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Seehar, Tahir Hussain; Conti, Federica; Shah, Ayaz Ali; Toor, Saqib; Pedersen, Thomas Helmer; Rosendahl, Lasse

Publication date:
2019

Document Version
Publisher's PDF, also known as Version of record

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Citation for published version (APA):

Seehar, T. H., Conti, F., Shah, A. A., Toor, S., Pedersen, T. H., & Rosendahl, L. (2019). *Techno-Economic feasibility of producing renewable fuels from sewage sludge through hydrothermal liquefaction..* Poster presented at 27th European Biomass Conference and Exhibition (EUBCE 2019), Lisbon, Portugal.

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Techno-Economic feasibility of producing renewable fuels from sewage sludge through Hydrothermal Liquefaction

Tahir H. Seehar, Federica Conti, Ayaz A. Shah, Saqib S. Toor, Thomas H. Pedersen, Lasse A. Rosendahl

Department of Energy Technology, Aalborg University, Aalborg, 9220, Denmark
Corresponding author. E-mail: ths@et.aau.dk

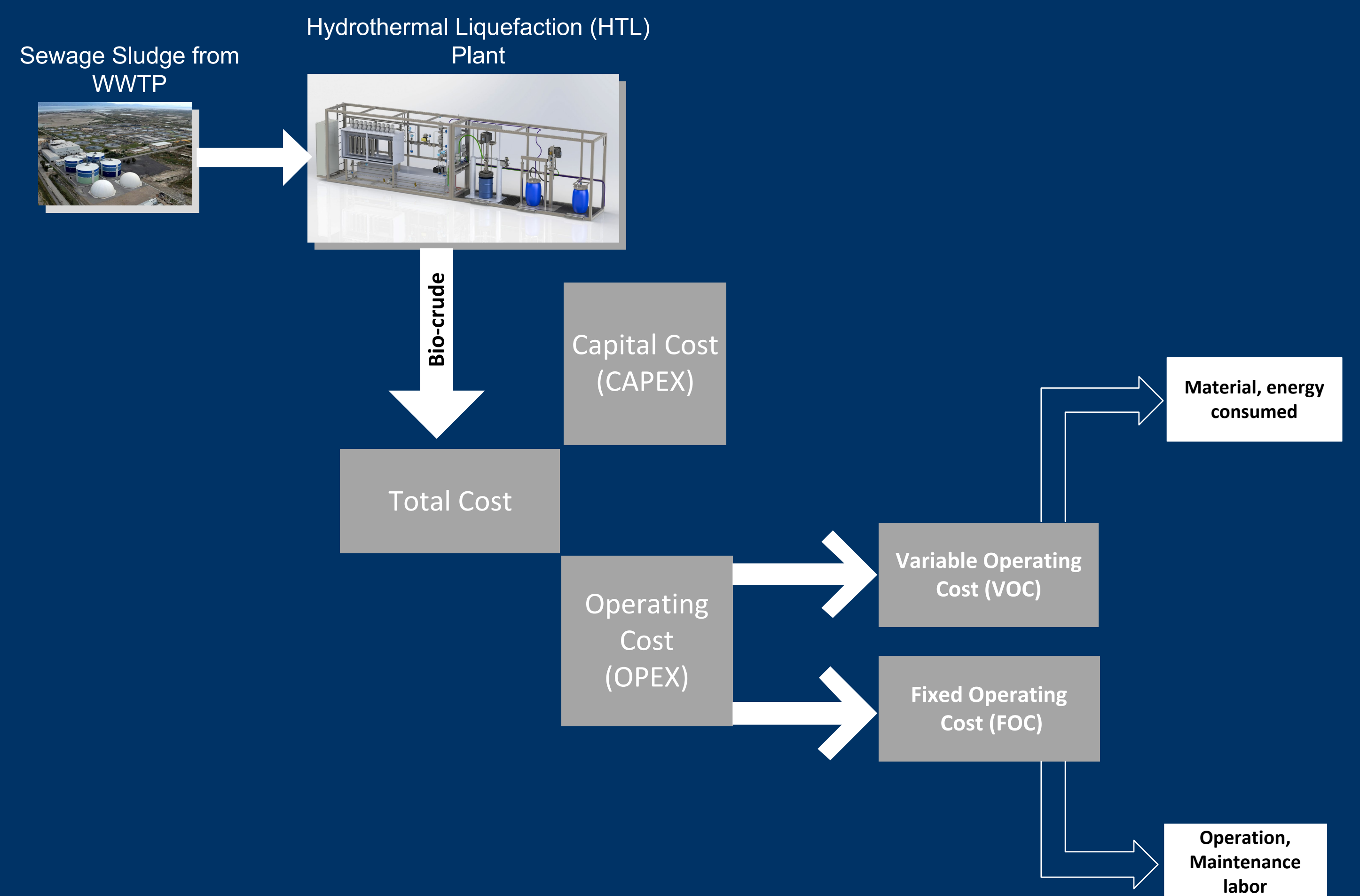
INTRODUCTION

- Hydrothermal liquefaction (HTL) is an efficient thermochemical process used to convert biomass into bio crude at sub- or supercritical temperatures, 280–400°C and pressures 10–35 MPa.
- HTL shows an economic friendliness due to the ability to process wet feedstock, saving energy and economy of a pre-drying step.
- Increasing sludge production and disposal challenges restrict the use on agricultural land due to potential risk of pathogens and transmission of contaminations and plastics. Sewage Sludge (SS) is a potential candidate for resource efficient circular valorization by HTL.

OBJECTIVES

- To investigate the conversion efficiency of SS to bio-crude through HTL process.
- To investigate the techno-economic feasibility of the HTL process utilizing SS as a feedstock for producing bio-fuels.

METHODOLOGY



RESULTS

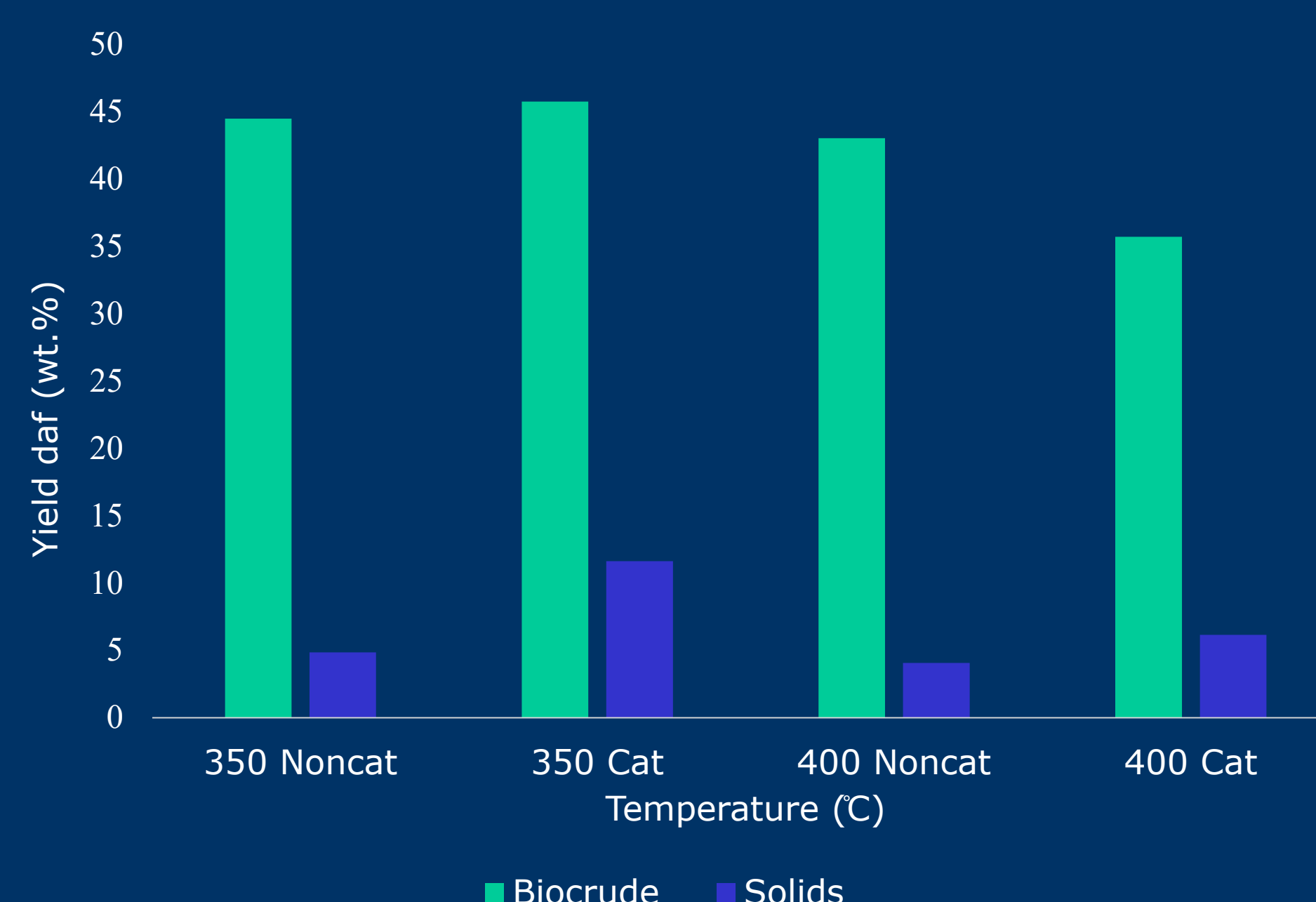
SS Characteristics

Moisture (%)	78.6
Dry Matter (%)	21.4
Ash (%)	23.2
C	35.7
H	5.9
N	5.7
O*	29.5
Crude Protein (%)	35.4
Crude Fat (%)	4.5
HHV (MJ/Kg)	22

*by difference (daf basis)

The potential for energy recovery from sludge is a function of its composition and energy content, depending mainly on volatile solid content that can be subdivided into readily degradable organics. i.e. 50% in sewage sludge.

Product Yield



The maximum bio-crude yield 45.73 wt% at 350 °C with the addition of K₂CO₃ catalyst, while approximately same trend was observed at 400 °C without catalyst with minimum solid formation.

Economic Assessment

General Assumptions	Parameter	Base cost	Source
	Plant Lifetime [years]	20	[2]
	Feedstock	Sewage Sludge	
	Feed rate [dry, ash free sludge]	95 ton/day	
	Plant Operation time [days/ year]	330	
	Bio crude yield, [daf]	44.46 %	
Parameters Variation			
CAPEX	HTL Oil Production Plant Capital Cost [Million Euro]	17.93	[1]
VOC	Sewage Sludge Credit [€/ton]	-63.6	[3]
	Electricity and other utilities [€/L]	0.015	[1]
	Thermal (Gas) cost [€/L]	0.063	[1]
	Water disposal	2.5% of VOC	[2]
FOC	Fixed operating Cost	17.5% of VOC	[2]
	Bio crude production cost [€/L]	1.0	

The calculated production cost of HTL Bio-crude at plant scale is 1.0 EUR/L. Production cost mainly affected by feedstock cost, equipment cost, energy consumption, electricity and thermal energy utilization cost.

CONCLUSIONS

- The maximum yield of bio-crude was 45.73 wt% in the addition of K₂CO₃ accompanied with maximum solid formation.
- The catalyst cost can be saved and solid formation can also be reduced at 400 °C condition.
- The production cost of bio-crude can be reduced by reducing operating cost, labor and thermal energy cost.

FUTURE WORK

- Model improvement and sensitivity analysis.
- Process Modeling and economic evaluation of HTL with bio-crude upgrading plant and whole product chain.
- Investigation of technical feasibility of water phase recirculation to enhance the bio-crude yield.
- Effect of integration with district heating grid on minimum fuel selling price MFSP.

REFERENCE

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