

State of the art of HTL

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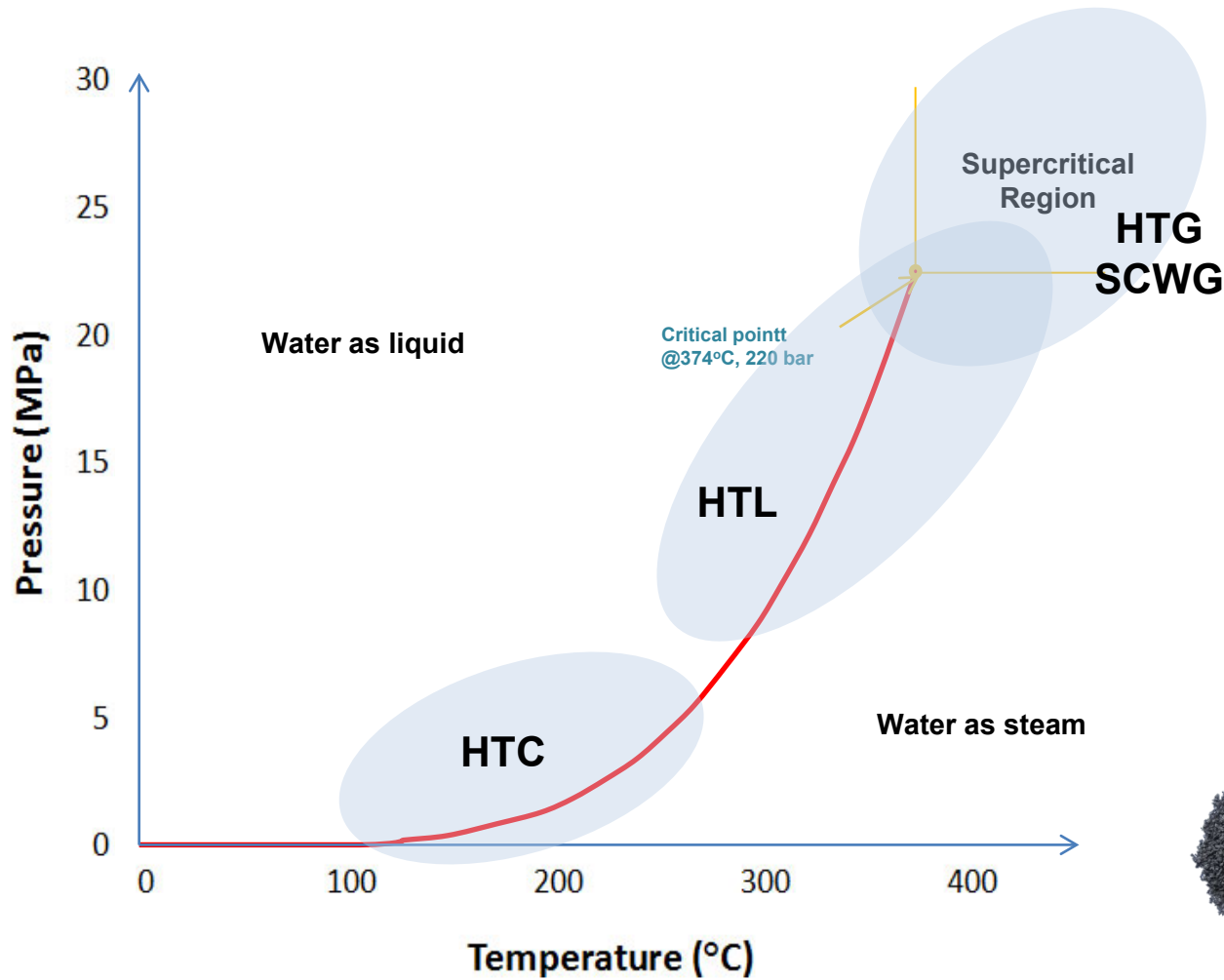
15TH MARCH 2022



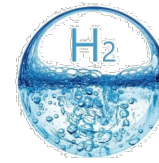
AALBORG UNIVERSITY
DENMARK

- HTL at a glance
- HTL and wastewater treatment
- Aqueous phase management and side streams
- Advances in HTL plants

Hydrothermal processes



Hydrothermal processes are conducted at conditions at which water is in its liquid or supercritical state



Hydrothermal gasification

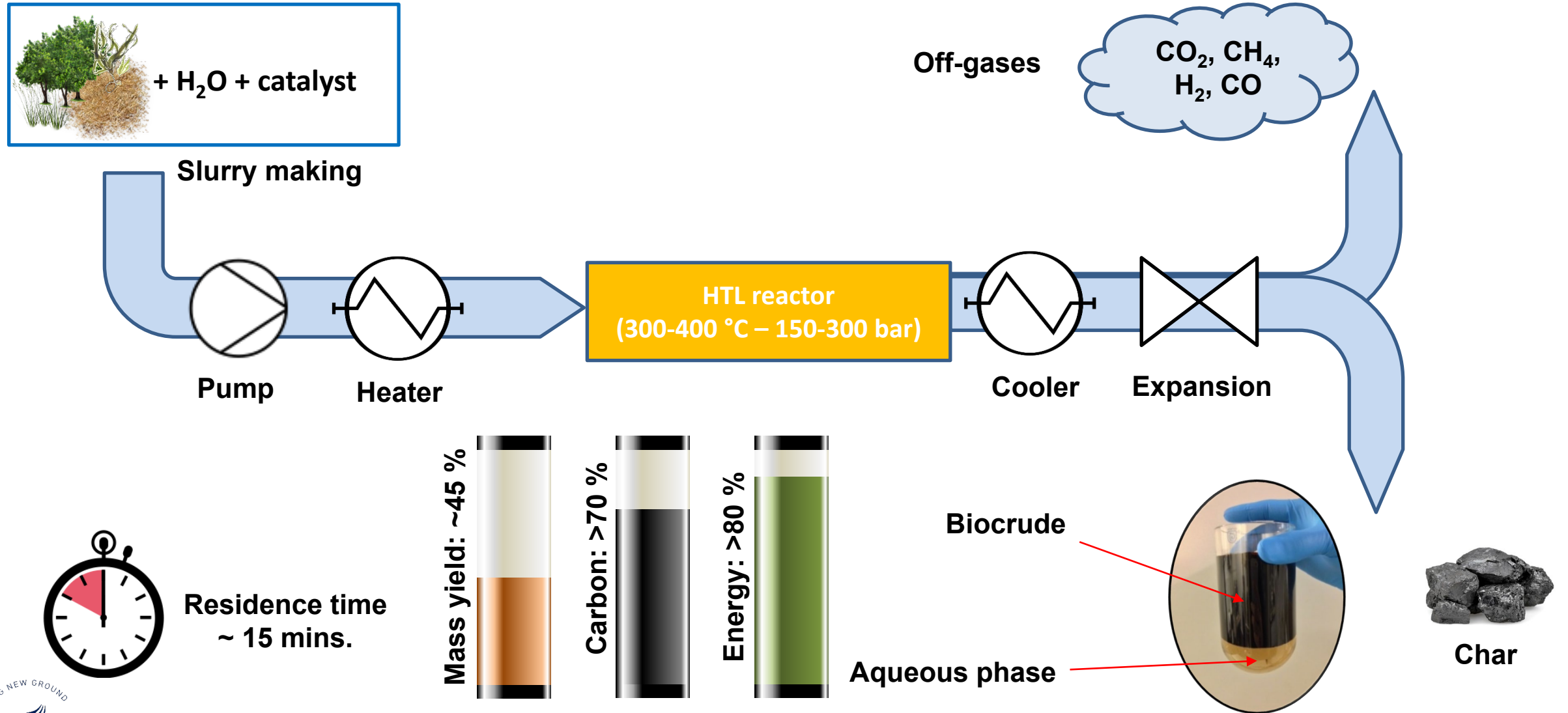


Hydrothermal liquefaction

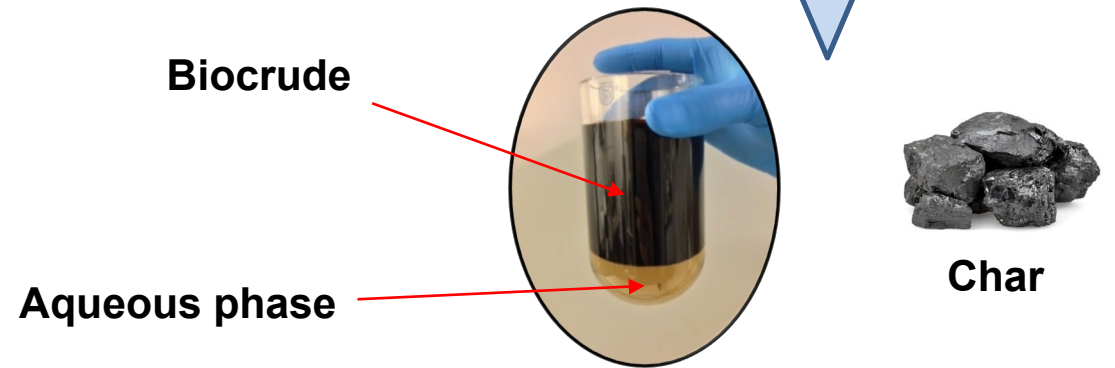
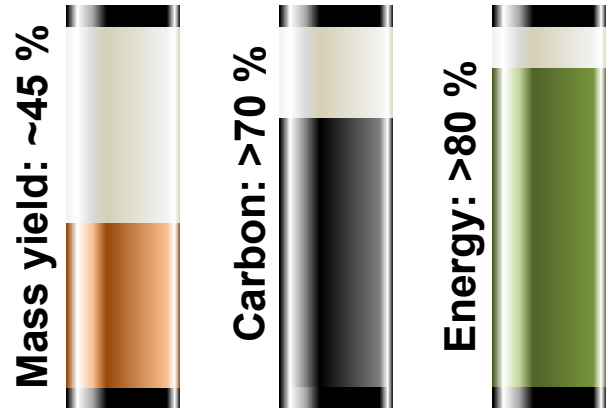


Hydrothermal carbonization

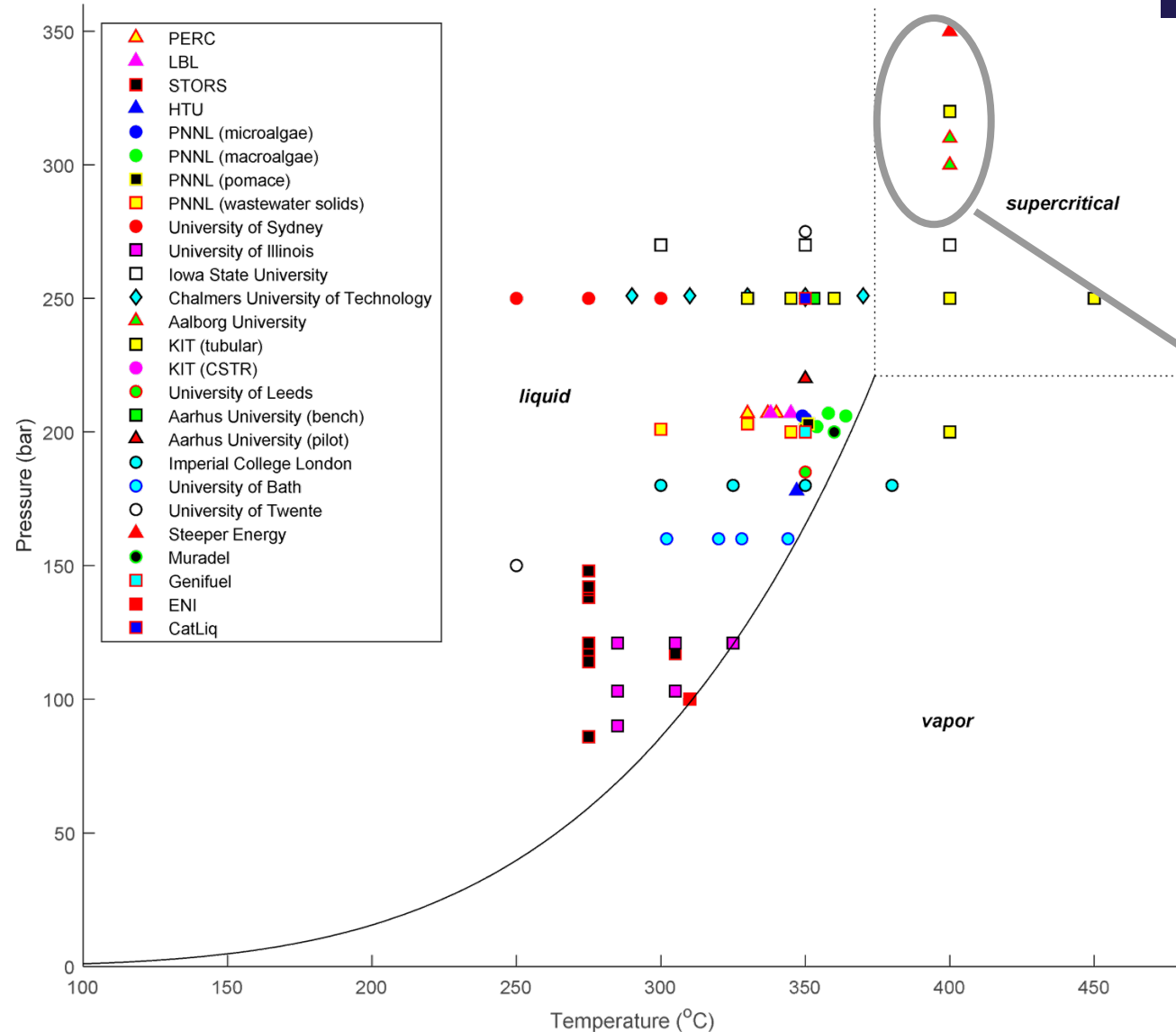
Hydrothermal liquefaction at a glance



Residence time
~ 15 mins.

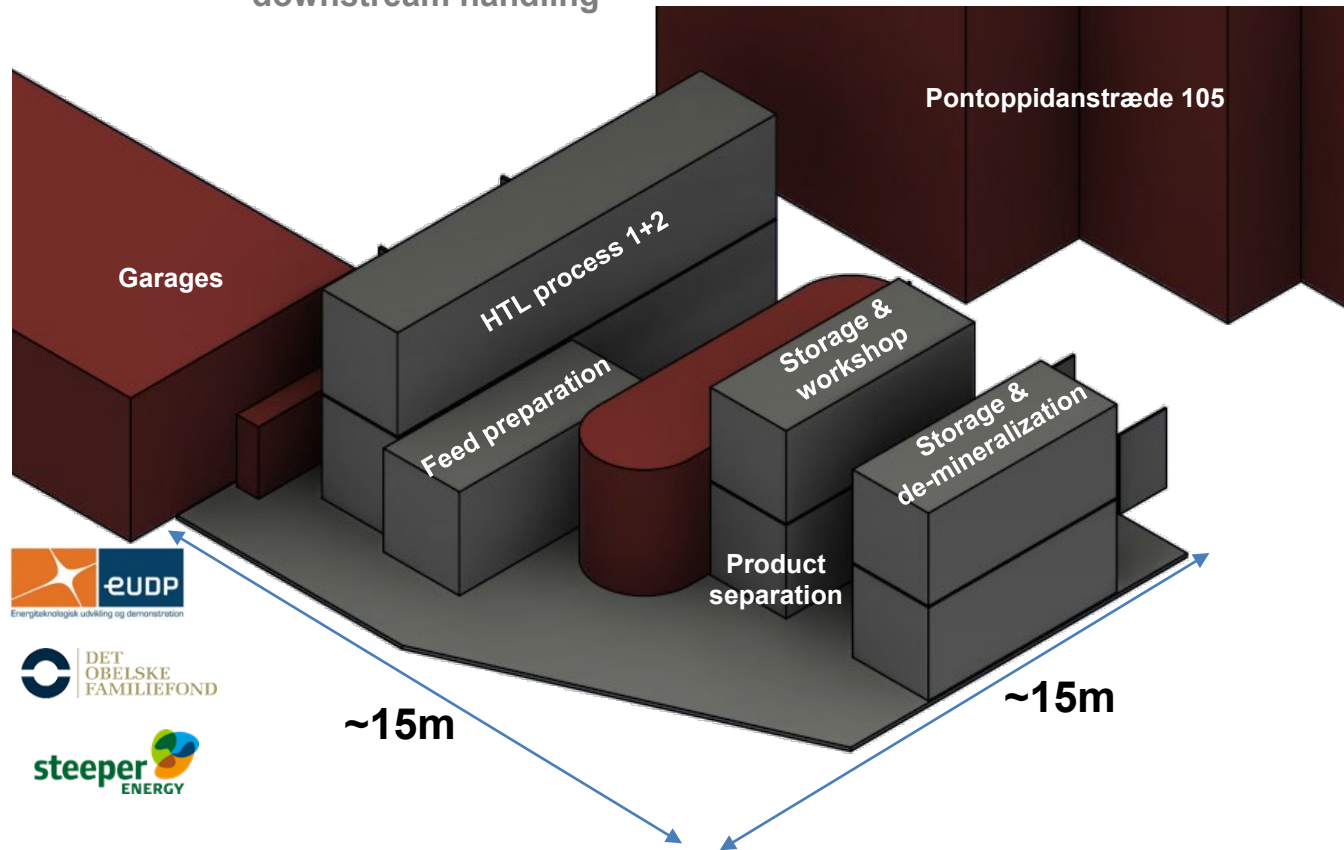


Different process conditions for HTL



CBS: the continuous pilot HTL plant at AAU

- Continuous Hydrothermal Liquefaction (HTL) facility (CBS-1)
- 25-50 kg/h feed, processing conditions up to 500 °C, 350 bar
- Oil production capacity: 1-5 kg/h (0.3 bpd)
- Designed in collaboration with and constructed by Steeper Energy
- Commissioned 2013, recommissioned 2018 with improved up- and downstream handling

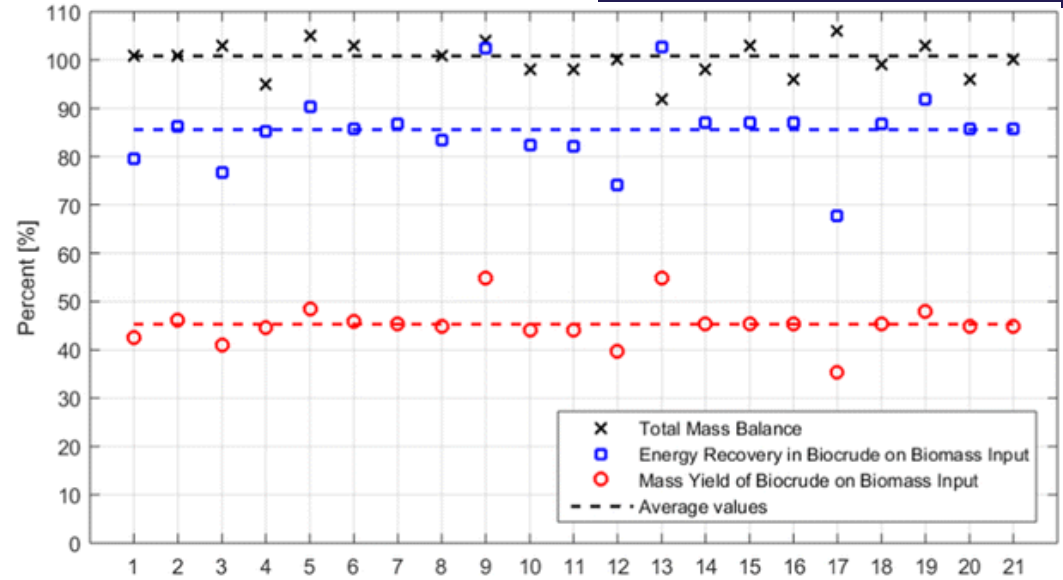


Typical HTL performance

		Feed (wood)	Oil	Off gas	Water ^a	Total out
Mass and energy balance						
Mass	wt. %	100	45.3	41.2	13.8	100.3
Energy	%	100	85.6	15.8	0	101.4
Elemental balance						
C	wt. %	100	73.7	26.2	0	99.9
O	wt. %	100	10.5	61.1	28.4	100.0
H	wt. %	100	63.8	25.4	25.1	114.3

Elemental balances reflect the distribution of feedstock elements in the products

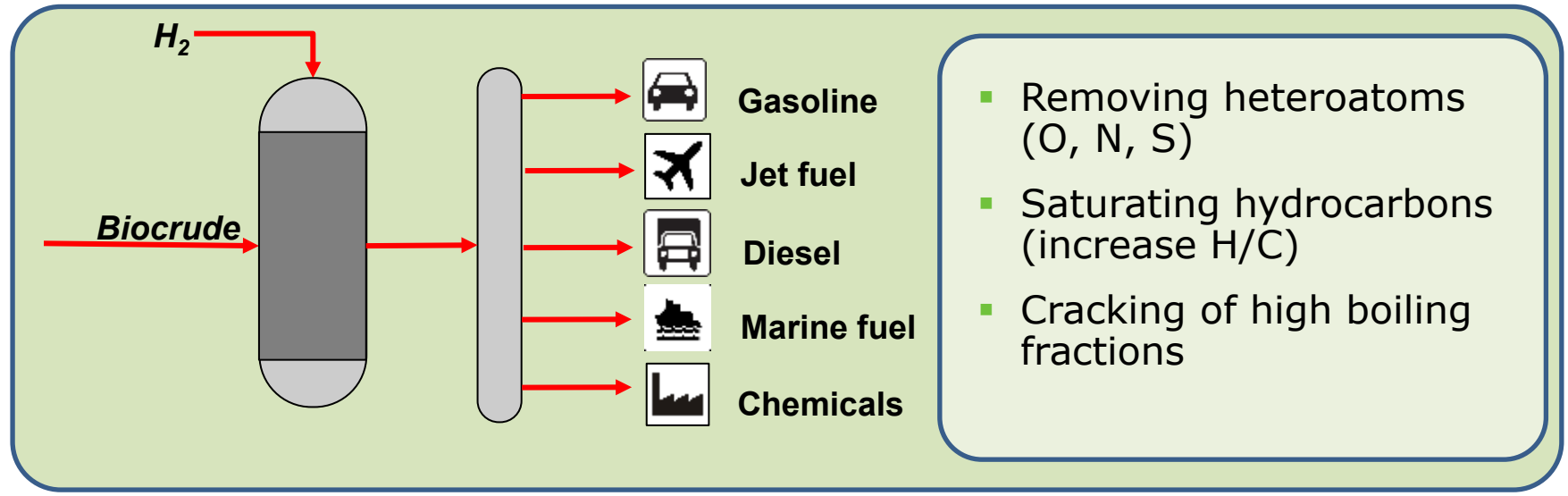
^a Determined based on 100% oxygen balance



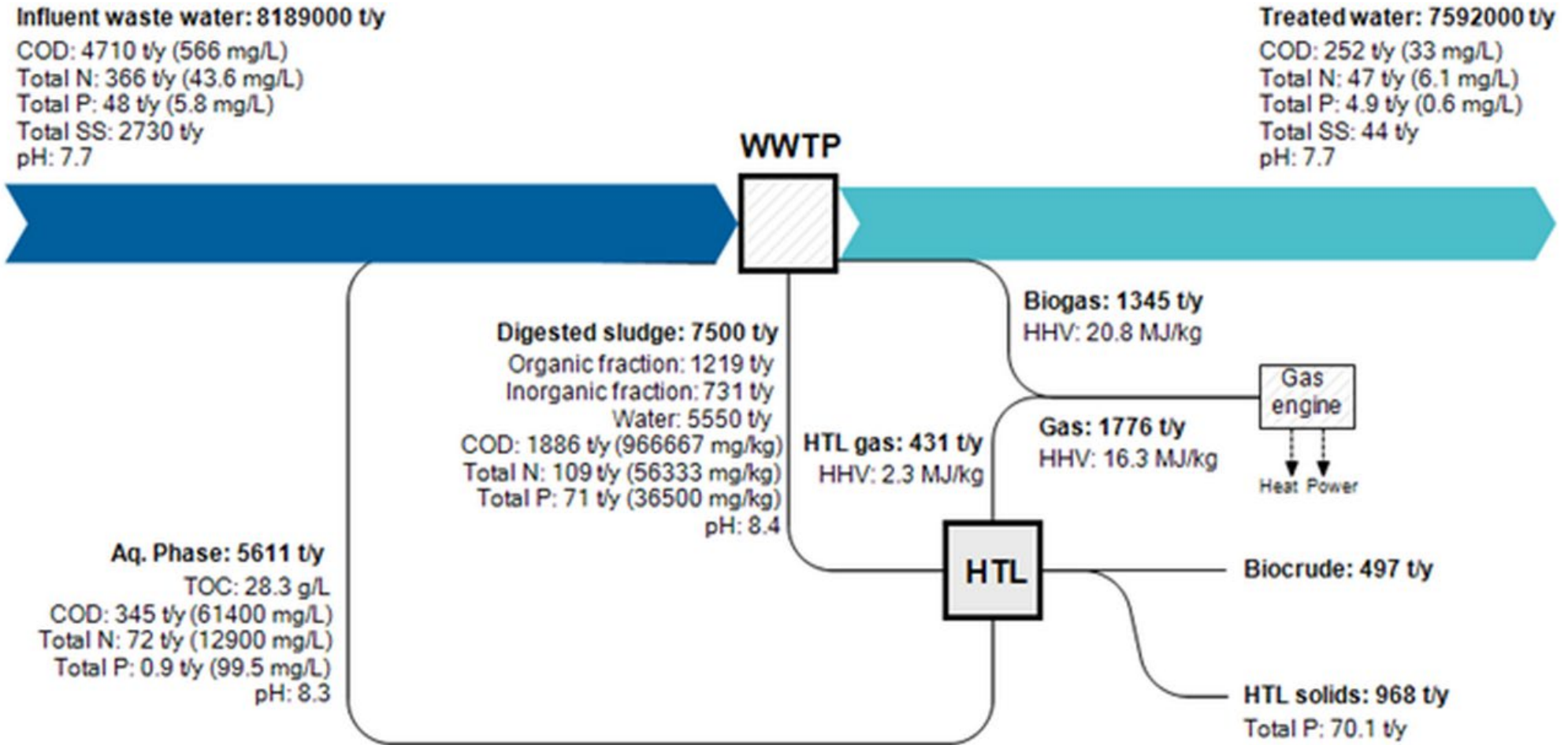
	Elemental composition (wt. %)					HHV (MJ/kg)
	C	H	N	S	O	
Wood	50.3	6.2	0.2	~0	43.3	20.2
Biocrude	81.4	8.7	0.095	0.01	9.8	38.6



Biocrude upgrading to fuels

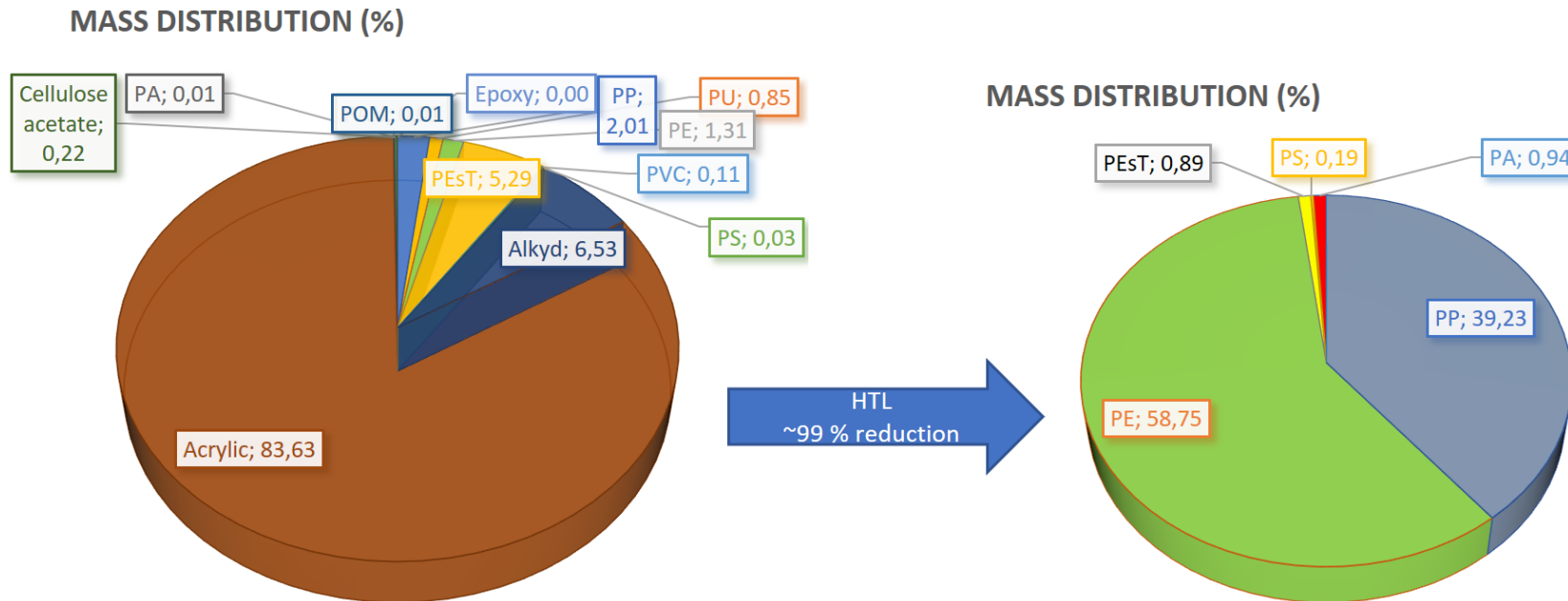


HTL and wastewater treatment



Removal of micropollutants

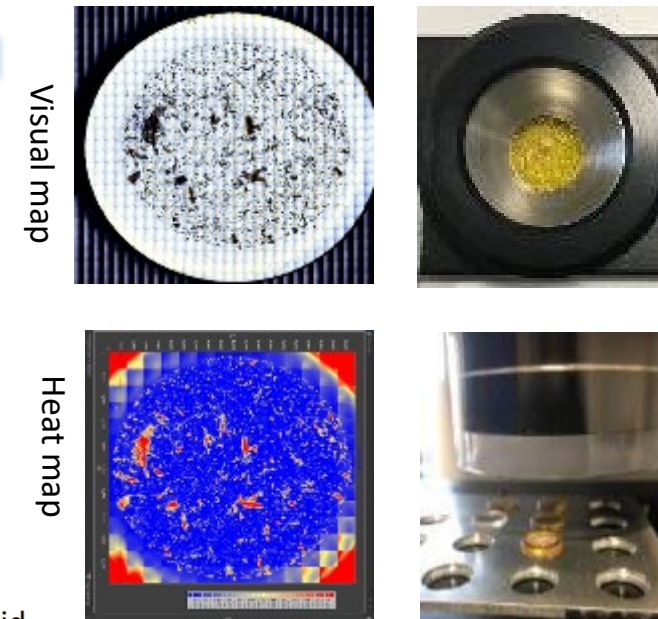
- Assay of common **pharmaceuticals** in urban waste shows **~100 % destruction**
- Detailed quantitative identification of **microplastics** shows **~99 % destruction**



Mass concentration = 0.82 g kg⁻¹ of wet sludge
 - Acrylic>Alkyd>PEsT>PP>PE>Others

Mass concentration = 0.0132 g kg⁻¹ of solid
 - PE>PP>Others

Spectral analysis by μFTIR

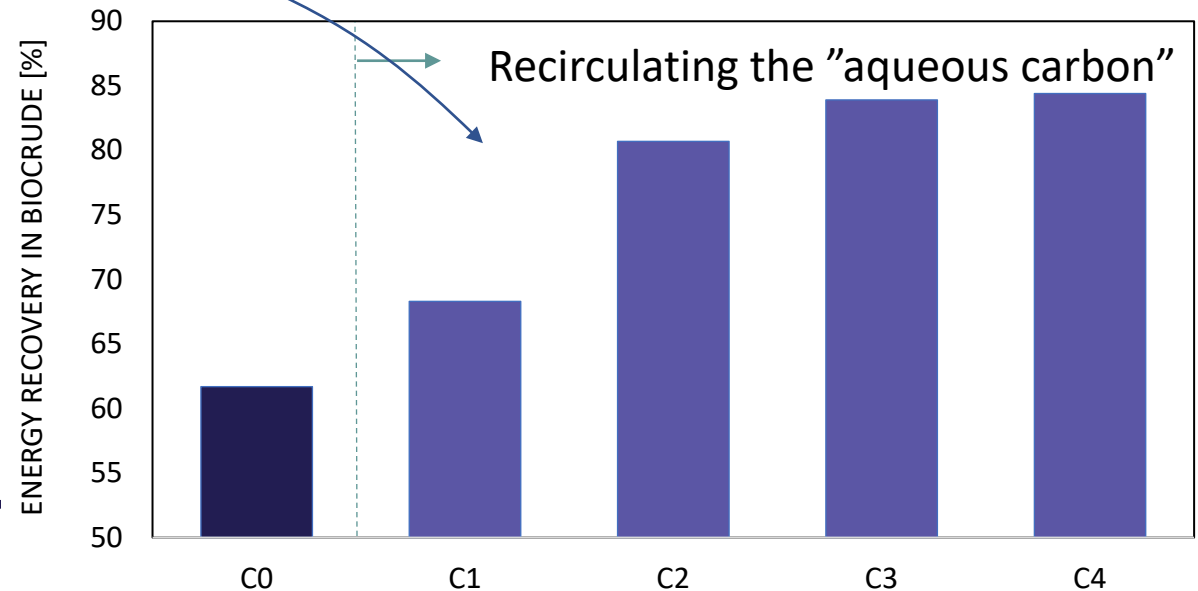
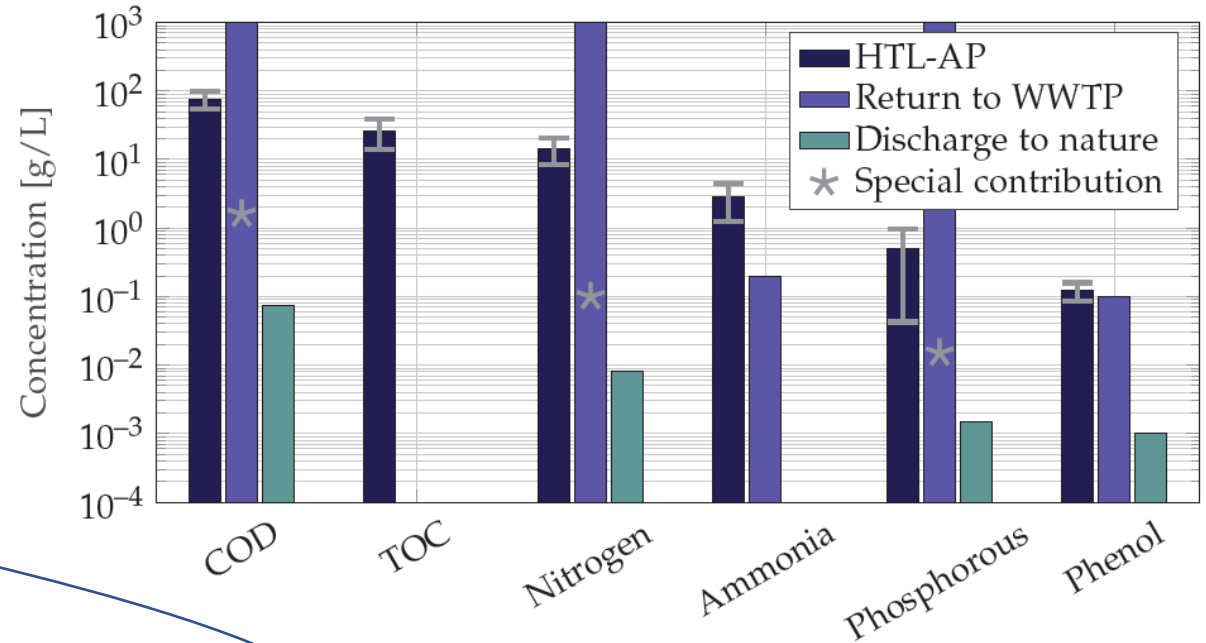


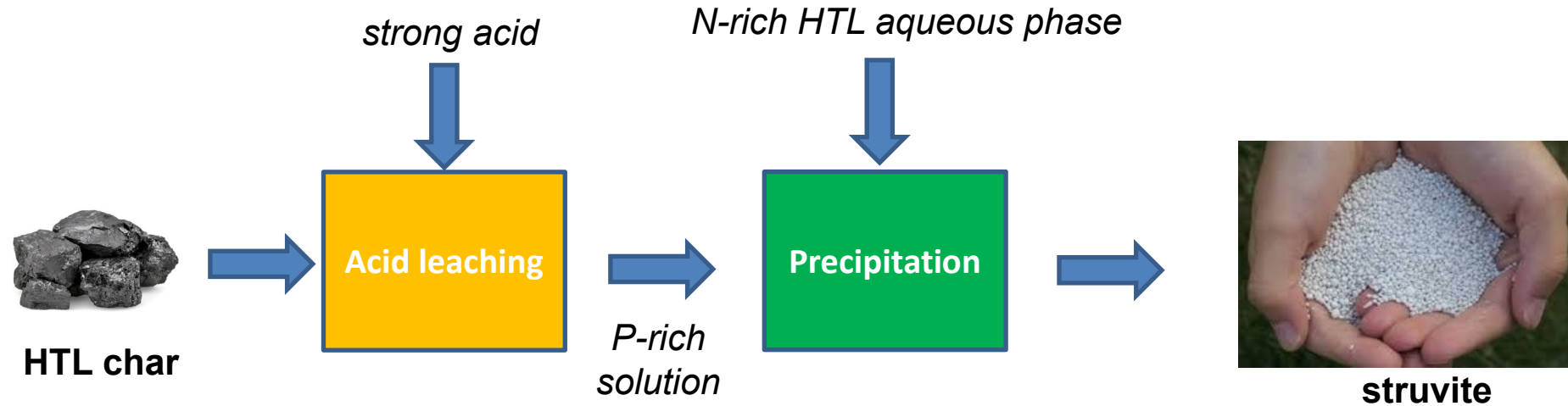
Managing the aqueous phase from the process

- HTL-AP cannot be directly discharged to nature or to WWTPs.
- Concentrating the AP by thermal distillation can both purify and increase process efficiency



- > 75 % carbon retained the concentrate.
- Other techniques under investigation.





- Many elements in the biomass end up concentrated in the solid phase
- Phosphorus is not abundant in Europe and its recovery is strategical
- From HTL char, phosphorus can be leached out with a strong acid and then precipitated using the N-rich HTL aqueous phase
- The final product is **struvite**, an appreciated fertilizer.

Contents

**Who:
MetroVancouver**

**Location:
Vancouver, BC, Canada**

**Capacity:
2 dry tons/day**

**Start up:
2020**



Oyler “Commercialization of Hydrothermal Processing”, *tcbiomassplus*, Chicago, October 7, 2019

Contents

Who:
Arbios Biotech
(JV CANFOR/Licella)

Location:
British Columbia, Canada

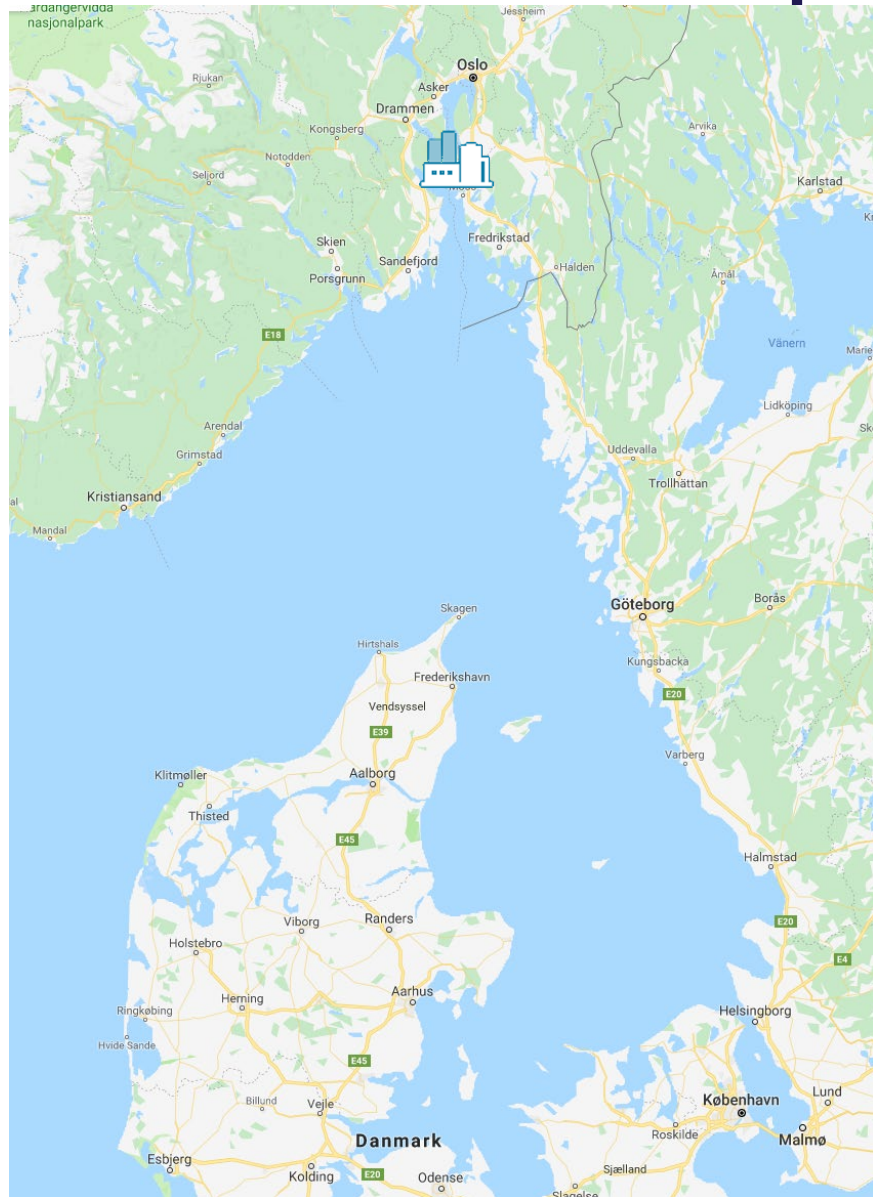
Capacity:
10,000 barrels/year

Start up:
2021



An aerial shot of Canfor's three pulp mills (clockwise from far top): the Northwood, Prince George, and Intercontinental mills.

First demonstration plant in Europe



Silva Green Fuel



Demo plant for
**2ND GENERATION
BIO FUEL**



Made from
**FOREST
FEEDSTOCK**




TOFTE
in Norway



Test period
2019 - 2020



OWNERSHIP
Statkraft 51%
Södra 49%



Can produce
4000 LITER
of bio fuel per day



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THANK YOU FOR YOUR ATTENTION!



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