



By:
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Study in:
Hydrogen...
Energy of The Future

Introduction

Hydrogen represents a new source of clean energy, as it is considered a candidate to change the face of the energy industry because it does not produce any carbon emissions, and the use of hydrogen as an alternative source of energy has become the focus of the attention of many countries in recent times, as it is one of the important sources of clean energy, due to its importance in reducing Carbon emissions and the reduction of climate change, as hydrogen can be used as a fuel in several sectors such as industry, utilities and transportation, which can be produced through several methods, and the most common methods today are natural gas reformulation and electrolysis, and other methods include processes that work with biological processes and energy Solar energy, and hydrogen energy is usually used to generate electricity or even as fuel in hybrid and electric cars.

❖ *Hydrogen energy and sustainable development in the UAE*

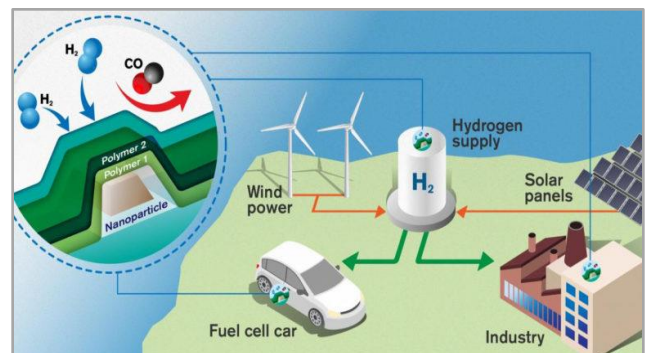
With the UAE's success in diversifying energy sources, over the past decades, to include besides gas and oil, both nuclear and renewable energy, as well as the generation of energy from waste, the country's plans to add hydrogen to the energy mix continue, supporting sustainable development strategies and economic diversification, and Emirati experts have confirmed Energy specialists that hydrogen energy can be one of the tributaries of achieving sustainable development in the UAE, which can be produced from available and traditional sources such as gas and oil, or from renewable sources such as wind and solar energy, geothermal energy, and organic sources, In addition to the multiplicity of sectors that can use hydrogen energy, it can be used in multiple economic sectors such as the real estate sector, transportation, and power generation using fuel cells. Hydrogen energy also has the advantage of being a clean energy source that reduces environmental impacts.⁽¹⁾

It is worth noting that the UAE is working to strengthen its presence on the map of the global market for hydrogen, as the International Energy Agency announced that the demand for hydrogen as an energy source has increased three times during the last period, and the global production volume has reached 70 million metric tons annually, which will contribute by 2040 to Reducing its production cost by up to 64%, and the UAE has started experimental stages in this field. Dubai Electricity and Water Authority has launched the "**Green Hydrogen**" project, which is the first of its kind in the Middle East and North Africa to produce green hydrogen using solar energy at the Mohammed Bin Complex Rashid Al Maktoum Solar Energy in Dubai. The station has been designed and built to be able to accommodate testing platforms for the various uses and future applications of hydrogen, including transportation and industrial uses. The Abu Dhabi Future Energy Company (**Masdar**) also announced that it has joined forces with Etihad Airways, the Abu Dhabi Department of Energy, Lufthansa Group, Siemens Energy, Khalifa University of Science and Technology and Marubeni in an initiative that contributes to the development of the green hydrogen economy in Abu Dhabi. Also, this initiative aims to establish a pilot plant project in Masdar City to explore opportunities for developing sustainable fuels, green hydrogen, and producing green kerosene using electricity for transportation, shipping and aviation purposes.⁽²⁾

Among the country's most prominent global initiatives in the field of hydrogen energy, the Ministry of Energy and Infrastructure and the Japanese Ministry of Trade signed a cooperation agreement to explore opportunities in the field of hydrogen development, which was at the beginning of 2021, which would expand the bases of partnership and promote investment in the hydrogen sector, as the agreement aims To open broad prospects for growth and development within the efforts of the two countries to diversify the energy mix and rely on clean ones, in addition to continuing cooperation to exchange information related to hydrogen production, build the supply chain and transport to Japan, and exchange information to develop regulations and policies, and through the implementation of the Energy Strategy 2050, the UAE seeks to Reducing the carbon footprint by reducing carbon dioxide in the country by 70%, and raising the efficiency of individual and institutional consumption by 40% by the year 2050. It also aims to diversify the future energy mix and raise the contribution of clean energy in the total energy mix produced in the country to 50%.⁽³⁾

❖ *Hydrogen production methods*

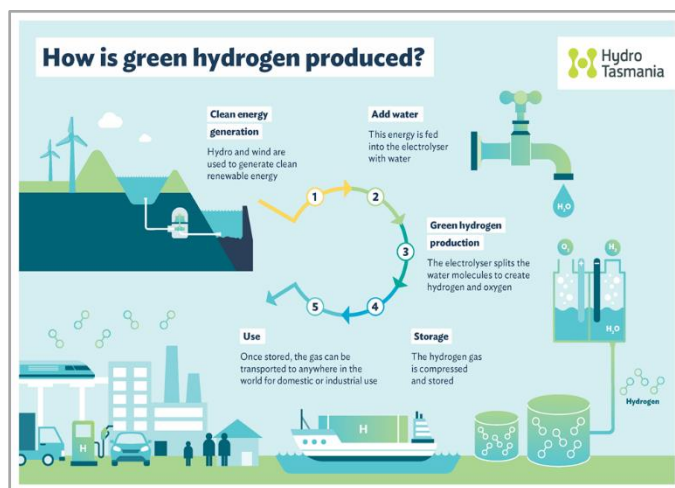
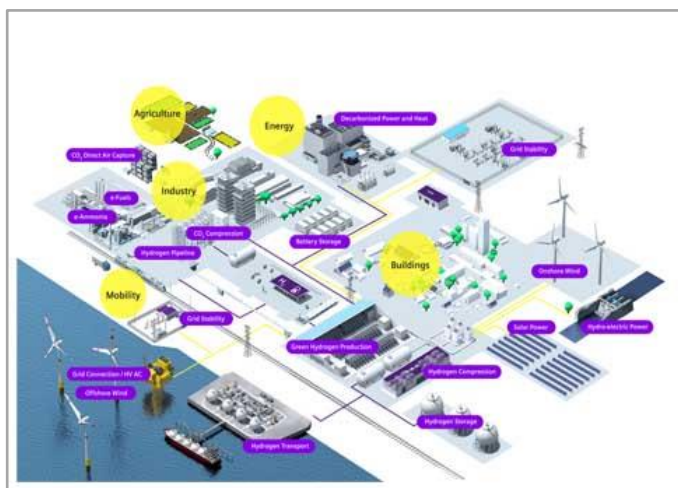
Because of the emission of greenhouse gases, hydrogen production by traditional methods, i.e. through fossil energy, is not of great importance, and it is preferable to use fossil energy directly without going through hydrogen, and therefore hydrogen production will become very important if it is produced in clean ways, that is through renewable energies (Geothermal energy, wind energy, solar energy,...) to produce the electricity necessary for electrolysis.



❖ **Methods of preparing hydrogen include chemistry, physics or biology, and the production methods can be summarized as follows :**

- **Electrolysis:** One of the most common methods through which an electric current is passed in the water leads to the analysis of the water into elements, so that the efficiency rate reaches 80% and decreases to 30% by calculating the efficiency of the process of generating electricity from another source.
- **Thermal analysis:** which is done by heating water vapor to 2500 degrees Celsius, which leads to the decomposition of water into oxygen and hydrogen. Nuclear reactors, as well as solar and other energy do not provide this amount of energy.
- **Thermochemical method:** This method relies on the interaction of water with some chemical compounds at high temperatures, which reach 800 degrees Celsius, which after a series of reactions leads to the decomposition of water, and this method faces the problem of high temperature in terms of conducting a series of reactions after obtaining on hydrogen to restore used materials and compounds to normal.
- **Photosynthesis of algae and:** The process of photosynthesis takes place in a reverse way in water than what happens in the air, as algae release hydrogen instead of oxygen, ie, obtaining hydrogen without other energy sources other than the sun, but one of the disadvantages of this method is that it needs very large areas of supplied areas Algae to provide large amounts of hydrogen.

Hence, we find that the production of hydrogen through the electrolysis of water is better because this production aims to store energy from a renewable and irregular source, where the surplus of the energy produced in it is used in an abundant and irregular manner in time to produce hydrogen and transport it to the place of demand or store it for a while. need it.⁽⁴⁾



❖ **Hydrogen storage and transportation :**

There are three predominant methods of hydrogen storage:

- As hydrogen gas in high pressure tanks, and this is the best method
- As a very cooled liquid
- Storage by absorbing it into a liquid or solid substance

The first and second methods are currently used, but they need tight conditions, as the tank pressure is usually between 5.34 to 69 atm.

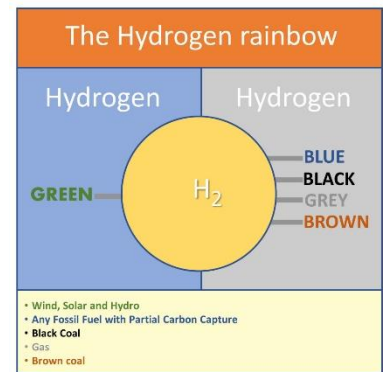
❖ **The expected role of hydrogen :**

“Green hydrogen” is the fuel of the future where the focus is now, and this means that we are in the process of a hybrid phase of energy fuels that are compatible with the new environmental regulations and laws: oil and gas (without carbon dioxide), green hydrogen and hydroelectric energy, as indicated by a recent study in the journal The Indian Economic Times indicated that there are plans for the construction of about 228 large projects to produce green hydrogen in 30 countries by 2030, the value of which exceeds 300 billion dollars, in transportation, huge sectors of industries, the new

hydrogen economy and infrastructure. But while hydrogen is considered the appropriate fuel to address the problem of climate change, there are several challenges that must be overcome in order to succeed in the future fortunes of hydrogen, perhaps the most important of which is obtaining the hydrogen itself despite the abundance of hydrogen in water and fossil fuels.

❖ It should be noted that there are two types of hydrogen, green and blue

- **Green hydrogen:** It is produced through electrolysis of water, as this method uses an electric current to separate hydrogen from oxygen in water, and feed electricity from renewable sources (wind and sun), while oxygen, the second component of water, is produced and released into the air, where it constitutes a positive factor for the atmosphere.
- **Blue hydrogen:** With a catalyst, hydrogen is produced by mixing natural gas with very hot steam, where a chemical reaction takes place between hydrogen and carbon monoxide. The carbon monoxide is then added to the carbon dioxide to create more hydrogen, where the carbon dioxide is captured and collected for underground storage in empty wells.⁽⁵⁾

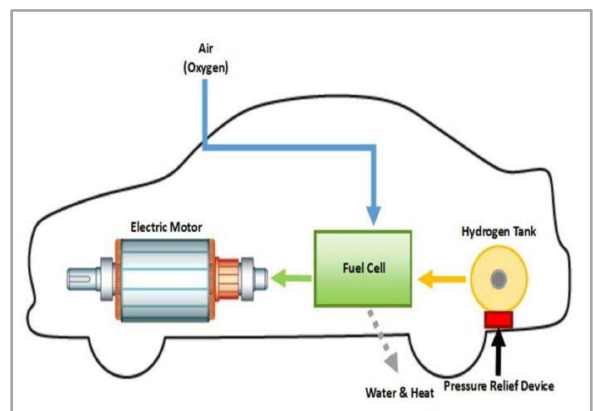


❖ Green hydrogen: a new member of the renewable energy family

Similar projects are under way in Norway, South Korea and the USA, where efforts are being made in California to eliminate fossil fuel-powered buses by 2040. The European Commission recently published the 2030 Hydrogen Production Plan, which calls for It aims to increase hydrogen production capacities to reach 500 gigawatts by 2050 (noting that the current capacities do not exceed 0.1 gigawatts). Which prompted the global financial services institution "Goldman Sachs", early this year, to predict that by 2050, the value of market investments in the production of green hydrogen will reach 12 trillion dollars.⁽⁶⁾

❖ Regular electric vehicles compared to fuel cell electric vehicles :

Electric vehicles are vehicles that run on electricity that is stored in a battery inside the vehicle, while the technology of these cars has developed remarkably in the past decade that the main challenges they face still exist and include the limited distance traveled, the weight of the batteries, and the long time to charge the battery (It ranges between one hour to 14 hours, depending on the power of the charger used), and additional problems associated with electric vehicles also include the environmental impacts of battery production, unlike the above, fuel cell electric vehicles rely on hydrogen that is converted in a fuel cell to electrical energy. Therefore, fuel cell electric vehicles do not need the same size batteries as electric vehicles. The hydrogen is stored in a tank like that used for diesel/gasoline in conventional cars, the refueling process is fast, and the distance traveled by conventional cars is like that of fuel cell electric vehicles. One of the challenges facing hydrogen cars at the present time is that it is still very expensive due to the lack of production on a commercial scale, as well as the non-completion of hydrogen fuel stations, which are one of the most important infrastructure facilities required for them.⁽⁷⁾



❖ Is the hydrogen revolution inevitable ?

“The switch to hydrogen entails huge infrastructure spending and in many cases, the additional costs make the idea unattractive compared to other alternatives (such as renewables),” said the E3G Environmental Research Center in a statement. Richard Black of the Energy and Climate Information Unit (ECIU) said in a statement to the BBC: "We will, and should, use hydrogen in the energy blending options, but it's not a magic bullet for everything, as some rhetoric sometimes suggests. There is hope, but there is also a lot of exaggeration".⁽⁸⁾

❖ *Examples of hydrogen political initiatives/programs in some major countries:*

- **UAE:** At the beginning of 2021, Mubadala Investment Company (Mubadala), the Abu Dhabi National Oil Company (ADNOC) and ADQ Holding Company announced the signing of a memorandum of understanding to establish the Abu Dhabi Hydrogen Consortium, with the aim of establishing Abu Dhabi's position as a reliable exporter of green hydrogen, and for refining and petrochemical operations. Currently, it is about 300 thousand tons per year of hydrogen, and it also plans to raise its production to 500 thousand tons per year. In February 2019, Dubai started the construction of the first solar water electrolysis plant in the Middle East, operated by Dubai Electricity and Water Authority, with an annual capacity of 250 tons, and which is based on technology produced by the German company Siemens. The Expo 2020 will use fuel cell vehicles using hydrogen. In October 2017, the first hydrogen filling station in the Middle East was opened in Dubai, in addition to 55 Toyota Mirai fuel cell vehicles on the roads in the UAE. Air Liquide and others estimate that 12 hydrogen filling stations are enough to cover the state's demand for hydrogen fuel. Abu Dhabi Police also announced plans to convert its vehicle fleet to fuel cell vehicles by 2050.⁽⁸⁾
- **Egypt:** During the second quarter of 2021, the LNG and Hydrogen Development Report revealed that the Egyptian government received in May an offer from the German company ThyssenKrupp to establish a plant for the production and export of hydrogen and green ammonia from Egypt to Germany, where it was agreed to move forward with the procedures for signing a memorandum An understanding so that the proposed project in the field of green hydrogen production can be implemented
- **The European Union:** A project worth 170 million euros for hydrogen-powered cars is currently in its second phase, to prove the practical feasibility of fuel-cell cars and to expand the network of hydrogen fuel stations in the European Union.
- **China:** In order to reduce environmental pollution, China seeks to quickly convert cars away from fossil fuels, which is one of the main policy challenges for the government, and after the successful conversion to electrification of short-distance vehicles, including 250 million two-wheeled vehicles and 4.0 Millions of city buses are currently on Chinese roads, in addition to studying the introduction of fuel cell-powered buses and trucks for use in long-distance transportation.
- **Japan:** Through research and development activities over the past years, Japan has invested an amount of 5.1 billion US dollars. In the Olympic Games in Tokyo 2020, US\$ 380 million was spent on 35 hydrogen fuel stations and 6000 fuel cell vehicles. The national spread of fuel cell vehicles by 2030 is to reach 8.0 million vehicles.⁽⁹⁾

❖ *Advantages of hydrogen energy?*

- **Powerful and Effective:** Three times more powerful than gasoline and other fossil fuels, which means it has the potential to get more energy done for less.
- **High Efficiency:** Fuel cells used to generate hydrogen power when used in a combined heat and power system can have an efficiency level of about 80% greater
- **Creates long-term jobs:** Hydrogen plants are already committed to investing 1.4 billion euros annually in the marketing of the fuel cell and hydrogen sectors, and through continued investments we have a lot of job opportunities that are free from the vagaries of the foreign oil market
- **It has a vital application in the crude oil and natural gas industry:** for example, hydrogen is deployed to treat crude oil and turn it into refined fuels such as gasoline and diesel, and hydrogen may be used to get rid of pollutants such as sulfur from these fuels, and most other industries also benefit from hydrogen fuel in Chemical production, electronics manufacturing, metal refining, and food processing.⁽¹⁰⁾

❖ ***The benefits of green hydrogen, the global revolution in clean energy: One of the renewable energy sources: many countries around the world are seeking to benefit from it.***

- **Supporting the future of clean energy:** Contribute to providing a future of clean, safe and inexpensive energy.
- **High efficiency:** Each kilogram of hydrogen fuel enables the car to travel 100 km.
- **Ease of production:** Green hydrogen is obtained from the electrolysis of water in a simple way.
- **Ease of storage and transportation:** the possibility of storing it for longer periods, and it can be moved to places where there is no possibility of generating renewable energy.
- **Reducing the selling prices of electricity:** It contributes to reducing the selling prices of electricity and addressing climate change and global climate challenges.
- **There are no by-products:** it is characterized by the separation of the two elements of water, namely, oxygen and hydrogen, both of which can be used.
- **Speed in providing vehicles:** the possibility of providing vehicles with fuel in 5 minutes, unlike electric vehicles that need an hour.
- **Environmentally friendly:** The production of green hydrogen contributes to a carbon-neutral society that can be produced with low energy and can become the fuel of the future.
- **Energy needed from renewable energy sources:** The energy needed to extract it can be obtained from renewable energy sources such as wind, solar energy, waste recycling, tides, waves and geothermal energy.⁽¹¹⁾

❖ ***Recommendations:***

- All research conducted in most countries of the world shows that the largest proportion of toxic gases released into the atmosphere are caused by gasoline and diesel cars.
- The use of hydrogen as a fuel for cars will lead to the disposal of toxic gases emitted from the exhaust of current cars, at an estimated rate of about 60% of the total public pollutants.
- The use of hydrogen as a fuel for future cars is a strategic and vital project that must be taken into consideration and benefit from the experiences of other countries looking into this field.
- Develop a future for establishing hydrogen supply stations in a way that ensures easy and quick access to it, in addition to establishing technical complexes that will convert existing cars into hydrogen-powered cars.
- Compared with the positive benefits for public health and the surrounding environment, with the initial cost of the large project, it is invaluable.
- To achieve this project, concerted efforts and coordination between all governmental and federal bodies must be made to be the site of future investment and in the required manner.

Conclusion

In the end, we can say that there are still challenges facing the global ambition to increase the representation of green hydrogen in the global energy structure in the future, perhaps the most prominent of which is the high production costs that ultimately depend on the prices of electricity generation through renewable energy sources and the investment cost of the electrolyzer. Noting that the bet on enhancing the economic feasibility of using green hydrogen globally depends on the support of the global innovation system that supports reducing the investment and operational costs of producing this clean fuel, and in a way that makes it a more attractive future for end users in various economic activities.

References

- [1] Majdi Obeid, (July 14, 2010), Albayan - economic, due to the multiplicity of its production sources and the diversity of its uses. Hydrogen energy achieves sustainable development in the Emirates, available: <https://www.albayan.ae/economy/2010-07-14-1.264793>
- [2] Moamen Bani Mustafa, (January 11, 2021), eArabic, Science, Advantages of Hydrogen Energy, Available: <https://e3arabi.com>
- [3] AL bayan-Economic, (10 April 2021), UAE and Japan Expand Partnership and Investment in Hydrogen, Available: <https://www.albayan.ae/economy/uae/2021-04-10-1.4136940>
- [4] Walid Khadduri, (20 July 2021), Fuels of the Future - The Expected Role of Hydrogen, Middle East, No. 15575, Available: <https://aawsat.com/home/article/3088841>
- [5] Jeff Karbeck, (December 11, 2020), Scientific American, Green Hydrogen - a new member of the renewable energy family, Available: <https://www.scientificamerican.com/arabic/articles/features/green-hydrogen-could-fill-big-gaps-in-renewable-energy/>
- [6] Dr. Axel Michaelhova, (September 2019), Emirates Diplomatic Academy, Developments in Hydrogen Technologies until 2030 - Opportunities and Risks for the Gulf Countries and the Implications of International Policies, Available: https://www.agda.ac.ae/docs/default-source/Publications/eda-insight_hydrogen-economy_ar_final.pdf?sfvrsn=2
- [7] Roger Harrabin, (3 Jan 2020), BBC, Climate change Can hydrogen become the fuel of the future?, Available: <https://www.bbc.com/arabic/science-and-tech-50976452>
- [8] Sayed El-Hagggar, (February 21, 2021), Alittihad-Economic, Hydrogen: The Future of Clean Energy, Available: <https://www.alittihad.ae/news>
- [9] Ali Shehab, (June 18, 2019), Makkah Magazine, 5 Benefits of Refueling Vehicles with Hydrogen, Available: <https://makkahnewspaper.com/article/1105377>
- [10] Youssef Mohajer, (27 May 2017), Study of Solar Hydrogen Production, Available: <http://dspace.univ-eloued.dz/bitstream/123456789/1922/1/660-065.pdf11>
- [11] Arabi. Septin News, (14 February 2021), Green Hydrogen reduces electricity prices in Egypt, available: <https://arabic.sputniknews.com/mosaic/202102141048112987>
- [12] Hanan Al-Sawy, (January 16, 2021), Akbar Al-Youm, 5 benefits of green hydrogen. The world revolution in clean energy, available: <https://m.akhbarelyom.com/news/newdetails/3229164>
- [13] Marwa Al-Ghoul, (17 August 2021), Youm7, OAPEC - Egypt received 3 new offers for green hydrogen and ammonia production projects, available: <https://www.youm7.com/story/2021/8/17//5427839>