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Sanchez, Eliana Maria Lozano; Pedersen, Thomas Helmer; Rosendahl, Lasse

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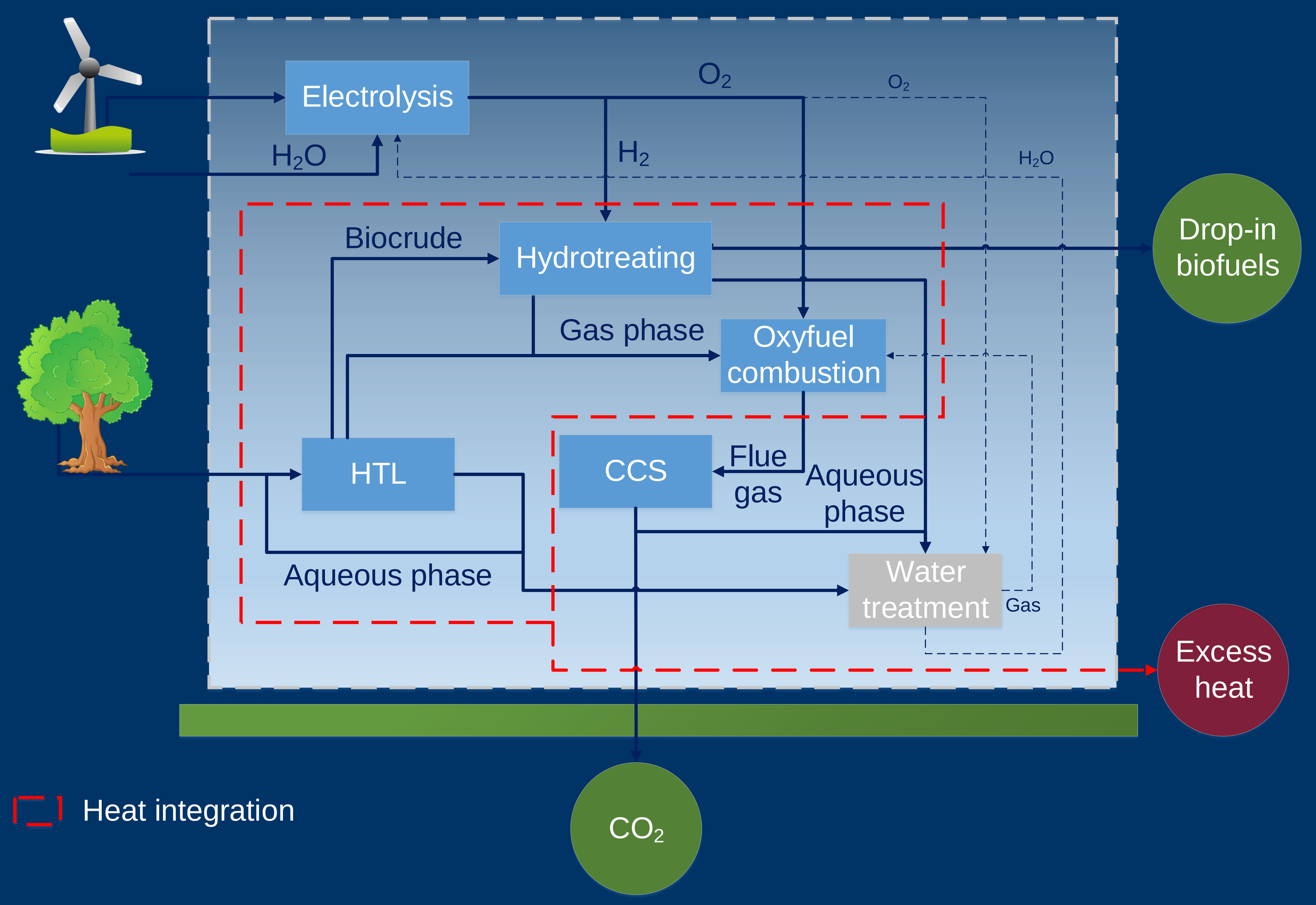
Modelling of the integration of HTL with CCS for the production of drop-in biofuels

Eliana Lozano*, Thomas H. Pedersen, Lasse Rosendahl
Department of Energy Technology, Aalborg University
*els@et.aau.dk

BREAKING NEW GROUND
AALBORG UNIVERSITY

PURPOSE AND MOTIVATION:

- Modeling of combined production of drop-in biofuels through hydrothermal liquefaction (HTL) of forestry residues with carbon capture and permanent underground storage (CCS) to provide net removal of CO_2 from the atmosphere.
- Assessment of the energy requirements and excess heat production for district heating application.
- Base study for further analysis on biofuel production via HTL as sink of renewable electricity fluctuations.



METHODS AND ASSUMPTIONS:

Assumptions:

- Steady state operation: Recirculation of aqueous phase in HTL avoids use of fresh water.
- Hydrogen produced in stoichiometric quantity for hydrotreating step.
- Solids/coke production is not considered.

The process was modeled in the software Aspen Plus ®.

	Approach	Description	References
HTL reactor	Ryield	Thermodynamic approach based on improved biomass and biocrude models from experimental data	[1*]
Hydrotreater	User model	Thermodynamic approach based on experimental carbon yields. HBO modeled with petro-characterization tools in Aspen Plus®	[2]
Electrolyzer	User model	Available model in literature	[3]
Adsorption unit	User model	Available model in literature	[4]
Oxufyel	Rstoic	Mass and energy balance based on stoichiometry of combustion reactions	--

[1] Lozano, E, Pedersen, T.H, Rosendahl. (2019). Generic approach for the modeling of liquefied thermochemical products and biomass heat of formation. Case study: HTL biocrude, Pyrolysis oil and assessment of energy requirements. Applied Energy. (*In review process*)
[2] Jensen, C. (2018). PIUS - Hydrofaction(TM) Platform with Integrated Upgrading Step. Aalborg Universitetsforlag.
[3] Shen, et al. (2011). A concise model for evaluating water electrolysis. International Journal of hydrogen energy, 36, 14335- 4341.
[4] Ferreira, et al. (2011) Effective adsorption equilibrium isotherms and breakthroughs of water and CO_2 on different adsorbents. Ind. Eng. Chem. Res, 50, 10201–10210.

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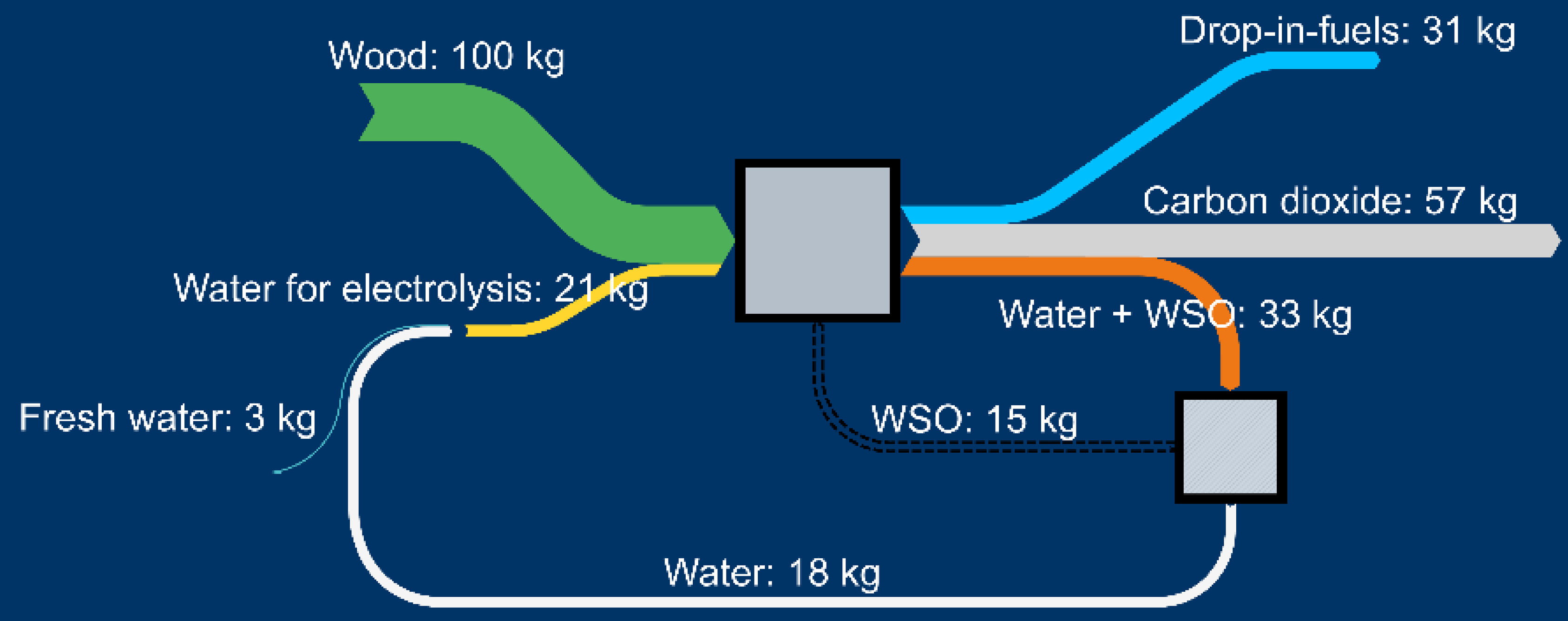
ENSYSTRA

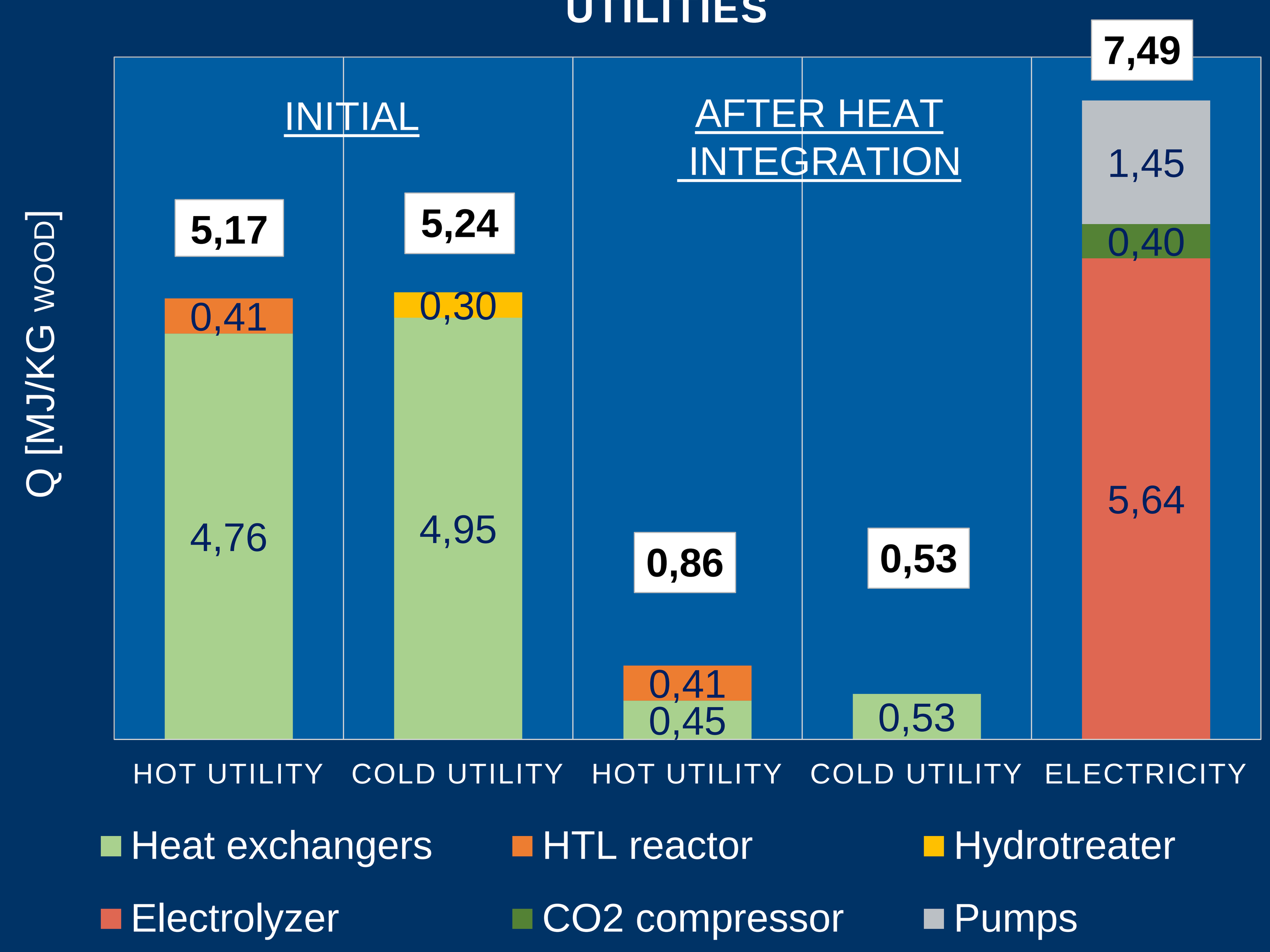
EUBCE 2019
27th EUROPEAN BIOMASS CONFERENCE & EXHIBITION

RESULTS:

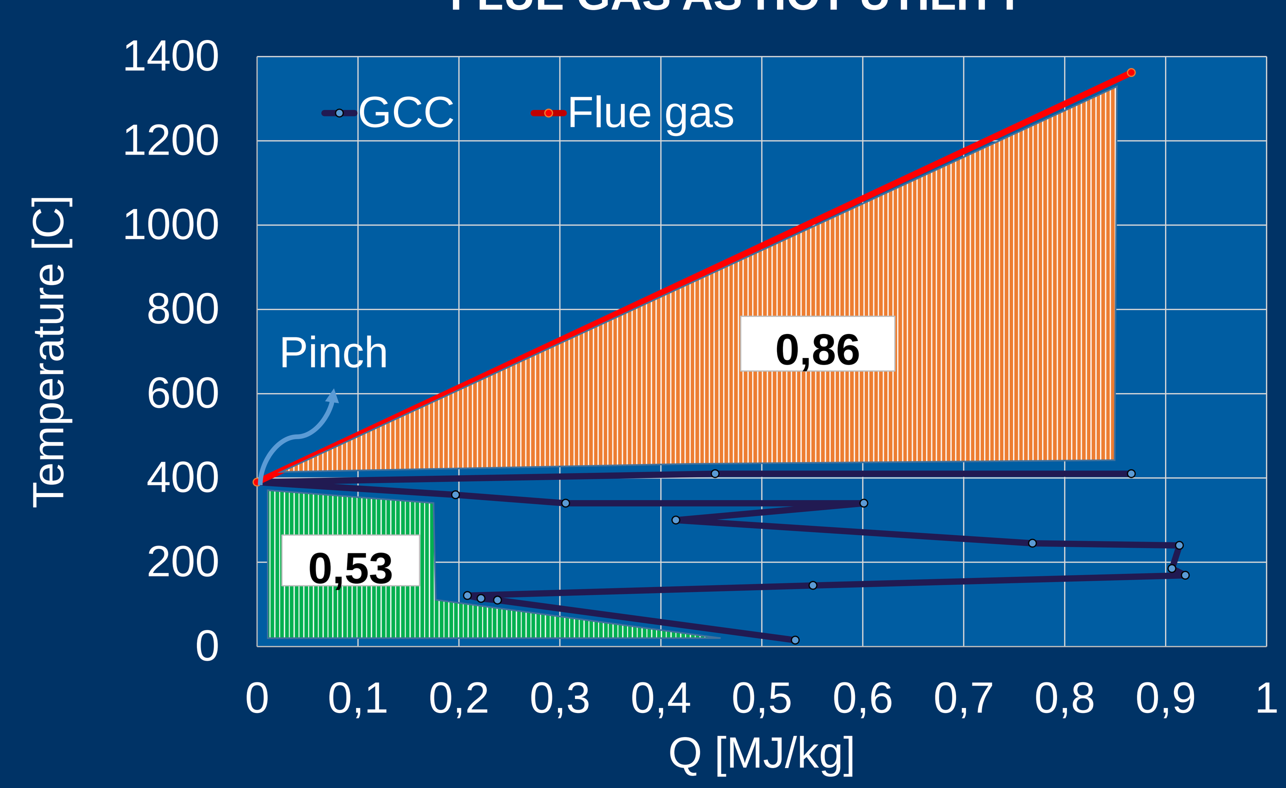
MASS BALANCE

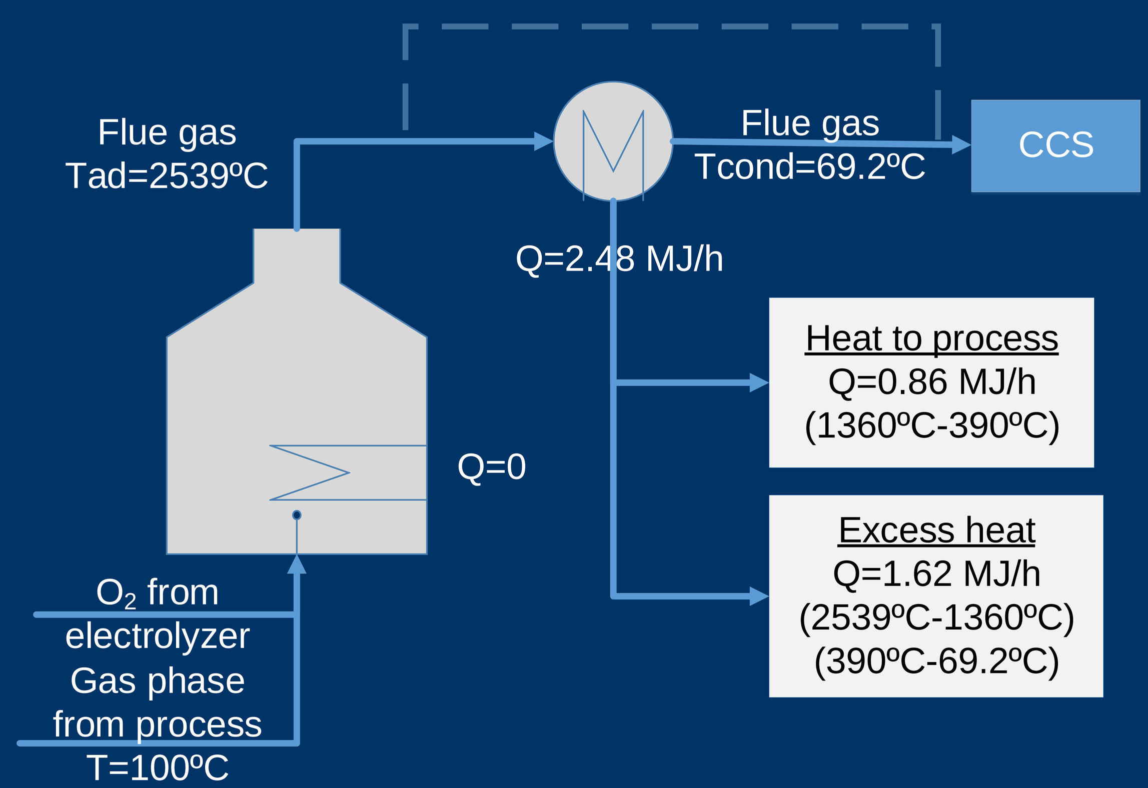


UTILITIES



FLUE GAS AS HOT UTILITY





CONCLUSIONS:

- More reliable estimation of the heat requirement in the HTL reactor allows a better assessment of the heat integration in the process.
- From the total carbon fed to the process, approximately 54% ends in the drop-in biofuels while 32% is captured for permanent underground storage. The recovery of the remaining carbon in aqueous phase/solid residue will be further analyzed together with water recovery and reuse.
- A reduction of 83% and 90% in hot utility and cold utility respectively were obtained through heat integration.
- The use of flue gas in the process allows to cover the hot utility demand with excess heat production for possible district heating use.