

Green Hydrogen: Pre-ESIA scoping of a Gigawatt-scale Project

Jay Wagner and Murray Jones, Plexus Energy¹

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Introduction

Green hydrogen - hydrogen produced by splitting water into oxygen (O₂) and hydrogen (H₂) through electrolysis using renewable energy (RE) - is touted as an essential fuel in the Energy Transition to help reduce CO₂ emissions. As the cost of production is largely a function of the availability of cheap solar and wind energy, countries well-endowed with RE potential stand to become key exporters of hydrogen and its derivatives.

To date attention of industry and regulators has largely been on the technical aspects of scaling up green hydrogen production to complement the Energy Transition. Comparatively less attention has been given to the environmental and social (E&S) aspects of the 'dash for green hydrogen'.

Producing green hydrogen at scale consumes vast amounts of electricity and water. Solar and wind energy projects require extensive areas of land and can result in significant impacts such as biodiversity loss, 'energy sprawl', visual and socio-cultural impacts and give rise to land use conflicts. Green hydrogen production also raises socio-economic issues including the benefits to local communities and exporting countries.

It is against this backdrop that a major green hydrogen investment was considered during 2023 at the pre-feasibility stage. Plexus was contracted, alongside a team of RE specialists, to carry out an early scoping study of the potential risks and benefits of developing a gigawatt-scale green hydrogen project in a remote location in the southern hemisphere. This paper discusses the key lessons from this study and examines the core E&S risks identified.

The Project

The Project involved the construction of hundreds of wind turbines, access roads and transmission lines, in addition to a hydrogen and ammonia production plant (HAP), and associated desalination, ammonia storage and transshipment facilities. The initially projected capacity in Phase 1 was >2 GW, rising to >7 GW over time.

The Project was located in a remote and sparsely populated coastal area characterised by open areas of land with easy access to (sea) water supply. Offering good opportunities for harnessing wind energy at scale, much of the land is made up of native grasses and low-lying vegetation, with the predominant land use being grazing. However, the site is situated in an area with significant deposits of peatland, and in close proximity to sensitive wildlife habitat.

Alongside the scale and E&S issues, the Project involved the recruitment of a workforce of up to 6000 during peak construction. Given the small population base and local capacity constraints - the local economy is largely based on fishing and tourism - this workforce would need to be brought in from outside.

¹ The authors are both Directors of Plexus Energy an environmental and social strategy and planning consultancy (www.plexusenergy.net)

Methodology

The scoping exercise started with a desk-top review of available information. This included consideration of a wide range of technical, economic and E&S issues. The Study was conducted on the basis of prefeasibility assumptions on the wind farm and the HAP. On this basis a constraints assessment was conducted.

The draft scoping report was used as a basis for early, limited discussion with government and the launch of the impact assessment (IA) process. Consultation would have refined the scoping exercise and proceeding to the Terms of Reference for an Environmental, Social, Health Impact Assessment (ESHIA).² As part of the E&S scoping exercise the following steps were taken:

- **Issue Statements:** An agreed format for two-page issue statements comprised: a) an issue description; b) an assessment of impact; c) an assessment of the likelihood of the risk materialising; and d) a conclusion characterising the overall risk.
- **Risk/Consequence Rating:** A system to categorize Impacts and Likelihood as High (H), Medium (M) and Low (L). An overall evaluation of Impacts and Likelihood was prepared to arrive at a single rating for each assessed 'Risk' (**Table 1**).
- **Risk Matrix:** The results of the issue statements were transposed onto a 3 x 3 Risk Matrix (**Figure 1**). Detailed mitigations were left to the ESHIA process.
- **Constraints Assessment:** Alongside the identification of potential E&S constraints, a technical and economic constraints assessment was undertaken, which looked at issues such as topography, optimal wind conditions, and hydrology.

Analysis

Eleven material E&S issues were identified, with the overall risk of the issue being made up of a single evaluation.

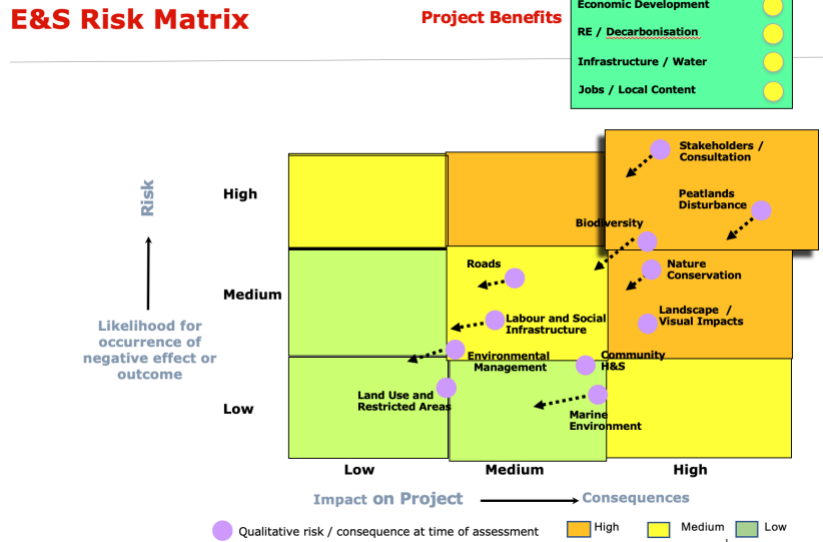
Table 1: Impact and Likelihood of Risks

	Impact	Likelihood
Land Use and Restricted Areas	L/M	L
Peatland Disturbance	H	H
Biodiversity	H	M/H
Landscape and Visual Impacts	H	H
Stakeholders and Consultation	H	H
Community Health and Safety	M/H	L
Environmental Management	M	L
Labour and Social Infrastructure	M	M
Marine Environment	M/H	L
Nature Conservation and Protected Areas	H	M
Roads and Transport	M	M

Green: minor impact; Orange = moderate impact; Red = high impact

² The term ESHIA (Environment, Social and Health Impact Assessment) is used to connote a full, integrated impact assessment.

Figure 2: E&S Risk Matrix



For illustrative purposes, three of the above-mentioned issues are summarised below.

Impact on Peatlands

Peatland ecosystems are carbon sinks of global significance. Although they cover a mere 3% of the land's surface, it is estimated that peatlands worldwide store around 415 gigatons of carbon³, more than the carbon stored in all other vegetation types.⁴ Degraded peatland, on the other hand, can emit more CO₂ than it removes.

Relative to the land required, the Project area is believed to hold one of the largest stores of peatland carbon in the world. The peatlands in the project location are relatively undisturbed but there have been impacts from grazing, peat use and poor land management. Any disturbance of peat, however, is a potential source of greenhouse gas emissions, with some studies having found that peatland windfarms may not be carbon neutral.⁵ The main source of such disturbance is the network of access roads for construction and maintenance. Other impacts on peatlands include loss of biodiversity, loss of peatland habitat and breakdown of the ecosystem services that peatlands provide.

On this basis it was concluded that the Project had a potential to create significant disturbance to peatlands with likely high environmental consequences. **The risk to was classified as high.**

Biodiversity

Although there are no protected areas in the Project area, the adjacent coastal zone is an important wildlife habitat supporting globally significant populations of land and sea birds, as well as marine mammals. The wider project area is also known for its unique wildlife and relatively untouched natural

³ Thus is equivalent to 46 times the global CO₂ emissions in 2019.

⁴ UNEP, Global Peatlands Assessment: The State of the World's Peatlands – Evidence for Action towards the Conservation, Restoration and Sustainable Management of Peatlands, 2022 ([https://peatlands.org/peatlands/where-can-peatlands-be-found/#:~:text=Estimated%20peatland%20area%20accounts%20for,\(Joosten%20%26%20Clarke%202002\).](https://peatlands.org/peatlands/where-can-peatlands-be-found/#:~:text=Estimated%20peatland%20area%20accounts%20for,(Joosten%20%26%20Clarke%202002).))

⁵ A Shephard, S.Roberts, G. Sünnerberg, A. Lovett, A.F.S. Hastings, Scotland's onshore wind generation, impact on natural capital & satisfying non-nuclear energy policy, *Energy Reports* 7 (2021), 7106-7117; UNEP (op.cit.).

environment. This aspect is particularly important as windfarms and high voltage transmission lines have potential negative effects on avifauna, including habitat loss and mortality due to collision and electrocution.

Further, it was found that there are several species of endangered fish in freshwater and brackish estuaries and brooks in the wider Project area. These are important considerations in regard to the siting of wind turbines, their number, spacing and proximity to sensitive receptors such as bird nesting areas and flight paths. **The risk to biodiversity was thus rated as high.**

Landscape, Visual and Spatial Impact

The Project area is flat and characterised by open landscapes with large zones of visibility. This means that the turbines (with hub-height of 100+) and transmission lines would be visible from a distance, resulting in a change in character of the landscape which could affect the local community's 'sense of place'. Notwithstanding that the area is sparsely populated, the scale and potential visual impact of the Project would likely result in changing the character of the area and on this basis it might face public acceptance challenges.

Another aspect of particular importance is the spatial footprint of the venture. For the initial phase of the project (>2 GW), 350 5-MW wind turbines would be required. With a 1km² buffer zone around each turbine, an area of approximately 35,000 ha, rising to >120,000 ha 7 GW (>1000 turbines) in subsequent phases. In addition, the construction of access roads has ecological impacts, with any disturbance of peatlands having the potential to cause the peat to dry out and release carbon.⁶ Similarly, the HAP (covering of >15km²) and associated hydrogen and ammonia storage facilities have a significant spatial footprint. **The landscape and visual impact risk of the Project was thus rated as high.**

Stakeholder and Public Consultation

Stakeholder consultation is neither an impact nor a risk. However, it is essential in decision-making and a core mitigation measure. Typically, perceptions are formed very early in the process as the public becomes aware of a project. The extent to which real and perceived impacts can be avoided and/or mitigated and local communities receive tangible benefits from the project is thus crucial. Meaningful engagement would be seen as essential in terms of securing the social acceptance of the project, not least given the visual and structural changes associated with the development.

With an economy dependent on fisheries and tourism, where income can vary significantly, a project of this nature could provide a significant economic opportunity. Consideration was thus given to establishing a partnership model, based on a sustainable and substantial contribution to local economy and GDP to ensure the delivery of tangible benefits. Necessarily, these benefits would be weighed by the government and the local community against the anticipated impacts of the Project. **The importance to the Project of a community engagement lens was rated as high.**

Discussion

Low carbon hydrogen can be an excellent source of clean energy and help to combat climate change. Production of green hydrogen can also be an economic opportunity for many countries. However, there

⁶ <https://www.iucn-uk-peatlandprogramme.org/sites/default/files/2023-03/Peatland%20and%20Development%20March%202023%20-%20FINAL.pdf>

are important E&S, governance, and techno-economic considerations that need to be taken into account from the earliest stages of planning, not least in view of the footprint and conversion issues involved in green hydrogen and ammonia production.

There are also important safety aspects which need to be considered as hydrogen is a flammable gas with relatively low ignition energy. However, it is the scale of green hydrogen projects, such as this one, that need to be understood. While green hydrogen does not produce emissions at the point of production, the energy needs of electrolyzers and the inherent conversion losses, coupled with factors such as location and distance to market, dictates significant economies of scale which means that for green hydrogen projects to be economically viable they need to be very large.

Producing electrolytic hydrogen also requires considerable amounts of water. Depending on the location, this likely requires a desalination facility, which raises issues in terms of energy consumption, siting and brine disposal. Further, the need to bring in up to 6000 workers during the construction phase raises labor influx and associated social, cultural and environmental issues.

Conclusions

One of the most important features of the Study was the close collaboration between E&S specialists and the technical wind energy and HAP experts from the earliest stages of the process. This approach was invaluable and enabled the timely identification of key E&S and economic issues and influenced decisions in relation to the design, siting, scale, economics and feasibility of the project.

Given the identified E&S issues and marginal economics, a decision was made to not proceed. The project nevertheless provides an example of some key issues involved in large-scale green hydrogen projects and underlines the value of early, integrated E&S and techno-economic pre-feasibility risk assessments of RE developments. Key lessons include the following:

1. As with any major project, RE projects require an **early** start in investigating impacts and benefits.
2. Major RE projects have a large footprint and impact on other land uses.
3. Because a project is delivering RE does not mean it can be assumed to be 'green' and public acceptance and regulatory approval by government cannot be taken for granted.
4. RE projects must deliver local benefits. This must be based on meaningful engagement and a transparent approach to identifying, communicating and managing project risks and benefits.
5. 'Green Hydrogen' projects need to prove they are providing overall net benefit which varies depending on local circumstances.
6. Early identification of key issues provides transparency for discussion and elaboration with government and stakeholders and helps to identify key issues to be addressed during the ESHIA.

From a risk management perspective, early scoping and pre-feasibility integrated E&S and techno-economic risk assessments are a recommended practice and can help to identify E&S risks and benefits, including potential red flags, and inform the scope and conduct of the ESHIA.