elektroder
- OSV



Biocarbon production – Feedstock

Feedstock characteristics

- Moisture content
- Ash content / inorganics
- Nutrients
- Density
- Mechanical pretreatment / Agglomeration etc



Biocarbon production – Challenges and possibilities

Key challenges

- Profitability
- Product functionality

Potential in novel pyrolysis technology

- Very low carbon yields in commercial biocarbon production by slow pyrolysis
- Side product valorisation
- Logistics
- Integration advantages
- Speciality biocarbon products



© PFI



■ Spørsmål ?

kai.toven@rise-pfi.no

