

Low-Carbon hydrogen in the United Arab Emirates and Algeria: Opportunities and Challenges

Benabbas Sahra*, University of Mohamed El Bachir El Ibrahimi, Bordj Bou Arreridj, Algeria,
sahra.benabbas@univ-bba.dz

Hadji Fatima, University of Mohamed El Bachir El Ibrahimi, Bordj Bou Arreridj, Algeria,
fatima.hadji@univ-bba.dz

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Abstract: This study examines the potential and challenges of renewable hydrogen production in Algeria, comparing it with the United Arab Emirates' experience. It analyzes both countries' efforts to balance energy security with sustainable development through hydrogen, reviewing their energy policies, production capabilities, and strategies. The research identifies key factors for industry development, such as international partnerships, infrastructure investment, and supportive regulations. The study concludes with recommendations for Algeria, drawing on lessons from the UAE, and highlights the potential for hydrogen to play a crucial role in their future energy landscapes.

Keywords: Hydrogen; Low-Carbon hydrogen; Renewable energy; Algeria; United Arab Emirates.

JEL codes : Q42; Q48; O53; O55.

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Introduction:

Algeria, a leading global oil and gas producer with substantial proven reserves, heavily relies on fossil fuels for domestic energy consumption, primarily using natural gas for electricity generation. Facing rising electricity demand, especially during peak periods, the Algerian government aims to increase renewable energy's share in its energy mix to 30% by 2030, leveraging its abundant solar, wind, and biomass resources.

To achieve this goal, the government has implemented various policy measures to promote renewable energy supply. It is also exploring the integration of hydrogen (H₂) into its energy mix in the medium term, with future export aspirations. H₂ stands out as a clean and highly efficient energy source compared to conventional sources, with diverse applications across various sectors.

Although the concept of utilizing H₂ as an energy source is not new, commercial barriers have hindered its widespread adoption, except for specific niche applications. This study explores the prospects and challenges of low-carbon H₂ production in both Algeria and the United Arab Emirates (UAE).

*. Corresponding Author

How can the UAE and Algeria leverage their potential in the low-carbon hydrogen market development? What key strategies and challenges define their approach to developing this sector?

Both Algeria and the UAE possess significant potential for low-carbon H₂ production, but they face distinct challenges in developing this sector.

This study aims to compare green H₂ development strategies in Algeria and the UAE, identifying similarities, differences, lessons learned, and common challenges.

Specifically, the study will examine:

- The drivers behind H₂ strategies in both countries.
- The policy and legislative frameworks supporting the H₂ sector in each country.
- Government and private investments in H₂ projects.
- The technical and economic challenges facing each country.

This study provides valuable insights into the emerging low-carbon H₂ sector in two key energy-producing countries. The comparative analysis offers lessons learned and identifies potential pathways for successful H₂ development in similar contexts.

This study will employ a comparative case study approach, utilizing data from a variety of sources, including policy documents, industry reports, academic literature.

Theoretical Framework of the Study:

1-The Nature of H₂ Energy:

1.1. Definition of H₂ Energy, Its Characteristics, and Importance:

H₂ is the most abundant element in the universe, comprising over 90% of all matter. It's a colorless, odorless, and non-toxic gas that burns easily with oxygen, releasing energy as heat and producing water. H₂ can be stored compressed or as a liquid, making it valuable for long-term energy storage.

Liquid H₂ is highly efficient, containing 2.3 times the energy of kerosene and 4 times that of gasoline per gram. However, it requires larger storage tanks due to its lower density. H₂ is more efficient than gasoline in engines, and fuel cells using H₂ can be up to 100% efficient. Importantly, H₂ -powered engines only emit pure water (Badri, 2018, p. 71).

Benefits of using H₂ as an alternative fuel include:

- Reducing or eliminating carbon emissions
- Replacing fossil fuels in hard-to-abate sectors
- Improving engine performance and efficiency
- Storing excess energy to support renewable energy flexibility

1.2. H₂ Production Pathways:

H₂ can be produced from various energy sources (coal, oil, natural gas, biomass, renewable, nuclear) using technologies like reforming, gasification, electrolysis, and thermolysis. Different production methods are categorized by colors (green, blue, gray) to indicate their environmental impact (Hashimy et al., 2017, p. 2)

H₂ production methods vary in environmental impact and costs shown in the figure1:

- Gray H₂: Derived from fossil fuels through processes like steam methane reforming.
- Blue H₂: Uses same methods as gray H₂ but incorporates carbon capture and storage (CCS).
- Green H₂: Produced via water electrolysis powered by renewable energy sources.

The choice depends on balancing energy-efficiency, resource-conservation, commercial viability, and environmental/social impacts.

1.3. H₂ Applications

Low-carbon H₂ has diverse applications across various economic sectors. In the near term, it's valuable for de-carbonizing petrochemical and refining industries, as well as ammonia and methanol production. Its long-term potential includes large-scale energy storage and long-distance transportation; the following are its most important uses:

Industrial uses: Important in petrochemicals, iron and steel, and chemical manufacturing (Sharma et al., 2023, p. 4).

Energy storage: Helps mitigate intermittency of renewable energy sources, by storing surplus electricity generation during peak times and utilizing it when needed. (Djeghbala & Hamlaoui, 2023, p. 326)

Transportation: H₂ offers a promising alternative to fossil fuels in the transportation sector. It can power internal combustion engines or fuel cells, though the latter are more efficient but also more costly (Abdeldjalil, 2023, p. 348).

Electricity generation: Hydrogen is being developed as a turbine fuel, either alone or mixed with natural gas, with commercial use anticipated by 2030. It will play a crucial role in the electricity sector, particularly as a stored energy source used when renewable energy production is low. (Houasni, 2024, p. 45)

Heating: Can be blended with natural gas for heating buildings.

2. H2 Economically:

2.1. Current Status of H2 and Expected Demand

Global H₂ production reached 95 million tons in 2022, an increase of 3% from 2021. As **fig.2** shows most production is from fossil fuels, with natural gas (without carbon capture) accounting for 62% and coal 21% (mostly in China). H₂ as a by-product in refineries represented 16%. Meanwhile, low-emission H₂ production remained minimal (less than 1 million tons). Mostly from fossil fuels with carbon capture - CCS - (about 0.7%), and production of H₂ from water electrolysis remained limited (less than 100,000 tons). **Table 1** shows that more than 70% of production is concentrated in China, the United States, the Middle East, India, and Russia (30% for China alone) (IEA, 2023, p. 64).

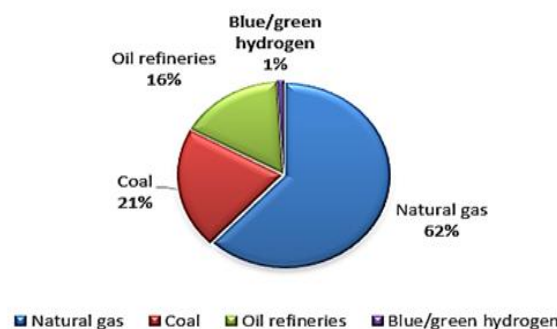


Figure 1: Source of hydrogen Production

Source: Figure created by the authors.

There are also 11 low-emission H₂ production plants: 7 facilities retrofitted with carbon dioxide capture and four using electrolyzers. They produced about 260 kilotons of low-emission H₂ in 2021 (about 0.7% of H₂ demand in refining), a slight increase from 230 kilotons used in refineries in 2020.

Table 1. The largest hydrogen producers/consumers in 2020

Country	Production	Usage	Source (%)
China	25.5 MT	9 MT for refining, 16.5 MT for chemicals	60% Coal, 25% Natural Gas, 15% Byproduct
USA	11 MT	2/3 for refining, the rest for ammonia production	80% Natural Gas, the rest Byproduct
Middle East	11 MT	>4 MT in refining, >5 MT in chemicals, 1.5 MT iron	Nearly 90% Natural Gas, the rest Byproduct

Source: created by the authors

2.2 Expected Demand for H2

H₂ is projected to play a significant role in future energy systems, meeting 12% of final energy demand and reducing 10% of carbon dioxide emissions in a 1.5°C scenario. While 2020 production relied solely on gray H₂ at about 120 million tons, forecasts for 2050 show a

dramatic increase to 360-560 million tons, with a shift towards blue and green H₂ production methods (Figure 3). The International Energy Agency expects low-emission H₂ production to grow rapidly, potentially reaching over 20 million tons annually by 2030, representing a 30% increase in announced projects within a year and signaling substantial growth in cleaner H₂ technologies (IEA, 2023).

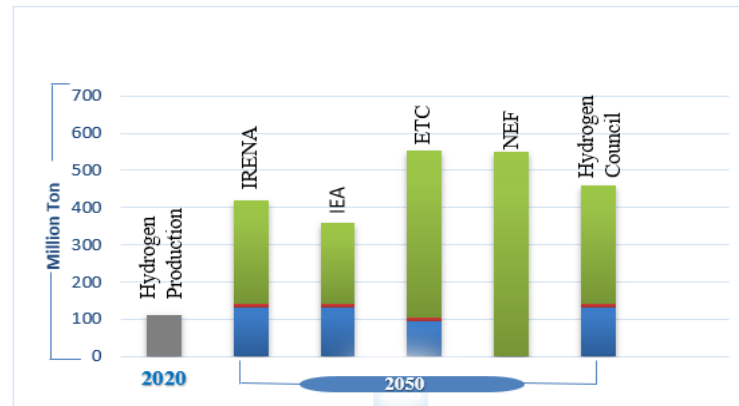


Figure 2: Expected H₂ Demand According to Specialized Agencies and Organizations

Source: GCC Statistical Center. (n.d.). H₂ as a source and carrier of sustainable clean energy in GCC countries. Retrieved November 23, 2024, from <https://www.gccstat.org/ar/statistic/publications/H2-as-a-source-and-carrier-of-sustainable-clean-energy-in-gcc-countries>

H₂ production is shifting towards more sustainable alternatives, with projections showing growth in blue and green H₂ while gray H₂ remains stable or slightly decreases compared to 2020. This change reflects the industry's move towards cleaner energy sources to meet growing demand.

2.3. Cost of H₂ Production:

H₂ production costs vary based on technology and energy source, often differing regionally. Currently, fossil fuels are the least expensive for producing gray H₂, used in chemicals, as a reducing agent, or for high heat in industry. However, rising carbon prices and falling renewable electricity costs are making low-carbon H₂ production methods (blue and green H₂) more economically viable and competitive for commercial deployment.

Table 2: cost of producing 1 kg of H₂ according to each type of fuel and the amount of CO₂ emissions

Type	kg CO ₂ -eq/kg H ₂	Cost in \$ per kg
Grey H ₂ (Coal Gasification)	22-26 kg CO ₂ -eq/kg H ₂	1.8-3
Grey H ₂ (STM)	9 kg CO ₂ -eq/kg H ₂	0.9-2.7
Blue H ₂ (SMR + CCS)	0.7 kg CO ₂ -eq/kg H ₂	1.5-3.6
Green H ₂ (Electrolysis)	/	3.4-12

Kg CO₂-eq/kg H₂: Equivalent CO₂ emissions per kilogram of H₂

Source: created by the authors, based on data from (IEA, 2023)

As the table 2 shows, costs range from \$0.9/kg of H₂ in the Middle East to \$2.7/kg in Europe, and the cost increases by about \$0.5/kg of H₂ when using CCS technology (at a cost of 9.65 cents/kg). This difference is due to natural gas prices, which are the main cost factor for H₂ production from natural gas with or without CCS, as doubling the weighted average cost of

capital from 5-11% leads to an increase in production costs by about 3-17%.

Meanwhile, the costs of producing H₂ from renewable electricity currently using PEM-type electrolysis range from \$3.4-12/kg, where electricity cost accounts for 25-45% of the cost of producing H₂ from electrolysis. Decreasing electricity cost and increasing electrolyzer efficiency work to reduce the cost of H₂ production. (IEA, 2023)

The high cost of green hydrogen produced from renewable electricity is due to the capital-intensive nature of the production method. H₂ production from renewable electricity requires substantial initial investments, not only for the electrolyzed but also for renewable electricity generation for H₂ production.

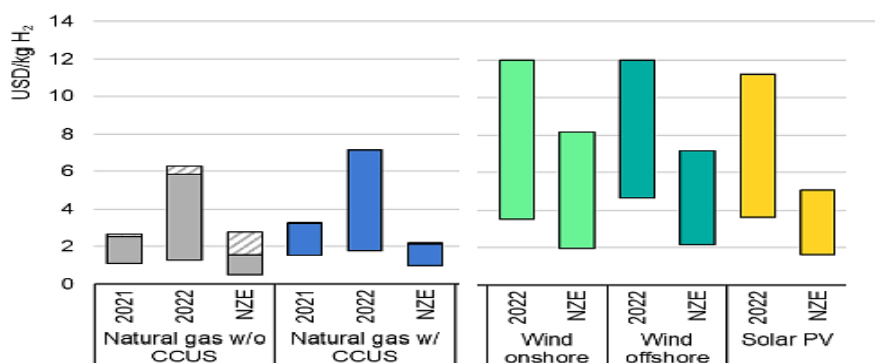


Figure 3: Levelized cost of H₂ production by technology in 2021, 2022, and 2030 under the Net Zero Emissions 2050 scenario.

Source: (IEA, 2023)

There's a significant cost gap between fossil fuel-based H₂ and green H₂, estimated to be five times. However, the International Agency expects the cost of producing H₂ from solar power to decrease to \$1.6/kg by 2030 in regions with high solar irradiation. National carbon pricing policies and increased H₂ demand may favor green H₂ producers.

Producing green hydrogen demands significant renewable energy resources. According to the "1-10-20-30 rule," generating 1 million tons of green hydrogen per year requires 10 GW of electrolyzers, 20 GW of renewable energy, and an investment of \$30 billion.(Houasni, 2024, p. 48)

III- Opportunities for Developing Renewable H₂ in the UAE and Algeria

The UAE and Algeria have strong potential to lead global sustainable H₂ trade due to their low-cost renewable energy, energy export experience, and strategic location near major markets. Both are among the top 20 likely H₂ production and export leaders, leveraging their abundant resources and "Sun Belt" positioning. We will examine both countries' H₂ production and export capabilities, analyze factors enhancing their global market position, and discuss challenges and opportunities.

1. Opportunities for Developing H2 in the UAE:

1.1. Potential and Drivers for H2 Production in the UAE

The UAE's H2 strategy is driven by ambitious goals for carbon neutrality and clean energy leadership. By 2030, the country aims to increase its clean energy share to 30%, reduce carbon emissions by 40%, improve consumption efficiency, create green jobs, and achieve financial returns. These objectives are part of the broader UAE Energy Strategy 2050, which seeks to establish the UAE as a global leader in clean and sustainable energy.

The UAE possesses several key assets that position it favorably for H2 production and access to the growing global market. These include abundant renewable energy sources for low-cost green H2 production, large natural gas reserves for blue H2 production using CCS technologies, developed energy infrastructure for H2 production, storage, and transportation, and strategic commercial partnerships worldwide. These advantages collectively position the UAE as a potential key player in the global H2 market, enabling it to leverage its resources and expertise for both domestic use and export opportunities.

1.2. The National H2 Strategy

The National H2 Strategy, launched in 2020, aims to integrate low-carbon H2, reduce fossil fuel reliance, and achieve carbon neutrality by 2050. The UAE targets becoming one of the top ten global H2 producers by establishing a stable policy environment, attracting foreign investment, leading the clean energy sector, and building a knowledge-based, innovative sustainable economy. The strategy's main pillars include:(MoEI, 2023, p. 3)

- Building a robust H2 economy to reduce carbon emissions
- Attracting foreign investment and creating job opportunities
- Enhancing UAE's position in low-carbon H2 production and export
- Increasing investment in research and development
- Establishing a flexible H2 supply chain for local industry growth.

1.2.1. Announced H2 Sector Objectives:

The strategy has set benchmark objectives to be achieved within specific deadlines, as shown in the table 3.

Table 3: stepwise goals for H2 development by 2030/2050

Objective	2031	2050
H2 Production	1.4 MMT annually (including 1 MT green and 0.4 MT blue)	15 MMT* annually (7 MT by 2040)
Reduction in emissions in hard-to-abate sectors	25%	100%
H2 stations	2	5
Job Creation	184,000 new jobs	500,000 new jobs
Innovation	H2 Research and Development	Global H2 Innovation Hub

	Center	
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**MMT: million metric tons*

Source: Prepared by the researchers based on (MoEI, 2023, p. 4)

The UAE aims for global leadership in low-carbon H₂ production and export by 2031, integrating H₂ into its energy mix to diversify sources and reduce emissions. As the **table 3** the strategy focuses on job creation, infrastructure development, and becoming a global H₂ innovation center by 2050, reflecting the UAE's ambition to lead in H₂ technology.

1.2.2 Pillars Supporting H₂ Development in the UAE

The UAE has developed a comprehensive framework for the H₂ sector, aiming to create an integrated system that connects both government and private entities. This framework covers the entire H₂ value chain and addresses several key aspects:

- Regulatory and Legislative Framework: Developing policies and regulations to support and encourage investment in the H₂ sector.
- Financing and Investment: Creating an attractive investment climate and activating local green financing mechanisms.
- Cooperation and Partnerships: Building strategic partnerships with local and international entities to enhance cooperation, share experiences, and attract investments.
- Research and Development: Enhancing R&D in H₂ technology, supporting innovation, and developing national capabilities through training and qualification programs.
- Infrastructure: Establishing advanced infrastructure to support the H₂ value chain, including transport and distribution networks and storage centers, while leveraging existing assets.

1.2.3. Existing and Future H₂ Projects in the UAE

The UAE is actively developing its H₂ sector to become a global clean energy hub. Key projects include:

- The UAE Carbon Capture Leadership Project, which is a DRI project with CCUS that was launched in 2016, producing an estimated 70 kilotons per year of low-emission H₂. However, this is the only project of its kind currently operating. There are no similar large-scale projects under development.

- Masdar - a major company enhancing the renewable energy and green H₂ efforts of ADNOC, TAQA and Mubadala - is thus one of the world's largest clean energy companies. Masdar's ambitious growth plans target the production of at least 100 GW of renewable energy and the production of up to 1 million tons of green H₂ by 2030.

- The first green H₂ plant in Dubai was opened in May 2021 at a cost of \$14 million. The plant produces H₂ using electricity generated from the Mohammed bin Rashid Al

Maktoum Solar Park, and is the first facility of its kind in the Middle East and North Africa region. It is a public-private partnership project with the German company Siemens. The produced H₂ is stored to support the electricity grid, and the plant also enables testing of H₂ applications in industry and transport (Alnuaimi, n.d., p. 4).

- ADNOC - the national oil company - is one of the leading companies in H₂ production and aims to capture 5% of the global low-carbon H₂ market by 2030 in support of the UAE' national H₂ strategy. ADNOC currently produces more than 300,000 tons per year of H₂ at its refining and petrochemical facilities and seeks to increase production to 500,000 tons per year, with this quantity being primarily used for industrial purposes.

In 2024, ADNOC delivered its first low-carbon ammonia cargo to Japan's Mitsui and began designing a facility in Abu Dhabi to produce 360,000 tons of low-carbon H₂ annually. ADNOC is also collaborating with partners to develop a 1 million ton per year low-carbon ammonia facility in the "Taaziz" petrochemical area (ADNOC, n.d.). A joint venture between Taqa and Abu Dhabi Ports, announced in 2021, aims to convert green H₂ to liquid ammonia. The project includes a 2 GW solar power plant, an electrolyzer unit, and an ammonia production plant connected to Khalifa Port, strengthening Abu Dhabi's role as a major green ammonia export hub.(TAQA, 2021).

The UAE's diverse H₂ initiatives reflect its efforts to establish a comprehensive and sustainable sector, focusing on both blue and green H₂ production. The country adopts a holistic approach covering the entire H₂ value chain and emphasizes international partnerships for attracting investments and exporting H₂ to global markets.

2. Opportunities for Developing H₂ in Algeria

2.1. Drivers and Potentials for H₂ Production in Algeria

Algeria is focusing on developing its H₂ sector as part of its strategy to transition towards clean and sustainable energy sources. The country aims to become a global power in green H₂ production and export, leveraging its natural resources to diversify its economy away from oil dependence and promote sustainable growth. This shift is expected to create new job opportunities, foster innovation, and help Algeria meet its climate commitments. The development of green H₂ also aligns with the country's goals to optimize renewable energy utilization and enhance power grid flexibility.

Algeria's strategic geographical location and significant renewable energy potential position it as a strong candidate to become a major green H₂ production and export hub in the Mediterranean region. The country boasts extensive solar and wind resources, with high solar irradiation levels and vast areas suitable for large-scale solar power plants. Additionally, Algeria's existing natural gas infrastructure can be adapted for H₂ transport, and its proximity to the European market, along with its port infrastructure and extended coastline, facilitates H₂ export. With large natural gas reserves, Algeria is also well-positioned to lead in blue H₂ production. These advantages, combined with the growing European demand for H₂, enable Algeria to produce and deliver green H₂ at highly competitive costs.

2.2. The National H2 Development Strategy:

At the end of 2022, Algeria announced the National H2 Development Strategy, under the supervision of the Ministry of Energy and Mines. A National H2 Committee was formed, which is a joint ministerial committee composed of the Energy Transition, Education and Scientific Research, Startups and Finance sectors, and the Renewable Energy and Energy Efficiency Directorate. It was tasked with preparing a roadmap for this strategy. The main strategic objectives can be summarized as follows: (Direction des Etudes et de la Prospective, n.d., p. 15)

- Enhance energy security by accelerating the energy transition (diversifying the energy mix, reducing domestic natural gas consumption) and reducing the carbon footprint in various economic sectors.
- Develop a H2 economy and its derivatives by developing the full H2 value chain, and enhancing industrial integration and innovation.
- Build technical and human capacities to make Algeria a hub for H2 production and a leader in exports.

Algeria aims to achieve an ambitious goal by 2040 of producing 40 terawatt-hours of H2, equivalent to 1 million tons. Algeria aims to cover 10% of European H2 demand and achieve export revenues of up to \$10 billion, through planned investments worth \$25 billion.(MEM, 2023, p. 16).

Algeria's national H2 roadmap considers both blue and green H2. For blue H2, the country will conduct a comprehensive assessment of its natural gas reserves and carbon capture (CCS) potential. Some industrial sectors using gray H2 will be equipped with CCS to produce clean blue H2 through international partnerships.

For green H2, Algeria plans to primarily export it through pipelines and as liquefied derivatives like ammonia and methanol. In the short-medium term, the strategy focuses on developing a domestic industry to manufacture H2 equipment and components.(Direction des Etudes et de la Prospective, 2023).

According to the completed roadmap, the development of the H2 sector in Algeria goes through three main stages, As the Fig.4 shows, starting from the initiation and formation stage (2023-2030), then the expansion and market establishment stage (2030-2040), to the manufacturing and export stage (2040-2050).

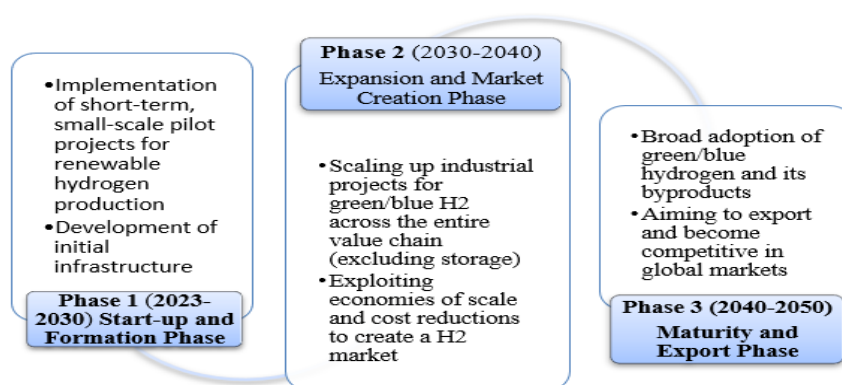


Figure 4: Green/Blue H2 Development Plan in Algeria

Source: Prepared by the researchers

This roadmap aims to develop a H2 industry in stages, starting from small-scale trials and progressing towards large-scale production and global competitiveness, with a focus on sustainability and reliance on renewable energy sources. Therefore, development will be gradual, depending on the maturity of H2 technology and the penetration rate of renewable energy sources in the national energy mix.

2.2.1. H2 Production Forecasts:

The projection to achieve the target of producing 40 terawatt-hours of green H2 by 2040 (equivalent to 1 million tons) is based on the following assessments:(Direction des Etudes et de la Prospective, 2023, pp. 11–12)

- **Green Electricity:** H2 production will rely entirely on renewable energy sources, specifically photovoltaic solar energy and wind power, with a 70% share for solar and 30% for wind based on the National Renewable Energy Development Strategy and the complementary nature of these two variable sources.
- **Electrolysis:** PEM electrolyzers have been selected due to their technological maturity and efficiency, and their compatibility with intermittent renewable energy sources, making them the optimal choice for achieving the lowest H2 production cost.

2.2.2.FutureH2 Projects in Algeria:

Algeria recognizes the importance of practical experiments in developing the H2 sector and has initiated several pioneering pilot projects: (MEM, 2023, p. 12)

- Sonatrach project in Hassi Messaoud (2-4 MW).
- Sonatrach joint project using PEM technology (2 MW).
- Arzew project (50 MW) with Power-to-X technology study.
- Two pilot projects with Eni for green H2 production.
- "SouthH2Corridor" project: a 3,300 km pipeline connecting North Africa to Europe.

Algeria is also enhancing international cooperation, particularly with the EU, Germany, and Italy, to leverage advanced technologies and attract investments. A notable example is the "TakatHy" project with Germany, focusing on renewable energy and green H2 development.(German-Algerian Energy Partnership, n.d.).

3. Challenges in Developing H2 in Both Countries:

Despite ambitious goals, Algeria and the UAE face several challenges in achieving their H2 objectives:

- **High costs:** Green H2 technologies are expensive, hindering sector expansion. Even blue H2 faces high costs for CCS/CCUS technologies(ESCWA, 2022, p. 51).
- **Transportation and infrastructure:** Existing natural gas infrastructure can be adapted for H2, but challenges remain in storage and distribution due to H2 's unique properties(Cortés Leiss et al., 2023, p. 11).
- **Lack of investment:** High costs, market uncertainties, and competition from traditional energy sources deter investors(Mckinsey&company, n.d.).
- **Water scarcity:** Availability and quality of water for electrolysis is a concern, especially in water-scarce regions,which is the case in the Middle East and North Africa(ESCWA, 2022, p. 50)
- **Safety issues:** Governments and international organizations need to develop and implement safety standards across the clean H2 value chain. (Hashimy et al., 2017, p. 11).
- **Technological gaps:** Developing economies with abundant renewable resources often lack the necessary modern technology and require technical assistance.
- These challenges affect the speed of low-carbonH2 sector development and the achievement of clean energy goals. However, long-term projections suggest decreasing costs and increasing competitiveness of low-carbon H2 as technologies mature and production scales up.

4. Comparative Analysis of Opportunities for Algeria and the UAE in the H2 Sector:

Algeria's strengths in the hydrogen sector are notable. The country possesses huge natural gas reserves, enabling low-cost blue hydrogen production. Its strategic geographical location near Europe facilitates hydrogen exports, giving it a competitive advantage in the European market. Furthermore, Algeria is vigorously pursuing renewable energy development, striving to achieve its goals despite challenges.

However, Algeria faces several weaknesses. The country is experiencing delays in achieving its renewable energy targets, which impedes green hydrogen development and reduces its competitiveness. There is a pressing need to improve the investment climate to attract foreign investment, which is crucial for technology transfer and infrastructure development. Additionally, Algeria requires a clearer and more supportive regulatory framework for the hydrogen sector to provide certainty for investors and developers.

The UAE, on the other hand, demonstrates significant strengths in the hydrogen sector. The UAE shows regional leadership in renewable energy, (7.2% Share of Renewables in the Energy Mix 2020) enabling cost-competitive green hydrogen production (Al-Sarihi & Mansouri, 2022, p. 16). It offers an attractive investment climate, encouraging investment in the hydrogen sector and facilitating technology transfer. The country has established a comprehensive and supportive regulatory framework, providing stability and clarity for investors. Moreover, strong international partnerships enhance the UAE's ability to innovate and develop technology in this field.

Despite these advantages, the UAE faces some challenges. The country's reliance on desalination for green hydrogen production increases production costs and puts pressure on water resources, potentially affecting long-term sustainability. Additionally, the UAE faces fierce competition in the global hydrogen market, necessitating continued innovation and strategic planning to maintain its competitive edge.

Conclusion:

This research aimed to investigate the hypothesis that both Algeria and the UAE possess significant potential for low-carbon hydrogen production but face distinct challenges in developing this sector. The findings of this study strongly support this hypothesis.

both nations hold unique advantages, Algeria's vast natural gas reserves make it a prime candidate for blue hydrogen production, while its strategic location facilitates easy access to European markets. On the other hand, the UAE's pioneering efforts in renewable energy, coupled with its attractive investment landscape, pave the way for it to become a leader in green hydrogen. However, both countries also encounter distinct challenges, heavy reliance on fossil fuels requires a swift and decisive energy transition to unlock its full potential in the hydrogen sector.

Therefore, the initial hypothesis is confirmed. Both Algeria and the UAE are well-positioned to become major players in the global hydrogen market, by leveraging their strengths and addressing their specific challenges, these nations can contribute significantly to a cleaner, more sustainable energy future while simultaneously strengthening their own economies and energy security.

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