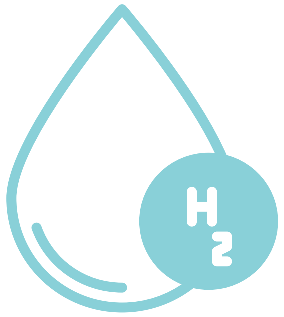
Hydrogen

Nuclear-produced hydrogen



Direct impact

Indirect impact

Low-carbon energy source

Hydrogen is quickly emerging as an energy source with the potential to decarbonize transportation, industry, and other sectors. Burning hydrogen emits water and no carbon dioxide. However, current hydrogen production is dominated by fossil fuel processes, causing lifecycle carbon emissions. Nuclear energy can help increase global production of hydrogen in a low-carbon manner.

The two most common methods of producing hydrogen are steam-methane reforming and electrolysis. Steam-methane reforming currently accounts for nearly all commercially produced hydrogen in the United States. The process intermingles steam with fossil methane to create discrete quantities of hydrogen, carbon monoxide, and carbon dioxide. In total, steam-methane reforming emits over seven times as much carbon emissions as hydrogen gas produced.

Electrolysis involves splitting hydrogen molecules from a source of water using an electric current. The process does not result in byproducts besides hydrogen and oxygen. However, electrolysis is electricity-intensive and only as clean as the electricity used. When renewable or nuclear power produces the electricity used, or when carbon is captured from steam-methane reforming, hydrogen becomes a low-carbon energy source.

Many projects are now exploring the use of conventional nuclear energy to supply electricity for hydrogen production. Further, research is ongoing into how advanced nuclear reactors can supply electricity, heat, or both to separate hydrogen from water. For example, in a high-temperature electrolysis process, direct heat produced from high-temperature gas-cooled advanced reactors is used to thermochemically split hydrogen from water. The overall thermal-to-hydrogen efficiency for this process can be up to 50% (double the efficiency of conventional electrolysis). This high output to input ratio means hydrogen produced via advanced nuclear reactors could become increasingly cost competitive as the technologies mature.

Affordable energy source

Hydrogen, as an energy carrier and not an energy source, holds important potential to replace oil in transport and in other applications. The main features that can propel the use of hydrogen relate to its complementarity with electricity (via electrolysis) and the circular nature of production and use while also providing a feedstock for producing fuels such as ammonia.

Today's hydrogen production largely goes hand-in-hand with the emission of CO_2 from the steam reforming of natural gas or coal gasification. The projected larger demand for zero-carbon hydrogen would mostly be based on electrolysis using low-cost electricity or, somewhat later, through the decomposition of water by direct use of heat via thermochemical processes. A decarbonised energy source for electricity and heat is anyhow required.

Today's nuclear power plants (NPPs) can already produce hydrogen via low-temperature electrolysis and by using nuclear heat assisting steam reforming of natural gas. Combining both heat as well as electric after-heating may lead to higher-temperature steam electrolysis. Later on, advanced NPPs providing higher working temperatures could opt for high-temperature thermochemical hydrogen production.

In a wide range of future scenarios, nuclear power is projected to provide competitive hydrogen production routes, given the low-cost base-load production cost for NPPs and the potential to exploit the dispatchability of NPPs to provide both electricity and process heat especially in high-share intermittent renewable energy markets.

Generation-III/IV NPPs and small modular reactors (SMRs) may also better respond to regional hydrogen production demand. The avoidance of important costs for transporting hydrogen, particularly from dispersed low-energy-density and intermittent renewable energy sources, through an increased co-location of nuclear power with hydrogen production plants would be beneficial as economies of scale will matter.

YES TO NUCLEAR PERSPECTIVES I INDUSTRY PERSPECTIVE

Reliable energy source

The production of hydrogen using nuclear power rather than renewable energy has several advantages. Firstly, nuclear power can supply energy at a far higher capacity, because it produces at maximum power over 90% of the time, allowing greater operational efficiency and continuous production of hydrogen, which is essential for its far-reaching industrial applications.

Secondly, much less land is required to produce hydrogen using nuclear power than renewable energy sources. Thirdly, the production of hydrogen using nuclear power will stimulate investment in the wider infrastructure upon which an integrated European clean hydrogen economy could begin to evolve and enable Europe to contribute to the 90-fold increase in global hydrogen production capacity that the International Energy Agency believes is needed by 2030 to keep the increase in average surface temperature below 1.5 C.

Low-carbon nuclear-produced hydrogen will provide a reliable energy source that will be an essential component of the global energy transition, removing or substantially reducing the role of fossil fuels.

Modern energy source

A significant departure from business as usual is urgently required to address the threat of climate change and to protect the environment. The production of hydrogen using nuclear energy is now attracting worldwide attention as demand for sustainable energy and for the development of new energy generation technologies to meet the need for cleaner energy sources increases.

For hydrogen production, nuclear energy is well suited and well-aligned with climate protection goals. This is leading many countries to actively explore the options of nuclear hydrogen as a non-carbon energy carrier and a promising alternative fuel.

The development of nuclear hydrogen offers great opportunities for the symbiosis of nuclear and hydrogen energy alongside renewable energy. This could lead to the formation of a more sustainable global energy system and strengthen energy security in countries that develop domestic production capacity.

Viewpoint

Initial IMO Strategy on reduction of Greenhouse Gas (GHG) emissions from ships.

In 2018, the International Maritime Organization adopted the Initial IMO Strategy on reduction of Greenhouse Gas (GHG) emissions from ships. This has set the following targets,

1. Reduction of CO_2 emissions per transport work (carbon intensity), as an average across international shipping, by at least 40% by 2030, pursuing efforts towards 70% by 2050, compared to 2008;
2. For the first time a reduction of the total annual GHG emissions from international shipping by at least 50% by 2050 compared to 2008, while at the same time pursuing efforts towards phasing them out as called for in the vision, for achieving CO_2 emissions reduction consistent with the Paris Agreement goals.

The Strategy has proved to be a catalyst to various initiatives on low-carbon and zero-carbon fuels for shipping, and several options are being pursued, such as nuclear-powered vessels, hydrogen-based synfuels, ammonia converted from hydrogen, and hydrogen fuel cells. Each of these options have merits although suitability can depend greatly on the size of the vessel and its trading pattern.

Fuel cell technology, and hydrogen-based synfuels, are already in use in certain sections of shipping. For this to continue, and grow, a reliable and sustainable source of hydrogen must be readily available to the maritime industry.

There are several companies developing technology for floating nuclear power plants that, along with electricity production, could produce zero-carbon hydrogen for marine use. Most major ports already have large areas of land currently used for the storage of marine fuels with dedicated bunker fuel supply berths. These facilities offer the ideal locations to securely moor floating nuclear power plants that could then be engaged in the production of green hydrogen.

wnti