

EXECUTIVE SUMMARY

Japan has been a **pioneer in hydrogen and fuel cell (FC) technologies** and has **the world's most ambitious vision**. Japan's ambition is to lead the way towards decarbonization in the world by providing hydrogen as a new energy option. In the context of the nation's unique energy challenges, the government wants to turn Japan into a **hydrogen society** to solve the issues of energy security and global warming. Japanese hydrogen and FC technologies are the world's most advanced. For long, the government has been funding a range of FC and hydrogen R&D and demonstration projects and introduced FC technology into the market as early as 2009 for household stationary fuel cells and in 2014 for FC electric vehicles. Japan is proactively expanding these technologies domestically and overseas to create a new growth industry and capture the global market. It accounted for around half of global fuel cell shipments in 2019. However, even in Japan the hydrogen market is not yet economically viable. At present, almost all hydrogen and FC technologies are highly dependent on public funding (the exception being household stationary FCs).

Japan is not only one of the leading countries in the area of hydrogen-related technologies but is also the first country to have adopted a national hydrogen strategy (the Basic Hydrogen Strategy of 2017). The main thrust of the strategy is to **increase the cost competitiveness of hydrogen** by increasing economies of scale and overcoming technological barriers. The goal is to achieve the **cost parity of hydrogen with competing fuels** (after allowing for environmental externalities), such as LNG in the power sector. To achieve that, Japan intends to **increase hydrogen demand dramatically**, by expanding current uses in buildings, transport and industry, and by introducing **hydrogen in power generation**. The power sector is the lever of the Japanese strategy. It will allow to create a viable, demand-based, high-volume market for hydrogen and achieve economies of scale and cost reductions necessary for the widespread use of hydrogen in a wide range of sectors. Because of the economic and technical challenges associated with a move to hydrogen generation, **co-firing of hydrogen** in existing natural gas power plants is an initial step, before moving to pure hydrogen gas turbines in the 2030s. An alternative in the short term, which is gaining strong support in Japan, is co-firing **clean ammonia**, starting with coal power plants, and moving to large-scale gas turbines by 2030.

At the same time, Japan intends to secure its hydrogen supply from low-cost, unused overseas clean hydrogen sources by developing **international hydrogen supply chains**. The first demonstration projects for the implementation of these international supply chains started in 2019. Japan also supports the supply of hydrogen from local renewable energy sources to contribute not only to expanding the use of clean hydrogen, but also creating new regional industries, while keeping its power system flexible and helping to balance the grid. While less advanced than European countries and Germany specifically, Japan inaugurated the so far world's largest **power-to-gas facility** derived from renewable energy in March 2020. The Japanese government also drives a comprehensive **carbon capture, utilisation and storage (CCUS) program** and collaborates with the private sector and other governments to reduce barriers to CCUS deployment.

Japan's state-backed approach is ambitious but not without challenges. Involvement of many countries in the hydrogen supply chain and increase in demand is the key to achieve **cost competitiveness** and **availability of carbon-free hydrogen energy**. Japan has been very successful in engaging other countries and companies in hydrogen energy and hydrogen supply chains. The nation is also well advanced in developing technologies for producing, transporting, storing and burning clean hydrogen. At this stage, however, the economic and technical challenges associated to hydrogen energy are still unsolved. The next five to ten years will be a crucial period for the Japanese government, Japanese companies and their international partners to demonstrate the economic feasibility of the multilateral hydrogen supply chains and to expand hydrogen uses in order to realize the hydrogen society in Japan. Given that power plants would consume a large volume of hydrogen,

an operation of several plants would indicate that the hydrogen supply chain is reaching price maturity.