Green Hydrogen: The Energy of the Future World

ENVIRONMENT
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"Polar glaciers are melting twice as fast as predicted.
Coral reefs have become white ruins beneath the sea.
Seasons that were once predictable have grown so erratic that they no longer resemble their former patterns."

Figures from the World Meteorological Organization (WMO) underscore the severity of the situation. The global average temperature in 2024 rose to 1.55 degrees Celsius above pre-industrial levels, making it the hottest year ever recorded. A rise of just a few degrees has awakened demons across the globe: deadly heat waves that have claimed thousands of lives in Europe, wildfires that have ravaged Canada so badly that smoke has drifted to the other side of the world, and flash floods that have swept away lives and homes and left devastation across Southeast Asia.

The cause of this crisis is greenhouse gas emissions from burning fossil fuels in the energy sector, which account for 75% of all greenhouse gas emissions from daily life. Every time we start a car, turn on the air conditioner, or plug in an electrical appliance, we add carbon dioxide to the atmosphere, where it accumulates like a heat-trapping blanket until the Earth can barely breathe.

Amid efforts to solve the global warming crisis, "green hydrogen" is one of the energy sector's key hopes. Its standout feature of requiring only water has drawn attention from around the world and expanded its use from the industrial and transportation sectors to household applications. Several energy research institutes estimate that this energy source could be key to achieving Net Zero, or net-zero greenhouse gas emissions, by 2050, contributing as much as 20% of the effort.

What Is Hydrogen Energy?

Hydrogen energy is one of the clean energy sources attracting the most attention today, because it can help reduce greenhouse gas emissions and is a sustainable alternative to fossil fuels. Hydrogen (H_2) is the most abundant element in the universe, but it does not occur naturally as a pure gas. It must be extracted from various sources, such as water (H_2O), natural gas, or other hydrocarbons, through production processes, which are categorized by how clean the energy source used is, as follows:

1. **Brown Hydrogen** is hydrogen produced using coal as the raw material through a gasification process, which is considered the process that releases the most carbon dioxide.
2. **Grey Hydrogen** is hydrogen produced using natural gas as the raw material through Steam Methane Reforming (SMR).
3. **Blue Hydrogen** is hydrogen produced from natural gas, just like grey hydrogen, but the carbon dioxide generated during production is captured using Carbon Capture and Storage (CCS) technology.
4. **Pink Hydrogen** is hydrogen produced through water electrolysis, which separates hydrogen from water, with the electricity originating from nuclear energy.
5. **Green Hydrogen** is hydrogen produced by separating hydrogen from water using electricity, where that electricity must come from renewable energy only, such as solar energy or wind energy.

From the explanations above, only two types of hydrogen energy are considered clean and carbon-free in both production and use: pink hydrogen and green hydrogen. Both produce hydrogen gas through water electrolysis using an electrolyzer. In terms of cost, volume, and production stability that does not depend on the weather, pink hydrogen is naturally a good option. But if the goal is the “cleanest energy” that can reduce overall environmental impact, nothing is more suitable at this time than green hydrogen.

Hydrogen Electrolyzers ที่ใช้สำหรับการผลิตก๊าซไฮโดรเจน

The Current State of Green Hydrogen

With its outstanding properties and its alignment with the idea of turning the energy crisis around, green hydrogen has attracted attention, and demand for it continues to grow worldwide. Besides European countries, which were already leaders in using green hydrogen fuel in industry and automotive, hydrogen energy is also one of the alternative energy sources that China is very interested in, as one of the world's largest energy consumers. In 2022, the Chinese government announced the "Hydrogen Energy Industry Development Plan" (2021-2035), China's first national hydrogen energy plan, which sets targets of having at least 50,000 hydrogen-powered vehicles in use and producing 100,000 to 200,000 tons of green hydrogen per year by 2025.

Australia has a policy of reaching net zero carbon emissions (Net Zero) by 2050, in line with the approach discussed at the COP26 conference last year. Adopting green hydrogen as an alternative energy is one of the key technology areas that the Australian government prioritizes in developing technologies to reduce carbon emissions. Australia was the first country to produce a national hydrogen strategy, in 2019, which set a target for Australia to become a leading hydrogen exporter by 2030.

As for Saudi Arabia, one of the world's top exporters of fossil fuels, it has a clean energy development plan through the Neom project, a major investment in clean energy intended to make Saudi Arabia no longer reliant on oil alone. The plan is to produce more than 650,000 tons of green hydrogen per year, mainly from wind and solar energy, with commercial production starting in 2026. The project will use a process that splits water into hydrogen and oxygen through electrical stimulation, to demonstrate its commitment to addressing climate change and to strengthen its image as a clean energy leader rather than an oil exporter

Using Green Hydrogen to Generate Household Electricity

Although the use of green hydrogen in industry is growing in popularity, at the household level, the hydrogen-powered home is still an idea in its early stages, requiring both suitable technology and cost-effectiveness, because green hydrogen production technology depends on energy storage systems as well as robust infrastructure. However, despite the limitations in cost and technology, efforts are being made to develop prototype hydrogen-powered homes to demonstrate the potential of this form of energy at the household level.

One interesting example is "Phi Suea House" of Sebastian-Justus Schmidt, a former German software engineer and founder of Enapter, which is a prototype of a green hydrogen home that can be completely self-reliant. The living area consists of a large main house, an energy systems building, a guest house, a swimming pool, a garden area, a pond, and an animal-keeping area, all of which use electricity generated on site from renewable energy, without relying on external electricity or energy sources.

The home's energy system operates as a solar-green hydrogen hybrid system, using a 140-kilowatt-peak (kWp) solar panel array to generate electricity during the day for use in the house, while excess solar energy is used to produce hydrogen through a 20-kilowatt (kW) electrolyzer, which splits water (H_2O) into hydrogen and oxygen.

The hydrogen produced is stored as a gas at a pressure of 35 bar in a tank that can hold up to 42 kilograms of hydrogen, which can supply the house with approximately 600 kilowatt-hours (kWh) of energy. At night or when there is little sunlight, the stored hydrogen is converted back into electricity through an 8-kilowatt hydrogen fuel cell system, in which hydrogen combines with oxygen to produce electricity and pure water, without causing pollution or carbon dioxide.

ห้องแบตเตอรี่ของบ้านผีเสื้อ ใช้สำหรับกักเก็บไฟฟ้า ที่ได้จากเชื้อเพลิงกรีนไฮโดรเจน

In addition, Phi Suea House has a 384 kilowatt-hour battery which, when working together with the hydrogen system, can store enough energy for at least 7 days of use, even during seasons with little sunlight and heavy cloud cover, ensuring a completely clean and environmentally friendly energy supply.

Green Hydrogen Is Worth Using, But How Feasible Is It for Thai People to Access This Technology?

As explained above, green hydrogen can be produced through electrolysis, using an electrolyzer to split water molecules into hydrogen and oxygen. However, one electrolyzer costs approximately 400,000 baht and produces only 1 kilogram of hydrogen per day, which is enough to power an average home for only half a day or one night.

Thanai Phothisat, Country Director for Thailand at Enapter, a manufacturer of hydrogen electrolyzers (or AEM electrolyzers), explained further that for a household to use hydrogen energy effectively, at least 2 electrolyzers may need to be installed, along with the related energy storage and supply systems. This could bring the overall cost to approximately 1 million baht, which is still a fairly high expense for household use in Thailand.

However, for remote areas such as mountains or islands that are not connected to the power grid, investing in infrastructure to produce green hydrogen together with solar energy may be a

cost-effective option, since many islands rely on diesel fuel to generate electricity, which has a lifetime cost several times higher than using green hydrogen.

Phi Suea House has electricity around the clock, at night, in the rain, or under cloudy skies, thanks to electricity generated from green hydrogen fuel.

In terms of cost, although the overall price of green hydrogen is still high today, Thanai believes this trend will change in the future, with growing support for clean energy and the development of more efficient technology helping to bring costs down. The same happened with solar cells, which were once expensive but have now become an alternative energy source that is easier for everyone to access. How affordable electrolyzers become will depend mainly on government support.

Therefore, if the government continues to view clean energy as too costly and chooses to keep relying on fossil fuels simply because they are cheaper, we may be overlooking the hidden costs that lie ahead: the cost of restoring nature and the environment damaged by greenhouse gas emissions, as well as medical expenses from air pollution that affects public health. If we keep delaying and fail to accelerate the transition to clean energy, these costs will keep piling up, until we may ultimately have to pay many times more to fix the problems we have neglected all along.

While many countries are beginning to invest seriously in advancing clean energy technology, Thailand also has to decide whether to be a leader or a follower on the path to sustainability. Investing today may be the key to helping our country break free from the cycle of unsustainable energy, achieve Net Zero, and build a secure future for the economy, the environment, and the health of Thai people in the long term.

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