



## Hydrothermal liquefaction of waste materials as the key technology for a circular economy of the chemical industry

### Hydrothermal Liquefaction

- Hydrothermal liquefaction is performed in hot compressed water
- Water is in liquid state due to high pressure (>180 bar)
- Primary product is a **bio-crude** with high energy density
- Bio-crude, like fossil crude is upgraded to drop in fuels (gasoline, diesel, kerosene, heavy fuel)



### AU HTL pilot reactor

- AU-ENG has the worlds' largest continuous HTL facility in operation at AU Foulum
- 100 L/h flow capacity at 350°C and 200 bar
- High heat recovery of >80%
- Energy ratio of ~10

### Bio-wastes and Plastics in the circular economy

- End of life plastics are usually mixed and dirty
- HTL offers a solution to effectively recycle plastics to a sustainable raw material for the chemical industry
- Partnership with Aarhus University Hospital (AUH) for HTL conversion of mixed end of life plastics and food waste
- Co-processing of biological and synthetic waste in the same plant offers flexibility for HTL plants
- Synergistic relations between feedstocks are being investigated.

Potential Feedstock in Europe	Potential (MtD/y)	Moisture content (%) typ	min	max
Cereal (wheat) straw	241	15	10	20
Manure cattle	157	-	-	-
Sugarbeet leaves	128	85	0	0
Biowaste unseparately collected	85	27	6	39
Maize stover	63	15	15	60
Miscanthus	62	40	24	46
Microalgae	49	-	-	-
Sunflower straw	34	20	10	70
Poultry manure	27	-	-	-
Biowaste separately collected	23	56	10	80
Oil seed rape straw	21	15	10	20
Sewage Sludge	10	-	-	-
Pig manure	8	-	-	-
Residues from olives tree plantations	7	32	20	45
Residues from fruit tree plantations	6	40	30	50
Rice straw	4	15	10	20
Residues from vineyards	4	35	25	50
Residues from citrus tree plantations	1	35	30	50

### Feedstock



Unseparated plastic waste from AUH



Manure

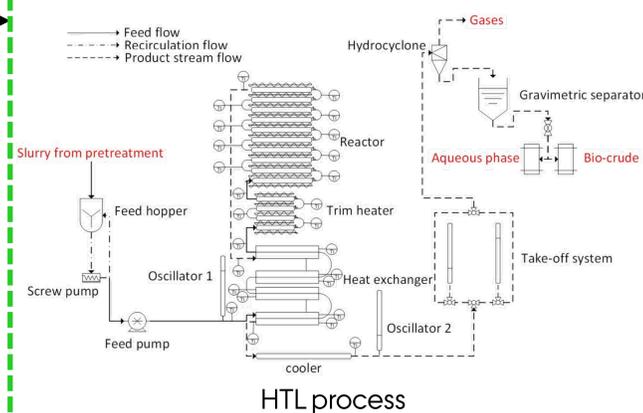


Different organic wastes

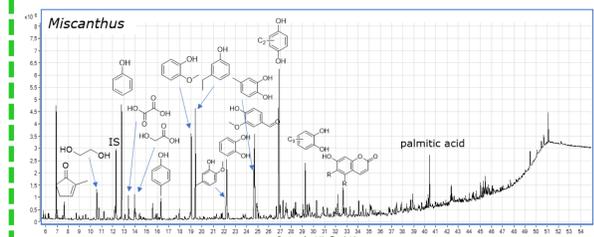
### Pre-treatment and HTL (350 °C / 200 bar)



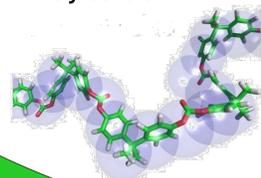
Extrusion and milling



### Biocrude



Sustainable chemicals for society and nutrients for agriculture



Phosphate recovery unit at the HTL pilot plant



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