Name: [redacted]

Reply to:

Consultation on the offshore renewable energy (ORE) Future Framework Policy Statement

Dear Minister Ryan & the Department of the Environment, Climate and Communications Team,

I hope this letter finds you well and thriving in your endeavours to steer our nation towards a more sustainable and environmentally friendly future. My name is [redacted], and I am currently a [redacted] at [redacted] pursuing an integrated master's degree in [redacted] with a major in [redacted].

In my academic journey, I have had the privilege of immersing myself in a variety of modules that are directly aligned with the critical environmental and energy challenges facing our society today. These modules include [redacted]. Through these studies, I have acquired a comprehensive understanding of the technical, economic, and social dimensions of sustainability and energy management. My education has equipped me with the analytical tools and innovative thinking necessary to contribute to the transition towards a low-carbon economy.

I am reaching out to you as a representative of the young, aspiring engineers of Ireland, who are deeply committed to applying our knowledge and skills to address the pressing environmental challenges of our time. My expertise, while still being honed through my studies, lies in the critical analysis of energy systems, the assessment of their environmental impact, and the development of sustainable solutions that reduce carbon footprints and enhance energy efficiency.

I believe that the knowledge and insights I have gained through my academic pursuits can contribute to the ongoing efforts of your department in crafting policies and strategies that are not only environmentally sustainable but also economically viable and socially equitable. It is my hope that through collaboration and dialogue, we can foster innovative solutions that will lead us towards a more sustainable future.

Kind Regards,

[redacted]

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Executive Summary

Main Findings and Recommendations on the Offshore Renewables Surplus Potential

WS3 – Renewable Hydrogen report:

- The document lacks comprehensive analysis on the water consumption associated with electrolysers for hydrogen production, despite their crucial role in the transition to renewable energy.
- There is a notable absence of environmental impact assessments regarding electrolyser technologies, which is essential for understanding the full implications of adopting hydrogen as a clean energy source.
- The document does not adequately address how water consumption will be balanced with the replacement of other carbon-emitting technologies, nor does it provide insights into the management of water resources during the transition to renewable hydrogen.
- Additionally, there is a lack of discussion on the potential need for additional water treatment volume to support electrolyser operations and mitigate any adverse environmental impacts

Supporting Information

Water Consumption and Electrolysis:

Hydrogen production via electrolysis requires high-purity water, where impurities can adversely affect the electrolysis process by depositing on the electrodes or membranes. The water quality requirements vary across different electrolyser manufacturers, but typically deionized water akin to Type I or II as defined by ASTM is necessary[1]. Electrolysis technologies, primarily, PEM, is used for green hydrogen production, as the least demanding technology, a significant number of 17.5l of water per kg of hydrogen is consumed with a total of 25.7l extracted from water bodies[2].

Environmental Impacts and Mitigation:

The environmental assessment of large-scale hydrogen production highlights the need for a careful examination of the impacts associated with water consumption. Hydrogen will be mainly produced via water electrolysis utilizing renewable sources such as photovoltaic, wind, hydropower, or decarbonized grid electricity. Although this process will have the potential to significantly reduce greenhouse gas emissions, it is imperative to consider the environmental burdens associated with water extraction, treatment, and the materials used in electrolyser construction, such as the scarcity of materials like iridium[3].

Water Treatment Needs for Electrolysis:

The selection of water sources is critical due to freshwater scarcity and the increasing vulnerability of water resources to climate change. The EU Water Framework Directive emphasizes the protection of water bodies, considering environmental objectives alongside the protection of water sources for various uses. This necessitates an integrated analysis, employing the Sustainable Value Methodology, to assess the suitability of water sources by combining technological, economic, environmental, and social criteria[1].

The transition towards sustainable hydrogen production through water electrolysis necessitates the exploration of innovative water treatment technologies and the utilization of non-traditional water sources. These approaches aim to meet the stringent purity requirements essential for electrolysis while mitigating the pressure on freshwater resources. This discussion delves into the potential of seawater desalination and recycled wastewater as alternative water sources, alongside the advancement of water treatment technologies that could enable their use in green hydrogen production.

Seawater Desalination:

Seawater desalination presents a promising solution for supplying the high-purity water required for electrolysis, especially in coastal regions where seawater is abundant. Modern desalination technologies, such as reverse osmosis (RO) and electrodialysis, have become more energy-efficient and cost-effective, making them viable options for large-scale hydrogen production. Reverse osmosis, for instance, can remove salts and other impurities from seawater, producing water of high purity.[2]However, the energy consumption of desalination and the management of brine disposal pose challenges that need careful consideration. Integrating renewable energy sources with desalination processes can further enhance the sustainability of this approach, aligning with the green hydrogen production ethos.

Recycled Wastewater

Utilizing recycled wastewater is another innovative strategy to secure water for hydrogen production without exacerbating freshwater scarcity. Treatment technologies such as advanced oxidation processes (AOPs), membrane bioreactors (MBRs), and ultrafiltration have demonstrated their effectiveness in purifying wastewater to levels suitable for industrial applications, including electrolysis[1]. This approach not only conserves freshwater resources but also contributes to a circular economy by valorising wastewater as a resource. The integration of wastewater treatment with hydrogen production facilities could streamline operations and reduce water-related costs, provided that regulatory and social acceptance hurdles are addressed. implications of freshwater and seawater usage for electrolysis:

Freshwater

1. Environmental Implications:

- Freshwater is a conventional source for electrolysis, requiring minimal treatment before use.
- However, its use can exacerbate water scarcity issues, especially in arid regions or during droughts.
- The environmental impact is related to the depletion of a precious resource and potential harm to ecosystems dependent on these water bodies[4].

2. Economic Implications:

- Treatment costs for freshwater are generally lower compared to other sources.
- However, beyond treatment expenses, freshwater allocation to industrial processes like hydrogen production can drive up costs for all users and lead to conflicts over water rights[4].

3. Social Implications:

- Freshwater use can lead to social challenges, especially where water scarcity affects human consumption, agriculture, and other critical needs.

- Prioritizing water use for hydrogen production may raise social equity concerns and opposition from local communities[4].

Seawater

1. Environmental Implications:

- Utilizing seawater for electrolysis, primarily through desalination, can reduce pressure on freshwater resources.

- However, desalination is energy-intensive and has significant environmental impacts, including the discharge of brine, which can harm marine ecosystems[5].

2. Economic Implications:

- Using seawater involves higher initial costs for desalination and water treatment infrastructure.
- Operational costs can be offset by the abundance and reliability of seawater supply.
- The overall financial feasibility depends on proximity to coastlines and availability of low-cost, renewable energy sources for desalination[2].

3. Social Implications:

- Seawater usage has fewer direct social implications compared to freshwater, especially in coastal regions where it doesn't compete with drinking water or agricultural needs[5].

Portuguese case studies-The Sustainable Value Methodology (SVM)[1].

Sustainable Water Value Indicator:

The Sustainable Water Value Indicator, a key component of the SVM, quantifies the suitability of water sources by balancing qualitative performance against assessed costs. This indicator merges water costs, with and without the inclusion of reverse osmosis treatment, with a qualitative index to form a composite measure of water source viability. The results, ranging from 0 to 100, alongside estimated costs in $€/m^3$, guide the selection of optimal water sources for specific sites.

Evaluation of Water Sources

The SVM approach has identified water from the public grid as the optimal source for hydrogen production via electrolysis for the studied sites, primarily due to favourable water supply charges and suitable water quality levels for industrial use. In contrast, seawater, despite its abundant availability, is deemed less suitable due to logistical, legislative, and economic challenges, particularly for sites distanced from the coast. However, for locations near the seacoast, seawater's value could improve when considering reduced transport needs and associated costs.

This methodology's application to two distinct Portuguese sites—a semi-urban location near the seacoast (site A) and a rural location distant from the sea (site B)—illustrates its utility in guiding water source selection. It incorporates considerations such as water quality, reliability, treatment requirements, permitting complexities, and associated costs. The comprehensive analysis facilitated by the SVM ensures that the chosen water sources for hydrogen production meet high purity standards and are economically and environmentally viable.

Recommendations

Implement Advanced Water Treatment Technologies:

Action: Invest in research and development of cutting-edge water treatment solutions like reverse osmosis (RO) and electrodialysis (ED) for seawater desalination and advanced oxidation processes (AOPs) for wastewater recycling. This will ensure the provision of high-purity water necessary for electrolysis without placing undue stress on freshwater resources.

Rationale: Advanced treatment technologies can efficiently convert non-traditional water sources to the purity levels required for electrolysis, reducing reliance on freshwater supplies.

Expand Use of Non-Traditional Water Sources:

Action: Develop pilot projects to assess the feasibility of using seawater and recycled wastewater in electrolysis for hydrogen production. This involves evaluating the cost, energy efficiency, and environmental impact of such initiatives.

Rationale: Leveraging abundant seawater and recycling wastewater can significantly alleviate the pressure on freshwater resources while supporting the scalability of green hydrogen production.

Life Cycle Assessment (LCA) for Water Source Selection:

Action: Conduct comprehensive LCAs to compare the environmental, economic, and social impacts of using different water sources for electrolysis. This assessment should include the entire lifecycle from water extraction, treatment, use in electrolysis, and any post-treatment requirements.

Rationale: LCAs provide a holistic view of the sustainability of using various water sources, guiding decision-making towards options with the lowest overall impact.

Sustainable Value Methodology (SVM) Application:

Action: Utilize the SVM to evaluate potential water sources for hydrogen production facilities, particularly in areas prone to water scarcity. This methodology should inform the site selection process for new electrolysis plants by balancing water availability, quality, and the socio-economic context.

Rationale: Applying SVM helps in identifying water sources that not only meet the technical and quality requirements for hydrogen production but also align with broader sustainability goals and local community interests.

Policy Development for Water-Efficient Electrolysis Operations:

Action: Collaborate with industry stakeholders to develop policies that encourage the adoption of water-efficient technologies in electrolysis operations. This could include incentives for using nontraditional water sources, guidelines for water reuse within hydrogen plants, and standards for minimizing water loss.

Rationale: Policy support is crucial for accelerating the adoption of sustainable practices in the hydrogen production industry, ensuring that growth in this sector does not compromise water security.

Stakeholder Engagement and Public Awareness:

Action: Engage with local communities, environmental groups, and the broader public to raise awareness about the importance of sustainable water use in green hydrogen production. This engagement should include transparent communication about water source selection, treatment processes, and environmental safeguards.

Rationale: Building public trust and gaining community support are essential for the successful implementation of projects that rely on non-traditional water sources, ensuring that these initiatives are socially acceptable and aligned with local values.

Conclusion

Addressing water consumption and management in green hydrogen production is vital for ensuring the sustainability of this emerging energy sector. By adopting innovative water treatment technologies, exploring non-traditional water sources, and applying comprehensive evaluation methodologies like the LCA and SVM, it is possible to minimize the environmental impact of hydrogen production. These efforts, combined with supportive policies and stakeholder engagement, will pave the way for a sustainable transition to a low-carbon economy, leveraging the potential of offshore renewable energy resources.

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