Hydrogen East

H2 News Hub

Issue 15

February 2022

Top stories

Welcome to issue 15 of **Hydrogen East**'s Sector Review, where we take a look at important publications and developments over the month of January (2022).

Energy Futures Lab of **Imperial College London** released a report, exploring "**The Future of Home Heating,"** focussing on the prospects of hydrogen and heat pumps in particular as a means of decarbonising the heating sector. It found for a hydrogen grid to be a viable strategy for net zero, its production must be low carbon and made a series of recommendations.

The **"Geopolitics of the Energy Transformation"** have been explored by **IRENA**, with its focus specifically on how hydrogen is set to change the geography of energy trade, regionalise energy relations and result in new centres of geopolitical influence.

Closer to home, the **Energy Networks Association** published **"Britain's Hydrogen Blending Delivery Plan,"** in which it revealed that Britain's gas grid can be ready to deliver hydrogen across the country from 2023, outlining how this "ambitious" target can be achieved.

Switching focus to the continent, **Roland Berger** has warned that the transportation of clean hydrogen from future production sites to points of use is a "significant and often overlooked" logistics problem, and went on to assess three carrier technologies of liquified hydrogen; ammonia; and liquid organic hydrogen carriers, exploring their costs and feasibility.

Contents

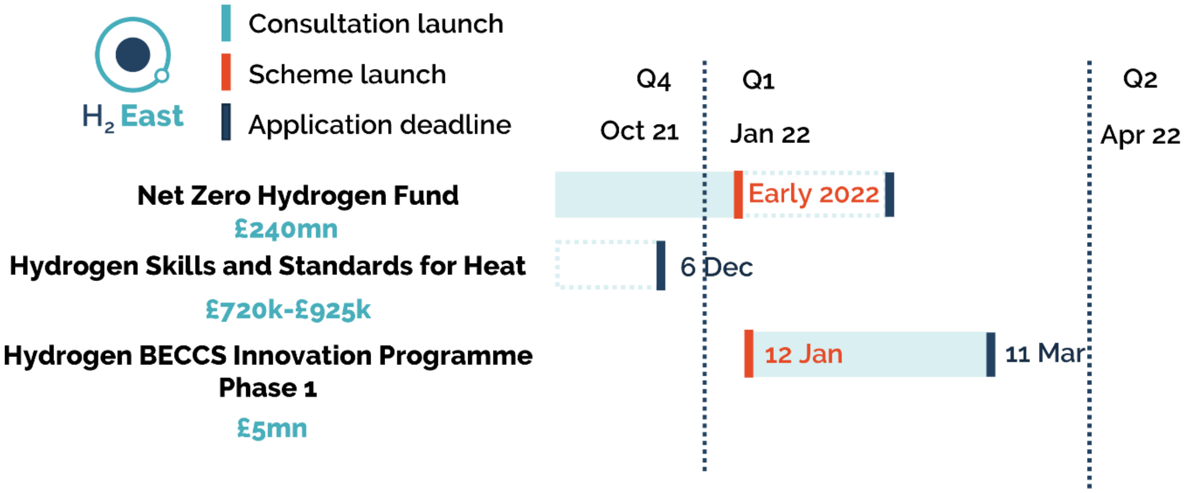
Upcoming webinars

8 Feb – **ENA:** Next for Net Zero: Building an offshore wind super grid | **10-11 Feb** – **US DOE Hydrogen Program:** Bulk storage of Gaseous Hydrogen Workshop | **15 Feb** – **NAAME:** The Opportunities of Hydrogen for Manufacturing Businesses | **15 Feb** – **Innovate UK & KTN:** Hydrogen Blending Standards: UK-Canada-US knowledge sharing and collaboration building **25 Feb** – **Network-H2:** Interim findings from hydrogen research

Funding tracker

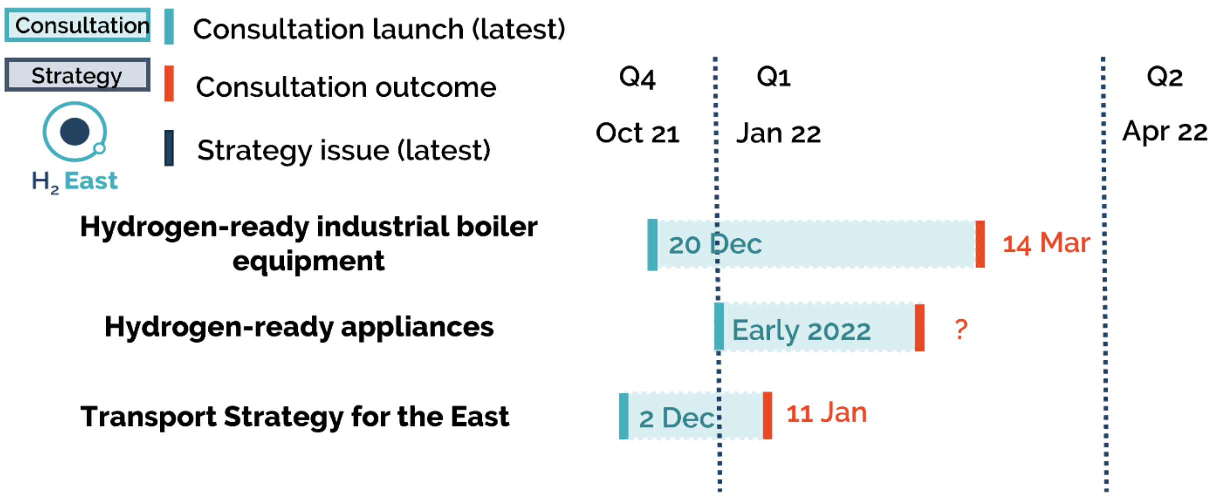
There are a number of funds already available for developers, local authorities and innovative organisations. These cover both feasibility studies and demonstrator projects.

The **Net Zero Hydrogen Fund**, expected to be consulted on in July 2021, has been promised for early 2022. This will be the primary area of government funding for hydrogen projects in the near-term, with up to £240mn on offer.



Policy tracker

A number of consultations and strategies are in development and are expected to be issued in 2021. Following the launch of the **UK Hydrogen Strategy** on 17 August 2021, government has opened a number of consultations, outlined below.

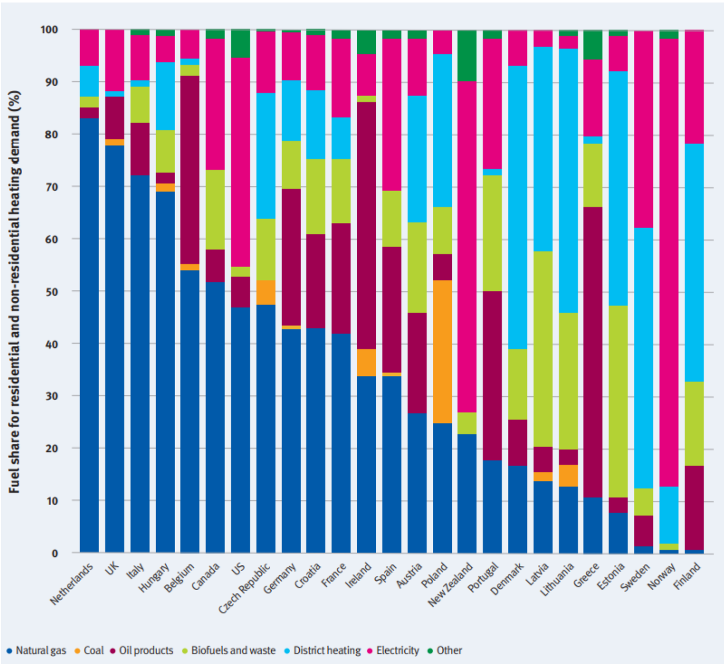


Paper explores hydrogen's future home heating potential

For a hydrogen grid to be a viable strategy for net zero, its production must be low carbon, a briefing paper has warned.

Figure 1: Diversity of fuel shares for residential and non-residential heating in selected countries

(Source: Energy Futures Lab)



On 26 January, Imperial College London's Energy Futures Lab launched *The Future of Home Heating*, in which it explored the prospects of hydrogen and heat pumps as a means of decarbonising the heating sector.

While renewable technologies are evolving at a rapid pace and dropping in price, offering a cost-effective path to decarbonising the power sector, heat – responsible for almost a quarter (23%) of UK emissions – is presenting a more difficult challenge, especially considering that the UK is more dependent on gas central heating than many other European nations.

Hydrogen, while potentially a solution, presents challenges such as the need to retrofit sections of the gas grid, replace steel pipework along with the large proportion of iron pipelines already replaced through the Iron Mains Replacement Programme, and the fact properties in areas converted for heating through a hydrogen grid would face a certain level of disruption.

This would include home surveys, any required updates of existing natural gas pipework and converting or installing appliances suitable for hydrogen use.

Furthermore, there are currently very limited sources of low carbon hydrogen and although government has set a target of delivering 5GW of capacity for 2030, this is set to prioritise harder to decarbonise sectors in industry.

There are also safety concerns that must be addressed before widescale adoption, the need for storage facilities to be established, the fact green hydrogen is not yet currently

Figure 2: UK Gas Network Overview

(Source: Energy Futures Lab)

Pipeline Type	Component	Pressure (bar)	Length (km)	Composition	
				Pre-1970s	Post-1970s
Transmission	Transmission	70 – 94	7,600	High-strength Steel	
Distribution	High Pressure	7 – 30	12,000	High-strength Steel	
	Intermediate Pressure	2 – 7	5,000	Steel	HD polyethylene
	Medium Pressure	0.075 – 2	30,000	Iron	MD polyethylene
	Low Pressure	‹ 0.075	233,000	Iron	MD polyethylene
Service	Building Connections	‹ 0.075	255,000	Copper	MD polyethylene

cost competitive, and how limited carbon capture roll-out means blue hydrogen is not yet commercially feasible as it stands.

To overcome these barriers and offer clarity, government has a number of initiatives forthcoming, including the £240mn Net Zero Hydrogen Fund; hydrogen trials commencing on a neighbourhood scale in the next few days to provide a safety case; a decision on hydrogen blending in 2023; and a strategic decision on the role of hydrogen in heating buildings, based on evidence gathered in the coming years, by 2026.

Considering hydrogen's potential application in building heat decarbonisation, it found that hydrogen would be best placed strategically in industrial clusters or as a hydrogen boiler component in hybrid heat pump systems. By strategically placing hydrogen facilities near industrial clusters, where demand is already in place, it will likely aid low carbon hydrogen's development. This means regions within proximity to clusters could transition away from natural gas to hydrogen heating in homes if hydrogen trials prove it to be viable and safe.

Figure 3: Estimated cost per kg of hydrogen by production method

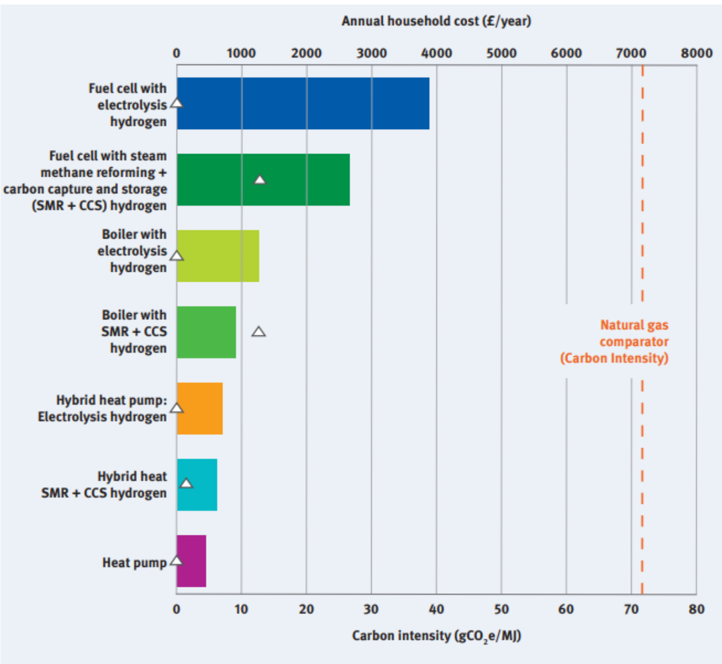
(Source: Energy Futures Lab)

Hydrogen Production Method	Cost per kg H_2[2]
Fossil fuel-based	£1.29 (€1.50)
Fossil fuel-based with CCS	£1.72 (€2.00)
Renewable	£2.15 – 4.73 (€2.5 – 5.5)

It went on to make a series of recommendations relating to the future of home heating, including that energy levies are moved away from electricity and transitioned over to more carbon intensive fuels, the introduction of green financing schemes and products for domestic renewables and energy efficiency measures.

Figure 4: Cost comparison and carbon intensities of different decarbonisation pathways of households in the UK

(Source: Energy Futures Lab)



It conceded that with hydrogen unlikely to be viable at scale for domestic heating applications in the next 10 years, the government's focus should be on deploying solutions available now, including energy efficiency, electrification through heat pumps and heat networks as the main focus for its strategy.

Therefore, its specific hydrogen recommendations include calling for the use of low carbon hydrogen in hard to electricity sectors such as industry and shipping; for low carbon hydrogen to be clearly defined and standards in place for the market to be developed for heat decarbonisation in buildings; and for the development of electrolysers in the UK to be supported as a means of improving the cost effectiveness of green hydrogen.

Government eyes hydrogen from biomass with new scheme

A new government programme is set to support the development of innovative technologies that generate hydrogen from biomass and waste.

Launched on 12 January, the Hydrogen BECCS Innovation Programme is inviting applications from the likes of small businesses, large companies, research institutions and universities to bid for a share of £5mn in funding to support the development of technologies that can produce hydrogen through bioenergy with carbon capture and storage (BECCS). Successful applicants will be awarded up to £250,000 to help develop their project plans and demonstrate the feasibility of their proposed innovation, with the second phase of the programme to provide further funding to support demonstration of the most promising Phase 1 projects.

It detailed how BECCS technology is unique in the way it offers the ability to remove carbon dioxide from the atmosphere, with CO_2 absorbed during the growth of the sustainable biomass and organic content found in waste, before then permanently removing it through use of carbon capture technologies. With hydrogen to be crucial as a clean fuel for hard-to-decarbonise sectors, such as transport and heavy industry, hydrogen BECCS technologies are therefore set to be key on the path to net zero.

National Grid set to trial "gamechanging" decarbonisation device

National Grid is to trial Levidian's "gamechanging" LOOP device, which, the developer says, aims to "turbo charge the UK's access to hydrogen."

On 27 January, Levidian announced that National Grid had signed up to trial the device as part of a world-first bid to boost the amount of hydrogen in the UK's gas supply. Its LOOP device works by using plasma technology to separate methane into its constituent atoms – carbon, which is locked into high-quality graphene, and hydrogen, which can then be used immediately or stored for use in future. It said the project could allow National Grid to reinforce parts of the gas pipe network by using graphene as a corrosion-resistant internal coating, ensuring it can carry increased quantities of hydrogen and be less likely to crack.

It further mapped out how reinforcing the network using graphene could increase the UK's ability to transport and access clean hydrogen. Existing infrastructure could be repurposed, with disruption minimised and it made far easier for consumers and businesses to make the switch over to hydrogen.

It also noted that National Grid will be trialling LOOP's ability to reduce the combustion CO_2 potential of the UK's gas on a larger scale. When run through the device, natural gas gets replaced with a hydrogen-methane mix, with no loss of energy potential.

easyJet looks to support development of zero emission aircraft

easyJet has joined forces with Cranfield Aerospace Solutions to support the development of its hydrogen fuel cell propulsion system for commercial aircraft.

On 10 January, it announced that it will provide an airline operator's perspective on the development of hydrogen propulsion and internal expertise, assisting the development of the technology for commercial aviation. Cranfield Aerospace Solutions is developing its hydrogen fuel cell propulsion system for an existing 9-seat Britten-Norman Islander aircraft, which it expects to be flying by 2023.

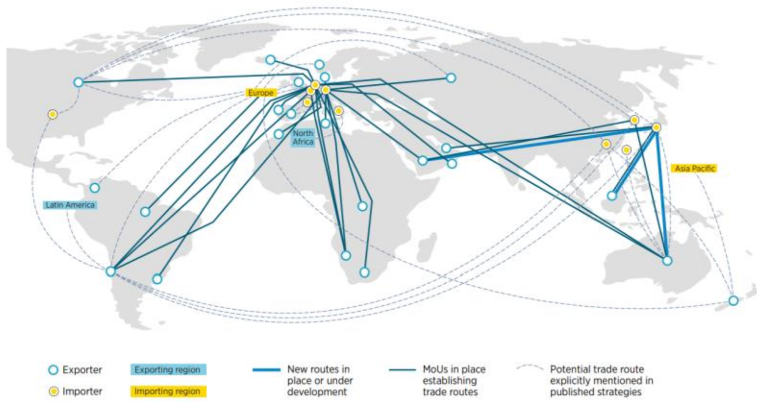
easyJet expressed its own optimism that it could begin flying customers on planes powered by hydrogen-combustion, hydrogen-electric, or a hybrid of both, by the mid to late 2030s.

Hydrogen economy set to drive new global power dynamics

Hydrogen is set to change the geography of energy trade, regionalise energy relations and result in new centres of geopolitical influence, a report has claimed.

Figure 5: An expanding network of hydrogen trade routes, plans and agreements

(Source: Natural Earth 2021)



On 15 January, the International Renewable Energy Agency (IRENA) published *Geopolitics of the Energy Transformation: The Hydrogen Factor*, where it estimated hydrogen to cover up to 12% of global energy use by 2050, with over 30% of hydrogen traded across borders – a higher share than natural gas today. Over 30 countries and regions are already planning for active commerce.

Some countries expecting to be importers are already deploying dedicated hydrogen diplomacy - Japan and Germany - while fossil fuel exporters are increasingly looking to clean hydrogen as an attractive way to diversify their economies, such as Australia, Oman, Saudi Arabia and UAE. Broader economic transition strategies will be required as hydrogen will not compensate for losses in oil and gas revenues.

Technical potential for hydrogen production also significantly exceeds the estimated global demand, with the report highlighting how those most able to generate cheap renewable electricity will be best placed to produce competitive green hydrogen. The likes of Chile, Morocco and Namibia, who are net energy importers today, will become green hydrogen exporters. Realising the potential of regions such as Africa, the Americas, Middle East and Oceania would limit the risk of export concentration. Many countries will need technology transfers, infrastructure and investment at scale for this to become a reality, however.

In terms of how the geopolitics of clean hydrogen will play out, it said the 2020s will be a "big race" for technology leadership, before demand takes off in the mid-2030s. Green hydrogen will cost compete with fossil fuel hydrogen globally by that time, though this will happen even earlier in countries such as China, Brazil and India.

Countries with ample renewable potential will become sites of green industrialisation, it continued, using this potential to attract energy intensive industries. Economic competitiveness can be boosted by having a stake in the hydrogen value chains. It noted China, Japan and Europe already have a head start in the production of equipment, but innovation will shape the manufacturing landscape. It further mapped out how green hydrogen could strengthen energy independence, security and resilience by cutting import dependency and price volatility.

Shaping the rules, standards and governance of hydrogen could lead to geopolitical competition or open up a new era of enhanced international cooperation. International cooperation will be key to devising a transparent hydrogen market that can contribute to climate change efforts in a meaningful manner, while supporting the advancement of renewable energy and green hydrogen in developing countries will be crucial to preventing a widening of a global decarbonisation divide and promote equity and inclusion, creating local value chains, green industries and jobs in renewable-rich countries.

Victrex calls for likes of chemicals industries to have hydrogen network access

Victrex has called on the UK government to help support access to future hydrogen networks, set to be key to helping companies and the UK hit climate targets.

On 20 January, Victrex – a world leader in polymer solutions – explained it wants to tap into UK hydrogen networks to support a 2030 carbon net zero goal. As a major UK exporter, serving the aerospace, automotive, electronics, energy and industry, and medical end markets, it explained such access could give it a competitive advantage, before more broadly calling on government to ensure high-tech industries such as chemicals are able to access hydrogen networks.

It noted how there are several hydrogen clusters already being proposed in the UK, including one in Cheshire, but there are no links to major chemical and defence industry companies in parts of Lancashire. It is therefore also asking for greater collaboration between those involved in developing future hydrogen clusters around the UK, making sure key industries are not left behind, and for a way to use alternative fuels such as hydrogen that manufacturing industries can consider in their future investment plan.

Hydrogen refuelling station begins operating at Teesside airport

A refuelling station serving hydrogen-powered vehicles is now operational at Teesside International Airport.

On 28 January, Tees Valley Combined Authority revealed the station is up and running as part of a £2.5mn region-wide trial. Through the Tees Valley Hydrogen Transport Hub, the airport, along with other key organisations, are testing out 100% zero-emission, hydrogen-fuelled commercial and support vehicles. The station – set up by Element 2 – will provide fuel for two Toyota Mirai hydrogen fuel cell vehicles and a forklift, with a Kangoo hydrogen-powered light van and hydrogen tug set to arrive in May. Toyota is deploying a number of vehicles across the region's rapid response services, including emergency response units for Cleveland Police and NHS patient support, all of which will be able to use the refuelling infrastructure.

Brendan Bilton, Chief Technology Officer at Element 2, said: "For every 1kg of hydrogen fuel used, 3.7 litres of Diesel and 10kg of CO2 emissions is offset. The Tees Valley Hydrogen Hub will play a vital part in decarbonising the North East, local residents and workers will benefit from cleaner air and the hub will create more skilled jobs in the region."

Joint venture to deliver UK low carbon hydrogen production plant

Essar Oil UK and Progressive Energy have joined forces to launch Vertex Hydrogen, which will look to provide a catalyst for a low carbon economy across North West England and North Wales.

On 26 January, Vertex Hydrogen announced that around £1bn will be committed to deliver a low carbon hydrogen plant, generating over 1GW of hydrogen, as a central plant of the HyNet decarbonisation cluster. Vertex Hydrogen has submitted its plans to build the hub as part of the government's cluster sequencing process. The plant would be expected to begin production from 2026 and will see waste fuel gases form Essar Stanlow and natural gas converted into hydrogen, with carbon dioxide then safely captured and stored by HyNet partner, Eni SpA, underground offshore in Liverpool Bay.

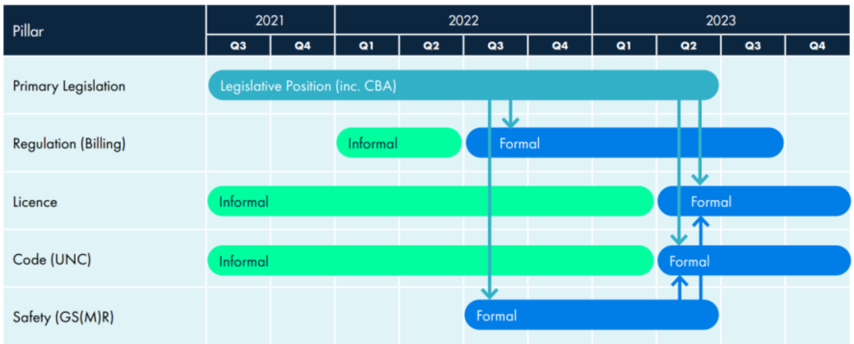
The resulting hydrogen will be used to replace fossil fuels in industry across the HyNet region, as well as heating homes, fuelling buses, trains and trucks. Initially, Essar will use it to reduce its carbon footprint at the Stanlow Manufacturing Complex, though Vertex will also provide low carbon hydrogen to businesses across a range of areas, including in chemicals, ceramics, paper, glass and flexible power generation sectors.

Gas grid can deliver hydrogen across Britain from 2023

Britain's gas grid can be ready to deliver hydrogen across the country from 2023, according to energy network companies.

Figure 6: Target 2023 Market Pillar Timeline

(Source: Energy Networks Association)



On 13 January, the Energy Networks Association (ENA) published *Britain's Hydrogen Blending Delivery Plan*, outlining how all five of the country's gas grid companies will meet the government's target of the gas network being able to deliver 20% of hydrogen to homes and businesses next year, saving 6mn tonnes of carbon dioxide equivalent each year in the process. They are also calling on government to double its domestic 2030 hydrogen production target to 10GW, ensuring as much hydrogen as possible is produced from sources in the UK, shielding homes and businesses from international gas market changes. It laid out two timelines to work towards a 20% blend, noting that considering it is an intermediate step towards a 100% decarbonised gas future, it is crucial it delivers maximum benefit for minimum outlay.

The first timeline is driven by the government's 2023 target which, it said, is achievable despite uncertainties over the volume of physical hydrogen production that will actually be available to connect to networks in 2023. The main reason for this is the concept of undertaking informal pre-work before a final policy decision is made on whether or not to move forwards with network blending, which is expected from BEIS in 2023. This pre-work should be undertaken in a collaborative way to build industry consensus and expedite formal process timescales. It did acknowledge that with this work being undertaken prior to a formal policy decision being made, there is a risk it could reduce the willingness of industry parties to engage.

Under the second timeline, steadier progress is made and while pre-work is still undertaken, uncertainties relating to certain change activities and how they could extend timelines are considered. This still sees market frameworks updated by the end of 2024 to enable blending, before residual system change is completed in 2025, as well as highlighting the importance of industry engagement and collaboration throughout 2022 and 2023.

From this work, it concluded that alongside 2023 being "ambitious, yet achievable" and the need for industry collaboration and engagement before a final policy decision is made, early policy clarity can accelerate change. Because minimal infrastructure changes are required to enable blending, the earlier policy clarity can be provided, the more it de-risks industry parties which, in turn, drives up engagement and collaboration, meaning the quicker formal change processes can commence. It also pointed out how the delivery of the timeline requires centralised coordination of change plans, with this removing the risk of piecemeal change, ensuring change is delivered in a coherent, structured way, and further recommended the need to implement quick-win system solutions first. For example, engaging with service providers at the earliest opportunity and implementing the quick wins in the first instance will reduce the potential risk of IT system change delaying the rollout of hydrogen network blending.

Vattenfall plots hydrogen upgrade to Aberdeen offshore windfarm

Vattenfall has set out new plans for its Aberdeen offshore windfarm that involve hydrogen.

On 5 January, *Energy Voice* reported that Vattenfall had submitted the plans in a November environmental screening report to the Scottish government, detailing a proposal for Hydrogen Turbine 1 (HT1) at its Aberdeen windfarm, which has a capacity of 96.8MW and an 8-mile array cable connected to an offshore transformer. HT1 would aim to demonstrate the feasibility of offshore hydrogen production by installing hydrogen generating equipment on an extended transition piece platform on the site's north east side.

The equipment would consist of an electrolyser, desalination facilities and compressors, located in up to seven 40-foot shipping containers, with desalinated seawater used as an input. Assuming maximum capacity from the 8.8MW turbine – the windfarm is made up of 11 of them – then it could produce up to 0.18 cubic metres of green hydrogen per hour, with this transferred to shore through an 8" flexible flowline.

Several potential pipeline routes have been identified, while the location of onshore facilities is yet to be finalised. The scoping report does suggest a site of up to 0.5 hectares with a storage capacity of up to 4 tonnes of hydrogen, compressed to 200bar. This would also include tanker refuelling facilities for as many as four trailers, capable of holding up to 1 tonne of hydrogen each, compressed to 500bar.

The HT1 facility would be targeted for being operational by 2024/25, then operating for 8-10 years, which is the expected lifetime of the electrolyser system. According to *Energy Voice*, Vattenfall said within its submission that the project would put Scotland "at the forefront of low carbon hydrogen production" and meet help to meet national hydrogen targets, as well as contributing to achieve international ones.

Go-Ahead agrees hydrogen supply deal

The Go-Ahead Group has agreed a 15-year hydrogen supply deal with Air Products to power a fleet of fuel cell buses.

On 5 January, it outlined how the buses – to be deployed in the Gatwick Airport, Crawley and Horley area – will become the first hydrogen powered vehicles in its fleet. The single-decker GB Kite Hydroliner buses have been manufactured by Wrightbus and will be delivered in June 2022, with the potential for a further order of 34 buses in future, bringing the fleet's size to 54. This would make it the largest local fleet of hydrogen buses deployed in Europe to date.

Go-Ahead noted the intention is for the hydrogen to power the buses to at least meet, or exceed, the UK government's standards on sustainable fuel for public transport. The hydrogen will be stored at the Metrobus Crawley depot in liquid form before it is then converted to gas held in tanks on the roof of the vehicles.

Incubator programme to showcase emerging technologies for net zero

The Energy Networks Association (ENA) has launched a new incubator programme, "Next for Net Zero."

Launching the series on 18 January, it set out how it will showcase the emerging technologies needed to address the decarbonisation of heat, transport and industry to drive the UK towards net zero. The programme will be centred around quarterly events, alongside regular publications, with domestic flexibility, system stability in a high renewables market, and the future role of hydrogen all set to be on the agenda.

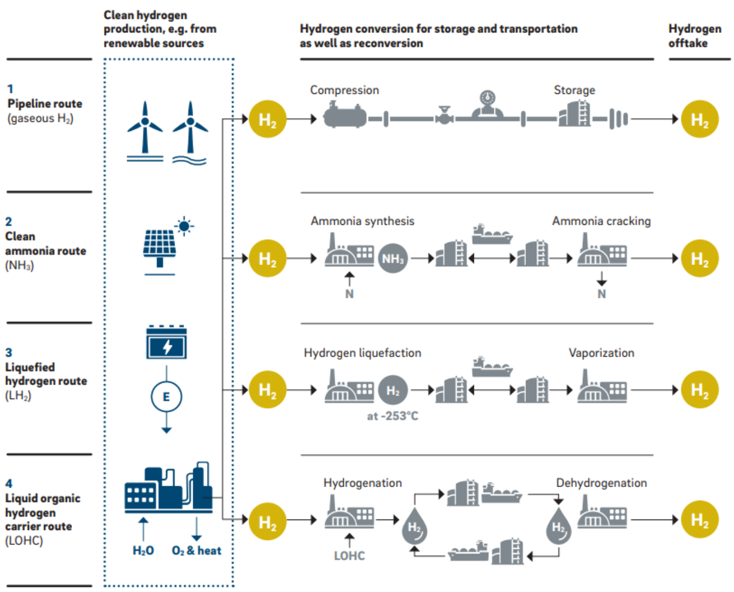
The first event, set for 8 February, will focus on the North Sea "supergrid" and how connections can be consolidated or combined with hydrogen production.

Transportation crucial clean hydrogen economy consideration

The transportation of clean hydrogen from future production sites to points of use is a "significant and often overlooked" logistics problem, a report has warned.

Figure 8: Leading carriers – the most common routes for large-scale hydrogen transportation

(Source: Roland Berger)



Publishing its study, Roland Berger explained that reliable and cost-effective methods of hydrogen transportation are crucial to ensuring its commercial viability. It assessed three carrier technologies – liquified hydrogen (LH_2); ammonia; liquid organic hydrogen carriers (LOHC) – looking at their costs and feasibility, focusing on Europe, in a bid to uncover which could prove the best solution over the coming decades for clean hydrogen.

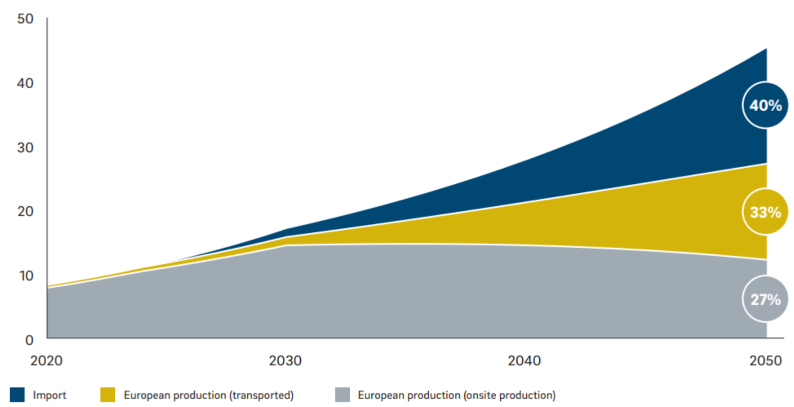
It devised a model to estimate the total cost of ownership (TCO) in 2025, built around four scenarios made up of different routes, distances, transportation modes and scales: large-scale harbour to harbour; mid-scale multimodal transportation; small-scale multimodal transportation; and small-scale, truck-only transportation.

From this, it found ammonia and LOHC to have a similar TCO for hydrogen transportation under the first archetype (large-scale harbour to harbour) ranging from €2.2-2.3/kg of hydrogen, while liquified hydrogen was the more expensive (€2.8/kg).

Adding in production costs, which were assumed to be €2/kg under all scenarios, this would mean the overall cost for large-scale, imported clean hydrogen could be between €4.2-4.8/kg in 2025, depending on the carrier method.

Figure 9: Projected hydrogen demand in Europe by supply route (mt H²)

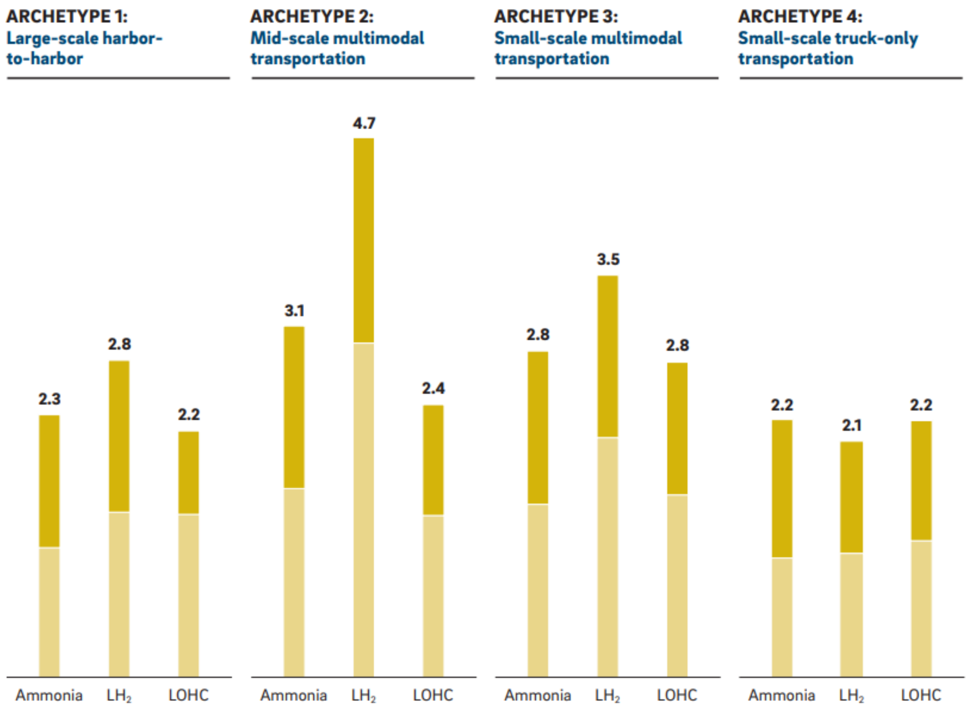
(Source: Roland Berger)



Under the second archetype (mid-scale multimodal), LOHC was found to be the cheapest option (€2.4/kg), whereas liquified hydrogen was once more the most expensive at €4.7/kg, ahead of ammonia (€3.1/kg). This was explained as being down to storage and transportation contributing more than 50% to the overall cost, driven up by the long duration of the journey and

Figure 10: Costs in 2025 – comparison of total cost of ownership for hydrogen transportation by archetype and carrier (€/kg H_2)

(Source: Roland Berger)



need for storage along the way, as well as when transloading the LH_2 to the next transportation medium.

Ammonia and LOHC have a similar TCO of €2.8/kg under the third archetype (small-scale multimodal), while liquified hydrogen is higher once more (€3.5/kg). In the final archetype, however, of small-scale, truck-only transportation, liquified hydrogen was found to be the cheapest option (€2.1/kg) with the shorter distance and shorter travel times meaning storage and transportation costs are not the major cost drivers.

It concluded from this that there is not yet a one-size-fits-all solution when it comes to ease of use and cost. Choice will be dependent on concrete use cases, transportation modes, distances and potential partner synergies. They also all require substantial development work. In the short-term, therefore, it expects the technologies to coexist, with ultimate success depending on cost-cutting potential, speed of market uptake and ease of use.

It went on to make a series of recommendations to enable low-cost hydrogen transportation, calling on governments to strongly encourage further research and development of all hydrogen carriers, to use public financing to fund anchor projects, and put enabling market rules in place to trigger the necessary investment in hydrogen transportation infrastructure and carrier technologies.

Industry, meanwhile, was told to increase its engagement in hydrogen transportation and for carrier providers to focus on improving their efficiencies, integrating clean energy intakes and managing the more volatile energy supplies of renewable sources. It stressed that businesses that move fast and quickly to gain experience will be able to better position themselves in the market and set market standards.

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