Techno-economic analysis of using renewable methanol for inland and coastal shipping

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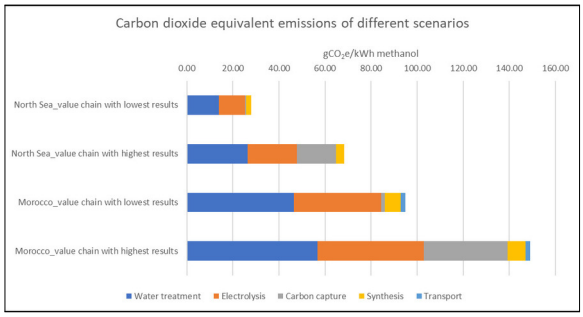
Initial Situation: The European inland and coastal navigation sector heavily relies on fossil fuels for its energy needs, making it an important area for transitioning to a defossilized Europe by 2050. In order to comply with the target of a defossilized navigation sector, retrofitting the shipping fleet of Europe with combustion engines using renewable methanol as energy carrier is one of multiple promising solutions. For the purpose of finding the most suitable solution, an initial step is to analyse the various options from a well-to-tank perspective. The core aim of this research is to analyse and compare multiple methanol well-to-tank value chains in order to identify the most advantageous pathways from a techno-economic perspective.

Approach: To achieve the aim of the research, multiple possible value chains were predefined and their technical and economic impact was calculated. The technical impact was quantified by calculating the carbon dioxide equivalent emissions (CO_2e) per energy unit of methanol and the economic impact was quantified by calculating the costs per energy unit of methanol.

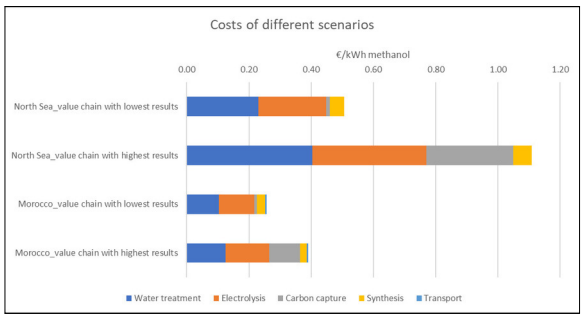
Result: The analysis shows that producing electricity with wind turbines in the North Sea and converting it to e-methanol in Rotterdam results in lower CO_2e emissions but higher costs compared to producing electricity with photovoltaic in Morocco, converting it to e-methanol in Morocco and transporting it to Rotterdam. The calculation of different variants of the North Sea related value chain leads to 28-68 gCO_2e/kWh and to 0.51-1.11 €/kWh. The calculation of the Morocco related value chains leads to 94-150 gCO_2e/kWh and to 0.25-0.39 €/kWh.

From a techno-economic perspective, none of the examined pathways successfully combines both low CO_2e emissions and low costs. Therefore, it is recommended to acquire renewable methanol from multiple pathways in order to achieve a balanced combination of the strengths and weaknesses across different value chains.

The figure shows the lowest and highest emissions of the examined value chains as a representative part of the results.
Own presentment



The figure shows the lowest and highest costs of the examined value chains as a representative part of the results.
Own presentment



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Subject Area
Energy and Environment