

Assessment of a novel alder biorefinery concept to meet typically conflicting demands of short term economic feasibility and long term environmental sustainability

T. P. Thomsen

DTU Chemical Engineering, Technical University of Denmark

ABSTRACT

Biorefineries are developed to produce the same commodities that present day oil refineries produce, and ideally they should replace old non-sustainable technologies and production patterns with novel highly efficient solutions with focus on long term perspectives and sustainability criteria. However, the short term considerations of a free market is often conflicting with long term sustainability concerns and to make a biorefinery embrace the concepts of climate change mitigation, fossil fuel depletion, long term sustainability and economic feasibility all at once is no easy task. When balancing the potential pathways and products of such a concept several competing requirements must be taken into account. These include feedstock production and availability, resource use, waste production and handling, process efficiency and integration, product requirements and necessity, potential markets, concept robustness and development perspectives, overall carbon balance and net energy yield.

In the present work a biorefinery concept based on alder tree plantations on degenerated or marginalized soils is developed, to illustrate how it is possible to comply with all the before mentioned requirements. The proposed concept is a state-of-the-art biorefinery based on alder, producing the following 5 end products:

- Heat and power from the wood
- Highly specialized value-added products in the form of diaryl heptanoids produced from the alder bark
- Process chemicals produced from the leaves in the form of ethyl acetate and ethanol
- Bio-SNG and fertilizers produced from process residuals
- Replenished soils and increased carbon sinks from long-term process operation.

The alder is chosen as feedstock due to the nitrogen-fixating symbiosis of alder trees and Frankia bacteria, which provide many benefits in terms of soil regeneration, reduced fertilization requirements, and prolonged photosynthesis and growth period. The alder has other beneficial characteristics as well making it a very interesting choice for biorefinery feed stock purposes.

The biorefinery concept is described with focus on alder management and productivity issues, and an assessment of the main products and production processes, process integration, and sustainability issues. The proposed biorefinery concept embraces the need for co-production of value added products in the energy generation, short- and long term sustainability issues, resource use and re-use, and overall process carbon balance.

The proposed biorefinery concept represents a potential outline of an upcoming extended work within alder biorefinery in DTU and is based on extended literature review and unpublished results.