Techno-economic analysis

of using renewable electricity and battery containers for shipping

Graduate

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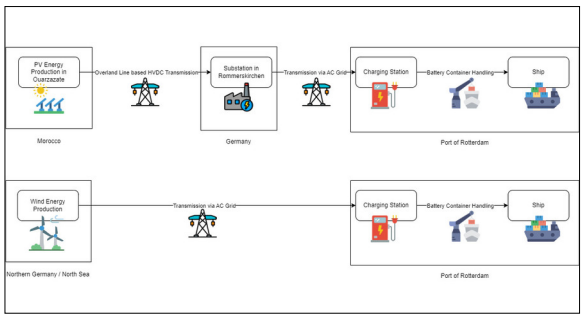
Initial Situation: The transformation of the shipping industry to fossil free propulsion is still going on slowly. To accelerate the transformation, a large scale retrofit of the existing fleet would be necessary. There the EU project SYNERGETICS comes in, to offer a catalogue with retrofit solutions for inland water and coastal vessels with a certaintype, dimension and operation profile

Approach: In the SYNERGETICS project a possible retrofit solution is identified, where swappable battery containers in combination with an electrified propulsion system are used. In this solution, the electricity for the battery container is produced with renewable sources. In a first step the well-to-tank pathway is analysed. For the well to-tank pathway five elements are identified: energy production, energy transport, charging infrastructure, battery container and container transport onto the ship. For each element the cost and global warming potential per kWh provided electric energy is modelled. This is done over the whole lifecycle of the element with a cradle-to-gate approach. For each element different variants are identified and modelled. For the data basis of the model, a literature research is conducted, from which the relevant values are extracted. At the end, the variants of each element are combined to form multiple well-to-tank scenarios.

Result: The best well-to-tank scenario, considering an optimum with low cost and low global warming potential, is a charging network scenario with onshore wind turbines producing the electricity in Northern Germany. From there the electricity is transmitted to the charging stations at the ports along the Rhine via the existing grid. At the port the li-ion based battery containers are then charged and loaded onto the ship, with the existing logistics infrastructure from the port. This scenario provides the electric energy at a specific cost of 25.0 €cent/kWh and specific GWP of 25.5 g CO2eq/kWh.
To further minimise the cost of the overall chain, the cost for handling the battery container from and onto the ship, could be subsidized by the port. Additionally, the cost could be further reduced by producing the electricity with PV in Morocco. The problem of the higher specific GWP of PV could be significantly reduced by switching to renewable electricity during the manufacturing of the cell.

visualization of transport volume on European waterways
Zentralkomission für die Rheinschiffahrt (ZKR)

schematic visualization of the well-to-tank charging network scenario
icons designed by Smashicons (www.flaticon.com)



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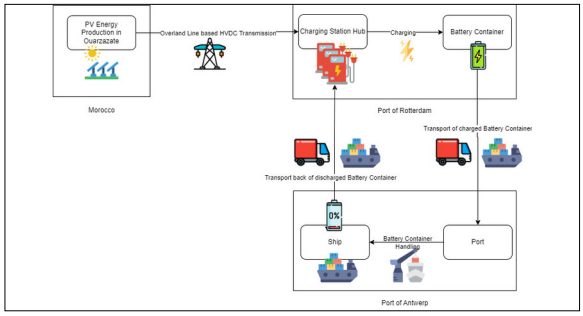

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Subject Area
Electric solar technology, Electrical Power Engineering, General energy technology, Environmental Economics