# Energy storage applications port of spain

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While the interest in hydrogen solutions in the 2010s was mostly driven by oil price shocks and concerns about peak oil demand or air pollution, the current interest in hydrogen seems to be primarily driven by a heightened focus on net-zero emissions, combined with a dramatic decrease in the costs of renewable electricityFootnote 1 and a recent cost surge in fossil fuels due to geopolitical tensions and the war in Ukraine. Still, demand for green hydrogen is expected to really take off only in the mid-2030s. By that time, green hydrogen should have become cost-compete with fossil-fuel hydrogen globally, and this is poised to happen even earlier in some countries like China, Brazil, and India.

The strong focus on green hydrogen is visible both in the private and the public sector. By mid-2022, more than 1500 hydrogen-related projects were announced globally, while more than 60 countries have already developed or are developing hydrogen strategies (IRENA 2022c).

The plan REPowerEU, initiated in 2022, gives further impetus to the hydrogen economy. The plan states that an additional 15 million tons (five of which produced in Europe with the remainder imported) of renewable hydrogen are required to replace imported Russian gas. The European five million would be additional to the 5 million tons already planned in Fit for 55. In September 2022, the European Union announced the setting up of a European Hydrogen Bank to help create a market for hydrogen. The bank will receive 3 billion euro in cash to bridge the investment gap and connect future supply and demand.

Since 2014, the European Investment Bank (EIB) has been providing significant support to hydrogen technologies: An overall investment of 1.2 billion euro, with over 550 million euro in direct financial support to technologies such as electrolysers, catalysts and fuel cells, and the co-financing of large-scale hydrogen production, carbon capture and storage, as well as hydrogen stations (EIB, press release 16 March 2022).

Indeed, ports can play a crucial role in the production and distribution of green hydrogen. They are important nodes, given existing and future local demand for hydrogen, the emerging offshore parks, and as junctions of transport nodes, some of which could shift to hydrogen or related fuels (e.g., vessels, barges, trucks). Additionally, the infrastructure and handling capabilities of seaports make them prime locations for the storage and distribution of hydrogen. Seaports can serve as hubs for the export of green hydrogen to other countries, helping to drive the global transition to clean energy.

Ports aiming for a strong position in green hydrogen are challenged to be active in all parts of the hydrogen value chain. A favorable location, a well-developed pipeline network, strong worldwide maritime connectivity, state-of-the-art terminal and logistics infrastructures, well-functioning and efficient industrial ecosystems and a strong customer base, are all important factors enabling a seaport to take up an important, pioneering, role in an emerging hydrogen economy, positioning itself as a hydrogen import, transit and production hub.

A number of seaports in Europe are stepping up their efforts to become energy and feedstock hubs and growing producers of green hydrogen. Ports are aware it is essential to offer affordable green energy to all players in port areas, at all times, in order to keep the big industry in the region. Both local production and import play a crucial role in this. The first projects related to imports of renewable energy are expected to take shape between 2025 and the end of this decade. Extensive feasibility studies are conducted to analyze ideal sourcing regions, to prepare seaports for receiving the hydrogen carriers of the future, and to set up specific pilot projects in the context of a sustainable economy.

As local green hydrogen production in Europe is not expected to be sufficient to meet demand, hydrogen transport over long-distance will be necessary. Most of the available techniques to do this require the conversion of wind or solar energy to hydrogen carriers in or near the exporting port, and the transport of a suitable hydrogen carrier to importing areas. The most commonly considered hydrogen supply chains include (Fig. 1):

Hydrogen can be transported in liquid form (LH2) at an extremely low temperature in its pure form, but cooling to below -252.87 ?C consumes a lot of energy. A wide range of large-scale hydrogen liquefaction methods and approaches exist (see for an overview Aasadnia and Mehrpooya 2018);

Hydrogen can also be compressed in hydrogen tanks at very high pressures to compressed hydrogen (CH2 or CGH2);

Hydrogen can be transported by coupling it to other Liquid Organic Hydrogen Carriers (LOHCs). These are organic compounds that can absorb and release hydrogen through chemical reaction. A good example is methyl cyclohexane (MCH) which is a liquid obtained from the chemical reaction of hydrogen and toluene. After the initial hydrogenation step, MCH can be transported by ship, truck or tank wagon. Dehydrogenation ensues, followed either by direct use of the obtained hydrogen, or its conversion back into electricity. The byproduct toluene can be returned to the hydrogenation plant for reuse. Obara (2019) concludes that a hydrogen supply chain based on ammonia has better energy efficiency than one based on MCH.