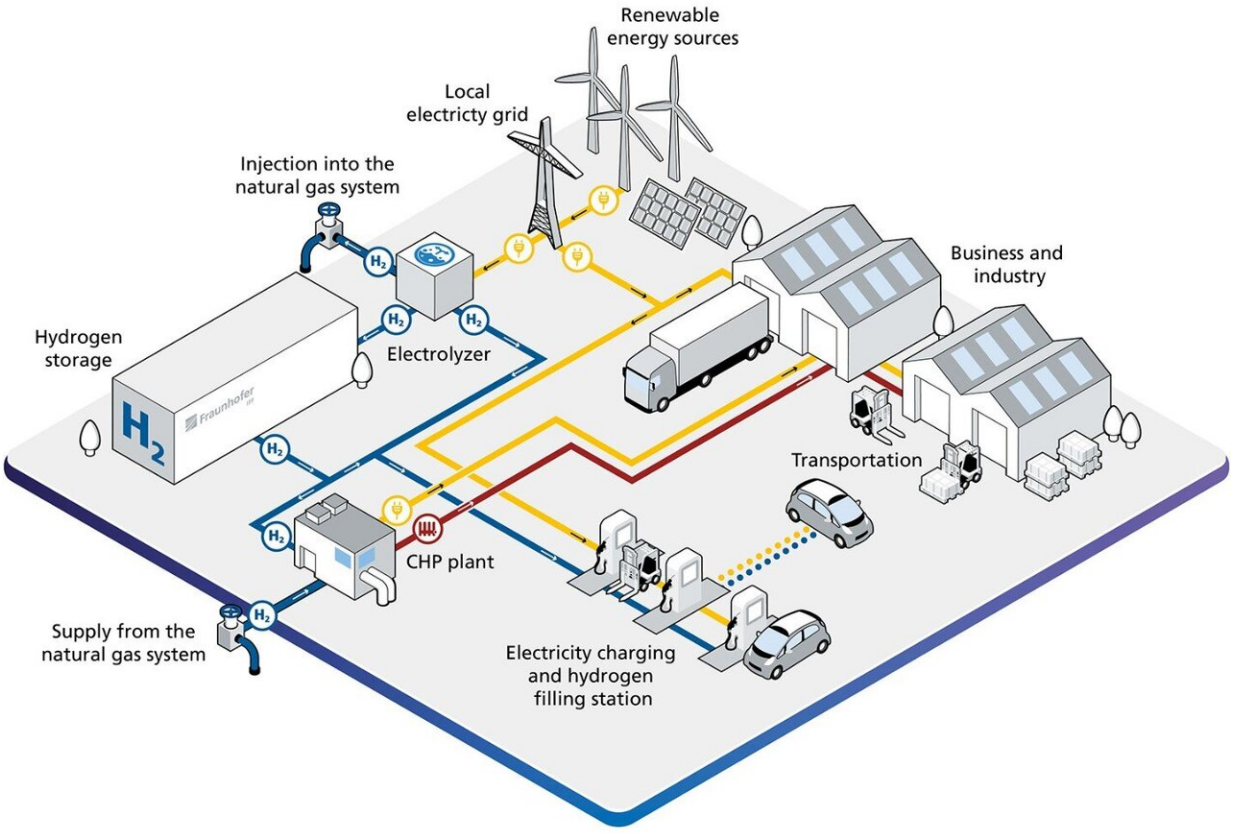
The hydrogen factory of the future

April 2 2020



The hydrogen factory of the future. Credit: Fraunhofer IFF

Hydrogen is indispensable to successfully transitioning to renewables and meeting climate targets. It is the essential building block of sector coupling. While it provides an ecofriendly option to meet industry demand for electricity, heat and transportation, this versatile energy source is only ecofriendly when it is sourced from renewables. The Fraunhofer Institute for Factory Operation and Automation IFF has a demand-driven, distributed, modular solution that produces and distributes green hydrogen.

The only way to contain global warming is to slash greenhouse gas emissions on a global scale. Power-to-X technologies are considered a promising means to this end: Electricity sourced from renewables is converted into hydrogen to power fuel cell vehicles, for instance. Researchers at the Fraunhofer IFF in Magdeburg are taking this a step further. They are establishing a design for the distributed and modular production and distribution of green hydrogen for industry, business and transportation throughout the value chain with their hydrogen factory of the future. "Electricity sourced from sun and wind is used to split water into hydrogen and oxygen in a process called electrolysis. The hydrogen is stored and can be converted by fuel cells in vehicles back into electricity that powers them. We primarily have vehicle fleets with vans and forklifts operating in industrial and business parks in mind here," says Dr. Torsten Birth, a research scientist at Fraunhofer IFF. "We additionally want to supply electricity, gas and heat to industry. The hydrogen produced during electrolysis can be injected into the gas grid, used as fuel, converted into methane or methanol, and made available as industrial feedstock."

Coupling hydrogen production into a biogas plant

The research scientists are developing modularly expandable

subcomponents that can be interconnected and integrated in business and industrial parks, which will enable them to implement their hydrogen factory design. Electrochemical or biochemical processes are used to produce hydrogen, depending on the conditions at the site. "It is not possible to build wind and PV plants everywhere. We are opting for site-specific solutions and using biogas plants for production where possible. Plans for a pilot plant near Gommern in Saxony-Anhalt are on the drawing board. The outcome is always green hydrogen," the engineer Birth explains.

The Fraunhofer IFF is working together with MicroPro GmbH and Streicher Anlagenbau GmbH & Co. KG in the HyPerFerMent I project to produce renewable hydrogen from biomass. They are employing a special microbial fermentation process similar to biogas production to produce hydrogen directly from organic waste. The metabolites of certain bacteria produce a gas mixture containing CO_2 and fifty percent H_2, which can be easily purified by subsequently separating the CO_2. "Fermentative production of green hydrogen will play a major role in distributed production of this energy carrier in the future," says Birth.

A mobile hydrogen filling station for industrial and commercial parks

Fraunhofer researchers intend to produce hydrogen in biogas plants, too. Credit: Fraunhofer IFF

Researchers at the Fraunhofer IFF have teamed up with Anleg GmbH to build one of the aformentioned subcomponents, the Mobile Modular H_2 Port (MMH_2P), a portable hydrogen filling station for short trips of up to 200 kilometers. Expandable pressure systems with compressors on a trailer can be refilled and can also dispense hydrogen. The German Federal Ministry of Education and Research (BMBF) is funding the project.

Disinfecting with ozone

Since systemically integrated hydrogen production is important to the researchers, they will not only be using the hydrogen produced during electrolysis but also the oxygen—for welding processes or for ozonation in sewage treatment plants, for instance. Troublesome micropollutants such as pharmaceuticals, pesticides and cosmetics can be removed from wastewater when ozone is introduced. Another use scenario envisions using the oxygen in agriculture to desulfurize biogas plants.

The research team acquired expertise for the implementation of their hydrogen factory in the projects Energieregion Stassfurt 2020 and Energieregion Ostharz. A regional energy plan was implemented in these projects to switch the energy supply in different sectors (power, gas, heat, and transportation) from fossil fuels to regionally produced renewables and renewable sector coupling systems were developed.

Provided by Fraunhofer-Gesellschaft

Citation: The hydrogen factory of the future (2020, April 2) retrieved 30 May 2023 from https://techxplore.com/news/2020-04-hydrogen-factory-future.html

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