Assessment of Bio-Advanced Synthetic Aviation Fuel Hydrocarbons Production from Biorefinery Streams using Furfural and Ketones: A Techno-Economic Analysis

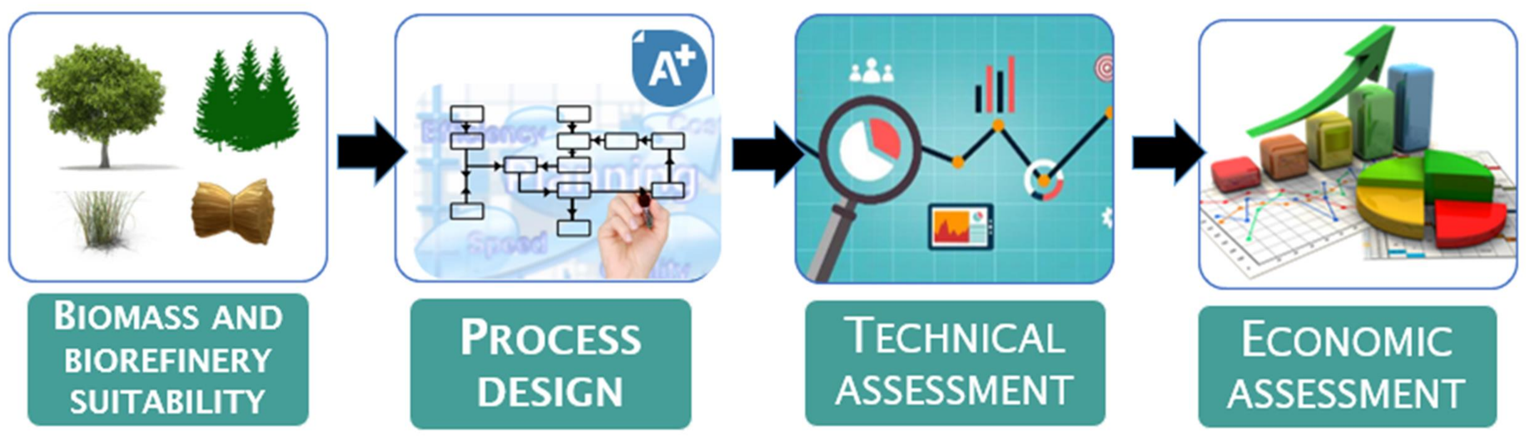
Stefania Luzzi[1], Jan Wilco Dijkstra[1], Karla Dussan[1], Andre van Zomeren[1]
1 The Netherlands Organisation for Applied Scientific Research TNO, Petten, the Netherlands

Introduction

Biomass plays a crucial role in reducing greenhouse gas emissions within the aviation industry. The European Commission, through the REfuelEU aviation initiative as part of the Fit for 55 package, acknowledges this and encourages investments in cleaner technologies for sustainable aviation fuels.

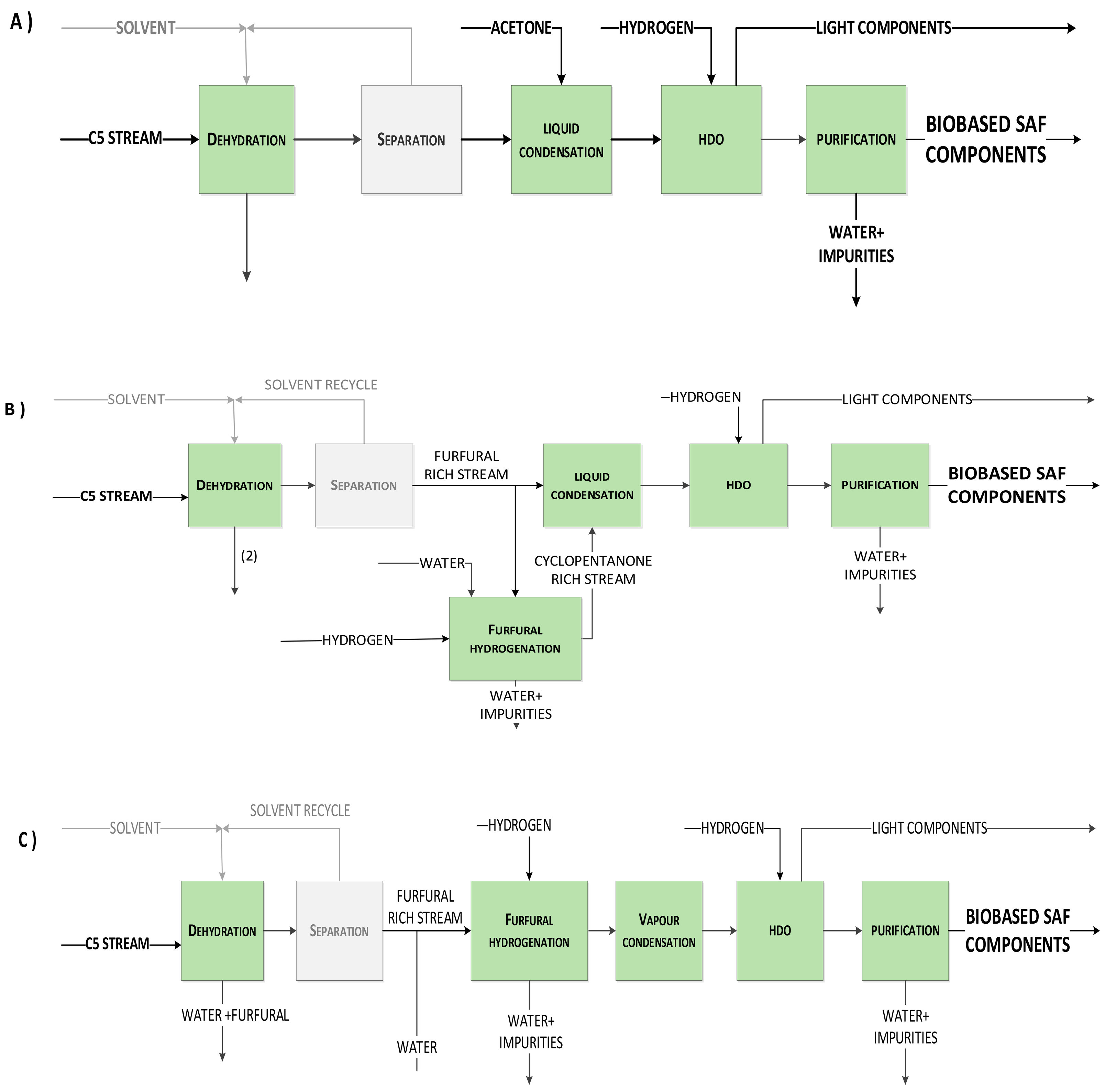
In this context, the HIGFLY project aims to develop advanced bio-jet fuels by converting underutilized hemicellulose (C5) fractions into hydrocarbons suitable for blending with jet fuel. Supporting experimental work, the current work presents process design for different technological pathways and evaluating the technical and economic aspects for long-term sustainability and commercialization of these sustainable aviation fuels.

Method



Process alternatives

Within the HIGFLY project, three main process alternatives were investigated to obtain biobased SAF components derived from C5 sugars through intermediates furfural (A), furfural-cyclopentanone (B), and cyclopentanone (C).



Starting points

- Conversions based on current status of technology development based on experimental results
- C5 sugars: biorefinery by-product (202 EUR/tonne)
- Import green hydrogen (2500 EUR/tonne)
- Revenues for side products (alkanes <C9) (1.5 EUR/l)

Key results and outlook

Scenario A (Furfural-derived):

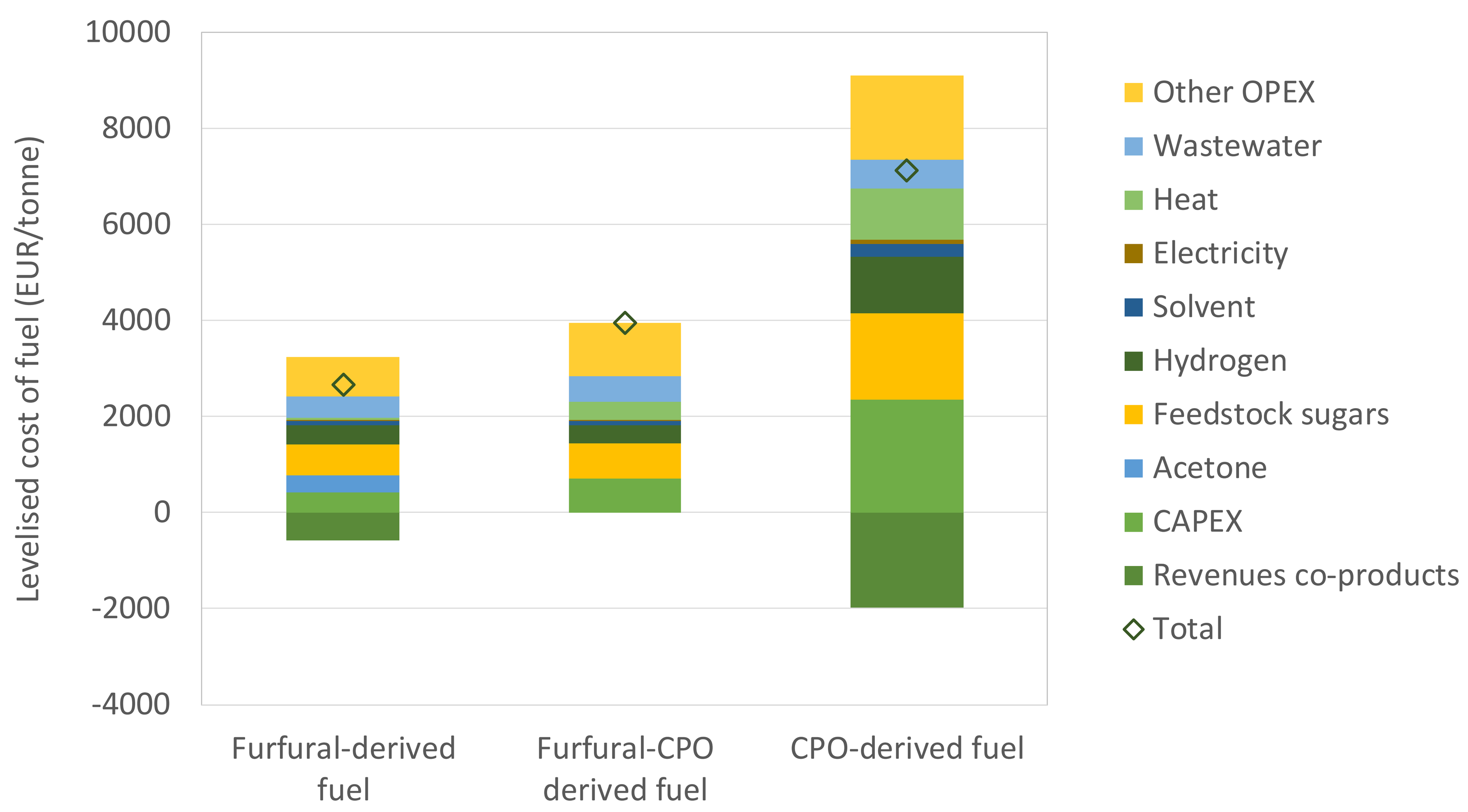
- Relies on import precursor, acetone
- High carbon efficiency (67%)
- Lowest heat demand

Scenario B (Furfural-Cyclopentanone (CPO) derived):

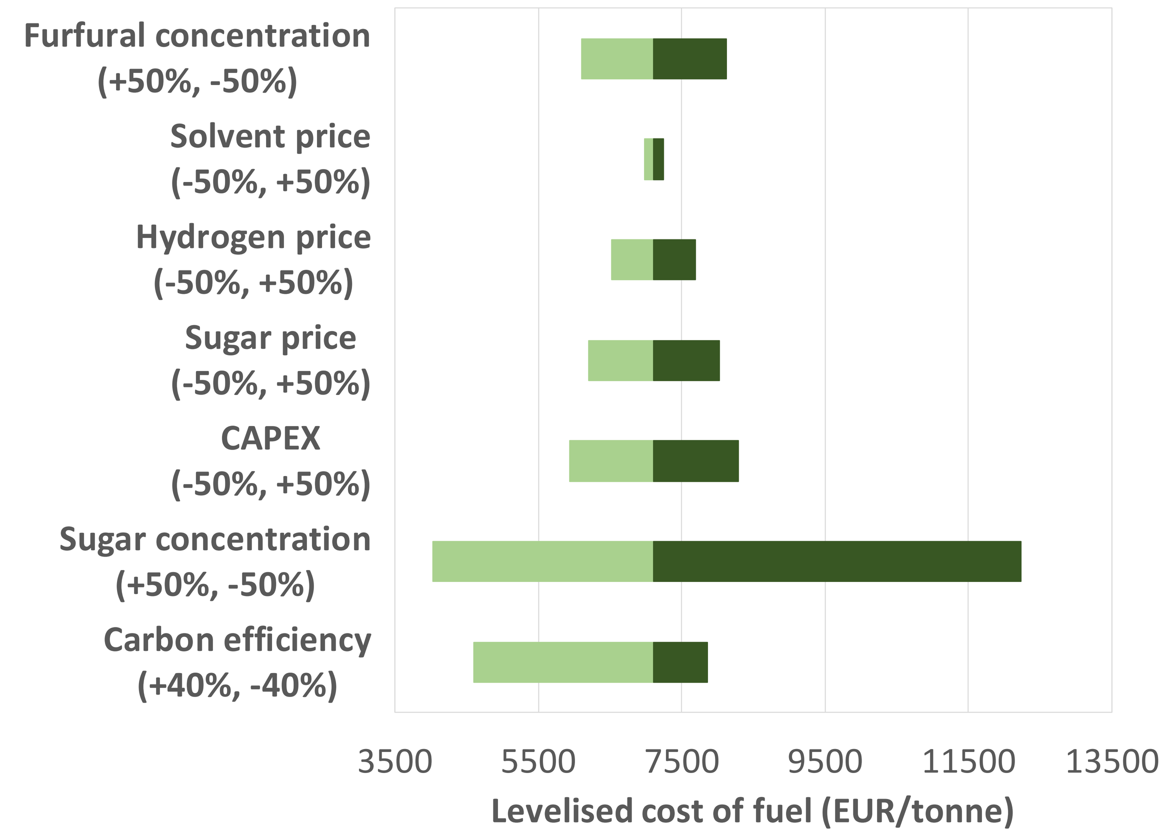
- More complex process (involving an additional step)
- Lower carbon efficiency (49%) due to low CPO yields
- Sub-optimal heat demand: water-based process with low concentrations

Scenario C (Cyclopentanone (CPO)-derived):

- Highest complexity process
- Lowest carbon efficiency (38%) due to poor CPO yields
- Highest heat demand: water-based process with low concentrations and full conversion of furfural to CPO



Cyclopentanone - derived fuel sensitivity analysis



Outlook

Currently, Scenario A appears to be the most economically attractive option, requiring acetone import. Scenarios B and C may hold promise for the future if improved carbon efficiency and higher furfural concentrations in the feed can be achieved through further technology development.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°101006618
The present publication reflects only the author's views and the European Union is not liable for any use that may be made of the information contained therein.