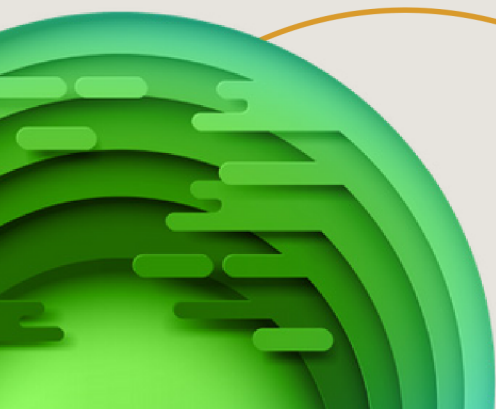





Green Hydrogen White Paper

6 Core Considerations to Keep Your Project on Track





The drive to decarbonise is ushering in new ways to produce hydrogen.

Traditionally hydrogen has been produced for heavy industry by industrial gas suppliers; with supplier and user often in close proximity. Green hydrogen allows for more distributed production in more diverse locations, serving a broadening client base.

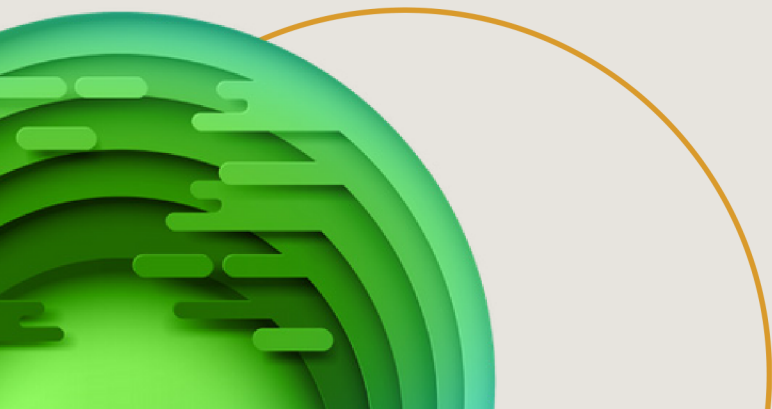
This has heralded a slew of new projects - many first-of-a-kind - and new entrants into the hydrogen market. Many renewable energy companies seeking to participate in the burgeoning hydrogen economy are among the new entrants.

As we help organisations bring green hydrogen projects to fruition, we have identified six core considerations that require serious attention in a project's earliest stages to ensure a successful outcome.

1 Have a clear understanding of what to do with your green hydrogen

For owners and developers of renewable energy projects, green hydrogen offers an attractive alternative to selling power, especially in light of the forecasted growth in demand for green hydrogen. But a clear understanding of the short-to-medium-term market for the chemical is needed, which considers both local demand and markets further afield. This analysis should encompass level of demand, types of use, and the relationship between patterns of demand and your hydrogen production profile. The latter factor will influence areas such as the project's hydrogen storage capacity as well as potential customer base.

Options for transporting hydrogen is another factor that supports an understanding of how a project's product can be used. Although the prospects for green hydrogen consumption are incredibly strong, demand in many areas is currently low. However, this will almost certainly alter the rate of change that needs to be factored into a project's business plan. We found that local market characteristics for one green hydrogen project, for example, meant that converting green hydrogen in situ to green ammonia resulted in a more commercially-viable product.



2 Understand the cost of your product

Include in your planning levelised cost of energy analysis and levelised cost of hydrogen analysis, or a commitment to undertake them. Doing the research to ascertain your energy costs and a per kilogramme cost for your product will inform the creation of an accurate and robust business plan – an understanding of the price points required to reach your business goals.

There are two physical hydrogen storage options, compressed or liquefied. Due to the fact that your choice of storage option will have significant implications on project cost and end-use opportunities, storage needs to be given careful consideration during the very early stages of project development. A business plan including these types of detail will help attract and reassure investors.

Our real-world hydrogen experience

Black & Veatch is building 365MW of electrolysis capacity across three projects, all scheduled for commercial operation before 2025. Our projects are more than doubling the world's electrolysis capacity.

3 Be sure water resources are sufficient to support your ambitions

An abundant and reliable water supply is essential for green hydrogen production. High-purity water is one of the feedstocks needed for electrolysis. The quantity of water consumed will be different depending on the application, but roughly 9,800 litres of demineralised and deionised water is required for each tonne of green hydrogen produced. In addition to being a feedstock, water is also necessary for cooling the electrolyzers and other equipment such as compressors. It is vital to know if sufficient water is available to support the capacity of electrolysis planned.

4 Consider early on how to ensure your project is safe

Safety considerations are vital for a green hydrogen project. From the project's earliest phases onwards, safety compliance has to be integrated into planning. Safety compliance is a potentially steep learning curve for green hydrogen projects because they are a fast developing area, many aspects of which are not yet covered by designated safety regulations. Instead, in many areas existing codes and regulations are being applied to projects for which they were not originally designed. Actions and requirements are not always explicit, and in comparison to more established types of project, more time and effort is required to understand what compliance entails.

Developers and owners need to establish a full and clear understanding of what health and safety regulators want to know in order to authorise project construction and operations. In our experience, for example, understanding how the requirements of the Control of Major Accident Hazards (COMAH) regulations apply to green hydrogen projects requires a significant amount of time and attention. The amount of hydrogen being stored, for example, has a significant effect on the measures the regulations require, and thus influences other elements of the project. COMAH regulations apply within the European Union and many other European countries.

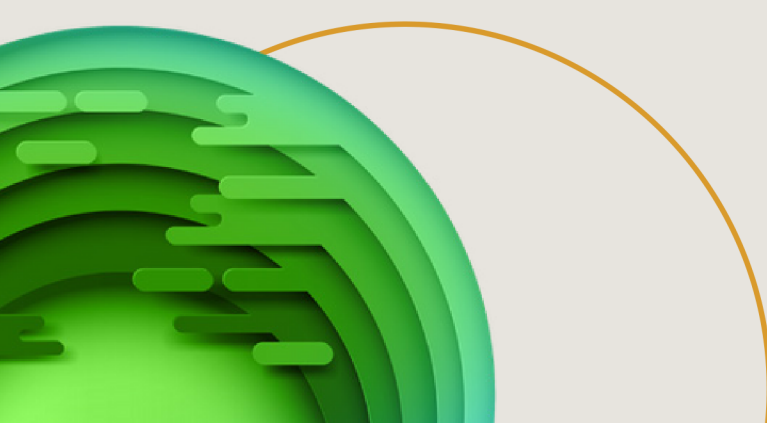
5 Engage the public early for dividends down the line


Making stakeholders aware of your intentions early in the development of a green hydrogen project will give you early insight into concerns that may potentially disrupt progress. More importantly, it will give you time to address concerns before they become a major issue. You will have the opportunity to engage, inform and influence parties with reservations about your project and, if necessary, amend your plans to ameliorate those reservations at a time when change will engender fewer disruptions. This is an opportunity to show how you are supporting the drive to decarbonise; and reassure communities that hydrogen production, storage and distribution are tried and trusted processes – you are bringing a proven technology to a new setting.

6 Establish the right balance between power output and electrolyser capacity

You are confident of your windfarm's or solar array's 100 megawatt (MW) capacity rating. But does this mean 100 MW of electrolyser capacity is the best business choice? On this basis maximum electrolysis can only be achieved when maximum power generation is being achieved, which with intermittent renewables will not be possible consistently. Hydrogen production calculations need to take this into account in order for customer expectations to be met, and to avoid unprofitable levels of redundant electrolyser capacity. Conversely, curtailment will be necessary if electrolyser capacity is significantly lower than typical power output. This will have a potentially adverse effect upon the cost of hydrogen production because that cost is highly dependent upon the cost of energy – which is increased when energy is wasted. Thus, it may be worth calculating not just energy yield, but the generation profile.

The ability to export surplus power to the grid will help address the power and revenue loss that curtailment may cause, but the location of many renewable assets means grid interconnection is not a viable prospect. For both scenarios, battery storage has a potentially valuable role to play. Ultimately, a trade-off between capital and commercial considerations is required to ascertain the optimal configuration for achieving the project's business goals.





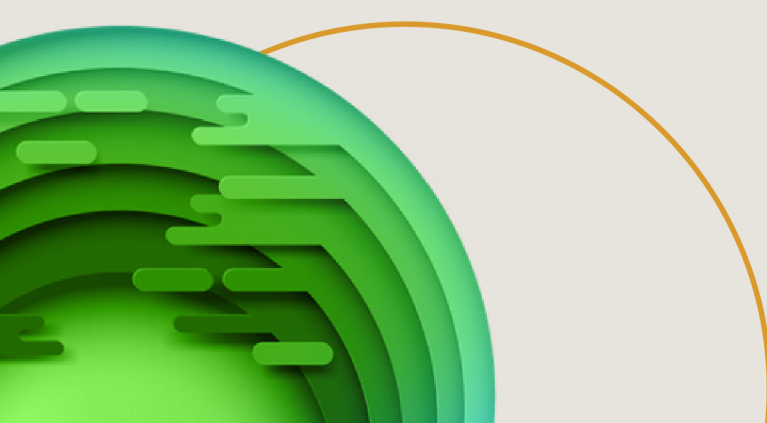
Want to know more?
Contact our team or
visit bv.com.

If you would like to learn more about the ways in which our experts can help your green hydrogen projects succeed, please contact our team:

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