From theory to practice

by Stuart Nicoll, *Director, Maritime Strategies International (MSI)*

The prospects for hydrogen trade are developing rapidly but are still theoretical. Estimates prepared by bodies such as the International Energy Agency (IEA) and the Hydrogen Council (a body that seeks to promote the hydrogen economy) provide a wide range of potential outcomes. However, once the hydrogen economy moves past the theoretical stage, shipping demand will increase, and ammonia's role will be transformed.

Major challenges remain before significant trade can become a reality. Perhaps the most important are policy uncertainty and final investment. Increased capital costs combined with unclear regulatory decisions surrounding government subsidies have led to low developer confidence and widespread project delays. Nevertheless, progress is being made, most notably with Saudi Arabia's Public Investment Fund and ACWA, in partnership with Air Products, reaching the final investment decision (FID) in 2023 on the NEOM Helios Green Fuels Project ($8.5 billion investment of 3.9 gigawatts of capacity to produce 600 tonnes of green hydrogen per day).

National and regional energy plans are emerging. The EU has a stated aim to import 10 million tonnes per annum of hydrogen by 2030 for use as an alternative to natural gas and as a transportation fuel. Progress is being made towards meeting this target, as set out in the RePowerEU plan.

In March this year, Canada and Germany signed an agreement committing them to back transactions between Canadian hydrogen producers and German off-takers as a means of working towards commercial-scale trade of clean hydrogen fuel. As yet, details of the import mechanism are unclear, but it seems most probable that this will be in the form of ammonia. Meanwhile, in the US, the Inflation Reduction Act aims to stimulate the development of low-carbon energy sources.

The decarbonisation of the global economy and its implications for shipping are increasingly fundamental to MSI's long-term forecasts. As a result, we have developed a series of interlinked models looking at the evolution of hydrogen production, consumption, and trade. The models assess the potential for supply and demand in ten countries/regions. Each country/region is also evaluated for potential for exports and imports.

Hydrogen production

Energy analysts categorise methods for hydrogen production according to the associated carbon emissions using a veritable rainbow of colours. However, for MSI's purposes, we have simplified the analysis to cover green and blue (collectively clean). Blue represents production from coal or natural gas with carbon capture, while green is via water electrolysis using renewable electricity.

Indeed, the key to the production of green hydrogen lies in the development of renewable energy production, which globally increased by 54% in the decade to 2020 – and the pace of investment is set to accelerate. Significant development of renewables has been seen across the globe, most notably in China, Europe, and North & Latin America. Under our Base Case, this is sufficient to meet projected requirements for the hydrogen economy and other key sectors.

MSI's analysis extends to 2050, integrating our forecast for hydrogen demand with our Energy Model. Long-term forecasts are aligned to some extent with the IEA's Announced Pledges Scenario and forecasts from BP and Shell.

The output of the initial phase of our modelling is a forecast for exports and imports of hydrogen for each country/region. A forecast for pipeline and seaborne trade is also provided, based on proposals for Europe and assumptions on pipeline supply to China.

The next issue to be addressed is what form the seaborne trade in hydrogen will take. At present, there is a widespread assumption that, in the first instance, ammonia and methanol will be the 'hydrogen carriers' produced from clean hydrogen. In the longer term, the liquid hydrogen trade is assumed to become viable.

Project ≠ project

Short-term forecasts are based on our database of hydrogen projects. MSI has identified more than 1,000 of these for clean hydrogen production that are either operational, under construction, have taken FID, or are at the feasibility study stage.

Photo: Kawasaki Heavy Industries

These generally include an indication of focus in several categories: domestic use/export, transportation as hydrogen/methanol/ammonia, and/or use for bunkering.

The large number of operational projects tells a story in itself. The operational supply of clean hydrogen accounts for just under 2% of the total announced supply. These facilities are small-scale and proof of concept, with an average capacity of around 1,200 tonnes/year. For those projects under construction, the average capacity rises to about 18,000t/y. The need to scale up is clear in the fact that for projects that have taken FID or are at the front-end engineering and design stage, the average rises to almost 70,000t/y.

The overwhelming majority of projects under consideration at present are in Europe and North America, with most of the output to be consumed locally. In the major export centres of Latin America, the Middle East, and Oceania, there are over 170 projects with a potential capacity of almost 14mt of hydrogen by 2030.

MSI's assessment of the current pipeline of projects suggests that the production of clean (blue/green) hydrogen could reach 18mt by 2030. To put this in context, it is worth mentioning a caveat that has been noted repeatedly by the World Hydrogen Council. They suggest that while growth in the number of projects is exponential, for projects taking FID, the graph is linear with a very low slope. The gap between proposed and actual needs to be bridged – and soon – if there is to be sufficient green hydrogen and derivative products available by this decade's end and beyond.

Marked market transformation

Despite high costs and safety issues, clean ammonia's role as a prospective marine bunker fuel, hydrogen carrier for use in power generation, and industry feedstock has solidified its place in the green transition, especially for high-volume uses. For example, plans for direct co-burning of ammonia in coal-powered electricity plants in Japan provide a clear opportunity for end-use without reconversion.

This signals a marked transformation for the industry, which has been focused on fertiliser production, to one driven by energy markets. Future volumes of clean ammonia are set to dwarf the existing grey trade. The nascent industry is anticipated to achieve clean exports of up to 30mt by 2030 and, in the best-case scenario, could reach 300mt by mid-century.

Production of clean methanol is also ramping up, driven by uptake agreements for methanol as a marine fuel, its use as a chemical feedstock, and its role in the hydrogen economy. Whilst sharing similar drivers, clean methanol trade is forecast to be significantly lower than that of ammonia, with 2030 seeing almost 15mt of product traded. By 2050, global clean methanol trade is expected to rise to 95mt – equivalent to half of the amount of clean ammonia trade.

Despite our model showing a relatively slow start for green methanol trade, incremental growth is expected year-on-year from 2026. We expect exports of green methanol to be around 8.0mt, equivalent to 23% of the projected grey methanol trade by 2030.

The requirement for methanol-capable chemical tankers will continuously and gradually expand. We expect 25 methanol carriers (of 50,000 deadweight) will be required to transport 15mt of trade by 2030; our modelling suggests a total of 215 methanol carriers of 50,000 dwt could be required by 2050 to ship the expected 95mt of clean methanol trade.

Ammonia trade is likely to be transformed over the next 25 years. By the middle of the century, clean ammonia could provide demand for up to 400 very-large gas carriers (VLGC), compared to the current fleet of 375 that is focused on carrying liquefied petroleum gas. In this context, it is striking that the current order book for ammonia-capable VLGCs is reported to be more than 50 ships. In contrast, though a requirement for just under 200 methanol carriers will be significant, it compares to an aggregate methanol-capable 35,000+ dwt fleet of 277 at the end of 2023. ■