The #1 Element of Renewable Energy for a Greener Earth

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What comprises three-quarters of the mass of the universe? This particular element may sound like the largest being for it is the most abundant but in fact, it is the simplest in nature. Having only one proton and one electron, its isotopes are responsible for the nuclear reactions occurring in the sun and the stars in providing light to the earth. The element, as you may have guessed, is hydrogen, which exists as a diatomic gas. According to the Los Alamos National Laboratory in New Mexico, U.S.A., its name originated from the Greek words: "hydro" for water, and "genes" for "forming". It can be found in organic matter and water and it is also used for various applications such as for the Haber process in the fertilizer industry, hydrogenation of fats and oils, and rocket fuel.

However, hydrogen that exists solely in a gaseous state would quickly dissipate and be scarce in the atmosphere if it is not combined with other compounds. Therefore, hydrogen preparation should be done to be able to utilize hydrogen as a raw material in its applications. The Los Alamos National Laboratory stated that the common methods for producing hydrogen are steam reforming, decomposition of hydrocarbons, the reaction between aluminum and potassium hydroxide or sodium hydroxide, electrolysis of water, and displacement by metals from acids. Considering that hydrogen gas has three times the energy content of gasoline and it burns "clean" for it only emits water and heat, it is found to be a promising alternative for conventional energy sources such as fossil fuels and coal. Thus, researchers have been developing fuel cells that could utilize hydrogen as fuel and consequently provide large quantities of electrical power for the stationary and transportation energy sectors.

The world today is shifting to the use of renewable energy over fossil fuels with the aims of reducing greenhouse gas emissions, leading to the prevention of climate change. Regarding hydrogen fuel, approximately 95% of the world's hydrogen production comes from fossil fuels as stated by the International Renewable Energy Agency (IRENA). On the bright side, hydrogen is still viewed as a favorable source of energy for it can be produced from renewable energy, provide several benefits to society, and secure a cleaner environment.

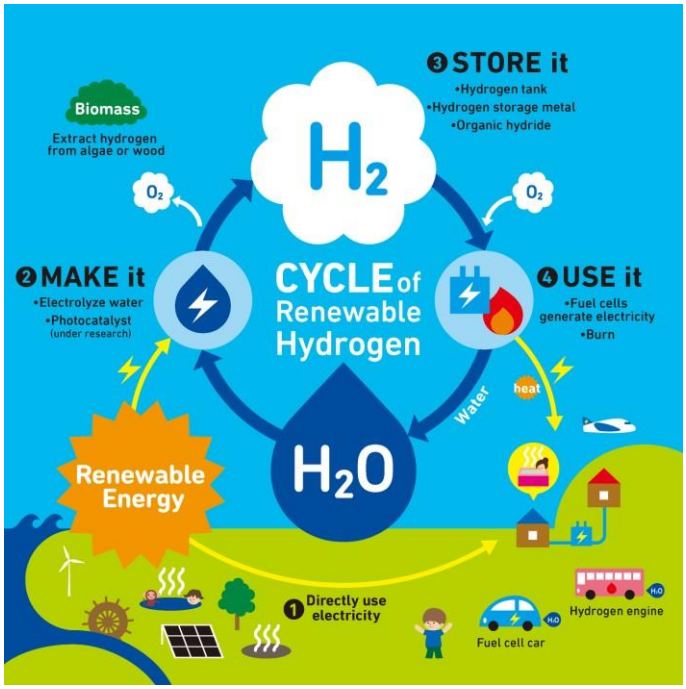

Figure 1. The Cycle of Renewable Hydrogen (RH_2 Network, 2018).

There are various ways to produce hydrogen from renewable energy. One reliable source of hydrogen is from biomass which can be obtained from agricultural residues, forestry residues, wood, municipal solid waste, and animal manures, as stated by Qian, *et al.* Biomass can be subjected to gasification. According to the office of Energy Efficiency & Renewable Energy (EERE) of the Department of Energy in the United States, gasification is a controlled process wherein heat, steam, and oxygen are used to convert the biomass to hydrogen and other gaseous products without combustion. Another is through the fermentation of biomass wherein microorganisms break down the organic matter into hydrogen. Researchers from the National Renewable Energy (NREL) are also studying the conversion of agricultural residues and consumer wastes into

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bio-oil, which can then be separated into hydrogen and other fuels. Aside from the usage of biomass, hydrogen may also be produced from an electrolyzer, which splits water into hydrogen and oxygen with the use of electricity. To make the process of electrolysis "greener", renewable electricity obtained from photovoltaic systems, wind power, hydropower, or geothermal energy should be employed. Alternatives for an electrolyzer are also being developed, and they are through photobiological, solar thermochemical, or photoelectrochemical means, all of which utilize sunlight. Furthermore, NREL states that the cleanest hydrogen production process is by using sunlight for electrolysis.

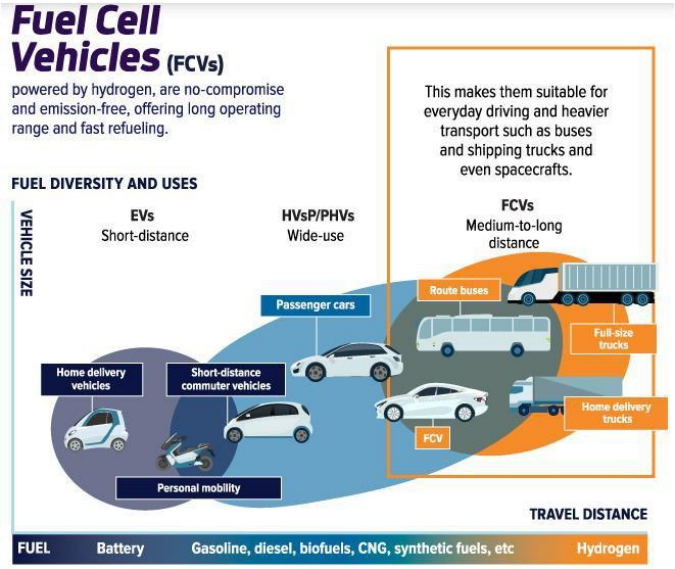

Figure 2. Fuel Diversity and Uses (LePan, 2019).

Several countries such as the U.S., Japan, Norway, Canada, and France to name a few, are already moving towards a green hydrogen economy and have greatly benefited them, as stated in an article by Deign for Greentech Media. It also reported that Japan leads the hydrogen fuel cell-vehicle development, which involves the automakers Toyota and Honda. With this, hydrogen remarkably diversifies the energy options in transportation. According to EERE, one-third of the carbon dioxide emissions of the U.S. are from transportation hence hydrogen derived from renewables can greatly reduce it and prevent environmental and health damages along the way.

Hydrogen has great potential in the transportation sector for it is more fuel-efficient than diesel or gasoline. For the same amount of fuel, hydrogen provides twice the mileage than conventional fuels. On the other hand, stationary fuel cells are used to supply power to buildings, establishments, villages, and off-grid homes for they can produce a few to a thousand or more kilowatts of power, as stated by the Environmental and Energy Study Institute (EESI). Furthermore, there would be no electrical transmission since the fuel cells are placed on-site, hence increases the overall efficiency of the system.

Despite its global notability, hydrogen also has its disadvantages. One difficulty that hydrogen poses is its storage because it requires high pressures to be kept in cylindrical tanks, low temperatures to keep it liquefied, or chemical processes to store it in a solid adsorbent. Moreover, manufacturing the fuel cell stack can be expensive, as well as the cost of hydrogen fuel since the technology behind its production is fairly new. For hydrogen fuel to compete in the marketplace, the cost of the fuel cells must be considerably reduced without compromising its performance, as reported by EERE.

The Union of Concerned Scientists elaborated that while hydrogen-powered fuel cell vehicles (FCEV) do not release harmful tailpipe emissions, its corresponding carbon emissions will depend on the hydrogen source, the process in extracting the hydrogen, and the energy source that drives that process, and this is also known as the full lifecycle of the vehicle. Therefore, the source of hydrogen is important to be from renewables to further minimize its total emissions. In comparison with the total lifecycle emissions if conventional gasoline were to be used, the Union of Concerned Scientists stated that the lifecycle analysis of FCEVs that utilize hydrogen from natural gas has reduced emissions by over 30% and by over 50% if part of the total hydrogen production is made from renewable energy. Moreover, it is more likely that the future FCEVs will be cleaner.

Moving forward, gaining the acceptance of the public regarding hydrogen is very important because it is relatively newer than the current energy technology being used. The public also plays an important role as citizens and consumers. Thus, investments in hydrogen fuel regarding its research, growth as part of the energy industry, and proper administration should be made so that society will trust the technology and will consequently reap its benefits in the long run. Although it might be costly as of today, hydrogen, the first element in the periodic table, is reliable and capable of providing clean energy that may serve as the number one of many elements from renewable energy that can progress technology and society towards a greener earth.

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