1st MEDREG Hydrogen Workshop
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Empowering Mediterranean regulators for a common energy future

1st MEDREG HYDROGEN

Gas
Working Group
(GAS WG)

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Keynote Speaker:

Tudor Constantinescu

Principal Adviser
DG Energy, European Commission

1st Discussion Panel: Hydrogen Technologies and Usage in the Energy Sector

Moderator

Hasan Ozkoc

MEDREG Director

1st Panel Speakers

Marco Alverà

CEO of SNAM

Cecilia Fouvry-Renzi

VP. Hydrogen Energy
Air Liquide

Mehmet Serif Sarikaya

Project and Int. Rel. Manager
GAZBIR-GAZMER

Luis Ignacio Parada

Head of Global Regulatory Services
ENAGAS

2nd Discussion Panel: MEDREG Hydrogen Strategy and Challenges for Southern Shore Members

Moderator
Stefano Besseghini
MEDREG Permanent VP

2nd Panel Speakers

Karem Mahmoud
MEDREG Vice-President

Rachid Nadil
ARH President

Mohamed Bernannou
ANRE Council member

Pedro Verdelho
ERSE President

Mustafa Yilmaz
EMRA President

ABSTRACT

The national regulatory authorities (NRAs) from the Mediterranean region met at the 1st MEDREG Hydrogen Workshop, held online on the November 3, 2021.

For MEDREG, it was an opportunity to gather different voices and perspectives from different sub-regions of the Mediterranean region that do not necessarily have the same scale of economics and strategies to achieve the decarbonization of their respective energy sector.

The objective to share knowledge and experience among MEDREG's members has always been an important pillar in its long-term strategy, even more so nowadays when we are witnessing a new starting point for the design of the electricity and gas markets for the coming years with a view to reach the global objectives of decarbonization and energy transition.

The 1st MEDREG Hydrogen Workshop aligned with the United Nations Climate Change Conference (COP 26) that was held in Glasgow, United Kingdom, where almost every country on Earth gathered to discuss and present updates on their plans and strategies to mitigate global warming.

The workshop was attended by 76 participants to discuss and debate the development of hydrogen in the Mediterranean region, in terms of both technological aspects and the regulatory framework.

AKNOWLEDGMENTS

This report is the result of a high-level workshop on hydrogen organized by the MEDREG Gas Working Group (GAS WG), the report summarize the main discussion during the events and provide the main outcomes from the workshop. MEDREG wishes to thank the GAS Working Group for their efforts and the valuable intervention of all the speakers of the event.

Main drafters: Mr. Bardhi Hoxha and Mr. Zitouni Lamine Abdelkader (MEDREG Secretariat)

If you have any queries regarding this paper, please contact:

MEDREG Secretariat

Email: info@medreg-regulators.org

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ABOUT MEDREG

MEDREG is the Association of Mediterranean Energy Regulators, bringing together 27 regulators from 22 countries, spanning the European Union, the Balkans and the MENA region.
Mediterranean regulators work together to promote greater harmonization of the regional energy markets and legislations, seeking progressive market integration in the Euro-Mediterranean basin. Through constant cooperation and information exchange among members, MEDREG aims at fostering consumers rights, energy efficiency, infrastructure investment and development, based on secure, safe, cost-effective, and environmentally sustainable energy systems. MEDREG acts as a platform providing information exchange and assistance to its members as well as capacity development activities through webinars, training sessions and workshops. The MEDREG Secretariat is located in Milan, Italy.

For more information, visit www.medreg-regulators.org
If you have any queries relating to this paper, please contact:
MEDREG Secretariat
E-mail: info@medreg-regulators.org

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Hydrogen Technologies and Their Role in the Energy Sector

1.1. European Commission's Hydrogen Strategy

At the European level, the first step toward the creation of a hydrogen market is the elaboration of the energy system integration strategy that aims to develop a more circular and energy efficient market through an intense electrification of consumption based on renewable electricity and the use of renewable and low-carbon fuels in hard-to-abate sectors. The European Commission simultaneously developed the European Hydrogen Strategy that set the ground for the investment agenda, supply & demand, market & infrastructure, innovation, and international cooperation.

The European Commission established the European Clean Hydrogen Alliance that defines the key projects' pipeline on H2 in Europe and involves more than 1400 stakeholders with six roundtables covering the H2 value chain: energy, production, Transport, and distribution (T&D), mobility, buildings, and industrial applications.

The first project's pipeline shared at the forum event in June is represented in Figure 1 below. The upcoming projects will be presented during the next annual meeting of the EU H_2 Alliance on November 30, 2021.

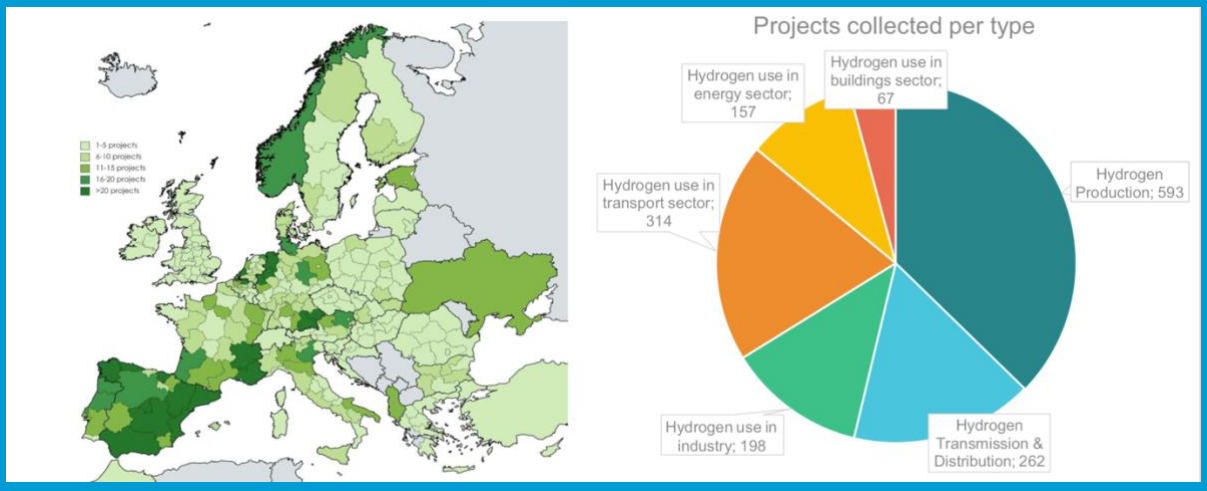

Figure 1. The Hydrogen Alliance – Overview of all eligible projects collected – Source: The European Commission[1]

In addition to the Hydrogen Alliance, the revision of the 3rd gas package considers the development of hydrogen target model following the steps illustrated in Figure 2 below.

This package starts out by allowing the combination of infrastructure operators (natural gas and hydrogen), followed by the development of hydrogen network at EU level, and finally by the harmonization of hydrogen quality to facilitate cross-border trading and an integrated EU-wide network.

[1] https://prod5.assets-cdn.io/event/6779/assets/8375992644-bc85860f7c.pdf

Figure 2. 3rd gas package revision

Finally, to reach the goal of the decarbonization of the energy sector and succeed in the energy transition, a solid articulated regulatory framework is needed to enable and foster the participation of investors.

The use of renewable and low-carbon fuels needs to increase and should be included into the energy strategies of the member countries.

Besides the use of renewable energy and low-carbon fuels, energy efficiency is a must across all the sectors: energy, transport, building, and services.

Furthermore, there is a need to develop and invest in alternative fuel infrastructure together with a regulatory framework that facilitates its rapid evolution. To achieve it, cooperation and collaboration between EU members and neighboring countries is a key element.

a) Technical development of hydrogen

The first panel of the workshop was dedicated to the recent technological developments and improvements by leading European companies (such as SNAM, Air Liquide, ENAGAS, and GAZBIR & GAZMER) and the main challenges and barriers that they have been facing in producing hydrogen in large scales as a fuel that helps achieve sustainable energy future.

At the industrial level, several studies and analysis have been carried out to first assess the potential of hydrogen and to which extent it could play a role toward the decarbonization of the energy sector.

Similarly, during the first years of the renewable energies (solar PVs and wind), the hydrogen potential seems promising and follows the same steps involved in the evolution of the renewable energy sources. However, technical barriers including the maturity of technologies and necessary infrastructure, plus the costs generated for the massive deployment decreased in its attractiveness for some investors.

It was highlighted that many industrials started to work on several pilot projects in different sectors to better understand the technology uses and its limits.

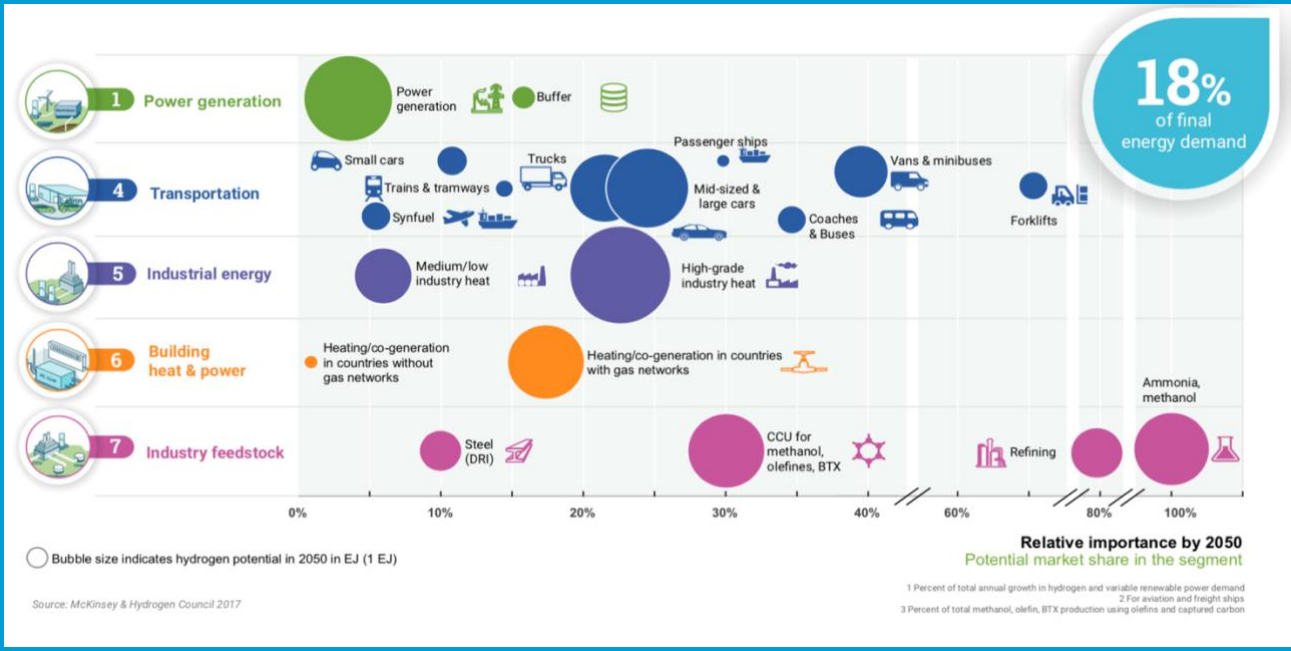

Figure 3. Hydrogen potential across applications

Air Liquide has already started to invest in hydrogen by installing more than 120 hydrogen refueling stations (HRS) across the world, where more than 50 are directly invested and operated by Air Liquide ALIAD; further, the company has invested in 5 start-ups with a capacity of 14 bn m3/year, 1850 km H2 pipelines, 46 large H2/CO plants, 40 electrolyzes in operation and €2 bn sales.

SNAM, on the other hand, was the first company to experiment with the introduction of a 5% hydrogen and natural gas blend into the Italian gas transmission network in 2019 in Salerno, Italy.

In terms of R&D, SNAM is one of the leaders in hydrogen research, and they are working on a proposal of technical and non-technical solutions to improve hydrogen technology and increase the rates of blending. Thus far, the highest rate reached by SNAM is 15% without any technical constraints.

SNAM is also part of the Hydrogen Alliance. They are working on a technological solution to support the developments pertaining to hydrogen. The research focuses on the possibilities of cost reduction by reusing the old technology in a way to find new solutions such as the new membrane technology like the Electrochemical Hydrogen Purification and Compression (EHPC) – jointly developed by the Netherlands-based company in cooperation with Socalgas in USA.

In addition, Marco Alvera, the CEO of SNAM, has underlined that there are some studies confirming that the production price of green hydrogen is expected to drop by 50% in 2028 and by 75% by 2030. These expectations most likely would significantly change the growing role of hydrogen in all energy markets, competing with coal prices that are even lesser.

In addition to technical improvement, incentives may also be a temporary solution to foster the development of the hydrogen market, for example, by using hydrogen guarantee certificates and providing funds to support the R&D, which is the case in Turkey where its national regulatory authority (EMRA) supports GAZBIR & GAZMER in the R&D.

The recent outcome of the studies conducted in Turkey reached up to 12% of blending without any issue and up to 20% with some constraints. GAZBIR & GAZMER focuses on the integration of hydrogen at the distribution level (boilers and heaters), which presents more challenges and difficulties.

b) Challenges and difficulties in hydrogen development

At the distribution level, the main barriers may be the metallurgical characteristics of the materials used in the distribution pipes and the topology of the infrastructure along with the security requirements to ensure the safety of consumers from hydrogen leaks due to its high volatility. However, there are several developments that help ensure the highest safety for consumers such as by adding some chemical elements to hydrogen to either make it visible or give it an odor as suggested by GAZBIR & GAZMER.

GAZBIR stressed that in terms of essential infrastructures, the distribution level doesn't require long pipelines in the absence of technical constraints. On the contrary, the transmission and massive scale hydrogen deployment need either adaptation to the existing network or investment in new infrastructure.

As highlighted by ENAGAS, in terms of costs, hydrogen can be competitive in the mid long-term perspective, but at the moment, the cost of producing hydrogen is still high due to the lack of maturity of the used technology and its dependency on freshwater that requires additional costs if unavailable near the facilities.

Still in mid/long term perspective, the costs related to the use of renewable low-carbon gases and hydrogen will decrease and reach a competitive level for the following reasons:

- The existing infrastructure will be adapted to be used for hydrogen, or new infrastructure will be developed.
- The technology is developing at a fast pace and will no longer present many restrictions or limitations.
- The dependency of freshwater will be tackled either by using sea water or wastewater, the feasibility of which is being tested by some studies.
- For safety requirement, guidelines and regulation will be put in place as it's already done for natural gas or any other risky energy carrier.
- The market will be more attractive once a harmonized standard and incentives will be implemented nationally and regionally.
- In terms of storage, renewable low-carbon gases and hydrogen are much easier and less costly to store than using batteries to store the renewable energy sources.
- Carbon prices and taxes can be used to cover for the high cost of hydrogen.

And finally, once the prices of renewable low-carbon gases and hydrogen reach a certain competitive level that is attractive for the Asian market, the hydrogen market will witness a huge boom.

In the MENA region, with its huge RES potential, it's more efficient and less costly to use RES for the distillation process needed for hydrogen production. However, the local needs are currently either non-

existing or very low. **Nevertheless, most countries of the MENA region expressed their willingness to be hydrogen exporters, which will require the development of the necessary infrastructure to transport the produced hydrogen.**

Regarding renewable low-carbon gases and hydrogen, the future looks promising in terms of price levels as the industry aims to reach ambitious targets for reducing the price of hydrogen production, as expressed by SNAM CEO Mr. Marco Alvera, to a very competitive level in less than ten years' period.

1.2. MEDREG Hydrogen Strategy and Challenges for Southern Shore Members

In the workshop discussions, it has been confirmed that the South Shore Members are willing to produce and export hydrogen to the EU energy market.

The combination of the availability of RES resources in Egypt, Algeria and Morocco put these countries in a favorable position to produce green hydrogen. Moreover, Turkey presents a considerable potential and have already started developing some pilot projects.

1.2.1. South Shore strategy and expectations

a) Egypt

Egypt's energy strategy covers all the pillars of the energy transition toward a decarbonized energy production while ensuring the security of supply. The Integrated Sustainable Energy Strategy to 2035 plans to increase the volume of natural gas production progressively and boost the share of RES.

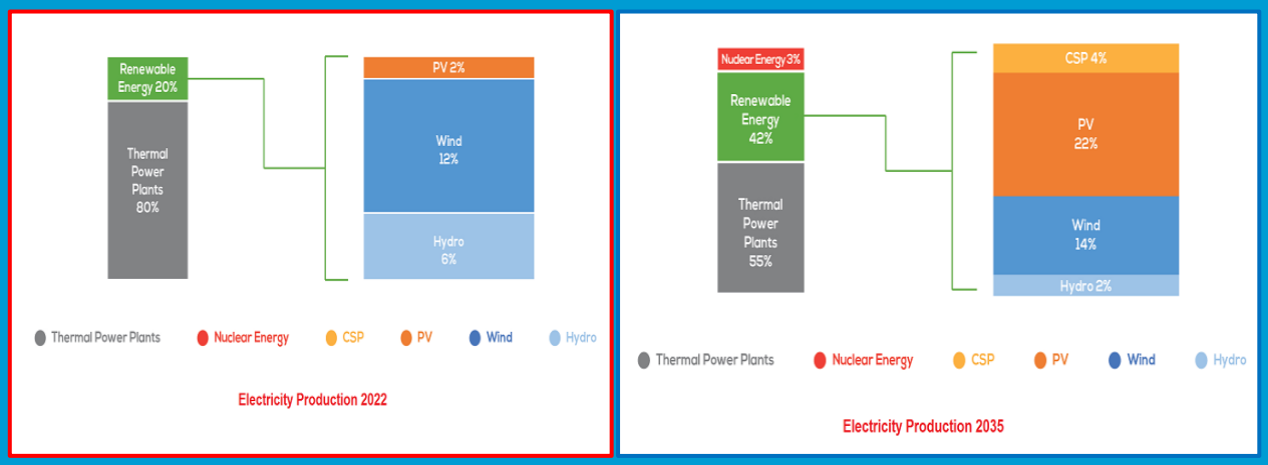

Figure 4. Integrated Sustainable Energy Strategy to 2035 – Egypt

With this perspective of developing more RES sources, the hydrogen production in Egypt will be focused on green hydrogen. The first step has been initiated by the Egyptian Cabinet of Ministries that formed a

committee comprising different related ministries and entities with an objective of preparing the National Hydrogen Strategy. The scope of the committee includes the following:

- Studying opportunities to produce/export hydrogen
- Exploring available financing schemes
- Updating the Egyptian Energy Strategy of 2035 (hydrogen: green energy source).

Date	Agreements
March	Egypt's Ministries of Electricity and Petroleum and the Navy signed a cooperation agreement with the Belgian "DEME" company to start special studies for producing "green hydrogen" and exporting it from Egypt.
July	Egyptian Electricity Holding Company (EEHC) and Egyptian Natural Gas Holding Company (EGAS) signed an initial agreement with Italian energy company Eni to cooperate on plans for green and blue hydrogen production in Egypt.
August	Germany's Siemens Energy signed a (MoU) with the Egyptian Electricity Holding Company (EEHC) to jointly develop hydrogen-based industry in Egypt with the capability for export.
October	Norway's Scatec and Fertiglobe, a joint venture of the local Orascom Construction Industries and UAE-based Abu Dhabi National Oil Company (ADNOC), has entered into an agreement with the Sovereign Fund of Egypt (SFE) to develop a 50–100MW electrolyser facility to produce green hydrogen for green ammonia production in Egypt.

Table 1. Hydrogen cooperation agreements and pilot projects in Egypt.

Furthermore, the Egyptian government initiated several cooperation agreements and pilot projects in the current year, with the most recent ones listed in the table below.

b) Turkey

The potential for hydrogen production in Turkey is also considerable; research on the potential of Turkey for the development of hydrogen market suggests as follows:

- 5% of Turkey's current energy demand can be replaced with green hydrogen.
- This requires a 12.1 GW of installed electrolysis capacity, which corresponds to 36.3 GW of installed power generation.
- Such a capacity growth requires a $45.4 billion investment.

Following these studies, the Ministry of Energy and Natural Resources (MENR) initiated the preparation of a national hydrogen strategy. An extensive good governance and collaboration have been already reached by main stakeholders. Therefore, MENR is expected to adopt its first Hydrogen Strategy by the end of 2021.

Concerning this consultation process, EMRA shared its regulatory prospects on hydrogen and proposed its proposals toward 2030 and 2050 for regulatory developments with a view to pave the way for hydrogen deployment:

Proposals	Agreements
Toward 2030	Assessment of the compatibility of the current regulatory framework with the development of hydrogen industry.
	Development of electricity and natural gas market legislation to couple these sectors with hydrogen industry, considering the following: • Sustainable hydrogen generation pathways The assessment of outputs of R&D carried out by the Turkish gas sector, and the injection of hydrogen into natural gas networks
Toward 2050	Diversification of hydrogen generation pathways.
	Deployment of hydrogen injection into natural gas networks

Table 2. EMRA's regulatory proposal for the development of the regulation of hydrogen

c) Algeria:

In the North African area of the Mediterranean region, Algeria and Morocco represent the most promising potential for hydrogen production.

In Algeria, the need of diversification in the energy mix comes from three major issues; the first is the dependency on fossil fuels (hydrocarbons). In addition, the energy demand has and will grow for the next years. On the other hand, to ensure the energy transition, Algeria is now showing interest in the production and use of low-carbon and renewable hydrogen.

The hydrogen strategy in Algeria will focus on using hydrogen mainly in the chemical and refining industries. This energy carrier could help decarbonize certain industrial sectors, ensure electricity storage, or power the transportation sector. However, the deployment of hydrogen technologies requires the removal of a certain number of constraints.

Currently, the hydrogen production process in Algeria involves the reforming (conversion of molecules by chemical reactions) of natural gas by superheated steam. Hydrogen is currently used in Algeria in the refining industry to produce ammonia.

In the future, green hydrogen has the best potential in Algeria. Indeed, the Algerian Sahara is a place of choice for green hydrogen production for the following reasons:

- Intense insolation
- Enough water and natural gas
- Vast spaces for the installation of solar energy collection and conversion systems
- Existence of pipelines for the evacuation of solar hydrogen to potential users

Solar hydrogen represents the method of conversion and the vector of energy having the best qualities as well energetic as environmental benefits.

d) Morocco

Similarly, to its neighboring country, Morocco also presents a considerable potential for hydrogen production. The Moroccan government-initiated debates on the solutions to be adopted to be able to produce green hydrogen using RES. Studies have acknowledged the feasibility of hydrogen production and the potential of exporting it to the European market in the future.

However, the main issue that Morocco currently faces is the high prices of today's hydrogen technologies, the lack of funds to develop pilot projects, and the need for infrastructure for the production and transport of hydrogen.

In that regard, the Ministry of Energy created a committee that aims to monitor hydrogen prices in the world and to follow the improvement of technology. Depending on the evolution of hydrogen technology, a committee is supposed to choose and propose a roadmap for hydrogen production.

1.2.2. Barriers and challenges for hydrogen development in the south shore

In the discussions in private and public sectors, similar barriers and challenges have been highlighted.

The first challenge is the requirement of further R&D in the hydrogen technology to improve the efficiency and reduce the prices of production/transport.

The second one is the creation or adaptation of infrastructure to transport and export the produced hydrogen.

On the other hand, regulatory challenges are also utmost important in paving the way for the developments as well as promoting hydrogen production through similar feed in tariff mechanisms that have been used in promoting renewable energy sources. In addition, a harmonized and/or common rules and procedures will further facilitate, allow, and foster the creation of a hydrogen market.

The main challenges and barriers that both public and private hydrogen developers are facing today are as follows:

- High prices
- Lack of project financing
- Lack of infrastructure for transport and production
- High use of fresh water or high prices for desalination
- Lack of suitable regulatory framework and harmonized standards

2
Hydrogen future perspectives

Hydrogen, although clean and versatile, is not an energy source, but an energy vector: it must be produced, transported and stored before being used (converted to other forms of energy, such as electricity or heat; this is true for the use of H2 but probably not relevant to the vectorial nature of H2). A market exists (or will exist) with the expectation of share in the primary energy mix from 14% (IRENA).

The cost of hydrogen supply from renewables has come down and continues to fall, while the urgency of greenhouse gas emission mitigation has increased. In particular, the cost reduction in less than 10 years are expected to be 60% for hydrogen production cost, 70% for hydrogen distribution cost, and 45% for component/equipment (Air Liquide).

The discussion in the high-level meeting between national regulatory authorities of the Mediterranean region has shown a considerable potential for the creation of a well-functioning hydrogen market in the region between the producers/exporters in the south shore and the producers and consumers in the north shore. Furthermore, hydrogen production is clearly and actively considered in several energy strategies of the MENA countries.

However, as hydrogen technologies are still not mature enough for massive deployment, further research and development are needed to improve the technology in terms of efficiency and security of large-scale deployment. In that aspect, incentives and support from government to research centers is essential. In particular, funding mechanisms for R&D are crucial for a better understanding, for example, of the different storage services and the possible decrease in the use of freshwater by using waste/sea water.

MEDREG is providing a unique platform for its members to exchange their views and develop best practices toward a harmonized and common regulatory framework with a view to establishing a functioning and competitive Mediterranean sustainable energy market that will further require the following:

- Address investment risks: for example, a specialized database like the ones developed by OME, ENTSOG, ENSOE, etc., to collect hydrogen data on all levels (production, supply, transportation, distribution, consumption, etc.) to attract investment and hydrogen deployment efforts
- Develop standards of Guarantee of Origin and Safety
- Eliminate unnecessary regulatory barriers and harmonize standards for hydrogen (export light-touch regulation) that will allow exchanges and trades among the countries
- Adopt functional and innovative incentive mechanisms

At the same time, in case the hydrogen services are not resulting from a greenfield market, the regulators as the watchdog of the market must avoid abuses of dominant positions and implement regulatory tools for creating a fully functioning transparent, non-discriminatory, and sustainable energy market.

In that respect, a proper balancing among TPA and regulated access regime as well as exemption regulations on tariffs, TPA, and unbundling rules are to be considered to promote investment and development in the market.

Funding mechanisms are required to initiate more pilot projects in each country for getting a better understanding of the limits and real potential of hydrogen in the area. Furthermore, it is essential to test the requirement either by upgrading the existing infrastructure for hydrogen transport or by creating new independent pipelines.

As such, hydrogen is a new and very promising energy vector that has significant potential to facilitate the energy transition and decarbonize the energy markets. However, as any other new technology, it will further require additional R&D.

Finally, with the scaling-up of renewable electricity production, hydrogen (together with biomethane) can provide an efficient storage and flexibility solution. This combination would balance the intermittency of renewables and therefore allow a simpler transition to cleaner energy systems. In that regard, a common and shared Mediterranean regional hydrogen strategy would be beneficial – one that would place cross-border cooperation at its core and consider a road map for designing a regional regulatory framework.

2
Conclusions

The first MEDREG workshop on hydrogen offered an opportunity to initiate discussions among the regulators of the Mediterranean region on the state of developments regarding hydrogen production and the future perspective and expectations from the MEDREG members.

The main outcome from the discussion is that the vision of the North and South shores of the Mediterranean region is complementary in many ways. The North shore, with a focus on the EU countries, has a strategy that is centralized around the adaptation of the existing infrastructure to combine natural gas and hydrogen and to develop a hydrogen network at the EU level. Meanwhile, the South shore countries have shown an interest in producing and exporting hydrogen.

However, the hydrogen sector still requires further improvement and maturity in the technical and regulatory aspects, including the progress of production technologies and developing safety standards and guarantee of origin or similar mechanisms to harmonize the exchanges between both sides of the Mediterranean region.

In that respect, there is a strong interest in visiting hydrogen infrastructure projects for a better understanding, and it is recommended. Moreover, cooperation and continuous collaboration between the regulators of the Mediterranean region is a crucial element for the success of the development of a hydrogen market in the region.

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MEDREG – Association of Mediterranean Energy Regulators
Via Fieno 3, 20123 Milan, Italy –Tel: +39 3402938023
info@medreg-regulators.org www.medreg-regulators.org