COMMENTARY

HYDROGEN: 10 QUESTIONS CEOS AND THEIR BOARDS MUST ASK BEFORE INVESTING

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Marakon
Management Consulting at
Charles River Associates

We are witnessing a great deal of renewed enthusiasm for hydrogen as a major element of a clean energy future. While versions of the so-called “hydrogen economy” have come and gone without much traction, this time could be different given how the energy, policy and technology landscapes have changed over the last decade. Increasing commitments to net zero carbon by 2050, and the recognition that these commitments cannot be achieved through electrification alone, give alternative clean fuels such as hydrogen a potentially major role in the energy transition.

Recent narratives and actions of governments, companies and investors around the world certainly point to expectations of a lot of resources (time, money and human capital) being invested into what is commonly known as blue and green hydrogen development.[1] But do the fundamental economics support these investments? And how can CEOs and their Boards contemplating investments be confident they are staying true to the promise of being good custodians of investors’ capital?

The market for clean hydrogen remains nascent and has many uncertainties. There are undoubtedly compelling opportunities, such as decarbonising the current hydrogen production chain which is produced almost entirely using fossil-based fuels. Other opportunities include storage solutions to deal with intermittent renewable supply and as a clean fuel for industrial sectors that are difficult to decarbonise via electrification. Improving electrolysis technology will be a critical driver of green hydrogen growth, and while capital costs are too high today, there is scope for substantial cost reduction through economies of scale as we have seen with solar, wind and batteries.

But challenges remain. Hydrogen’s physical properties make it an inefficient energy carrier relative to other fuels. Under some circumstances, it can take more than two units of energy input to create a single unit of hydrogen energy at the point of use. Moreover, the distribution of hydrogen at scale requires establishing new, costly infrastructure, presenting one of the largest barriers to the more optimistic forecasts of hydrogen’s potential usage. (See Appendix for an overview of hydrogen’s benefits and limitations.)

STATE OF PROGRESS AND ECONOMICS

Early-stage demonstration and pilot projects are underway, and more are making their way through the business case and investment appraisal processes. For example, in Europe electrolyser projects linked to offshore and onshore wind, such as those in the coastal areas of Belgium, the Netherlands, Germany and Denmark, are at least in the feasibility study phase. And in the US, the Department of Energy is supporting demonstration of high- and low-temperature electrolysis at select nuclear reactors to produce hydrogen at scale.

For large energy providers often at the centre of these projects, the economics are modest at best with project returns in the medium single digits, and many have negative net present values (NPVs) given the application of corporate cost of capital. Surprisingly, these economics are poor despite the fact that they often include some sort of government subsidy provided by tax incentives or grant funding.

As with other early-stage technologies, the value chain needs to be understood in greater detail to make sense of the economics. Often, it is the “pitch and shovel” companies that find ways to extract value even in early-stage projects by providing engineering services, financing or component pieces that enable the projects. Larger energy providers that own and operate the assembled assets are often left with little or no value creation. Therefore, they must take a more strategic and longer-term view to justify their investments.

[1] Definitions:

- Grey Hydrogen: widely used in oil refining and fertiliser manufacture; generally manufactured from methane (via Steam Methane Reforming) or coal, producing substantial quantities of CO_2
- Blue Hydrogen: manufactured from methane, but with addition of Carbon Capture and Storage to create hydrogen that is largely carbon-free
- Green Hydrogen: manufactured from power via electrolysis; if the power is carbon-free then the hydrogen is “green”

QUESTIONS TO ASK BEFORE INVESTING

Despite the uncertainties, the space is too important to be ignored. CEOs and their Boards should consider opportunities but also apply greater scrutiny to avoid moving too fast and too far in front of economic viability and demand.

CEOs and their Boards with investment opportunities need to consider 10 key questions before committing material time, money and human capital.

1. **What is the role of hydrogen in the long-term enterprise strategy and is the pathway for development clear and coherent?** What is the role of any viability/demonstration project for the longer-term strategy? Is the “cart” being put well before the “horse?”

2. **How does hydrogen compare to alternatives?** Is the hydrogen investment case clear and compelling relative to alternatives that might create the same outcome in the context of the longer-term strategy (e.g., to develop potential storage solutions, to enhance utilisation of existing assets)?

3. **Is it better to be a fast follower?** Who else is pursuing similar investments, and what are the trade-offs of moving faster to lead the market versus being a fast follower?

4. **Is internal momentum driving decisions?** To what extent is decision-making influenced by internal enthusiasm, lobbying and momentum? Is this potentially clouding objectivity?

5. **Where should the focus be along the value chain?** What do the current assets and capabilities imply about where to focus? Where does it make sense to partner, and how do you determine the right partner? What strategic acquisitions could increase the odds of success?

6. **What is the path to value creation?** Is it clear what needs to happen, from internal and external factors, for the investment to create value over time? What commercialisation model will be used, and what customers are being targeted? Are there “tangential benefits” that can/need to be quantified?

7. **What is the funding strategy?** Where should the funding come from, e.g., from a ring-fenced “innovation” fund? When does it make sense to pursue regulated investments (e.g., capitalised in the rate base of a utility) versus non-regulated?

8. **Should there be a different set of investment criteria?** Have the right criteria been defined to support the investment evaluation process to ensure hydrogen-related investments align with broader strategic, financial and sustainability objectives?

9. **Are the safety and operational aspects of hydrogen production, storage, transmission and use fully understood?** Hydrogen has some uniquely challenging physical characteristics. Is the company equipped to manage these risks?

10. **What is the exit plan?** What are the decision points for exiting the investment? Is there clarity on how to execute the exit?

Many CEOs feel pressure to participate in clean hydrogen to avoid being seen as “back-footed” or to demonstrate they are investing in “innovation.” Depending on the company context, it could make sense for some to invest early in the “S-curve,” while a fast follower model may prove more prudent for others. However, the reality is that hydrogen is not a “miracle fuel,” and the nature of the space requires all business leaders to adopt a deliberate investment decision-making approach and ask the right questions, while building in degrees of flexibility to ensure they can navigate towards a commercially viable business model.

APPENDIX: CLEAN HYDROGEN OVERVIEW

Potential Benefits of Clean Hydrogen	Challenges and Limitations
• Physical properties of hydrogen mean it is free of all pollutants at the point of use, with water the only byproduct • Scope to reduce CO_2 emissions by more than 800 MT/year through decarbonisation of the current hydrogen production chain (current production of ~70 MT/year hydrogen globally) • One of the few storage solutions for dealing with the increasingly intermittent renewable supply (along with pumped storage and batteries) • Allows for decarbonisation of the "hard to reach" areas such as industrial heat and domestic and commercial space heating as well as long-haul heavy transport (aviation, marine transport, heavy duty trucking) • Provides longer duration storage relative to batteries, and in the application to transport, it can offer advantaged vehicle range and more rapid refuelling • Scope to create marginal improvements in carbon intensity of existing natural gas systems through some mixing of clean hydrogen	• Physical properties also make hydrogen inefficient in its use of energy in production, transmission and distribution. Under some circumstances, it can take more than two units of energy input to create a single unit of hydrogen energy at the point of use. • Clean hydrogen ("blue" and "green") is currently substantially more expensive than fossil-fuel-based hydrogen production methods. Incentives such as a carbon tax and clean fuel standards will be necessary for large scale uptake. • Energy losses associated with green hydrogen manufacture and then conversion back into power are considerable and may present a real barrier to widespread deployment. Also, the economics of electrolysis are dominated by two factors in addition to electricity costs: (i) the current high capital costs of electrolysers; and (ii) the load factor of the electrolyser. • Establishing a new hydrogen infrastructure will be challenging and costly. As one example, the low volumetric heat content of hydrogen (more than three times lower than natural gas) means that much higher volumes, and therefore larger pipes or more compression, will be required if hydrogen is used as a substitute for natural gas.

Written by:
Neal Kissel
Managing Director, London
nkissel@marakon.com
+44-20-7664-3727

Anthony Meggs
Senior Advisor
meggst@mac.com

Quan Li
Principal, London
qli@marakon.com
+44-773-834-9170

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