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Energy Ships: Transition to the Hydrogen Economy

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BACKGROUND AND PROBLEM FORMULATION

The energy ship is a novel concept proposed by Platzer et al. which seeks to address the global energy crisis in a way that is clean but without the baggage associated with almost all current renewable energy sources (low energy density, grid connectivity problems etc.). In this concept, hydrogen is produced by electrolysis of ocean water, the required power for which is provided using wind energy captured by the sails propelling the ship. The ship is intended to operate in the North Atlantic Ocean which has high average wind speeds of over 9 m/s. This hydrogen is stored in cylinders on-board the ship before it is eventually transported to land where it can be used to generate clean energy.

ADVANTAGES AND ORIGINAL CONTRIBUTION

The major advantage of this concept is that while the system can benefit from many of the regulations aimed at increasing the diffusion of renewable energy sources especially off-shore wind, it side steps many of the accompanying problems (prohibitive costs for deep water wind turbines, problematic grid connection due to turbulent nature of wind energy and required infrastructure to transport generated electricity on-shore). At the same time, the system is not without its own share of problems, especially the low density of hydrogen leads to prohibitively high storage costs.

Due to this limitation, we diverge from the monolithic model presented by Platzer and develop the concept of an autonomous (or semi-autonomous) worker ship swarm model that can move about independently in search of the optimal wind speeds. We envision this system to drastically reduce the amount of hydrogen we need to store on board. We compare the proposed system with the original model via a thermodynamic analysis to make explicit the differences between the two systems as well as discover possible candidates for optimization.

RESULTS AND FUTURE WORK

Based on the work so far, we have found that this system has the potential to substantially offset the carbon footprint if utilized in large numbers. The thermodynamic analysis has also revealed that the proposed swarm model yields an efficiency improvement of about 5% over the original monolithic model. Furthermore, a multi-criteria analysis has been conducted to identify the ideal market for deployment of such a system (including considerations such as carbon reduction commitments, proximity to transatlantic trade routes and national legislation).

Having already concluded the thermodynamic analysis, in the next step we intend to identify the gain in power by employing the swarm model instead of the monolithic model by conducting simulations based on real world data. We also intend to dimension both systems in terms of commercial technology available currently to conduct a complete cost-to-benefit ratio and calculate the overall energy return on investment (EROI).