

DELTA-EE

Shining the light on clean hydrogen

Delta-EE whitepaper
June 2021

Written by: Robert Bloom
Jon Slowe jon.slowe@delta-ee.com

Report reviewed by: Andy Bradley Andy.bradley@delta-ee.com

Date of issue: 01/06/2021

Delta-EE is a leading European research and consultancy company providing insight into the energy transition. Our focussed research services include Connected Home, Electrification of Heat, Electric Vehicles, New Energy Business Models, Digital Customer Engagement and Local Energy Systems. We also provide consultancy for clients including networking companies and policymakers. Delta-EE's mission is to help our clients successfully navigate the change from 'old energy' to new energy.

Delta address and contact details

Edinburgh: Floor F Argyle House, Lady Lawson Street, Edinburgh, EH3 9DR, UK +44 (0)131 625 1011

Cambridge: Future Business Centre, Kings Hedges Road, Cambridge, CB4 2HY +44 (0)1223 781 605

London: Sustainable Workspaces, 25 Lavington Street, London, SE1 0NZ

Paris: 2 Boulevard de Strasbourg, 75010, Paris, France. +33 6 51 33 73 74

Copyright

Copyright © 2021 Delta Energy & Environment Ltd. All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means electronic, mechanical, photocopying, recording or otherwise without the prior written permission of Delta Energy & Environment Ltd.

Unless otherwise credited all diagrams in this report belong to Delta Energy & Environment Ltd.

Important

This document contains confidential and commercially sensitive information. Should any requests for disclosure of information contained in this document be received, we request that we be notified in writing of the details of such request and that we be consulted and our comments taken into account before any action is taken.

Disclaimer

While Delta Energy & Environment Ltd ('Delta-EE') considers that the information and opinions given in this work are sound, all parties must rely upon their own skill and judgement when making use of it. Delta-EE does not make any representation or warranty, expressed or implied, as to the accuracy or completeness of the information contained in the report and assumes no responsibility for the accuracy or completeness of such information. Delta will not assume any liability to anyone for any loss or damage arising out of the provision of this report.

Where this report contains projections, these are based on assumptions that are subject to uncertainties and contingencies. Because of the subjective judgements and inherent uncertainties of projections, and because events frequently do not occur as expected, there can be no assurance that the projections contained herein will be realised and actual events may be difference from projected results. Hence the projections supplied are not to be regarded as firm predictions of the future, but rather as illustrations of what might happen. Parties are advised to base their actions of an awareness of the range of such projections, and to note that the range necessarily broadens in the latter years of the projection.

Clean hydrogen: what's driving the excitement?

For years hydrogen was on the edges of the energy transition. In the last few years, it has appeared on the main stage. Why? And will it stay there?

First, let's look at why. There are four reasons.

1. **Decarbonisation ambitions moving from significant reductions in carbon emissions to a net-zero future.** In a world of 80% carbon reductions, it was possible for a sector to say, “we'll decarbonise to a point, but other sectors must decarbonise more”. This is no longer possible. Hydrogen is a key solution for several very-hard-to-decarbonise sectors, and perhaps more.
2. **The rise of whole-energy system thinking as renewable electricity generation and direct electrification gathers pace.** In a world that is much more reliant on electricity, cross-vector thinking and flexibility is rising up the agenda. Hydrogen, and its interface with other energy vectors can help to smooth out some of the peaks and troughs, network and system operation challenges, in a more electrified future.
3. **The potential shown by green hydrogen –** based on its pure low carbon credentials compared to blue hydrogen, its ability to provide flexibility to the energy system, the ongoing falling costs of renewable electricity, and the potential dramatic cost reductions promised by electrolyzers.
4. **The drive shown by the gas industry for low and zero carbon gases –** as the only way for it to play a significant long-term role in a net-zero future.

The coming together of these four factors has resulted in a huge wave of interest in hydrogen as it moves from the fringes onto the main stage. National governments and regions are putting forward targets and strategies – and the money to back them up.

Will hydrogen stay on the main stage of the energy transition?

In short, yes. But the size of its presence is hotly debated, with some very different views.

Two points are clear, in our opinion.

- **It has a clear role to play in hard-to-decarbonise sectors** – for example used directly in process industries that require high temperature heat, process industries that use hydrogen as a feedstock, or parts of the transport sector. There simply aren't that many practical alternatives to hydrogen or hydrogen-derived fuels in such sectors.
- **Hydrogen is unlikely to be the solution for us to continue using gas in all the ways we currently do.** It will be a very long time, if ever, before it is available at the right cost and scale to completely decarbonise all current uses of natural gas. Betting our ability to hit our net-zero targets on a simple transition from natural gas to hydrogen is a very risky strategy and must not distract us from more immediate action.

It is the large areas between these extremes where the debate is so heated. Where is direct electrification feasible and desirable – and where is hydrogen a better answer than electrification? Where do whole energy system challenges tilt the playing field to hydrogen? To some, this is a battleground between the two.

Our view, based on our in-depth analysis is:

- **Direct electrification is the most obvious way to decarbonise – wherever it is practical and possible.** It is clearly the most efficient approach on a 'well to wheel' basis. We will find it is practical and possible in more and more applications, but there are and will be limits.
- **The more you electrify, the greater the need for capacity and flexibility in the electricity system** – for networks, system operation, as well as balancing generation and demand. Demand response and batteries will play a big role as the electricity system learns to cope with the challenges of electrification, but more will be needed, for example with longer duration flexibility. Hydrogen is part of the answer. This will come in many forms from large salt caverns to distributed hydrogen fuel cells.
- **Hybrid solutions have a clear role to play.** Heating buildings is one of the best examples: hybrid electric – hydrogen heating systems, running on electricity for much of the time but with hydrogen to help meet the demand and energy system peaks.
- **In certain applications** – such as heavy goods vehicles and some types of buildings – **the challenges for direct electrification will likely mean hydrogen has a role to play.** There is still much more learning – and likely roles for both approaches in these types of sectors. Using hydrogen as efficiently as possible in these applications will be critical.

So where exactly will the line between direct electrification and hydrogen lie? Indeed, is it a line or should we thinking more about the two working together? If so, where and how? This is and will continue to be an ongoing focus of our research. The answer lies in better understanding of the applications, the customer proposition, and whole energy system thinking. And policy: future government policy will be critical in determining which of the many scenarios out there will be correct.

To understand hydrogen's role on the main stage, it's natural to explore future scenarios – but important to have a laser-like focus on how hydrogen can deliver outcomes for customers, communities, and the whole energy system.

What is the market for clean hydrogen today?

The Cambridge English Dictionary defines a market as follows:

*the people who might want to buy something, or a part of the world where something is sold
the business or trade in a particular product.*

In short, there is hardly a market at all for clean hydrogen today. Demand for clean hydrogen needs to be created.

- Existing hydrogen demand is largely from the refineries and ammonia production sectors. These industries are today, in the main, focused on buying or producing hydrogen per se rather than more expensive clean hydrogen.
- New demand for clean hydrogen is emerging, but in very early stages. Nearly all demand today has been stimulated by public funding to varying degrees, to overcome real and perceived risks, and the current high costs across much of the clean hydrogen value chain.

Figure 1: Green Hydrogen Demand for live electrolyser projects in Europe (Tonnes / year)

Demand from projects built in the last ten years is largely found in industry and transport applications. Transport projects are spread across many countries, whereas most of the industrial projects are found in Germany and Austria. Note that the supply of clean hydrogen to heat is almost completely based on blending hydrogen into the natural gas network.

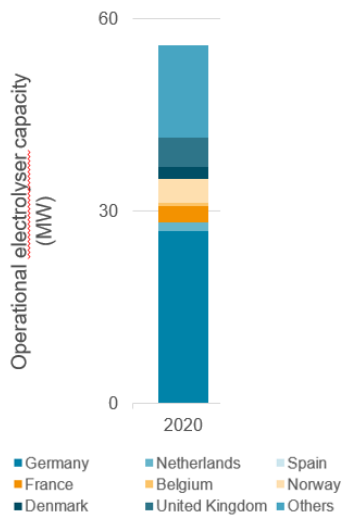


Source: Delta-EE Clean Hydrogen Database

Most of the current hydrogen activity, in terms of capacity, is found in Germany as shown below.

Figure 2: Live electrolyser projects in Europe, installed capacity by country

Almost half of the European electrolyser capacity deployed in the last ten years is in Germany.



Source: Delta-EE Clean Hydrogen Database

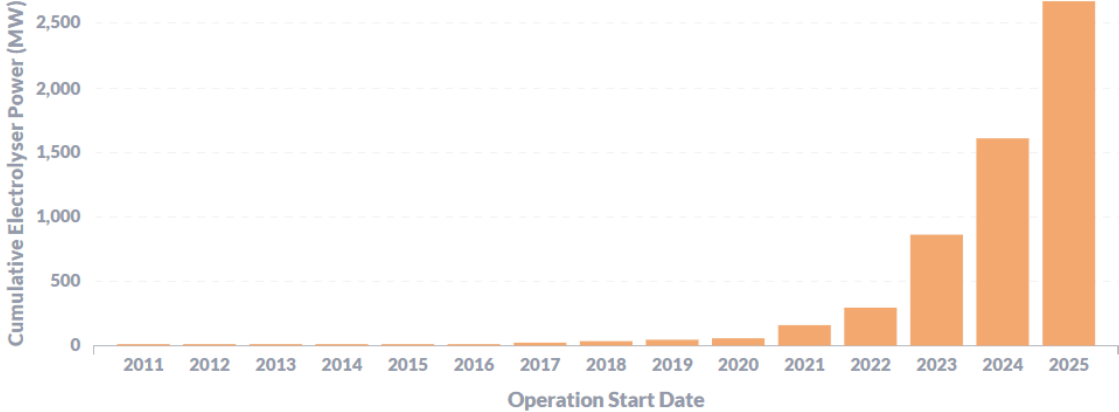
Clean hydrogen is not cost competitive against more carbon-intensive hydrogen today. And the economics of displacing other fuels using clean hydrogen (including value from flexibility) are generally not compelling.

It is the promise of both of these changing that is seeing exponentially growing activity in the market today. It is Europe where clean hydrogen activity is growing the fastest, backed by public funding for decarbonisation, trials, demonstrations, and even early commercial projects. Almost all of this is being met by production of green hydrogen.

The exponentially growing pipeline for electrolysers producing green hydrogen is shown in Figure 3 below.

Figure 3: European Electrolyser Pipeline to 2025

Capturing live projects commissioned since 2011 and clearly defined announced projects, our pipeline estimates cumulative capacity since 2011 reaches 2.7 GW by 2025 – some way below the European Union’s target of 6 GW by 2024, but with time still for more projects to be added.

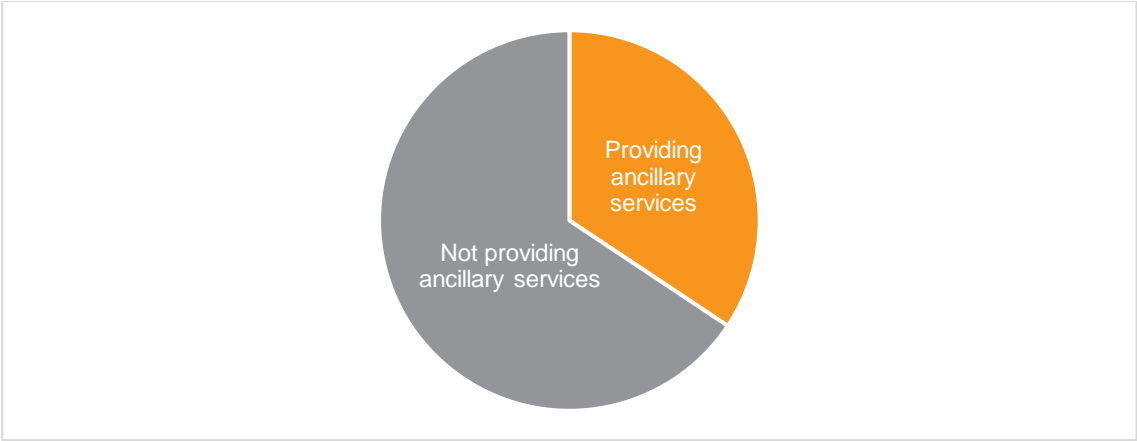


Source: Delta-EE Clean Hydrogen Database

Providing ancillary services (to electricity system operators) is being explored in many projects. The range of flexibility services and values that clean hydrogen projects capture will increase in the future, and in some applications will be an important source of value.

Figure 4: Proportion of electrolyser projects providing ancillary services to electricity system operators

Almost one third of projects are delivering some form of ancillary services to electricity system operators.



Source: Delta-EE Clean Hydrogen Database

The way forward: market creation is the key

Market creation entails risk, uncertainty and challenge. It's about developing demand that doesn't necessarily exist today. Demand, storage and distribution, and production need to be developed together. Potential customers need to be nurtured, comforted and given the confidence to move forward.

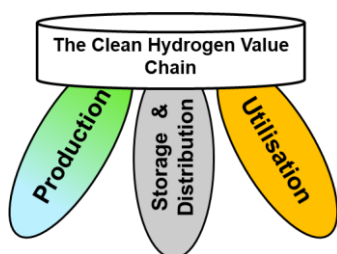
Do nothing and the market and competitors might move too fast away from you. Opportunities may be missed. Do too much and the leading edge will look too much like the bleeding edge; money, time and effort could be wasted.

Companies in the energy sector will (or certainly should) have their own strategies towards clean hydrogen. Their strategy, based on their own circumstances, will drive activity that should clearly address these four points.

1. **Look outwards and learn:** not because you will find all of the answers; but because everyone is learning. Looking outwards can help to position yourselves at the right point and place on the leading edge for your organisation, learn from innovative business models and propositions, and capture learnings and insights from others to help you make the best decisions and find the right partners.
2. **Customer-led:** what problems is hydrogen solving for customers? Why will hydrogen be the best solution to the problem? While any new market has an element of 'push', it also needs clear 'pull' from customers.
3. **Solutions thinking:** the hydrogen value chain is complex. Asking customers to switch to green hydrogen typically requires the three legs of the hydrogen stool, illustrated below, to be brought together – at the same time.

Figure 5: The Clean Hydrogen Stool

All three legs of the stool need to be in place for clean hydrogen to develop. For some applications, such as blending hydrogen into gas networks, some of the legs are less challenging.



Business models and propositions that make this simple for customers are essential. A great example of this is the hydrogen transport ecosystem in Switzerland built around the Hydros spider project. It covers the full value chain, with Hyundai providing hydrogen trucks 'as a service' as a simple and clear customer proposition. In general, the more the value chain is integrated for customers the better.

4. **Whole energy system approaches:** how can the vital flexibility that hydrogen offers be built into projects? How can hydrogen work alongside and be integrated with other energy vectors? Where and when is hydrogen the best solution from an energy system perspective?

Hydrogen has entered the main stage of the energy transition and in our opinion it will now remain on the stage as the energy transition accelerates. Hydrogen has a clear role to play in many applications and will complement electrification in a more joined up energy system. The size and scope of hydrogen's role relative to electrification remains uncertain. The development of clean hydrogen markets, and the role of hydrogen in the energy transition will be a focus for Delta-EE's ongoing research.

To learn more about how Delta-EE's Global Hydrogen Intelligence Service and bespoke consultancy can support you, visit <https://www.delta-ee.com/hydrogen> or contact andy.bradley@delta-ee.com.