

# Baltic Sea Oxygenation and the Super-Green Hydrogen Economy (BOxHy)

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## Executive summary of the project

Internal phosphorus loading in the Baltic Sea Proper and Gulf of Finland is caused by strong anoxia below the halocline. Since 1992, external nutrient loading has decreased and is now surpassed by internal loading, caused by a legacy of past nutrient loads (Forth, Liljebladh, Stigebrandt, Hall, & Treusch, 2015) (Rantajärvi, et al., 2012). The Baltic Sea Oxygenation and the Super-Green Hydrogen Economy (BOxHy) project took a multi-phase approach to evaluating the feasibility of injecting by-product oxygen from electrolysis as a service for managing internal nutrient reserves and combating anoxia and hypoxia in the Baltic Sea. Through a detailed scientific investigation including a literature review and risk assessment, two Swedish sites (Säbyviken and Skärpösundet) are identified as potential for conducting a Pure Oxygen Injection (POI) pilot in a marine environment. The pilot project is estimated to take six years and require 5-6 million Euros.

In parallel to planning the pilot project, the next phase for achieving the long-term ambition of combatting anoxia and hypoxia on a Baltic-sea wide scale was explored. With the emerging production of offshore wind energy and growing demand for renewable hydrogen, the development of offshore electrolyzers for co-production of hydrogen and oxygen is deemed feasible. Our desktop study concludes that the installation of nearly 20 GW of offshore electrolysis capacity would be required to meet the Baltic Sea's total calculated oxygen injection demand of 57.16 +/- 25.261 kilotonnes Oz/day to increase oxygen concentrations to 10 mg/l on the sub-basin and basin scales. Methods for sourcing electricity from offshore wind parks and transporting hydrogen to final off-takers were investigated. It is concluded that there is theoretically sufficient offshore wind capacity already under development in the Baltic Sea to meet electricity demands, but further discussions with wind developers and coordination of project timelines is needed. Establishing intermediate pipeline connections from offshore electrolysis platforms to the planned "Baltic Sea Hydrogen collector" was deemed the most feasible method for transporting hydrogen to off-takers, contingent upon final routing and further techno-economic studies.

The project investigated the conceptual design of a 400 MW capacity offshore electrolyser platform integrated with POI. The additional costs for producing oxygen for POI and integrating POI with such a platform are 79 million Euros in capital expenditure and 2.17-2.73 million Euros per year in operational expenditure (depending on production rate). The resultant annual cost for providing reoxygenation as a service to the entire Baltic Sea is 367-612 million Euros, which compared to the current estimated annual economic loss of 5.6 billion Euros from direct and indirect losses due to the poor state of the Baltic Sea is a small price to pay. As the continuation to the BOxHy project, the BOxIn project is proposed to pilot POI in a marine environment at one of the identified sites, take steps towards piloting an offshore electrolysis platform integrated with POI, and continue engagements with a wide array of stakeholders in the Baltic Sea region.