The system architecture for renewable synthetic fuels

Ridjan, Iva

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THE SYSTEM ARCHITECTURE FOR RENEWABLE SYNTHETIC FUELS

Iva Ridjan,

supervised by Brian Vad Mathiesen

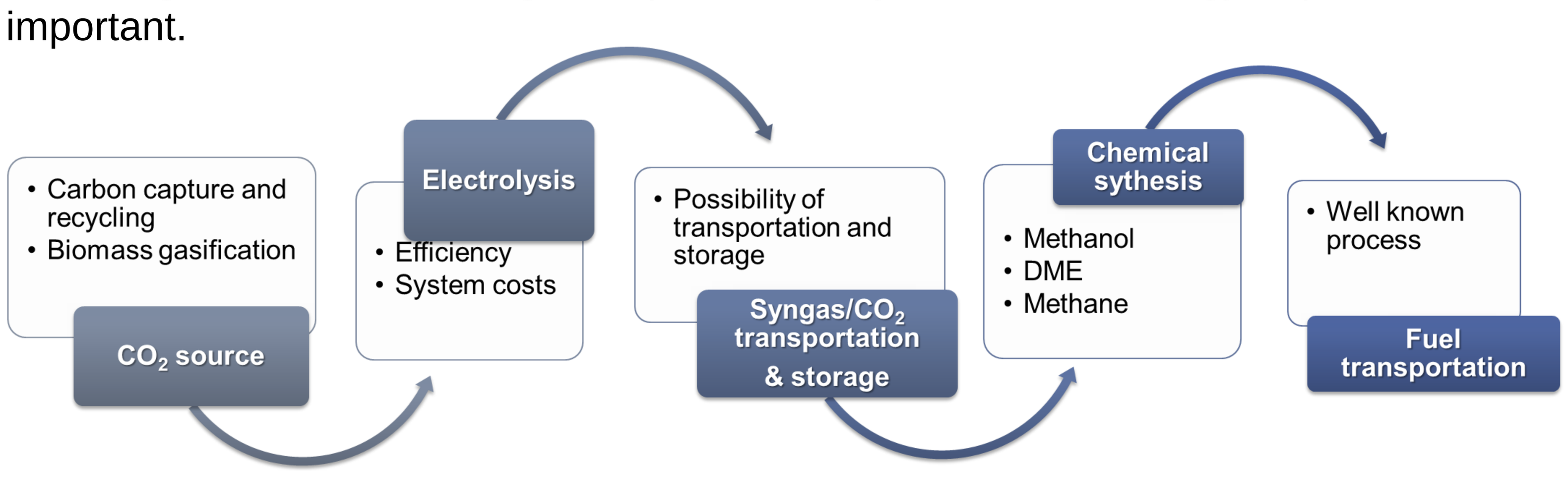
iva@plan.aau.dk

DEPARTMENT OF DEVELOPMENT AND PLANNING, SUSTAINABLE ENERGY PLANNING RESEARCH GROUP

To overcome and eventually eliminate the existing heavy fossil fuels in the transport sector, there is a need for new renewable fuels. This transition could lead to large capital costs for implementing the new solutions and a long time frame for establishing the new infrastructure unless a suitable infrastructure is present. The system integration of synthetic fuels will therefore depend on the existing infrastructure and the possibility of continuing its exploitation to minimize the costs and maximize the use of the current infrastructure in place. The production process includes different steps and production plants, so it is important to implement it in the best manner possible to ensure an efficient and flexible system. The poster will provide an overview of the steps involved in the production of synthetic fuel and possible solutions for the system architecture based on the current literature and best practice.

PRODUCTION CYCLE OF SYNTHETIC FUELS AND PROPOSED PATHWAYS

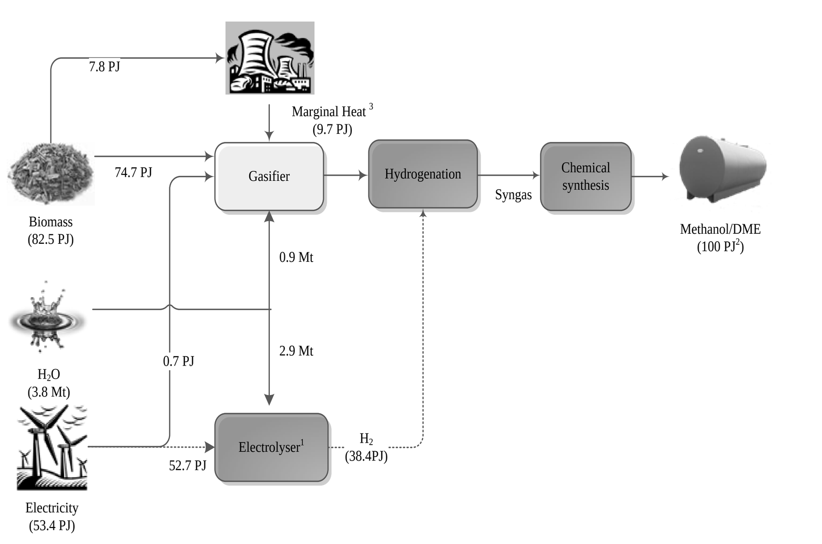
In order to evaluate the potential of electrolysers for liquid fuel production, the knowledge on individual stages of production cycle and technology implemented is important.

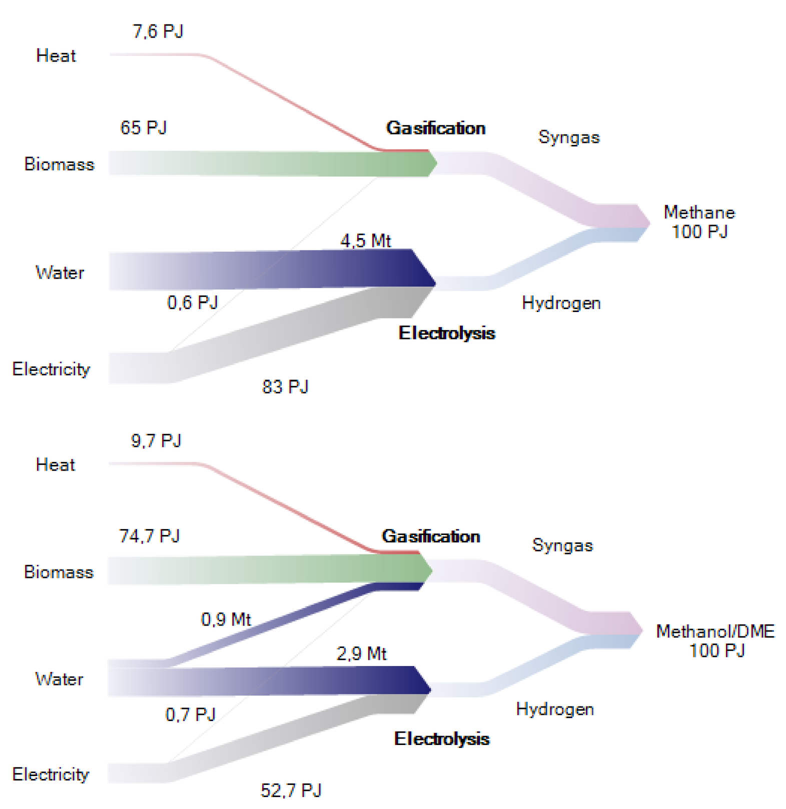


Three proposed pathways:

- Biomass hydrogenation
- CO_2 hydrogenation
- Co-electrolysis

BIOMASS HYDROGENATION

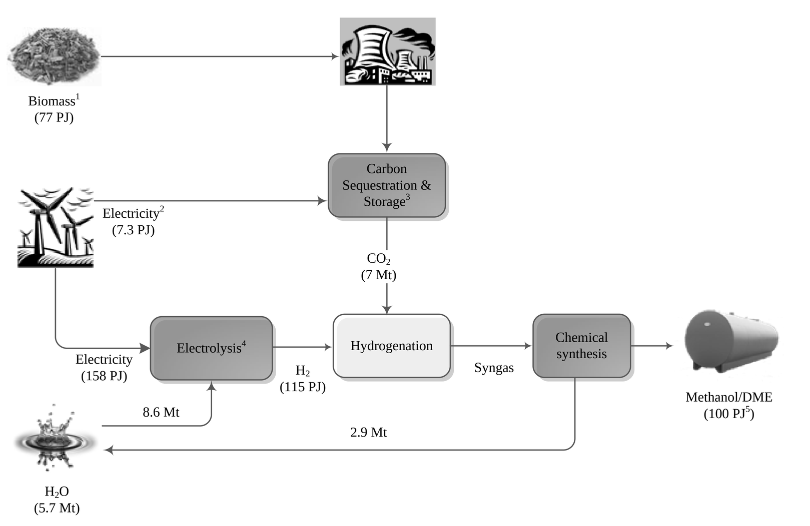


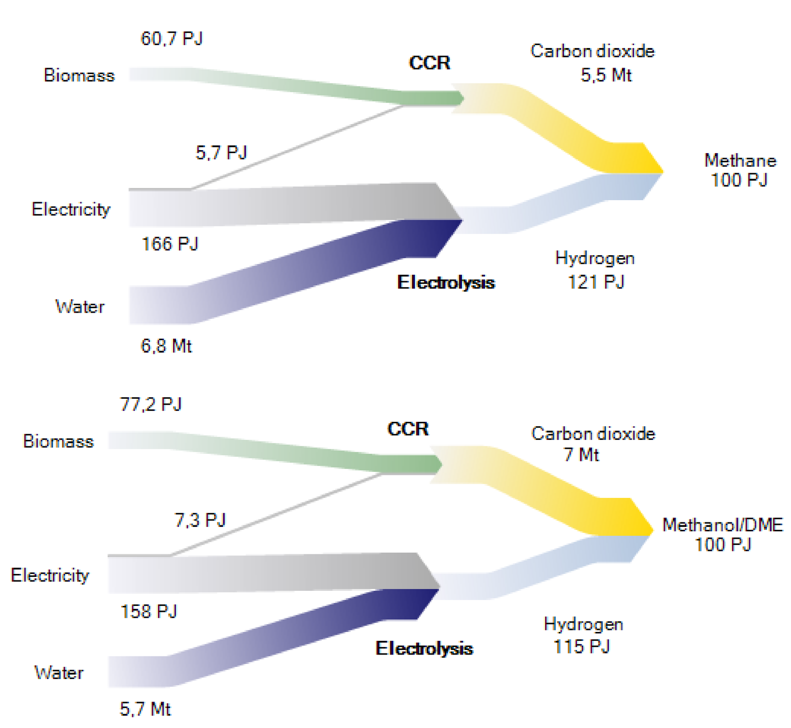


The principal objective in this pathway is to create a liquid fuel from biomass, which is boosted by hydrogen from steam electrolysis. In this way, the energy potential of the biomass resource is maximized.

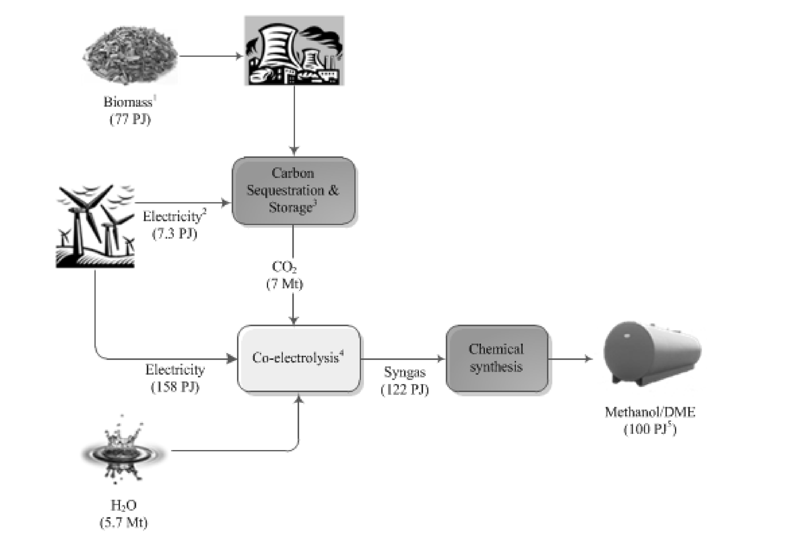
CO_2 HYDROGENATION

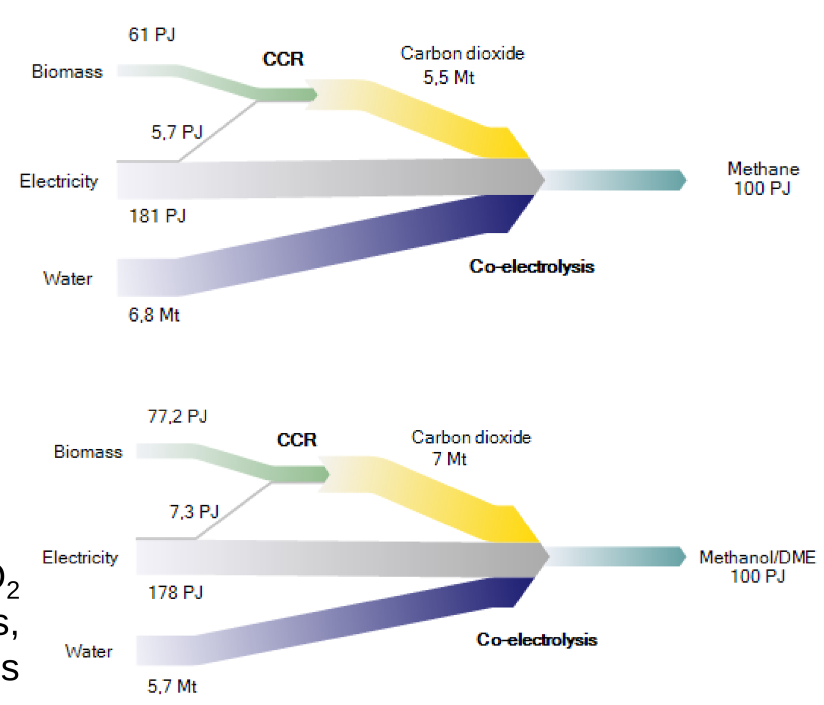
This pathway combines carbon dioxide and hydrogen gases together in form of syngas, which is thereafter converted by chemical synthesis to fuel.





CO-ELECTROLYSIS





This pathway combines steam and CO_2 electrolysis into a process called co-electrolysis, and the produced synthetic gas can afterwards be catalysed into various types of fuel.

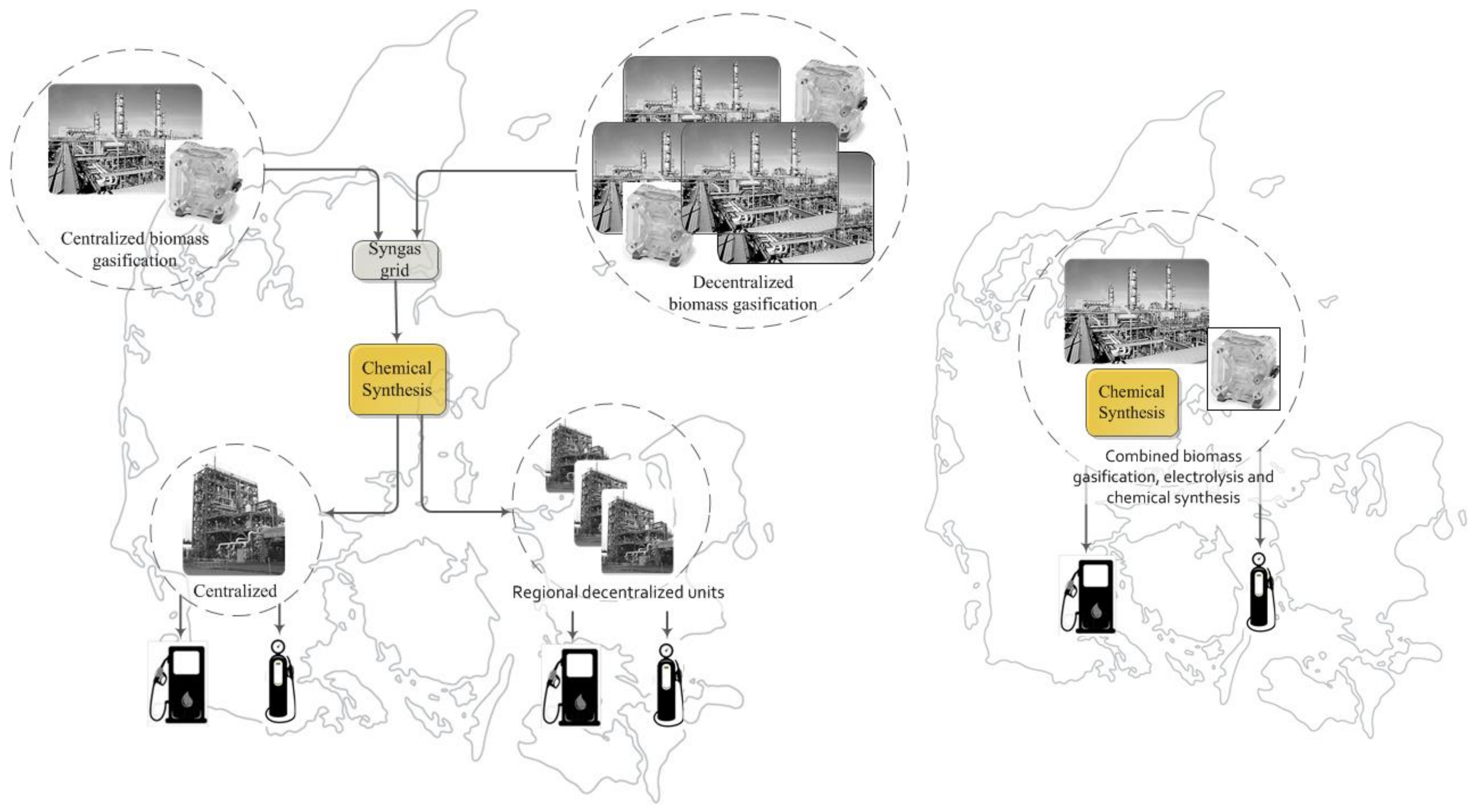
SYSTEM ARCHITECTURE

Two proposed systems:

- Centralized – big scale production plants and high electrolyser capacities
- Decentralized – smaller production plants, possible local optimization

Key principles:

- One large grid solution is preferred (local smaller grids could be needed)
- Transportation of electricity is first priority followed by transportation of CO_2 , syngas or hydrogen
- The capture of carbon from air using synthetic trees is excluded from the analysis because it is more expensive solution at the moment - small difference in the electricity needed for CO_2 extraction compared to stationary CCR.



Decentralized and centralized solution for utilizing renewable fuels biomass gasification pathway and combined cycle

CO_2 hydrogenation and co-electrolysis possible system structure

CONCLUSION/FUTURE WORK

The work to date indicates that there are a lot of possible solutions that need to be further investigated to clarify some insecurity related to different production steps. During the research, it became apparent that the true benefits of each system structure cannot be determined without a detailed understanding of the most likely technologies to be used in the future.

The biomass gasification pathway infrastructure could be defined by possibility and costs of syngas transportation and chemical synthesis losses, while CO_2 recycling pathways structure will be defined by distributed nature of future carbon sources as well as process heat losses of chemical synthesis.

The chosen fuels are going to depend on the engine efficiencies, driving range and driving efficiency of methane and methanol/DME vehicles. Future research will therefore orient more in the detailed analysis of the end use of the produced fuels.