Wind Energ. Sci. Discuss., author comment AC2
https://doi.org/10.5194/wes-2021-39-AC2, 2021

Reply on RC2

Aurélien Babarit et al.

Author comment on "Exploitation of the far-offshore wind energy resource by fleets of energy ships – Part 2: Updated ship design and cost of energy estimate" by Aurélien Babarit et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2021-39-AC2, 2021

Thank you very much for your detailed reviews of our manuscript. We greatly appreciate your comments and suggestions. We have revised the manuscript accordingly. Please find below our point-by-point responses to your suggestions and concerns.

General comments:

Your first general comment is about the fact that in Figure 6, one can see that the generated power of the energy ship is steady for different true wind angles and constant true wind speed while the generated power stagnates with increasing true wind speed. This is because the Flettner rotors rotational speed and the water turbines' induction factor are controlled in order to maximize power production while satisfying the constraints (maximum rotation velocity and thrust force for the rotors, maximum power generation for the water turbine). In the proposed design, the maximum power generation of the water turbines is limited to 1,600 kW (2 x 800 kW). Similar to wind turbines, there exists a rated wind speed above which the available wind energy exceeds the conversion capability of the energy ship (in other words, the ship could produce more power if it is equipped with generators of greater capacity). One can see in Figure 6 that for the proposed design, this rated wind speed is approximately 10 m/s. For wind speeds above that threshold, the rotational velocity of the Flettner rotors reduces (corresponding to the pitching of the blades for a wind turbine) in order to maintain maximum power generation while reducing the rotors' power consumption (panel c) in Figure 6). To clarify, the following sentence has been added after Figure 6:

"Note that for each data point, the water turbine's induction factor and the rotors' spin ratio were optimized in order to maximize power production while satisfying the constraints (maximum rotation velocity and thrust force for the rotors, maximum power generation for the water turbine)."

Your second general comment is related to uncertainty, and more specifically to (i) the fact that no distributions are provided for the identified uncertainty ranges, and (ii) the fact that the rate of production does not include uncertainty.

Regarding (i), the uncertainty ranges are based on suppliers, experts' recommendations and/or publicly available literature. Unfortunately, none of these sources provided distributions. Regarding (ii), we believe that it would be arbitrary to put an uncertainty on a number which is the result of a numerical model. Comparisons with experiments (which are not yet available) would be necessary to determine the level of accuracy.

Regarding the propagation of uncertainty, the low end of the LCOM (respectively high end) was obtained by using the most optimistic cost data (respectively most pessimistic cost data). Therefore, it is equally as likely to yield lower or upper LCOM. Therefore, we modified Figures 8 and 10 (now Figures 8 and 9) following your recommendation to show the mean and error bars. The following sentence has also been added at the end of the first paragraph of section 4.1*:*

"Note that the low end of the range (respectively high end) was obtained by using the most optimistic cost data (respectively most pessimistic cost data)."

Requested revisions

- line 71: no definition of the Reynolds number is given

The definition of the Reynolds number has been added in the revision of the paper: *"(…), with the Reynolds number defined as: Re=VD (2) where v is the kinematic viscosity and D is the rotor diameter."*

- Sections 2.4 to 2.6 list assumptions for the power-to-methanol plant, tanks and auxiliary equipment: No references were given! They might be included in the first part, but this isn't stated either. References are given later in section 4.1, it's unclear however, if those are the ones considered in 2.4 to 2.6 as well.

Indeed, the references are included in the first part. It is clarified in the revision of the paper:

"2.4 Power-to-methanol plant

(…)

Assuming the same 60% efficiency for the electrolyzer and the same 78% efficiency for the hydrogen-to-methanol plant as for the initial design (Babarit et al., 2020), the rated power of the hydrogen-to-methanol plant is 680 kW (850 kW for the initial design). Its weight estimate is 17 t (24 t for the initial design).

2.5 Storage tanks

The capacities of the storage tanks (CO2 and methanol) are set such as they can accommodate 7 days of production at rated power (approx. 17 t of methanol). Thus, the CO2 tank weight is 15 t and that of the methanol tank is 4 t (Babarit et al., 2020),.

2.6 Auxiliary equipment

As for the initial design (Babarit et al., 2020),, the weight of the auxiliary subsystems is taken equal to 10% of the total mass budget excluding the hull weight (41 t)."

- Figure 6: polar plots are missing units of measure for power and speed!

Yes indeed. This mistake is corrected in the revision of the paper.

- line 301: Please double check the units! The market price of methanol is given as 0.4 Euro per kilogram or 72 Euro per Megawatt hour. With carbon tax it is given as 6 or 13 Euro per Megawatt hour depending on the taxation, which is about ten times lower than the price given w/o tax.

You may have read this paragraph too quickcly. 6 €/MWh to 13 €/MWh is not the price with taxation but the price increase with taxation: *"In 2018, the carbon tax was 44.6 €/ton in France and 110 €/ton in Sweden; if CO2 emissions were taken into account, the methanol price would increase by 6 €/MWhth and 13 €/MWhth respectively."*

- line 401. The title of the reference seems to have changed. Consider adding DOIs to your references where possible!

Yes, there was a mistake in the title (and list of authors) of this reference. It has been corrected. The DOIs have also been added wherever possible.