May be considered fully clean the tidal power technologies?

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TIDAL ENERGY

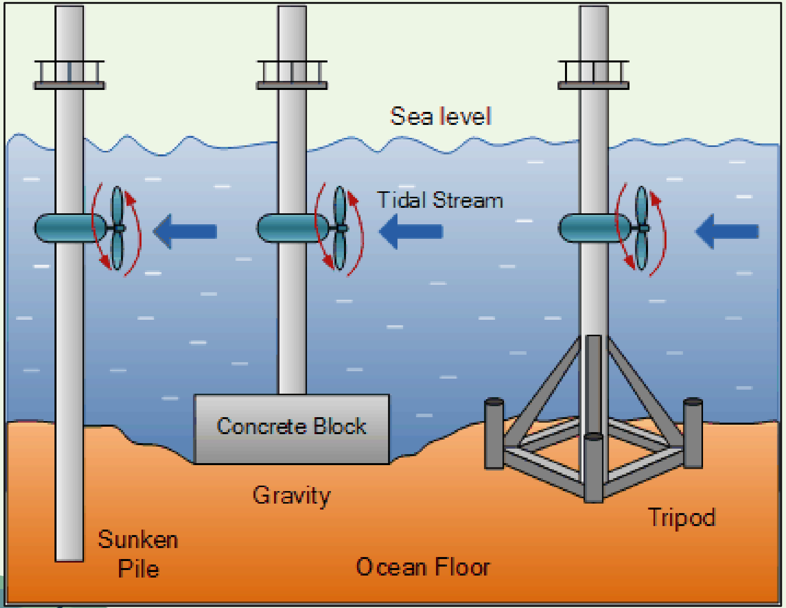
Unconventional renewable energies, such as tidal energy, harness the sea level changes caused by tides to generate power.

Tidal energy is a renewable energy source, and its use aims to:

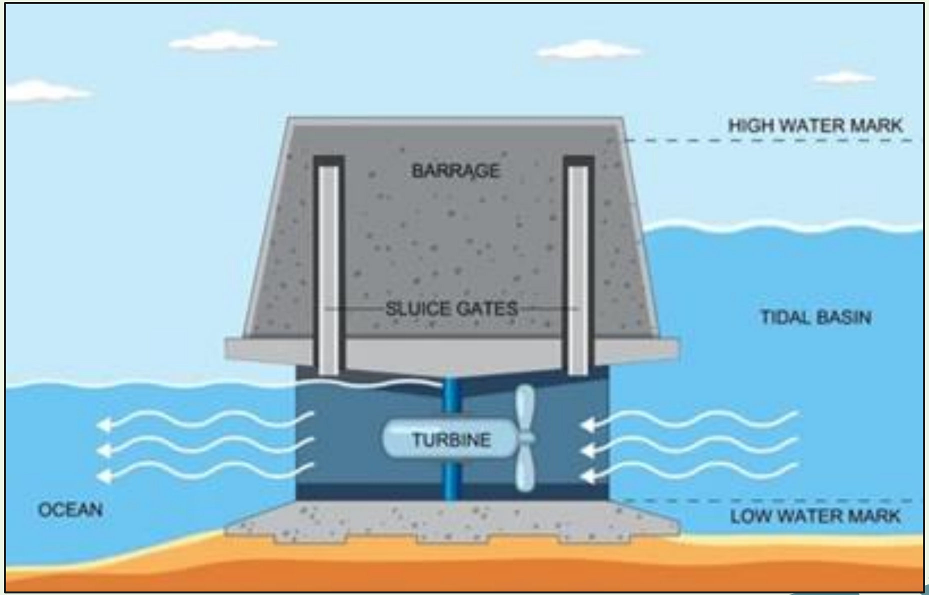
- Reduce dependence on technologies that use fossil fuels.
- Decrease greenhouse gas emissions (GHG).
- Generate energy to meet global energy demand.

TYPES OF TECHNOLOGY

Stream turbines



Tidal barrage or dam



METHODOLOGY

Information gathering

The selected articles supporting the information were gathered from the most renowned scientific repositories:

- Scopus
- Web of Science (WoS)
- ScienceDirect
- Springer
- ASCE

Reference article

This work focuses on the article presented by Rueda-Bayona, Cabello, and Chaparro (2022), highlighting that the study explores the materials used in the processes of manufacturing, installation, maintenance, and dismantling of wind farms through the Life Cycle Assessment (LCA) method.

LCA method

The method used to assess the impact of materials was through Life Cycle Analysis (LCA).

In the related articles, the impacts of each material were identified and classified into the 18 categories evaluated by the LCA method.

LCA IMPACTS OF TIDAL ENERGY

Manufacturing processes of the technology:

- Acquisition and transformation of materials
- Installation
- Operation and maintenance
- Dismantling

Through studies conducted by various authors, it was concluded that the manufacturing stage of the materials used in turbine construction generates the highest impacts.

3 categories of LCA impacts

ISO 14042 defines three protection areas as categories of final impacts.

Final environmental impacts

Human health	Environment	Natural resources
		

Life Cycle Analysis

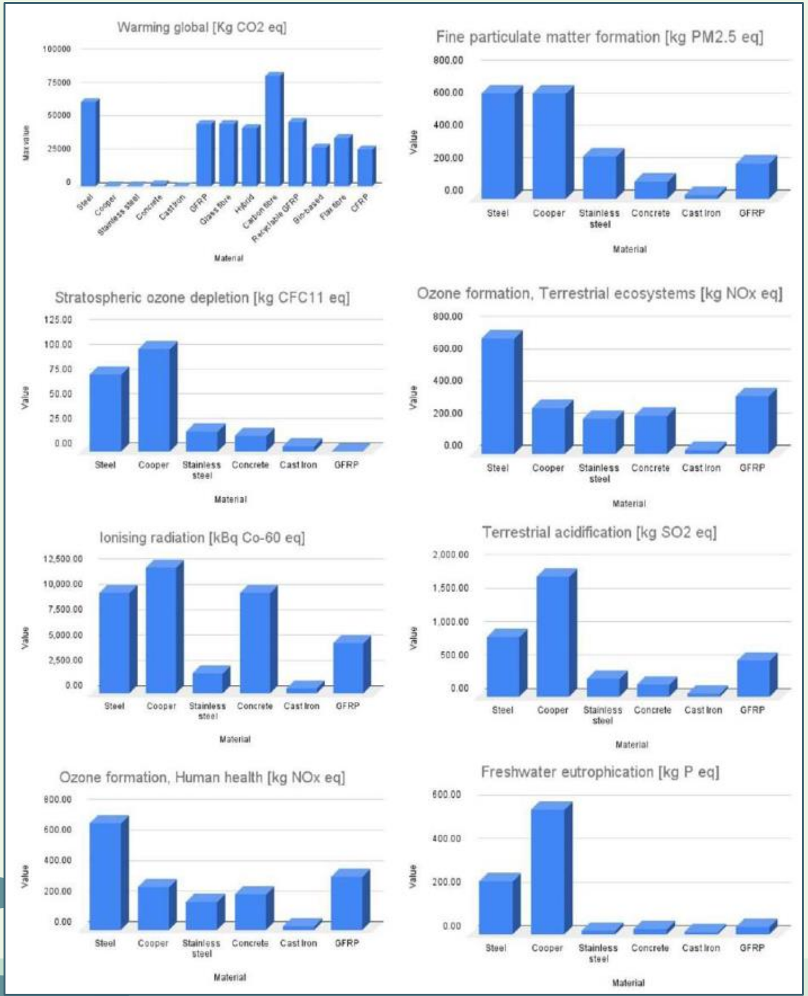


Figure 1a. Materials implemented in tidal energy turbines evaluated in 18 LCA categories.

STEEL

It is the major contributor to global warming, ozone formation, human health, ozone formation, terrestrial ecosystem, carcinogenic human toxicity, and mineral resource scarcity. It is the primary material constituting more than 70% of the turbine mass.

COPPER

Despite its lower usage compared to steel, copper is responsible for more than half of the impacts in acidification, eutrophication, and toxicity. This impact is due to the release of various materials during the manufacturing process, such as phosphate, which causes eutrophication through discharge.

Life Cycle Analysis

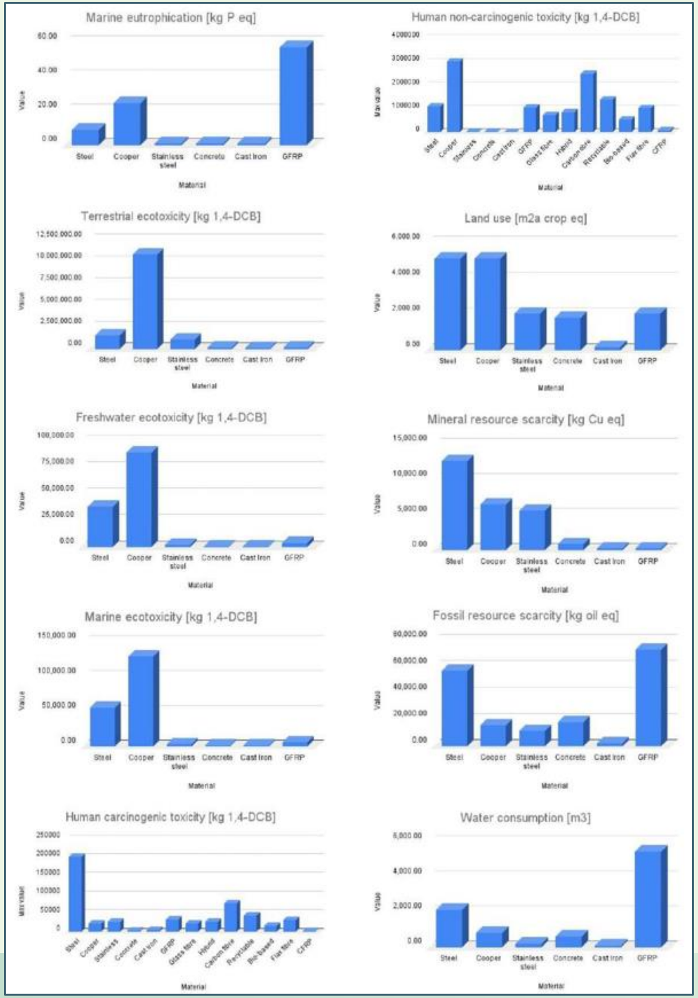


Figure 1b. Materials implemented in tidal energy turbines evaluated in 18 LCA categories.

GFRP

Primarily affects stratospheric ozone depletion, marine eutrophication, fossil resource scarcity, and the impact of water consumption.

CFRP

Considered a lightweight alternative for turbine blade manufacturing. However, it generates more greenhouse gas emissions than GFRP.

RECYCLABLE AND BIOLOGICAL PRODUCTS

Offer lower environmental impacts. They produce fewer greenhouse gas emissions compared to other materials and, in the 18 LCA categories, have the lowest impacts.

LCA

In the figures, the final impacts for the 18 categories were calculated through a literature review and a study using ReCiPe. This method provides representative characterization factors on a global scale to model impact pathways from the midpoint to the endpoint, categorized into three groups.

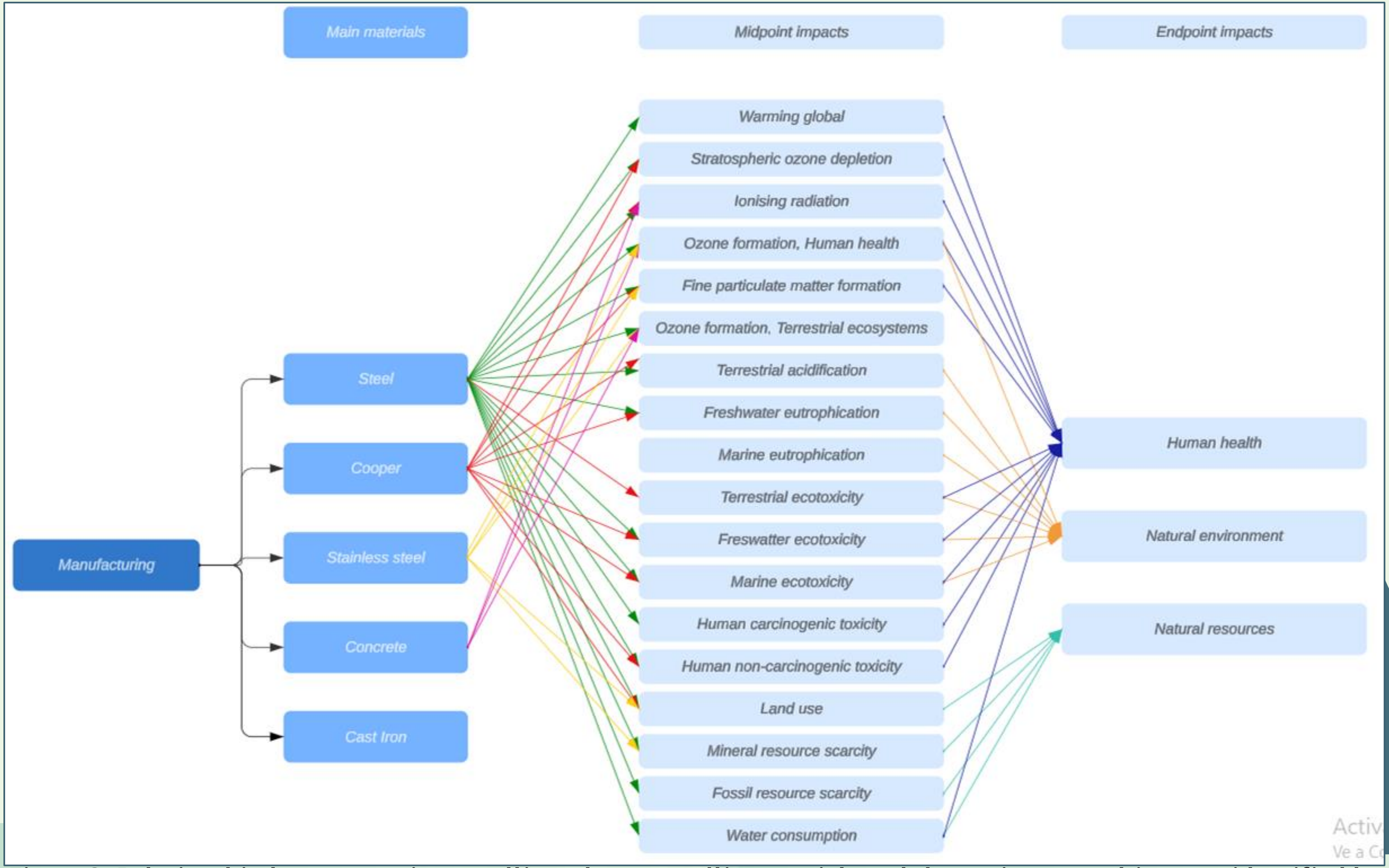


Figure 2. Relationship between major metallic and non-metallic materials and the environmental impacts identified by the 18 midpoint and endpoint impact categories.

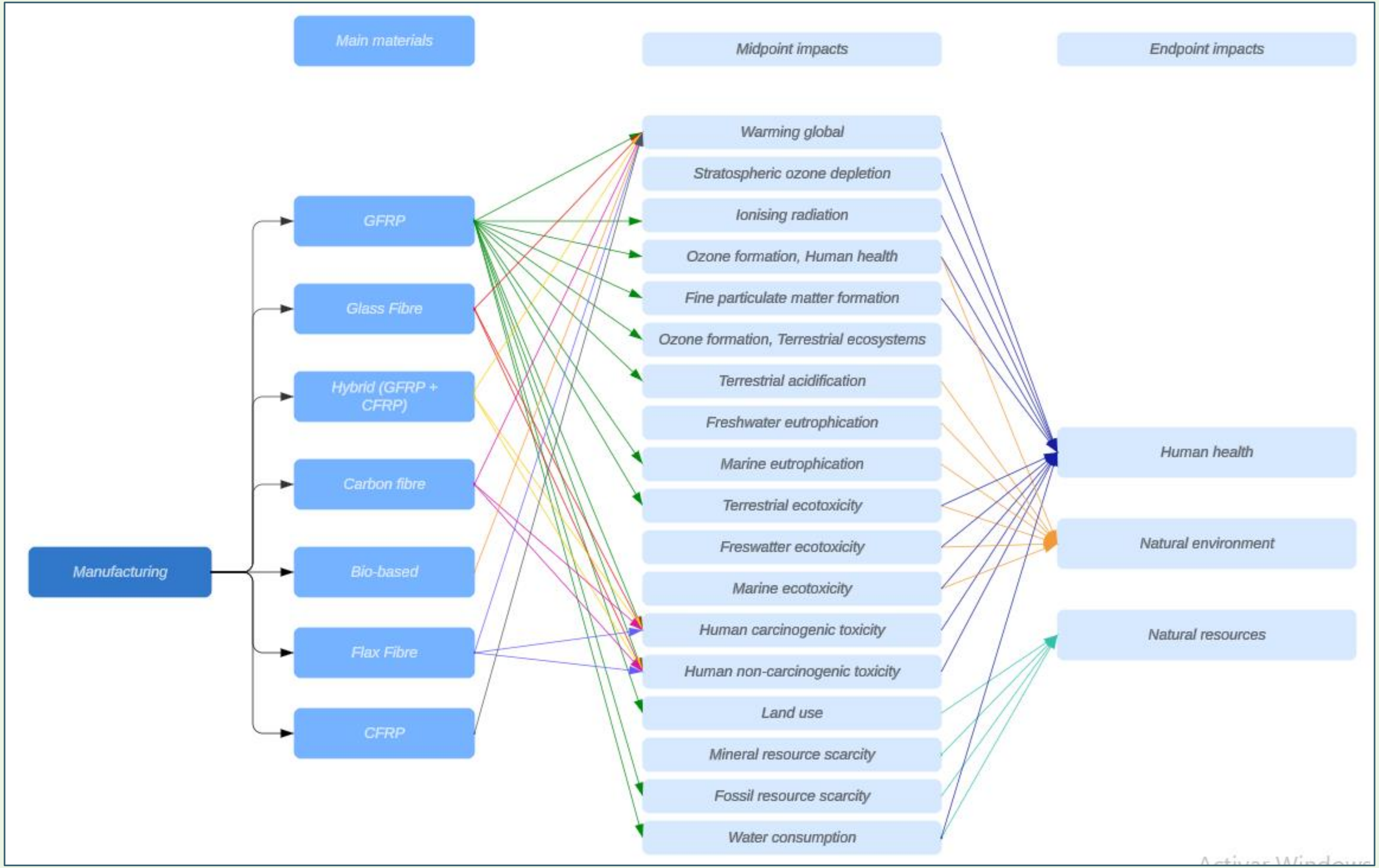


Figure 3. Relationship between major biological and composite materials and environmental impacts identified by the 18 midpoint and endpoint impact categories.

IMPACTS GENERATED BY

INSTALLATION, OPERATION, AND MAINTENANCE ACTIVITIES, DISMANTLING

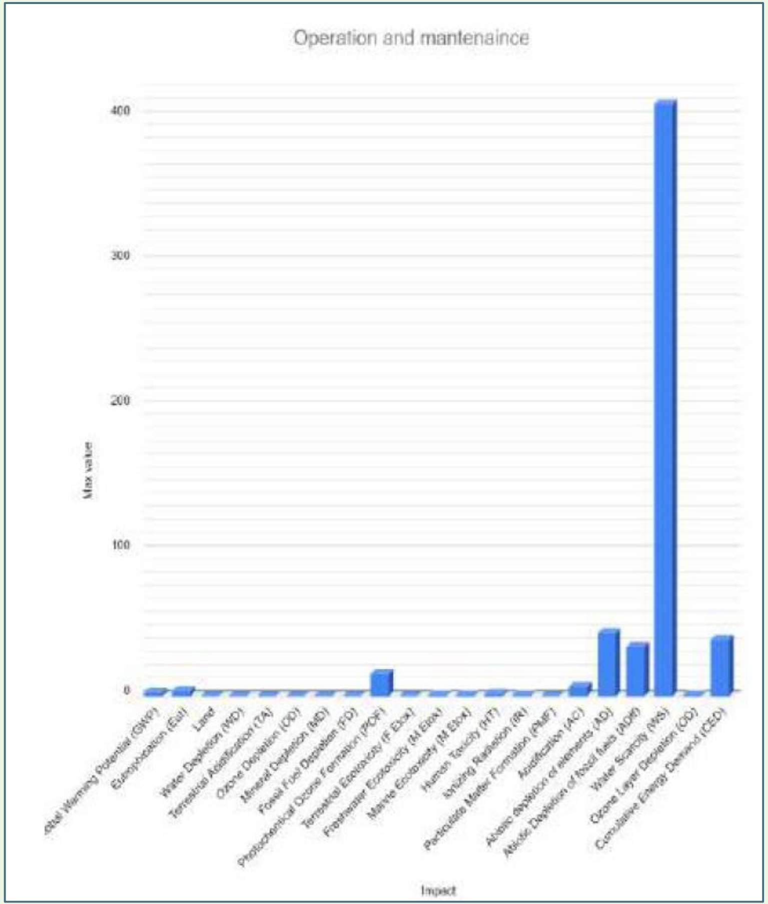


Figure 4. Impact produced by the operation and maintenance stage in the LCA of different marine technologies (i.e. naval, floating offshore wind, wave energy conversion).

IMPACTS GENERATED BY

INSTALLATION, OPERATION, AND MAINTENANCE ACTIVITIES, DISMANTLING

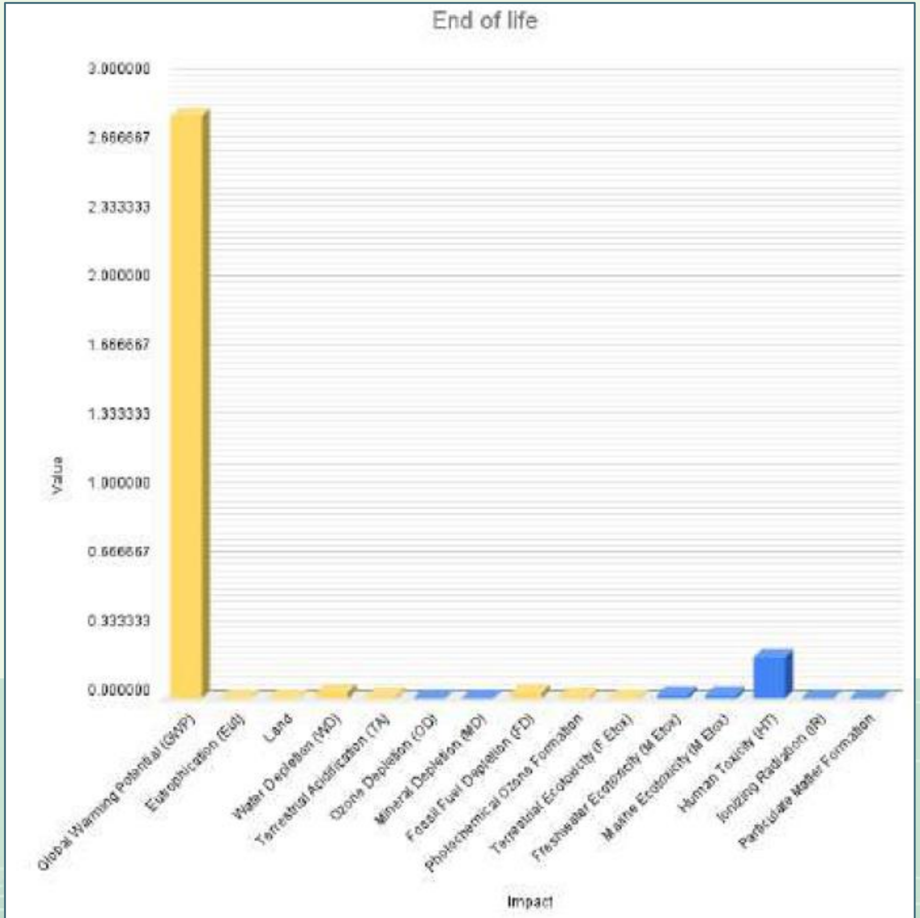


Figure 5. Impact of end-of-pipe stages on the LCA of wave energy conversion technology.

Note: The yellow bars indicate that the technologies evaluated in the Burgess and Biswas (2021) article are contributing to the reduction of the categories, while the blue bars indicate that the categories are contributing to the environmental impact.

CONCLUSIONS

Partial results to date indicate that the materials manufacturing stage is the main critical point in the life cycle of all marine technologies. The most representative materials impacting different categories are steel, copper, and GFRP.

It is important to note that, although copper constitutes a smaller proportion of the total weight of turbines compared to steel, it is the primary metal that can have negative impacts on eutrophication and toxicity ratings.

Biological materials are still under study; however, they have shown to be a viable alternative by generating lower emissions in some categories.

As for cast iron as a material, its contribution in all impact categories is less than 5%, so it is not attributed a significant participation in these categories.

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Thanks