The Reality of Hydrogen and Renewable Energies in International Legislation

Lachelah Mohamed[1]
[1] Faculty of Law and Political Science, Ibn Khaldoun University of Tiaret, (Algeria),
Email. lacmohamed@gmail.com

Received: 21/09/2025 ; Accepted: 25/04/2026 ; Published:26/05/2026

Abstract
The Mediterranean countries are a very promising region for solar energy potential, along with Mali and the Sultanate of Oman, which are a fundamental pillar for the production of green hydrogen. At the same time, new opportunities are opening up for "gold hydrogen", or natural or geological hydrogen. The research is devoted to the analysis of the international legal framework (Paris Agreement and Energy Charter Treaty) and national legislation in the leading countries (Morocco, Algeria, Tunisia, Egypt). It also reviews the challenges and opportunities in the development, transportation and trade of these two energy resources, and provides recommendations to bolster regional cooperation and promote sustainable investment.
Keywords : Solar Energy ;Green Hydrogen ;Gold Hydrogen ; International Law ; Paris Agreement.

Résumé
Les pays méditerranéens constituent une région particulièrement prometteuse en matière de potentiel solaire, aux côtés du Mali et du Sultanat d'Oman, lesquels représentent un pilier fondamental pour la production de l'hydrogène vert. Parallèlement, de nouvelles perspectives émergent autour de « l'hydrogène doré », également désigné sous les appellations d'hydrogène naturel ou géologique.
La présente recherche est consacrée à l'analyse du cadre juridique international, notamment l'Accord de Paris et le Traité sur la Charte de l'énergie, ainsi qu'à l'étude des législations nationales des principaux pays concernés (Maroc, Algérie, Tunisie et Égypte). Elle examine également les défis et les opportunités liés au développement, au transport et au commerce de ces deux ressources énergétiques, tout en formulant des recommandations visant à renforcer la coopération régionale et à promouvoir les investissements durables.
Mots-clés :Énergie solaire ;Hydrogène vert ;Hydrogène doré ;Droit international ;Accord de Paris.

I- Introduction :

The Paris Agreement (United Nations, Paris Climate Agreement, 2015) of 2015 and the climate challenges it poses, which are a real threat to environmental stability, make it imperative to develop adequate solutions that go beyond traditional polluting energy sources, which have severely damaged the ecological fabric as a whole.
Most are still burdensome but have become faster over the past years. Clean energy requires a lot of know-how, a lot of material and money, and a lot of human effort.
Among the proposed solutions, alternative and clean energy i.e. hydrogen and solar energy are in the forefront. But a cohesive and harmonised legal framework needs to be set up by regional and

international consensus, which can meet these challenges, shorten implementation timeframes and provide binding rules for all stakeholders during implementation.

The main actors of concern in the Mediterranean Basin are the North African states and their adjacent hinterlands, which are in fact considered to be solar rich regions. These areas also have a great potential for natural hydrogen resources, as in Mali and in the other bordering countries with similar geological environments.

Regional and international harmonized legislation should therefore include joint production, processing, transportation, exploration and export operations, while guaranteeing local development and the protection of economic rights. This is especially the case when it comes to the water resources that will be required to produce hydrogen from solar energy, which can have a substantial impact on local populations, especially in scenarios where normal surface water resources such as rivers and springs are limited and the reliance is mainly on groundwater.

Statement of the Problem

What is the problem of competitiveness of the race for clean energy between the Global North and the Global South in the context of compliance with international law and what are the mechanisms and possible solutions?

I.1: International legal regime of solar energy and hydrogen

This section provides a detailed analysis of the main principles of international law **(Corporate Author, 2015)** governing the development of solar energy, and the production, transportation and commercialisation of green and natural hydrogen. The emerging global hydrogen economy requires a multidisciplinary legal approach at the intersection of climate law, law of the sea and international investment law to capture its complexity. Special emphasis is placed on the interaction of these legal regimes and their impact on state behaviour, transboundary energy flows and the sustainability of energy transitions in a cooperative international environment.

Central to this analysis is the emerging system of climate commitments under instruments such as the Paris Agreement, which establishes both binding and non-binding obligations for states to cut greenhouse gas emissions and advance clean energy technologies. These commitments are complemented by soft-law mechanisms and policy frameworks such as the Sustainable Development Goals, in particular Goal 7 (affordable and clean energy) and Goal 13 (climate action). These instruments create a normative environment conducive to the massive development of renewable energies such as solar energy and the incorporation of hydrogen as a major vector for decarbonisation.

In addition, the paper examines the importance of the international law of the sea, especially the United Nations Convention on the Law of the Sea, in governing the use of offshore resources and demarcating maritime areas such as the exclusive economic zone (EEZ) and the continental shelf. These legal provisions are of particular relevance for hydrogen projects linked with offshore renewable energy installations and for the transport of hydrogen through subsea pipelines. The legal regime of maritime zones provides for the sovereign rights of States over natural resources, as well as for the obligations concerning the protection of the environment, marine biodiversity and the prevention of transboundary damage.

Also, international investment law is of paramount importance in the financing and development of large-scale solar and hydrogen projects. Foreign investors are given certain legal guarantees, such as protection from expropriation, fair and equitable treatment and settlement of disputes through

arbitration mechanisms under bilateral and multilateral investment treaties. These frameworks contribute to the reduction of investment risks and the enhancement of the attractiveness of regions such as North Africa and the Mediterranean basin for international energy partnerships.

This section is therefore divided into two main sub-sections. The first one concerns the legal foundations of climate obligations and clean energy transition, examining the extent to which international norms shape national energy policies and commitments. The second relates to regulation of exploitation of resources in maritime and economic zones, and legal frameworks for investment in the solar and hydrogen sectors. This twofold approach aims to show that the success of the global energy transition hinges not only on technological innovation and resource availability, but also on the coherence, effectiveness and enforceability of international legal regimes.

I. 1.1 : The Legal Basis of Climate Obligations and the Clean Energy Transition

In climate governance, the Paris Agreement requires States Parties to submit and regularly update nationally determined contributions (NDCs) to reduce greenhouse gas emissions and support renewable energy development. This is provided for in Article 4 of the 2015 Paris Agreement, which also implicitly encompasses policies related to hydrogen **(United Nations Convention on the Law of the Sea, 1982)** within the ambit of broader decarbonization efforts. The United Nations Framework Convention on Climate Change (UNFCCC) is the overarching legal framework for international climate action.

Moreover, Articles 9-11 of the Paris Agreement deal with technology transfer, capacity-building and financial support to developing countries. These provisions are of special significance in providing incentives for the Southern Mediterranean States to develop solar and hydrogen projects.

At the regional level, the European Union, through its Hydrogen Strategy (2020), has actively promoted large-scale imports of hydrogen, thus contributing to the establishment of a cross-border legal and economic framework for energy cooperation.

However, the Paris Agreement does not regulate “gold”, “geological” or “white” hydrogen, as it is called according to various classifications. The Agreement is therefore mainly about green hydrogen produced from water electrolysis with renewable electricity, especially from solar energy. In this sense, the Paris Agreement indirectly supports the expansion of solar photovoltaic systems for electricity generation and the subsequent production and transport of green hydrogen.

I. 1.2 - Administration of Resource Use in Maritime and Economic Zones and Investment Regimes

Under the UN Convention on the Law of the Sea (UNCLOS), Article 56, coastal States possess sovereign **(Corporate Author, 1982)** rights to explore and exploit natural resources within their Exclusive Economic Zones (EEZs). This legal framework will facilitate the development of offshore solar installations and floating electrolysis platforms for the production of green hydrogen from seawater.

In addition, the amended Barcelona Convention (1976), as well as the Protocol on Integrated Coastal Zone Management adopted **(United Nations Environment Programme, 1976)** in 2008, complement this legal framework by imposing environmental protection obligations on States involved in energy-related projects in coastal and marine environments. These instruments also include environmental impact assessment and precautionary measures for renewable energy projects including possible exploration of natural hydrogen resources.

However, a major legal constraint remains over maritime boundary delimitation, particularly in the Eastern Mediterranean, which continues to affect energy development and resource exploitation.

I. 1.2.1 - Investment Protection and Cross-Border Movement of Energy and Hydrogen

BITs and multilateral investment **(ChristophSchreuer, Rudolf Dolzer, 2012)** agreements are primarily used by the energy sector to protect investments. They provide investors in solar and hydrogen **(Energy Charter Secretariat, 1994)** projects with guarantees, mainly against expropriation, discriminatory treatment and restrictions on the repatriation of profits.

Likewise, Article 7 of the Energy Charter Treaty (1994) stresses the importance of cross-border energy transit, while Article 26 creates investor-State dispute settlement by means of arbitration.

In addition, Directive (EU) 2018/2001 on the promotion of the use of energy **(European Parliament and the Council, 2018)** from renewable sources allows the import of electricity and hydrogen from third countries. This legal framework consolidates the integration of Southern Mediterranean energy projects in European energy markets and the development of trans-Mediterranean energy corridors.

I. 2. National Legislation, Practical Projects and Gold Hydrogen

This section deals with the national legal frameworks of the major Mediterranean Basin countries, as well as the existing and planned projects connecting solar energy to the production and export of hydrogen. The analysis is divided into three subsections: (1) the Moroccan model of national legislation and solar-hydrogen projects, (2) the evolution of legislation in support of green hydrogen in Algeria, Tunisia and Egypt and (3) the concept of gold hydrogen and low cost source of energy.

Opportunities to Tackle Challenges and Build Equitable Solutions.Several solutions are proposed to address these challenges.

I. 2.1- The Moroccan Model of National Legislation and Solar-Hydrogen Projects

The Moroccan legal framework is primarily based on Law No. 13-09 of 2009 on renewable energy **(General Secretariat of the Government, 2010)**, which allows the establishment of the Moroccan Agency for Sustainable Energy Development and Energy Efficiency. This law establishes the institutional and regulatory framework for the development of renewable energy.

In addition, the Law No. 03-22 of 2022 on the green hydrogen (which defines the green hydrogen, its production and export mechanisms, as well as the fiscal and customs incentives, to attract investment).

In this strategic framework, Morocco seeks to produce about 4 million tonnes of green hydrogen by 2030. This objective is mainly based on solar energy projects that will produce the electricity needed for the electrolysis process, especially in large solar complexes such as Noor Ouarzazate and Noor Midelt.

I. 2.2 : The legislation development for supporting green hydrogen in Algeria, Tunisia and Egypt

In Algeria, the development of renewable energy and hydrogen **(SGG, 2004)** is governed by Law No. 04-09 of 2009, amended in 2023. The national strategy is based on long-term export-orientated development, notably towards Europe, through the existing gas pipeline infrastructure such as the Trans-Mediterranean network.

Tunisia's Law No. 2015-12 encourages investment in renewable energy **(SGG, 2015)** projects. Tunisia also benefits strategically from its role in regional energy transit infrastructure linking Algeria to Italy, collecting transit fees and a cut of energy consumption on its territory.

In Egypt, the legislative framework includes Law No. 2 of 2024, which provides **(SGG, 2024)** incentives for green hydrogen projects and their derivatives. Meanwhile, Egypt is making significant strides in the Suez Canal Economic Zone to transform the country into a regional hub for hydrogen production and export.

I. 2.3 - Gold Hydrogen – A Cheap Energy Source

Among the types of hydrogen—grey, blue and green—the production of green hydrogen is still very energy intensive, needing huge quantities of electricity through electrolysis or other technological means.

A naturally-occurring form of hydrogen, known as gold hydrogen, geological hydrogen or natural hydrogen, has emerged as a potentially low-cost alternative. This form does not need industrial production processes and does not need an electricity input from renewable or conventional sources. Commercial-scale discoveries were made in 2012 in geological formations in Mali (Bourakébougou) that contain natural hydrogen deposits. Neighboring countries such as Algeria and Niger may have a similar geological structure because of similar subsurface formations.

In addition, foreign companies have also started exploration activities in Oman with key players like Sonatrach, the Algerian national energy company, which underscores the increasing international interest in this resource.

I. 2.3.1 - Legal framework and potential of gold hydrogen

One of the biggest recent breakthroughs in the search for new sources of energy has been the discovery of gold hydrogen.

This hydrogen is naturally occurring and has high purity and does not require electrolysis, electricity or solar-based generation systems. Its commercial discovery in 2012 in Bourakébougou (Mali) suggests significant potential reserves, especially in geological zones in the Maghreb region.

As of today, there is no general international or regional legal regime for the exploration or exploitation of natural hydrogen. This in turn makes it generally treated as a raw natural resource , like natural gas **(Ruven Fleming , 2024)** .

However, France has established a regulatory framework for hydrogen within the mining law via **(Ordonnance n° 2022-536, 2022)**,Ordonnance No. 2022-536 which, despite being pioneering, creates challenges for investors in terms of legal certainty, investment conditions, and clarity of rights and obligations **(International Energy Agency , 2025)**.

The results show that solar energy and hydrogen are a key pillar of the future energy transition, particularly in the context of supportive legal and regulatory frameworks at national and international levels. The data collected show a steady increase in the use of solar energy, due to the decreasing production costs and the increased efficiency, buttressed by laws for the promotion of renewable energy deployment, investment incentives, and grid integration policies.

The results also show that green hydrogen is a promising solution for energy storage, sector coupling, and long-distance energy transport, especially in environmental legislation to cut down greenhouse gas emissions and to achieve carbon neutrality. Indicators suggest that coupling solar energy with technologies for hydrogen production (like electrolysis) substantially improves the flexibility of energy systems and facilitates the achievement of the objectives of international climate agreements aimed at limiting global warming **(Corporate Author, 2015)**.

Moreover, the results confirm a significant positive relationship between technological innovation and legal frameworks that encourage private and public investment in clean energy sectors. These findings are supported by comparative studies which demonstrate that countries with well-defined regulatory frameworks, financial incentives and long-term strategies have achieved faster progress in the adoption of renewable energy and hydrogen technologies.

But a number of challenges remain, particularly the legal and regulatory gaps in structuring hydrogen markets, certification standards, safety regulations and infrastructure development. The interpretation of the results also reveals that the effectiveness of public policies, governance mechanisms and regulatory stability has a decisive role to accelerate the energy transition. In addition, the establishment of specific and coherent legal frameworks for hydrogen production, storage and distribution will be essential to unlock its full potential.

Therefore, solar energy and hydrogen, backed by strong legal frameworks and strategic planning, can be considered as some of the most important pillars of a sustainable, low-carbon energy future, capable of ensuring energy security, environmental protection, and long-term economic development.

I. 2.3.2- Legal and Geopolitical Challenges and Prospects of Overcoming

The clean energy sector throughout the world is marked by a range of challenges, predominantly legislative, financial and administrative. These will be taken up through the following elements:

- **Common Challenges in Legislation and Regulation**

a- The lack of a clear legislative framework for investors with an incentive-based fiscal nature, including tax incentives and exemptions from certain barriers related to transportation.

b- Lack of clarity of vision due to the absence of a regional framework for hydrogen trade as a newly emerging and not yet fully recognised commodity, in addition to the absence of certificates of origin, indicators of purity, standards of source quality, and classification mechanisms.

c- Legal risks due to exploration and extraction operations.

- **Abrupt Geopolitical Challenges**

a- The maritime disputes landscape, as in the case of the Eastern Mediterranean, especially with Greece, Egypt, Cyprus, Libya, and Turkey.

b- Competition for the hydrogen resources between European countries, the United States, and Gulf States.

- **Opportunities for Addressing Challenges and Developing Equitable Solutions**

a- The need to amend the Barcelona Convention by a further treaty or protocol dedicated to natural and green hydrogen, alongside renewable energy sources.

b- Coordination of international and regional policies, in particular, among the countries of the Mediterranean Basin.

c- The establishment of an international financing fund on a co-financing basis between the European Union and producing countries, as well as international institutions such as the International Monetary Fund and the European Bank for Reconstruction and Development.

d- Creating a long-term outlook of at least a decade, say 2040 to 2050, for green hydrogen and solar energy, and seeking natural (geological) hydrogen.

e-Enhancing the role of the Solar Alliance, launched by France and India as a significant source of funding, with the purpose of decreasing pollution from fossil fuels, encouraging the use of solar energy, and aiding developing countries.

I. 2.3.3- Natural Hydrogen: A Strategic Resource for Supporting the Transition to Green Energy and Its Associated Legal Challenges

Natural hydrogen is a hidden treasure beneath the Earth's surface that could significantly support the transition toward green energy. Since their formation billions of years ago, the Earth's oldest continental rocks have generated vast quantities of natural hydrogen, part of which may have accumulated in subsurface traps and reservoirs.

This resource has the potential to sustain the global hydrogen economy for hundreds of years. Its viability was demonstrated through the extraction of nearly pure hydrogen from a gas field in Mali, an achievement that attracted the attention of governments in the United States, Canada, Australia, the United Kingdom, and several European countries.

Interest from major investors and global resource companies has also increased considerably. By the end of 2023, nearly forty companies were engaged in natural hydrogen exploration worldwide, and this number is expected to have doubled since then. Hydrogen resources have long represented a multi-billion-dollar market, even before they began to be considered as a source of green energy.

The geological environments that enabled its accumulation are widespread across the world. However, the legal regulation of natural hydrogen remains uncertain in some states, as hydrogen had not previously been recognized as a natural resource.

Hydrogen is currently used in several strategic industries, including fuel refining (44%), ammonia and fertilizer production (34%), and steel manufacturing (5%).

In a recent policy document, the British government emphasized that hydrogen, as a natural resource, should be incorporated into future legislation.

However, recent developments in the Sultanate of Oman point to a rising strategic interest in natural hydrogen (geological hydrogen), in addition to further growth of green hydrogen investments. Recent geological investigations have pointed to promising hydrogen-bearing formations within the Oman ophiolite sequences, globally renowned for their capacity to produce hydrogen via serpentinization reactions between ultramafic rocks and water. Against this background several international energy companies and research institutions have initiated exploration and geological assessment programmes to test the commercial potential of natural hydrogen resources in Oman.

I. 2.3.4- Natural Hydrogen in Oman: Geological and Economic Prospects

"However, recent developments in the Sultanate of Oman point to a rising strategic interest in natural hydrogen (geological hydrogen), in addition to further growth of green hydrogen investments. Recent geological investigations have pointed to promising hydrogen-bearing formations within the Oman ophiolite sequences, globally renowned for their capacity to produce hydrogen via serpentinization reactions between ultramafic rocks and water. Against this background several international energy companies and research institutions have initiated exploration and geological assessment programmes to test the commercial potential of natural hydrogen resources in Oman.

The Samail Ophiolite has been the subject of much scientific attention due to its unique geological properties that could see Oman become a world leader in natural hydrogen production. Recent studies also pointed out that fractures and subsurface structures play a role in promoting

hydrogen migration and accumulation in ophiolitic formations. At the same time, Oman is also developing its long-term national hydrogen strategy through large scale renewable energy and hydrogen projects to facilitate the global transition to low carbon energy systems. Unlike green hydrogen, natural hydrogen does not require energy-intensive electrolysis processes and that is why, from an economic perspective, it is gaining increasing attention as a potential low-cost and low-emission energy source. It could therefore have great benefits in terms of the reduction of the cost of production and the improvement of global energy security in a context of international climate and energy transition policies" (Kazuki Yoshida and others, 2026).

II– Methods:

The methodology and tools are outlined in the points listed below, which pertain to the approach used in processing the article.

Research Design

The study is comparative and analytical in nature.

Research Instruments:

Monitoring the evolution of energy-related legislation and relying on legislative changes.

Following developments in international energy.

Legal analysis of international instruments.

Review of specialized international reports published by the International Energy Agency (IEA) and the United Nations Environment Programme (UNEP).

The geopolitical dimension of energy: study of energy as a tool of international influence in the Mediterranean.

Just energy transition: Assessing the level of equity between Global North and Global South countries.

Environmental Legal Sustainability: Connecting Hydrogen and Solar Energy to Carbon Neutrality Objectives.

Energy market integration: A feasibility study for a Mediterranean green hydrogen market.

New international regulatory frameworks, such as EU hydrogen regulations and their extraterritorial impact.

Risks in the regulatory gap between legally advanced states and those still developing their legal frameworks.

Time Period:

2026–2015

Scope (spatial) :

The Mediterranean Area

III- Results and discussion :

The results show that solar energy and hydrogen are a key pillar of the future energy transition, particularly in the context of supportive legal and regulatory frameworks at national and international levels. The data collected show a steady increase in the use of solar energy, due to the decreasing production costs and the increased efficiency, buttressed by laws for the promotion of renewable energy deployment, investment incentives, and grid integration policies. The results also show that green hydrogen is a promising solution for energy storage, sector coupling, and long-distance energy transport, especially in environmental legislation to cut down greenhouse gas emissions and to

achieve carbon neutrality. Indicators suggest that coupling solar energy with technologies for hydrogen production (like electrolysis) substantially improves the flexibility of energy systems and facilitates the achievement of the objectives of international climate agreements aimed at limiting global warming. Moreover, the results confirm a significant positive relationship between technological innovation and legal frameworks that encourage private and public investment in clean energy sectors. These findings are supported by comparative studies which demonstrate that countries with well-defined regulatory frameworks, financial incentives and long-term strategies have achieved faster progress in the adoption of renewable energy and hydrogen technologies. But a number of challenges remain, particularly the legal and regulatory gaps in structuring hydrogen markets, certification standards, safety regulations and infrastructure development. The interpretation of the results also reveals that the effectiveness of public policies, governance mechanisms and regulatory stability has a decisive role to accelerate the energy transition. In addition, the establishment of specific and coherent legal frameworks for hydrogen production, storage and distribution will be essential to unlock its full potential. Therefore, solar energy and hydrogen, backed by strong legal frameworks and strategic planning, can be considered as some of the most important pillars of a sustainable, low-carbon energy future, capable of ensuring energy security, environmental protection, and long-term economic development.

IV- 1.Conclusion:

The paper shows that the Mediterranean Basin is characterised by a high level of interdependence of its states, which form a network of mutual dependence in the fields of energy, economy and environment. The results show that North African countries are among the most resource-rich regions in terms of natural hydrogen generation and geological storage potential due to their large geographical extensions and unique geological properties. This endowment places them in a strategic position in the emerging global energy system.

Algeria is a particularly interesting case in this respect, as it has very high solar irradiation, especially in the south-west bordering Mauritania. These favourable natural conditions allow the development of large-scale solar farms for electricity generation for photovoltaic systems and electrolysis processes to support the efficient and cost-competitive production of green hydrogen in the medium and long term. Data also further confirm that abundant solar resources and favourable geological structures are a rare competitive advantage at regional and global levels.

Europe is very important in the hydrogen value chain on the other hand, due to its advanced technology in exploration, production, processing and transportation, and its experience in developing energy infrastructure and regulating markets. This complementarity of the northern and southern shores of the Mediterranean calls for a model of cooperation based on the exchange of resources, with the southern countries providing natural potential and the northern countries providing technology, expertise and investment.

More specifically, the Paris Agreement, alongside the Sustainable Development Goals, establishes a multi-level international framework underpinning this cooperation, from a legal and institutional perspective, with the United Nations playing a leading role in coordinating global efforts to combat pollution and foster clean energy innovation, providing strong support.

This framework is further strengthened by regional and international initiatives such as the African Green Hydrogen Alliance which aims to boost green hydrogen projects across Africa and the African

Union with its forward-looking strategies for 2025, in addition to the International Solar Alliance which is getting strong financial and institutional backing especially from India, France and Algeria. Therefore, the future of energy in the Mediterranean, especially in the field of green hydrogen, depends not only on the availability of natural resources, but also on the effectiveness of legal and institutional frameworks to forge international partnerships, facilitate technology transfer and ensure adequate financing. Ultimately, the success of this model will depend on the capacity of the countries concerned to develop coherent national policies consistent with international commitments and to strike a balance between energy security and sustainable development.

The ophiolite complex contains evidence of active hydrogen generation associated with serpentinization processes in ultramafic rock formations. The geological conditions are regarded as very favourable for the continuous production of hydrogen and possible subsurface accumulation.

Likewise, recent geological surveys in Mali have identified promising zones of hydrogen seepage in particular in zones where the crystalline basement rocks of Precambrian age and the tectonically active structures are present. Preliminary observations suggest that hydrogen emissions in Mali may be more readily available at the surface, increasing its exploration potential.

The overall results confirm both regions as important emerging prospects for natural hydrogen resources. Oman is remarkable for its large ophiolitic system, while Mali presents important evidence of hydrogen leakage at the surface level, making both countries possible targets for future exploration and possible use of natural hydrogen.

IV- 2.Recommendations for Countries with Natural Hydrogen and Solar Energy Resources

A. Boosting geological and solar energy research and exploration
   Intensify geological, geochemical and solar resource assessments using advanced technologies like remote sensing, geological modelling and solar mapping to accurately identify natural hydrogen accumulations and high solar irradiation zones.
B. Establishing a particular legal and regulatory framework
   A clear national legislation is needed to regulate the development of both natural hydrogen and solar energy, including licencing systems, investment rules and environmental compliance standards.
C. Fostering international cooperation and investment
   Foreign investment and cooperation should be encouraged by promoting strategic partnerships with international energy companies and research institutions, especially in the area of integrated hydrogen-solar projects and technology transfer.
D. Protecting and maintaining the environment
   All exploration and production activities must meet rigorous environmental standards to minimise impacts on ecosystems, ground water and land use, while encouraging low-carbon energy systems.
E. Development of national energy and geospatial databases
   Integrated geo-energy databases need to be developed to record natural hydrogen occurrences and solar energy potential with continuous updating and digital monitoring systems.
   Support for Scientific Research and Innovation

Universities and research centres should be stimulated to develop efficient technologies for the extraction of hydrogen, the conversion of solar energy and hybrid energy systems integrating both resources.

F. Better regional and international cooperation
Countries with high potential in natural hydrogen and solar energy, especially in Africa, the Middle East and the Mediterranean, must increase knowledge sharing and joint projects.

Referrals and References:

[1]. International Energy Agency . *Technology Collaboration Programme on Hydrogen.* paris: IEA Publications. 2025.

[2]. Ordonnance n° 2022-536. ,modifiant le modèle minier et les régimes légaux relevant du code minier. (J. o. (JORF), Ed.) *Journal officiel de la République française (JORF)*, 1-2. Retrieved 4 14, 2022.

[3]. ChristophSchreuer, Rudolf Dolzer. *Principles of International Investment Law.* Oxford: Oxford University Press: Oxford University Press. 2012.

[4]. Corporate Author. lbid. *droit de la mer*, 1982. p. 58.

[5]. Corporate Author. lbid. 2015.3.

[6]. Corporate Author. *United Nations Framework Convention on Climate Change.* Low. New york: United Nations. 2015.

[7]. Energy Charter Secretariat. *Energy Charter Treaty (Art. 10).* Brussels,Belgium: Energy Charter Secretariat. 1994.

[8]. European Parliament and the Council. promotion of the use of energy from renewable sources. 2018.pp. 82-85.

[9]. General Secretariat of the Government. Law No. 13-09 on renewable energy promulgated by Dahir No. 1-10-16. *Official Gazette, Morocco*, 1. Consulté le 3 18, 2010

[10]. Kazuki Yoshida and others. “Depth Variations in Multi-Stage Hydrogen Generation Associated with Serpentinization in the Lower Crust and Mantle Sections of the Oman Ophiolite,” Geochimica et Cosmochimica Acta, vol. 418, 2026, pp. 1–22, especially pp. 3–5. (Elsevier, Éd.) *Geochimica et Cosmochimica Acta,Peer-reviewed journal;Q1, 418*(Issue),2026, P2-5.

[11]. Ruven Fleming . *«Current Hydrogen Regulation on the Continents».* Cambridge , England: Cambridge University Press. Consulté le 2024.

[12]. SGG. Law No. 2 of 2024 on incentives for green hydrogen production projects and their derivatives. *Official Gazette, 4*, 2024. p. 3.

[13]. SGG. Law No. 04-09 the promotion of renewable energies within the framework of sustainable development. *Algerian Official Gazette, 52*, 10. Consulté le August 8, (2004, August 14).

[14]. SGG. Law No. 2015-12on the production of electricity from renewable energies. *Tunisian Official Gazette*(38), 2015.P300.

[15]. United Nations Convention on the Law of the Sea. Article 87. *United Nations Convention on the Law of the Sea*, 1982.p. 58.

[16]. United Nations Environment Programme. *United Nations Environment Programme (UNEP). (1976, amended on 10 June 1995).* Barcelona Convention for the Protection of the Mediterranean Sea against Pollution. Newyork. Consulté le February 16, 1976.

[17]. United Nations, Paris Climate Agreement. Paris Climate Agreement. *Article 2(1)(a)*, 2015. p. 3.