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Hydrogen *for* Beginners

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Introduction

Energy is a necessity for daily existence and for further economic and social growth. To meet the public's urgent demands, this energy is, however, in short supply. In order to address the difficulties now present, the output must be increased. However, hydrogen has emerged as a suitable means to expand production and improve access to energy.

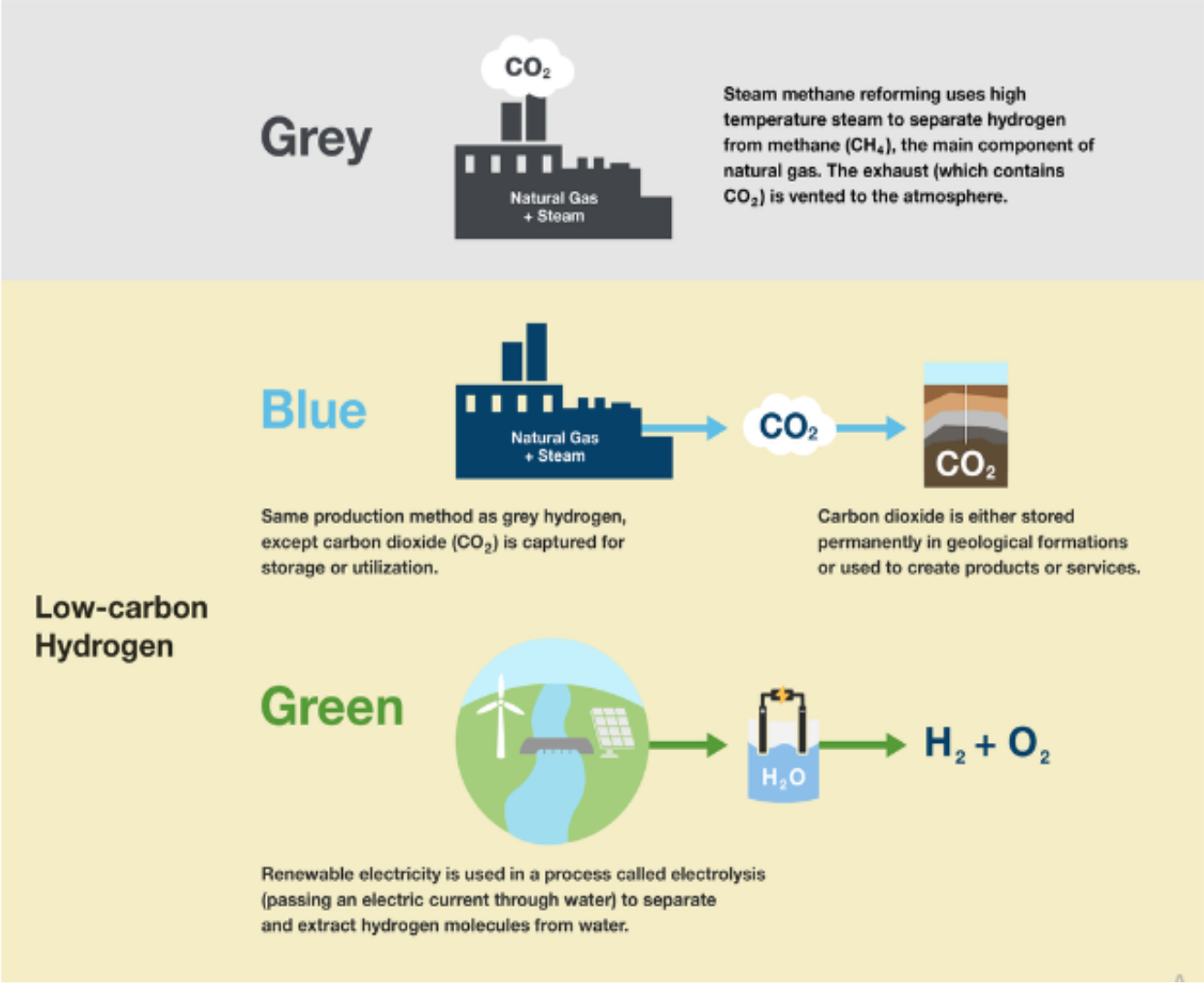
The main contributors to global greenhouse gas emissions are energy usage and production. Greenhouse gases are substances in the atmosphere[1] of the Earth that absorbs and releases heat. These gases include ozone, nitrous oxide, water vapor, nitrous dioxide, and carbon dioxide. The average temperature of the planet rises as a result of the heat they absorb and return to it. Since greenhouse emissions are the primary cause of climate change, nations around the world are actively pursuing a transition to clean energy. Countries all around the world are actively working on a clean energy transition by changing how energy is produced because greenhouse gases are the primary cause of climate change.

Hydrogen is a carbon-free fuel that can be used in a wide range of traditionally difficult-to-decarbonize applications. It has emerged as a substantial, industry-spanning promise. This industry includes the steel industry, chemical industry, refineries, shipping, aviation, railways, buses transportation. It is a clean fuel gives off majorly water when burned[2]. Many home energy sources, including natural gas, nuclear energy, biomass, and renewable energy sources like solar and wind, can be used to manufacture hydrogen. It is a desirable fuel choice for transportation and electricity-generating applications because of these characteristics.

[1] International Atomic Energy Agency. "What is the Clean Energy Transition and How Does Nuclear Power Fit In?" IAEA Bulletin, 62(2), 2018. Available online: https://www.iaea.org/bulletin/what-is-the-clean-energy-transition-and-how-does-nuclear-power-fit-in#:~:text=The%20clean%20energy%20transition%20means,some%20of%20these%20clean%20sources.
[2] National Grid. "What is Hydrogen?" Energy Explained, National Grid, n.d. Available online: https://www.nationalgrid.com/stories/energy-explained/what-is-hydrogen.

Types of Hydrogen

Hydrogen can be produced using multiple processes and sources. The color codes are used to differentiate the production processes and the energy sources used in production.



Source: Canada Energy Regulator[3]

Green Hydrogen is regarded as the energy carrier of the future. It is produced from renewable power sources which are seen as climate-friendly. This process involves the splitting of water using electrolysis of water from electricity (renewable sources). Water is split to produce hydrogen and oxygen. Electricity is used to power an electrolyzer that separates the hydrogen from water to create green hydrogen.

Hydrogen generally has the advantage of being transported over long distances and stored for a long period of time. Green hydrogen can also be used as a

[3] Alberta Energy Regulator. "Hydrogen." Emerging Resources, Statistical Report ST98, Alberta Energy Regulator, 2021. Available online: https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st98/emerging-resources/hydrogen.

feedstock for the production of chemicals like ammonia (where fertilizers are derived for use), synthetic fuels, and electricity supply. It completely avoids emissions by electrolyzing water to separate its hydrogen and oxygen.

The second method, "blue" hydrogen, [4]uses carbon capture and sequestration throughout the reforming process to reduce the carbon emissions of fossil-based methods. This method is produced by SMR or coal gasification including carbon capture and sequestration (CSS) technology.

An emissions-heavy, fossil fuel-based method of steam methane reforming, which yields what is known as "grey" hydrogen. Yet, there are a number of lower-carbon production options, primarily in the shape of one of two paths. Compared to other parts of the world, Africa uses hydrogen less frequently as an energy source. To promote the use of hydrogen in the continent, there are some active programs and initiatives. These programs are centered on the use of hydrogen as a clean and sustainable energy source for a range of industries, such as industrial, power generation, and transportation.

The most popular technique for creating bulk hydrogen is steam methane reformation, which generates the majority of the hydrogen produced globally. This process makes use of a reformer, which uses steam to react with methane and a nickel catalyst at high temperatures and pressures to produce hydrogen and carbon monoxide (CO). In Ato-Thermal Reformation (ATR), methane is reacted with steam, carbon dioxide (CO_2), and oxygen to produce hydrogen. Due to the fact that these blue and grey hydrogen processes generate carbon as a byproduct, carbon capture and storage (CCS) is necessary to capture and store this carbon.

Hydrogen's Role in the Energy Transition

Hydrogen can be used for generating electricity with the help of hydrogen fuel cells where electric energy is created by burning hydrogen together with oxygen to create water. The electric energy produced in this process can, for example, be used in stabilizing a grid or for transportation.

Hydrogen can help to decarbonize building heating. It also serves as chemical feedstock using captured carbon. It helps to decarbonize the transport industry such as long-haul trucks, aviation, and shipping. It decarbonizes industry energy use, especially high-temperature heat. It acts as a buffer to increase system resilience through energy storage. The fundamental building blocks of our clean energy transition include universal energy efficiency spending, rapid and sustained renewable energy deployment, and electrification of anything that can be converted from operating on fossil fuels to running on a clean power grid.

These initiatives will significantly advance our transition to a sustainable energy future. Yet, they are limited, particularly when it comes to energy end uses that don't lend themselves to electrification easily or completely. Interventions like

[4] McNamara, Julie. "What's the Role of Hydrogen in the Clean Energy Transition?" Union of Concerned Scientists, 16 June 2020. Available online: https://blog.ucsusa.org/julie-mcnamara/whats-the-role-of-hydrogen-in-the-clean-energy-transition/.

hydrogen may be really important in this situation. This includes providing energy for long-distance aviation, maritime transportation, large freight, and some types of on-road vehicles, as well as supporting sectors like steel production and cement manufacturing. When compared to a fully hydrogen-centered economy, hydrogen as a strategic intervention is clearly a scaled-back function; nonetheless, it's crucial to note that even this "limited" adoption would result in a lot of hydrogen fuel being produced, many times more than is currently used in the economy.

The production of hydrogen from renewable energy is a crucial step toward attaining net-zero emissions economies and the global switch to sustainable energy. It costs more than other fossil fuel alternatives and is currently only used in a small number of industrial applications. Despite this, there is a compelling reason why the global market for hydrogen is growing significantly. Energy must be transferred from one place to another via the energy carrier hydrogen, also referred to as H2. As an e-fuel in the transportation sector or a technique to cut emissions in steel manufacturing and other industries, it can in fact help drive the decarbonization of entire industrial sectors and combat climate change in the process[5].

Moreover, hydrogen can be quite important in supplying energy to regions that often import it. In regions where renewable energy sources, like wind, are widely available, energy may be produced economically, transformed into hydrogen or other molecules, and then transferred to import zones. The gasification of biomass is another potential source of hydrogen. Although this method immediately raises difficult issues regarding the source of suitable biomass and what it would mean for forests and competing biomass uses, it is particularly relevant for decarbonization because it has the potential to result in overall emissions that are carbon negative if process emissions are captured.

However, the potential for hydrogen is much greater. It is a flexible fuel that can change its form to meet the energy requirements of a variety of energy end-uses, including those that the long cord of clean-energy electrification may not easily reach such as industrial applications, long-haul aviation, maritime shipping, and heavy freight. These can all rely on hydrogen or fuel derived from hydrogen for their decabonization. Together with other strategies, hydrogen has the ability to enable a high-renewable power grid balance and fill in any gaps, taking the place of a resource like dispatchable natural gas. But, for those who are optimistic about hydrogen, these are merely the first few steps. There is a pitch for anything that uses fossil fuels now, including home heating, cooking, transportation, and trains.

[5] EWE AG. "Hydrogen: Shaping the Future." EWE, n.d. Available online: https://www.ewe.com/en/shaping-the-future/hydrogen.

Conclusion

Hydrogen can be adapted as a versatile, clean, and sustainable energy source. It is anticipated to play an increasingly significant role in the global energy mix due to the advancement of new technologies and the greater focus on decreasing greenhouse gas emissions. To resolve climate change, governments and industries are driving the energy transition to adopt various measures that reduce their climate impacts while maintaining the stability of their economy. Green hydrogen technologies are one of the upcoming central topics in the energy and green feedstock transition. Different nations are driving the deployment of a green hydrogen economy for decarbonization, export potential, and energy security.

Green hydrogen can also catalyze clean energy investment, energy access, cost digression, and market development towards 100% renewable energy globally. In advancing the energy transition, the development of a green hydrogen economy and trade is a global challenge: because green hydrogen is the most economical and also has an optimal combination of abundant renewable resources such as availability of land, access to water, and the ability to transport and export hydrogen to large demand centers.

Author

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Abigail is a young enthusiastic economist that is passionate about generating new ideas and devising feasible solutions to broadly relevant problems, especially in the energy sector. Abigail is currently a Junior Associate, Researcher at Clean Technology Hub, where she heads the hydrogen portfolio. She has developed Market Update report on recent development in Africa. She has also conducted engaging podcast and written articles to support the deployment of Hydrogen market in Nigeria. She is committed to the growth of the deployment of Hydrogen in Nigeria and across Africa.