

FLANDERS INVESTMENT & TRADE MARKET SURVEY



# THE GREEN HYDROGEN ENERGY

# **IN SPAIN**

FIT Madrid

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May 2021



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# 1. INTRODUCTION

According to the International Energy Agency (IEA), in 2019, global energy demand was expected to increase by 25-30% by 2040, making it clear that our way of life needs more and more watts to function and that we have an economy dependent on coal and oil, where this increase in energy demand would lead to an instant increase in CO2 and, of course, a worsening of the climate change scene. This is why decarbonisation of the planet has become an important point of emphasis for a large number of companies and governments all over the planet Earth.

2050 is the target date for achieving most of the goals set in the decarbonisation process: greater accessibility, efficiency and sustainability by promoting clean energy, including green hydrogen.

# 2. GREEN HYDROGEN

# 2.1 WHAT IT IS AND HOW IT IS PRODUCED

The simplest chemical element that can be found on Earth is hydrogen, since its atomic number is 1 and its atomic weight is 1 00784u. However, hydrogen does not exist in nature on its own, but is accompanied by chemical compounds such as water ( $H_2O$ ) or methane ( $CH_4$ ).

There are various ways of producing hydrogen and depending on the method, hydrogen can be labelled as grey, blue or green hydrogen. Green hydrogen is mainly obtained through electrolysis, i.e. it is obtained through the decomposition of water molecules  $(H_2O)$  into Oxygen  $(O_2)$  and Hydrogen  $(H_2)$ .

In short, electrolysis is based on breaking down water molecules to separate oxygen and hydrogen, and this requires a large amount of electricity which, if produced by renewable energies such as solar or wind power, generates hydrogen in its green form. There are less clean and environmentally beneficial methods, but it is a cheaper and more widely used process, grey hydrogen. It is not the most environmentally friendly method as its generation still requires fossil fuels, namely a hydrocarbon reforming process. To obtain blue hydrogen, methods very similar to those applied in the extraction of grey hydrogen are applied, however here carbon capture and storage (CCS) technologies are applied, which considerably reduces carbon emissions.

# 2.2 KEY PLAYERS AGAINST CLIMATE CHANGE

Green hydrogen has become an indispensable player as a "weapon" to combat climate change.

According to the report "Hydrogen Roadmap Europe: A sustainable pathway for the European Energy Transition", hydrogen is seen as a key element in accelerating the energy transition and generating significant socio-economic and environmental benefits, with the potential to meet 24% of final energy demand and create 5.4 million jobs by the target date of 2050. In addition, CO<sub>2</sub> reduction is vital, as it can reduce 560 million tonnes of carbon dioxide.

It is important to stress that the target date is 2050, so we are still in an initial phase of decarbonisation both in Spain and in the rest of the planet. The production and implementation of green hydrogen has a high cost and governmental measures are still scarce compared to the volume of action required for this process.

In summary, it is really important for the energy transition that institutions, supranational organisations such as the European Union or national governments adopt policies to provide consumers and users with accurate information and knowledge about the differences between hydrogen types in order to boost local hydrogen production and secure supply chains and reduce dependence on domestic fossil fuel imports.

# 3. SPANISH PRODUCTION

Spain currently produces 500,000 tonnes of hydrogen per year of which 95% is grey hydrogen thanks to its low price (<1.5 €/kg) compared to green hydrogen (3.5-5.5 €/kg).

Spain's renewable energy production potential is over 3,000 TWh/year according to the Institute for Energy Research of Catalonia (IREC) through the book "Hydrogen: energy vector of a decarbonised economy".

Based on figures, Spain can consolidate itself as the leader in green production, estimating its production at 1,750 TWh/year and anticipating a successful export to the rest of Europe and North Africa.

Spain is expected to start producing the world's cheapest green hydrogen in the mid-30s according to Aurora Energy Research, so by 2028, green hydrogen could overtake blue hydrogen.

# 3.1 SPAIN, A GREAT PLACE FOR GREEN HYDROGEN

Spain enjoys a geographical, climatic and industrial situation that endows it with great potential at world level in terms of green hydrogen production.

• Hours of sunshine per year: Spain has an annual average of 2,500 hours, making it one of the most ideal European countries when it comes to benefiting from solar energy. Depending on the geographical area of the country there can be large differences in the amount of sunshine hours received, with the north reaching figures even below the average values, while other areas, such as the Canary Islands, the Balearic Islands, Ceuta and Melilla receive more than 3,300 hours of sunshine per year. With regard to work-life balance, in Spain, 15.9 hours a day are spent on personal care and leisure, and 4.5% have working days of more than 50 hours a week.

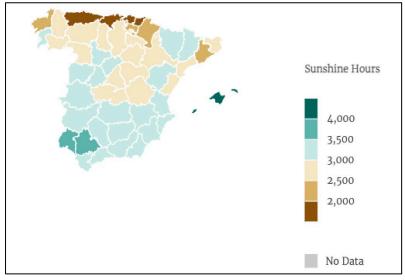


Figure 1. Hours of sunshine per year by province. Own elaboration.

- The wind in favour: Wind energy will account for 22% of the electricity consumed in Spain in 2020 and will be the most installed capacity that same year. Spain has 1,267 wind farms with 21,430 wind turbines installed throughout the country, with the exception of Madrid, Ceuta, and Melilla.
  - Zaragoza, Huesca, and Burgos are the Spanish cities with the most wind on average in Spain, while on the other side of the coin are Orense, Ciudad Real and Pontevedra. The Ebro Valley is consolidating itself as a perfect place for the presence of wind farms.
  - Other strong points within the Spanish territory are in areas such as the Strait of Gibraltar, specifically in Tarifa, where the wind is stronger and more persistent than in the rest of the country due to the easterly and westerly winds. Fuerteventura has also established itself as an area where the wind takes centre stage outside the peninsula, as the persistence of the trade winds and the insular nature of the area prevail there.

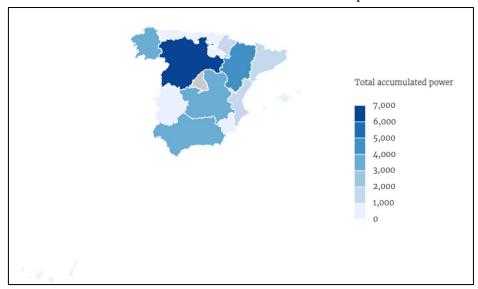


Figure 2. Cumulative power by Autonomous Community. Own elaboration. Source: La Vanguardia.

# 3.2 SPANISH AND EUROPEAN ROADMAP

In July 2020, the European Union approved the roadmap for hydrogen technology in which hydrogen is established as the indispensable energy vector for achieving the objectives established in the Paris agreement, avoiding temperature increases beyond 2°C and trying to keep it below 1.5°C in 2100. Four months later, Spain approves its own hydrogen roadmap, which sets out 60 measures in 4 lines of action (regulatory instruments, sectoral instruments, cross-cutting instruments and boosting R&D).

Within the Spanish roadmap, the main objectives for 2030 that the *Ministry for Ecological Transition and the Demographic Challenge* has set for Spain are:

- 1. 4 GW of installed capacity of electrolysers
- 2. 25% of hydrogen consumption in industry
- 3. 100-150 publicly accessible hydro generators
- 4. 150-200 FCEV buses
- 5. 5,000 7,500 light and heavy goods vehicles FCEVs
- 6. 2 commercial lines of H<sub>2</sub>-powered trains
- 7. 8.9 billion in investments for green or renewable hydrogen production projects
- 8. 4.6 million tonnes of CO<sub>2</sub>eq reduced.

Spain is expected to realise the 10% installed capacity of electrifiers set by the EU by 2030. In addition to the above direct targets, the development of electrifier technology will bring other side effects:

- A market development of 150 billion euros with 55 billion euros in annual sales by 2030.
- In terms of job creation, more than one million jobs are expected to be generated.

Spain will achieve the 10 % installed capacity of electrolysers set by the EU by 2030. In addition to these direct objectives, the development of this technology will bring other collateral effects.

The context is favourable as the natural resources for the mass production of renewable energy are available and there are companies in the entire hydrogen value chain to carry out its production, transport, storage and consumption.

When the above four actions are involved in an energy system, it is called Power-to-Hydrogen-to-X, where hydrogen production is carried out through the electrolysis of water and its subsequent use in different forms of energy.

Hydrogen Roadmap for Spain-Spanish Government (Link)

# 4. PROGRAMMES, PROJECTS AND FUNDING

There are many Spanish companies involved in in many hydrogen-related projects in which, like any company, the reduction of fuel production, storage and transport costs are objectives to be met.

# 4.1 HYDROGEN PROJECT IN SPAIN

There are also projects that are currently being carried out in Spain, with European, private or national funding.

# 4.1.1 HyTunnel-CS

This is a pre-normative study for the safety of hydrogen vehicles and transport through tunnels and confined spaces. Basically, the main objective is to facilitate the entry of hydrogen vehicles into underground traffic systems with lower or equal risk to fossil fuel transport.

The project is funded by Fuel Cells and Hydrogen 2 Joint Undertaking (JU) under project grant no. 826193. The company is supported by the Horizon 2020 research and innovation programme of the European Union, as well as by the UK, Germany, Greece, Denmark, Spain, Italy, the Netherlands, Belgium, France, Norway, and Switzerland.

The project budget is EUR 2,500,000.00.

Project duration: 1 March 2019 - 28 February 2022.

#### www.hytunnel.net

## 4.1.2 Metrology for Hydrogen Vehicles

One of the targets within the world of renewable energy is focused on vehicles, both private and transport. This project focuses on this as a solution for those countries that are facing very difficult CO<sub>2</sub> carbon dioxide reduction targets. The advantage of hydrogen vehicles is that they behave almost similarly to vehicles powered by fossil fuels, but do not emit any carbon-containing products in their operation. Legislation, especially European legislation, is perhaps one of the obstacles to the promotion of green hydrogen, as it must meet very specific requirements established by European Union legislation. Therefore, the main objective of the project is to ensure that the measurement challenges do not impede the global uptake of hydrogen vehicles in the automotive market.

The project is presented as an opportunity within the hydrogen industry, especially for vehicle manufacturers such as BMV, Daimler or Toyota, who join the 41 letters of support the project has received. Among them are also hydrogen refuelling station operators such as HRS, gas producers and standardisation bodies.

The main project partners are the European national metrology institutes and major hydrogen industry players, including:

Stichting Koninklijk Nederlands Normalisatie Instituut (Royal Netherlands Standards Institute Foundation); the Natitonal Physical Laboratory in the UK, where most of the project is carried out; Air Liquide, which produces about 1 million tonnes of hydrogen per year for steel, glass and food but mostly for refineries; AP2E which is a producer of gas analysis instruments based on OFCEAS (Optical Feedback Cavity Enhanced Absorption Spectroscopy) and LPS (Low Pressure Sampling) technologies; CASCADE Technologies, a leading manufacturer of gas analysers and monitoring systems using Quantum Cascade Laser (QCL) technology, a technology that is a game changer in gas analyser performance thanks to its increased sensitivity, speed of response and fingerprinting capability; the Spanish Meteorology Centre which provides the project with facilities and expertise in the preparation of compressed gas mixtures according to the gravimetric method described in the ISO 6142-1 standard, in addition, its analytical facilities consist of GC-TCD, GC-FID, GC-MS and GC-PDHID chromatographic techniques together with FTIR spectroscopy, EMPA-Material Science & Technology, a public research and service institution for materials science and technology; FORCE Technology, which is responsible for developing and testing a method to validate filling stations against relevant legal standards and regulations; the Foundation for the Development of New Hydrogen Technologies in Aragon, a private non-profit organisation promoted by the Regional Government of the Autonomous Community of Aragon in Spain, other public bodies and private companies, where the foundation's board of trustees is made up of 71 actors belonging to sectors of the economy such as automotive, chemical, energy generation, educational finance, engineering, research and development centres and real estate; IFE, which is dedicated to the modernisation, system simulation, design, controls, construction and testing of integrated hydrogen storage systems based on renewable energies, within the project, IFE will provide access and utility to the HYNOR, a small-scale green hydrogen reporting station and test centre for hydrogen technology; ITM POWER - Energy Storage & Clean Fuel, which has experience in building and operating HRS in the UK and the US, will help project partners understand and understand the challenges of real-world metering, in addition to, providing HRS for the development of sampling and testing protocols and providing the Teddington HRS as a real-life test site; Justervesenet, the National Institute of Meteorology and Legal Metrology Organisation of Norway, their expertise in research and application of methodology will be key to the project; Linde, one of the world's leading gas suppliers with a very high range of hydrogen activity, from the construction of steam reformers to gaseous tube trailers; METAS, the Swiss National Metrology Institute which disseminates harmonised units of measurement that are internationally recognised for their accuracy; NEL-Flow Measurement Services, holder of the UK national standards for flow measurement and which has a wide range of testing facilities, experience and expertise relevant to the project proposal; RISE, Sweden's national laboratory for volume, flow and temperature; Shell, an Anglo-Dutch energy company with a worldwide presence in an economically, energetically, environmentally and socially responsible manner; SINTEF, offering expertise in numerous projects funded by the company's Fuel Cells and Hydrogen 2 Joint Undertaking (JU) programmes, VSL -Dutch Metrology Institute, providing laboratories with a wide range of primary and secondary flow standards and CESAME-EXADEBIT, an internationally renowned laboratory in the field of gas flow measurement.

https://hidrogenoaragon.org/en/proyectos/metrohyve\_en/

Spanish companies involved in the project: The Foundation for the Development of New Hydrogen Technologies in Aragon and the Spanish Metrology Centre.

#### 4.1.3 H2 Ports

Logistics infrastructures such as ports, inland waterways, and logistics platforms, among other things, as well as everything related to maritime transport, are essential factors and elements for placing the European Union at the top of the world's developed areas. The importance of this strategic sector is related to the quality of life of European citizens and to the EU's competitive capacity, since, as we have said, maritime transport and the port sector are an important driving force for job creation and for the economic well-being of European countries. Therefore, innovation in efficiency and sustainability of ports is a key issue.

The H2Ports project aims to demonstrate and validate the Port of Valencia in port operations with two innovative solutions based on FC technology and a mobile hydrogen supply station with a design specifically designed for this project.

A Reach Stacker¹ to be tested at MSC Terminal Europe (part of the Grimaldi Group) has been selected as one of the best equipped for the use of Fuel Cells in port facilities. The project aims to put the equipment into daily operation during two years of real operational activity, and, in addition, to analyse the way in which the energy efficiency, performance and safety of the operations with Fuel Cells port equipment is developed. Cross-cutting issues such as the human factor, legislation, future deployment of the technology on a fully commercial basis and awareness of the potential of adopting hydrogen as an alternative fuel in port equipment will be considered.

Funding for the project is provided by the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No. 826339. It is supported by the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe, and Hydrogen Europe research.

#### Fundación Valencia Port.

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46024 Valencia
T +34 96 393 94 00
info@fundacion.valenciaport.com
Marina Sáez, Directora de Comunicación
www.h2ports.eu

#### 4.1.4 Inn.Balance Automotive Fuel Cell

The main objective of the project is to boost hydrogen mobility by developing a new generation of highly efficient fuel cell balance of plant components. The components are added to a new fuel cell system aiming to achieve improved efficiency and reliability of fuel cell powered vehicles.

The project is funded for four years (January 2017 - January 2021) by the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement no. 735969 within the framework of the European Union's research and innovation programme, Horizon 2020.

<sup>&</sup>lt;sup>1</sup> Reach Stacker, a reach stacker used for handling intermodal cargo containers in small terminals or medium-sized ports.

#### Fundación Ayesa

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www.innbalance-fch-project.eu

#### 4.1.5 Heaven

The H2020 HEAVEN project is based on designing, developing and integrating a high-power fuel cell-based powertrain using cryogenic technology into an existing 2-4 seater aircraft in order to test if it works in flight. In other words, the project proposes to design a modular architecture with modular systems that can be scaled up to other aircraft sizes and UAV applications.

The hydrogen storage will be based on cryogenic technology to try to achieve a gravimetric index of approximately 15% in order to obtain a hydrogen payload of between 10 and 25 kg to provide a range of autonomy to the demonstrator of between 5 and 8 hours.

In addition, the project will seek to leverage existing powertrain components and an aircraft demonstrator to achieve a successful overall LRT<sup>2</sup> at the end of this project.

The HEAVEN consortium is made up of large companies, SMEs and renowned research centres with extensive experience within the development of fuel cell technology for aeronautical applications that is backed up with participation in other relevant past H2020 and national projects.

## Fundación Ayesa

Avd. Marie Curie 2 41092 Sevilla T + 34 954 46 70 46 fundacion@ayesa.com

#### 4.1.6 **POCTEFA h2PiyR** - Pyrenees, Zaragoza, Fraga and Tarragona

This is a project whose objective is to establish a hydrogen corridor through the Pyrenees thanks to the new stations that have been built and continue to be built in the cities of Zaragoza, Huesca, Fraga and Tarragona, in Andorra and in Pamiers (France). These will join the wings already built in Huesca (in the *Walqa Technology* Park) and Zaragoza (in the Valdespartera district) and the stations in the French towns of Rodez and Albi, which are in the process of being built.

There are 16 hydrogen fuel cell electric vehicles, eight vans, six passenger cars and two buses. These will serve as a demonstration that hydrogen is a good alternative to fossil fuels.

As for its financing, in the 1st call for projects of the Interreg V-A Spain-France-Andorra programme (*POCTEFA* 2014-2020), with a total budget of 3,847,799 euros, of which 2,395,788 euros come from ERDF

<sup>&</sup>lt;sup>2</sup> Light rail transit (LRT) is a form of passenger urban rail transit characterized by a combination of tram and metro features.

funds. In addition, the Foundation for the Development of New Hydrogen Technologies in Aragon, *Applus ADIADA, Electricité de France and H2* Impulsion are project partners.

#### **POCTEFA**

Avenida Nuestra Señora de la Victoria, 8 22700 Jaca, Aragón T +34 947 36 31 00 info@poctefa.eu

www.poctefa.eu/blog/noticia/un-corredor-de-hidrogeno-atravesara-los-pirineos-con-h2piyr/

# 4.1.7 Iberdrola Puertollano Plant to Produce Green Hydrogen

The renewable energy project, with an installed capacity of around 100 MW, combines several innovative elements, from technology to storage capacity.

Iberdrola has obtained a favorable *Environmental Impact Statement (EIS*) for the photovoltaic plant in Puertollano, Castilla-La Mancha. It will supply energy to the first green hydrogen production plant - and also the largest for the moment - to be commissioned for industrial use on the European continent. At this point we come back to the Spanish wind energy that we have talked about before. In Castilla-La Mancha, Iberdrola operates 2,229 MW of renewable energy, mainly through wind farms, making it the third autonomous community with the "greenest" megawatts installed by the company.

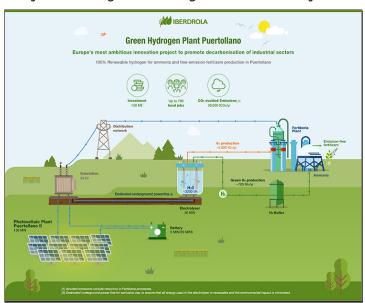


Figure 3. Hydrogen plant for industrial use. Source: IBERDROLA.

The project consists of:

- Installation with bifacial panels for higher production.
- Cluster inverters -string- for greater performance and use of the surface area.
- Battery-based storage system with a power of 5 MW and a storage capacity of 20 MWh.

The project has an investment of 150 million euros, is expected to generate 700 jobs, and is scheduled to start up in 2021, thus avoiding the emission of 39,000 CO<sub>2</sub>/year and producing clean energy to produce green hydrogen at the *Fertiberia group's* plant located in the town, making it the first European company in its sector to produce green fertilizers.

#### 4.1.8 Whitlee Wind Farm

The same Spanish company, Iberdrola, has programmed a project in Glasgow, Scotland. This is the first plant promoted by Green Hydrogen for Scotland, an alliance between *Scottish Power Renewables* (a subsidiary of Iberdrola), *BOC* and *ITM* Power.

This is where Iberdrola plans to install the UK's largest electrolyser next to the Whitelee wind farm, which generates around 539MW, making it the largest wind farm in the country. Iberdrola's project therefore focuses on installing a 20MW electrolyser to produce around 8 tonnes of hydrogen per day. The project also consists of a 20 MW photovoltaic plant with battery storage of up to 50 MW capacity. This project thus becomes one of the most ambitious projects on the European continent, in addition to submitting 53 initiatives to the Next Generation EU, which would trigger investments of up to 2.5 billion euros. The facility will have a hybrid solar energy system that will power the electrolyser together with a battery storage system with capacities of up to 50MW. The aim is to produce 8 tonnes of hydrogen per day, which, in equivalence, is approximately the daily tonnes of fuel required for more than 550 buses on round-trip routes between Glasgow and Edinburgh.

https://www.iberdrola.com/sala-comunicacion/noticias/detalle/hidrogeno-verde-llega-glasgow-mano-iberdrola

#### Iberdrola

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#### Environment

medioambiente@iberdrola.es

#### 4.1.9 DEMO4GRID

Project whose main objective is the commercial set-up and demonstration of a technical solution using pressurized alkaline electrifier (*PAB*) technology to provide balancing services under real operational and market conditions.

Asturias is the location chosen by Demo4Grid to install a viable business case project to demonstrate the operation of large-scale electrolysis adapted to the specific local conditions expected to be encountered across Europe.

The project coordinator is *DIADIKASIA* - Business Consulting, while funding comes from Full Cells and Hydrogen 2 Joint Undertaking under agreement No. 766351 under the European Union's Horizon 2020 research and innovation programme and from Hydrogen Europe and *N ERGHY*. It is also supported by the *Swiss* State *Secretariat for Education, Research, and Innovation (SERI*) under agreement No. 17.00009. Among the partners participating in the project are, *IHT - Industrie Haute Technology SA*, the Foundation for the Development of New Hydrogen Technologies in Aragon, *MPREIS*, *Fen Systems, DIADIKASA* and *Inycom*.

https://hidrogenoaragon.org/es/proyectos/demo4grid/

#### 4.1.10 Life Sustains Huts - Bachimaña, Aragon

Sustainable huts are the main objective of this project. It aims to modernise and optimise twelve mountain huts in four European countries from an energy point of view, with the aim of reducing polluting emissions.

The aim is to optimise energy through better insulation and technologies based on renewable energies, where it is intended to install complete systems for the production, storage and use of green hydrogen in one of the Aragonese refuges, specifically Bachimaña. This is expected to improve energy efficiency by 20%, reduce carbon dioxide emissions (CO<sub>2</sub>) by 10 tonnes per year per refuge and nitrogen oxides (NOX) by 0.06 tonnes per year per refuge, as well as reducing the number of helicopter trips to supply the current fuel, with a saving of approximately one and a half tonnes of paraffin per year.

The entities developing activities along the value chain of the project are: the Foundation for the Development of New Hydrogen Technologies of Aragon (which is also the coordinator), the Aragonese Mountaineering Federation, the Italian Alpine Club - Turin section, the Aragonese Mountaineering Federation, Environmental Park of Italy, the Alpine Association of Slovenia, the Centre for Hydrogen Technologies of Slovenia, the University of Ljubljana, and the French Federation of Alpine and Mountain Clubs.

Fundación para el Desarrollo de las Nuevas Tecnologías del Hidrógeno en Aragón - Fundación Hidrógeno - Foundation for the Development of New Hydrogen Technologies in Aragon

Polígono Walqa Carretera N330, Km 566, 22197 Cuarte, Huesca T +34 974 215 258 info@hidrogenoaragon.org http://sustainhuts.eu/es/

#### 4.1.11 Seafuel - Tenerife

This project aims to use the renewable resources of the Atlantic Area to fuel local transport and thus support the economy through carbon reduction. It is based on renewable energy infrastructures in order to demonstrate the viability of hydrogen as a fuel. Duration: 2017-2020.

Isolated regions, such as island territories, face specific challenges, such as the high cost of electricity and fuels and their high dependence on mainland infrastructures. The project will mainly focus on these regions, where about 30% of fuel consumption comes from local transport.

Within the project, the steps to be taken are:

- *Research*: studying new materials for seawater splitting with the aim of replacing and improving the efficiency of the process.
- *Hydrogenation*. The aim is to install a pilot hydrogen plant to produce hydrogen and supply vehicles using exclusively renewable energies.
- *Start-up and results.* After studying the viability of the transport system (private or public) and its subsequent conversion to the *SEAFUE* hydrogen system.

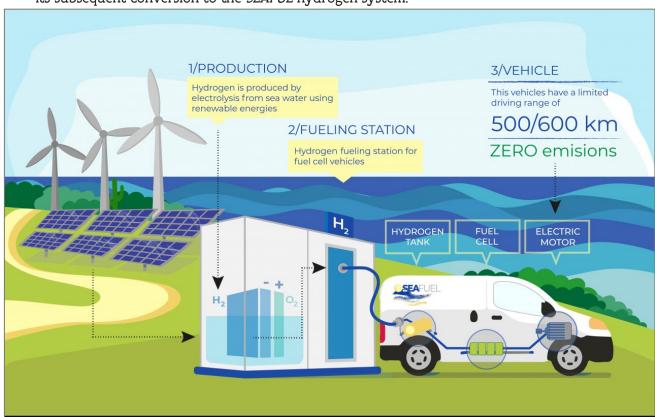


Figure 4. Supply to local transport. Image by SEAFUEL.

# Instituto Tecnológico y de Energías Renovables, S.A.

Polígono Industrial de Granadilla, s/n 38600 Granadilla, Santa Cruz de Tenerife info@seaafuel.eu

http://www.seafuel.eu/es/inicio/ http://www.seafuel.eu/es/el-proyecto/

# 4.1.12 Sun2HY - Repsol Technology Lab, Móstoles (Madrid)

This is a project developed by *Enagás* and *Repsol*, which each have a 50% share of the representation. It consists of a direct transformation of solar energy into hydrogen through a photo electrocatalysis plant (PEC technology), which does not need external electricity (bias free), it works only with water and sun.

Several leading research centres are collaborating in the project: the Catalonia Institute for Energy Research (IREC), the University Institute of Electrochemistry of the University of Alicante and the Hydrogen Foundation of Aragon, as well as a team specializing in engineering solutions, Magrana.

The first phase of the project will conclude with a pre-commercial scale-up demonstration (TRL-6) to be installed at the Repsol Technology Lab facilities in Móstoles, Madrid. The first phase was completed in 2020 and started the previous year. The project is co-financed by the CDTI (Centre for the Development of Industrial Technology) and the European Union through the European Regional Development Fund (ERDF). The ultimate desire of the companies is to achieve those steps that can bring the technology to a commercial and competitive status. The project budget is close to €1,929,906.

Enagás collaborates with various institutions and companies in the sector to promote the development of renewable gases and has signed agreements with the Government of Asturias, the Government of Aragon, the Government of the Balearic Islands and the Government of Castilla y León. With companies such as Repsol, as in this case, Ferrovial, Sacyr, *Ence* and *Emgrisa, Acciona* and *CEMEX*. In keeping with its commitment to the energy transition, it also helps start-ups in the sector through its *Enagás Emprende programme*, as in the case of *BioEnGas*.

#### **ENAGAS**

Paseo de los Olmos, 19 28005 Madrid + 34 91 709 92 00 sostenibilidad@enagas.es

www.enagas.es/enagas/es/Sostenibilidad/Compromiso\_con\_la\_transicion\_energetica/Gases\_renovables www.repsol.com/imagenes/global/es/proyecto-sun2hy-cofinanciado-feder\_tcm13-212744.pdf

# 4.1.13 Green Hysland - Island of Mallorca (Balearic Islands)

One of the projects chosen by the European Union's Fuel Cell and Hydrogen Joint Undertaking was the Green Hysland project, which is to be carried out in the Balearic Islands, specifically in Mallorca, and which would be subsidized by the European Union to the tune of 10 million euros. Green Hysland will produce, distribute, and use around 300 tons of renewable hydrogen per year in Mallorca through solar energy.

The main objective is to reduce the island's CO<sub>2</sub> emissions by up to 27,700 tons per year. Furthermore, the project is part of the "Hydrogen Roadmap: a commitment to renewable hydrogen" approved by the Spanish Government in search of positioning the country as a technological benchmark in the production

and use of green hydrogen, setting 2030 as the target year for producing 4GW of production capacity and mobilizing a total investment of close to €8.9 billion.

Why Mallorca? The island, part of the Balearic archipelago in the Mediterranean Sea, has become an ideal location for this project. The project includes studies and business models to replicate the project on other islands both inside and outside the European Union.

The hydrogen produced will be prioritized for use in supplying fuel to bus fleets and fuel cell rental vehicles, generating heat and power for commercial and public buildings, supplying auxiliary power to ferries and port operations, and finally, the creation of a refueling station. In addition, the possibility is being considered that part of the hydrogen produced could be fed into the island's gas pipeline network through a Guarantee of Origin System, which would allow the gas supply to be decarbonised.

The investment required for this initiative is approximately 50 million euros, including the generation of renewable electricity and equipment for the end uses of green hydrogen.

The project is coordinated by *Enagás* and promoted by *Acciona*, Cemex and *Redexis* as part of a plan to reindustrialise Cemex's land in *Lloseta*. The development will be carried out in a green hydrogen generation plant owned by Acciona and *Enagás*. The Ministry of Industry, Trade and Tourism, together with the Ministry for Ecological Transition and the Demographic Challenge are supporting the project through the Institute for Energy Diversification and Saving (IDAE) and the Balearic Government. The consortium is made up of up to 30 partners from 11 different countries, nine of them from the European Union plus Chile and Morocco. The target year for developing a renewable hydrogen commendation in Mallorca and the Balearic Islands is 2050 in line with the environmental objectives set for that year. The duration of the project is estimated between 2021 and 2025, serving as an example for other island territories such as Tenerife in Spain, *Maderia* in Portugal, Aran in Ireland, *Ameland* in the Netherlands, and the Greek islands.

Given the economic downturn caused by the impact of COVID-19 within the tourism sector, the initiative will help to boost the diversification of Mallorca's regional economy and create new employment opportunities in the fields of green hydrogen and renewable energies.

The consortium consists of: Acciona, the Dutch municipality ed Ameland, AMHYD, Aragon Hydrogen Foundation, AREAM Madeira, Spanish Hydrogen Association (AeH2), Balearia - CEA, National Hydrogen Centre (CNH2), Cotenaval, DAFNI, EMEC, EMT Palma, Enagás, Energy Co-operatives Ireland, Enercy, Fedarene, Gasnam, H2 Chile, HyCologne, HyEnergy Transstore, Instituto Balears de Energía, the municipality of Lloseta, New Energy Coalition - NUY Galway, Ports de Balears, Redexis, Universidad de les Illes Balears, Universidad de La Laguna (Tenerife).

www.acciona.com/es/actualidad/noticias/green-hysland-mallorca-primer-proyecto-hidrogeno-verde-pais-mediterraneo-seleccionado-para-recibir-financiacion-europea/

#### 4.1.14 CPV4H2

ISFOC is leading this project, the aim of which is to build a low-power system to produce solar hydrogen energy with maximum efficiency. It seeks to achieve the record of efficiency of hydrogen production through solar energy.

The specific objectives include:

- 1. Development and construction of a hydrogen production system by electrolysis of water where the electricity supply comes from a photovoltaic plant.
- 2. Development of a mathematical model of the hydrogen production system by electrolysis.
- 3. Development of a fully monitored pilot hydrogen generation system to test and validate production models and their operation.

This initiative is framed within the State Programme for Scientific and Technical Research and Innovation 2017-2020 (*State R&D&I Plan*) and specifically, within the subsidies aimed at promoting regional cooperation in R&D (FEDER *INTERCONECTA Programme*) - Call for 2018.

The Centre for the Development of Industrial Technology (Centro para el Desarrollo Tecnológico Industrial), E.P.E. (CDTI) is in charge of managing this programme in accordance with the priorities established in the "Programa Operativo Plurirregional de España 2014-2020" (Spain's Multi-regional Operational Programme 2014-2020), as well as in the Social Challenges contained in the Spanish Strategy for Science and Technology Innovation and in the Framework Programme for Research, Development and Innovation "Horizon 2020". The scope of the CPV4H2 project is closely linked to the scientific-technological priorities included in the State Plan for Scientific and Technical Research and Innovation 2017-2020.

#### **ISFOC**

Pol. Industrial La Nava III
C/Francia, 7
13500 Puertollano, Ciudad Real
T +34 926 44 16 73
isfoc@isfoc.com
www.isfoc.net/index.php/es/proyectos-3/mproyectocurso/cpvh2

## 4.1.15 EveryWh2ere

This project has a rather curious objective in that it aims to develop hydrogen-based portable generator sets as an alternative to the diesel generators currently available to meet the electricity supply needs of temporary events where access to electricity is difficult.

The project will integrate PEM technology fuel cells and pressurized hydrogen storage systems into transportable generator sets with zero noise and zero emissions.

They will be tested in Europe through construction sites, music festivals and temporary urban events. On the other hand, the strong involvement of local authorities means that the project can define within its roadmap a business model that will facilitate the inclusion of these generators in the market by 2025.

The EVERYWH2ERE consortium includes 13 partners from 6 EU countries (Italy, Finland, Sweden, Germany, France and Spain), each with valuable expertise in all the scientific and technological fields required for the project's objectives.

In the project, the Aragon Hydrogen Foundation leads WP7, which is responsible for disseminating and communicating the project and seeking commitments from potential stakeholders. It is responsible for the coordination of the demonstration of a 25 kW prototype and a 100 kW prototype at events in Spain.

www.everywh2ere.eu/
https://hidrogenoaragon.org/es/proyectos/everywh2ere/

Therefore, thanks to a greater integration of renewable energies in the electricity system (estimated to increase from 26% in 2018 to 55% in 2030, and 86% in 2050), the possibility of generating green hydrogen that is competitive with conventional energy sources is a reality today. Its role as a non-polluting energy vector makes it particularly attractive.

# 4.2 SPANISH HYDROGEN MAP

Prior to the publication of the Roadmap approved by the Spanish Government, 28 proposals were received from 26 companies, and although the typology of the projects is varied, as many projects have been identified with a large research and technological development component as innovation and commercial demonstration projects, including the production of renewable hydrogen on a large scale in the main petrochemical poles.

Below is a map showing the graphic location of the 20 projects submitted:



Figure 7. Hydrogen projects. Source: El Periódico de la Energía

There is already public information on 5 of the 20 projects although technical and economic details are not developed below due to their confidential nature.

- 1. *A Coruña*, Galicia with number 1 on the map. Production of renewable hydrogen for different industrial uses. This is a project for the production of renewable hydrogen on an industrial scale for use as an industrial and mobility feedstock. The main objective is to create a scaled hub for the production and transport of renewable hydrogen in the region for its decarbonisation.
- 2. At number 4 we find *Asturias* with a project on the production of green hydrogen and its use in steel factories. The project is based on the production of green hydrogen through the electrolysis of electricity from renewable sources and its subsequent use as a reducing agent for iron ore, thus displacing coke gas. The aim is to develop an industrial-scale electrolysis plant and adapt it to steelmaking processes.
- 3. Number 8 on the map, with *Ciudad Real*, Castilla-La Mancha where the project on the use of renewable hydrogen in the production of fertilisers is concentrated. It is an industrial-scale project for the production of renewable hydrogen and its integration into fertiliser production. The project is based on the construction of a renewable hydrogen plant using renewable electricity from another photovoltaic plant.
- 4. In 10th place, *Huesca*, Aragon with a project on the production of synthetic fuels from renewable hydrogen. Industrial-scale project for the production of renewable hydrogen and its subsequent use in mobility. Producing hydrogen from renewable electricity generation and connecting it to the grid for subsequent use in land mobility, whether by rail or road, and then injecting it into the natural gas network.
- 5. *Vizcaya*, Basque Country at number 18, responsible for the project on the production of synthetic fuels from hydrogen.

It is based on an industrial-scale demonstration plant for the synthesis of synthetic fuels from green hydrogen and captured  $CO_2$  from industrial processes.

The remaining projects (Huelva, Teruel, Almeria, Tarragona, Ebro Valley, Compostilla and Seseña, La Robla...) are dedicated to different technologies and stages of the hydrogen value chain such as the improvement of cathode plates for PEM cells, the separation of hydrogen previously injected and mixed in the natural gas network, the integration of hydrogen in high-temperature combustion processes for the manufacture of ceramic products, the development of co-electrolysis systems, hydrogen production by catalytic thermolysis, the use of carrier liquids in hydrogen logistics, and the improvement of storage materials and facilities.

The current Prime Minister, Pedro Sánchez, announced in November 2020 that "between 2021 and 2023, we will allocate more than 1,500 million euros to the development of renewable hydrogen", while the Minister for Ecological Transition, Teresa Ribera, assures that green hydrogen is a "country project" for Spain.

The government's plans for Spain are therefore to position the country as a renewable hydrogen exporting nation.

# 4.3 OTHER PROJECTS

Endesa and the Foundation for the Development of New Hydrogen Technologies in Aragon are the entities most involved in the energy transition towards green hydrogen.

#### 4.3.1 ENDESA

Endesa, which was founded as "Empresa Nacional de Electricistas Sociedad Anónima" whose legal name is Endesa, S.A., is a Spanish company operating in the electricity and gas sectors.

The company submitted to the Ministry for Ecological Transition a series of up to 23 projects related to renewable hydrogen in the different phases of the hydrogen value chain worth more than 2.9 billion euros to start up 340 megawatts (MW) of power in electrifiers fed with 2,000 MW of renewable power. The peninsular electrolysis projects involve an aggregate investment of Euro 2,000 million for the construction of eight 315 MW capacity power plants in As Pontes, Huelva, Teruel, Almería, Tarragona, Valle del Ebro, Compostilla and Seseña.

Endesa estimates that around 620 jobs will be created during construction and 320 in the subsequent operation and maintenance phase (around 20 years). This is in addition to the employment related to the implementation of the renewable generation that will feed the electrifiers.

It is planned to carry out extra-peninsular projects with an investment of 900 million euros and a production of green hydrogen in generation plants such as Barranco de Tirijana, Granadilla and Alcudia through 25 MW electrifiers.

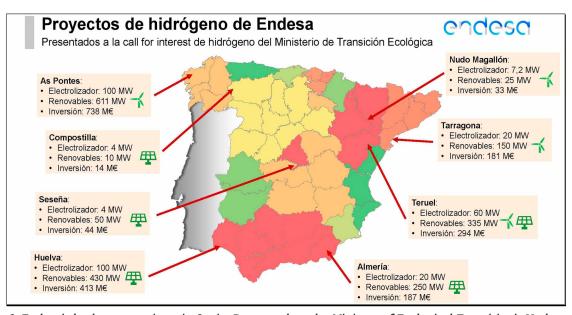


Figure 8. Endesa's hydrogen projects in Spain. Presented to the Ministry of Ecological Transition's Hydrogen Call for Interest. Source: Endesa.

#### 4.3.2 ENDESA and NATURGY

Naturgy has become increasingly active in the hydrogen sector in Spain, a Spanish company that operates in the electricity and gas sectors. The two gas companies have planned a clean hydrogen factory in La Roda, León, which will produce approximately 9,000 tonnes of green hydrogen per year through a 60MW electrolyser and a 400 MW solar photovoltaic park. The project is part of the Green Crane initiative promoted by Enagás and Naturgy and has been loaned as a candidate for a project of common European interest (ipcei) and a project for the Just Transition in Castilla y León.

Both companies intend to develop the facility in the surroundings of the thermal power plant (a coal plant) that Naturgy closed last summer 2020. The production of the green hydrogen factory will have several destinations, according to its promoters: local consumption and injection into the gas grid.

#### 4.3.3 There H2 Offshore - Maritime Transport

Proposal promoted by the marine energy cluster of Cantabria, whose objective is the design, construction, installation and monitoring of a marine prototype for the production of hydrogen and green ammonia through floating solar platforms. The project is included in the Cantabria re-Activa proposal and will be developed in an area of public domain of the Santander Port Authority. The green fuel obtained will be used for ships and equipment of lines and operators of the Port of Santander.

## 4.3.4 Madrid - Fast refuelling

Madrid is now a European city where hydrogen can be refuelled in 5 minutes for a range of 550 kilometres. The installation where it is possible to refuel in these terms supplies hydrogen at 700 bar/Mpa, making Spain the first to offer hydrogen at such a high pressure.

To give you an idea, the hydrogen tank can refuel an entire fleet of 12 Toyotas Mirai, vehicles that will be used by the companies behind this project, Toyota, Enagas (through Scale Gas, a startup), Urbaser, Carburos Metálicos, Sumitomo Corporation España and the Spanish Confederation of Service Station Entrepreneurs (CEES).

## 4.3.5 Barcelona - Hydrogen Buses

Barcelona City Council has already announced in November 2020 the purchase of 8 fuel cell electric vehicles for approximately 6.4 million euros. These vehicles will be the Caetano H2 City Gold LHD model.



Each bus is 12 meters long, and its technological core is based on a fuel cell from Toyota with a power output of 60 kilowatts. The motorization and electronics are provided by Siemens. On the other hand, the manufacturer estimates its daily consumption at 20 kilograms of hy.

Figure 9. Caetano's H2 City Gold LHD bus model.

Image by Caetano.drogen and a range of 300

kilometers.

# 4.4 HYDROGEN ASSOCIATIONS AND FOUNDATIONS

# 4.4.1 APPICE - Spanish Fuel Cell Association

"The aim of the Spanish Fuel Cell Association is to promote the scientific and technical development of this technology, to raise awareness of its potential at national and international level and to provide training and information to interested social agents".

#### Polígono Európolis

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28232 Las Rozas de Madrid, Madrid
T +34 910 291 078
T +34 647 851 186
gestion@appice.es
info@appice.es
presidente@apice.es

# 4.4.2 AeH2 - Spanish Hydrogen Association

They encourage, promote and drive the industrial development of hydrogen technologies in Spain. "The Spanish Hydrogen Association (AeH2) is the voice of the hydrogen sector in Spain. It represents more than 200 members from the entire hydrogen value chain, including renewable energy promoters, equipment and component manufacturers, engineering and EPC, Oil & Gas, industrial gases, transport, organisations linked to the sector, etc. It counts among its members the most active companies, institutions and researchers in Spain in these technologies, who are active in hydrogen and fuel cells and who are convinced that these technologies have great economic potential".

#### Its initiatives include:

- Spanish Hydrogen and Fuel Cell Technology Platform
Its mission is to facilitate and accelerate the development and use in Spain of systems based on fuel cells and hydrogen, in their different technologies, for their application in transport, the stationary and portable sectors.

# www.ptehpc.org/

- Hydrogen Industry Sectoral Agenda

The Hydrogen Industry Sectoral Agenda aims to be a document agreed with all the agents in the sector, from public institutions, financial entities and standardisation bodies to the organisations that operate in the different links of the hydrogen value chain: production, storage or transport and end use.

www.agendah2.es/

#### - Technical Committee CTN-181

Its main objective is the standardization of the aspects related to systems and devices for the production, storage, transport and distribution, measurement and use of hydrogen in its aspects of:

- 1. Hydrogen specifications.
- 2. Hydrogen production facilities and their associated devices.
- 3. Hydrogen storage facilities and associated devices.
- 4. Hydrogen transport facilities and associated devices.
- 5. Hydrogen using installations and equipment.
- 6. Hydrogen supply installations.
- 7. Qualification of personnel involved in the construction, operation, maintenance and inspection of facilities for the production, storage, transport, supply and use of hydrogen as a fuel.
- 8. Hydrogen measurement.

## https://www.une.org/encuentra-tu-norma/comites-tecnicos-de-normalizacion/comite?c=CTN%20181

- European Hydrogen Energy Conference (EHEC)

The Spanish Hydrogen Association (AeH2) has taken over the organisation of *EHEC 2021* with the aim of continuing to promote the use of hydrogen technologies worldwide.

# www.ehec.info/index.php/about-ehec

In addition, the Spanish Hydrogen Association has signed several collaboration agreements with entities such as:

- CEES: Confederación Espanta de Empresarios de Estaciones de Servicio, a national non-profit organisation that brings together Spanish entrepreneurs working in the service station sector.
- Curso\_H2: organised by ARIEMA Energía y Medioambiente S.:, a course whose objective is to provide students with the knowledge and skills necessary to become professionals in the hydrogen technology sector.
- Gasnam. Iberian Association promoting Portuguese natural gas and renewable gas in land and maritime mobility.
- REDEXIS: Company dedicated to the development of natural gas transport and distribution infrastructures, distribution and sale of liquefied petroleum gas and promotion of renewable applications for natural gas and hydrogen in Spain.
- Toyota España. Toyota subsidiary in Spain that distributes and markets Toyota and Lexus vehicles
  in Spain. They also have experience in technological research into hydrogen vehicles. In 2014 they
  launched Mirai as one of their objectives to contribute to the promotion of a hydrogen-based
  society.

They also collaborate with other international associations such as:

- 1. La Asociación Canadiense del Hidrógeno y de las Pilas de Combustible (CHFCA) The Canadian Hydrogen and Fuel Cell Association.
- 2. H2Chile.

3. Asociación Costarricense de Hidrógeno (ACH2) - Costa Rican Hydrogen Association.

T +34 91 804 53 72

T +34 91 241 95 31

info@aeh2.org

www.aeh2.org/

# 4.4.3 Centro Nacional del Hidrógeno - National Hydrogen Centre

"The objectives of the CNH2 include the use of its facilities as a centre for the testing, characterisation, homologation, certification or validation of technological developments obtained by the productive sector to improve the competitiveness of companies and to promote the introduction of hydrogen and fuel cell technologies in the national market".

Among its collaborative projects funded by international organisations are:

- 1. FCHRAIL
- 2. areNH3a
- 3. MACHBETH
- 4. Electromovilidad Minera
- 5. Interreg Sudoe
- 6. H2 Ports
- 7. Kart H2

Collaborative projects funded by national entities:

- 1. CO2-DUAL
- 2. ECOPEM-DUAL
- 3. TRACA
- 4. ENHIGMA
- 5. CONFIGURA
- 6. INcorportaPEME
- 7. agrosofc-cim&3d
- 8. Pirbioclm
- 9. Hidroam
- 10. TOGETHER
- 11. VITALE

## Centro Nacional del Hidrógeno

Prolongación Fernando el Santo, s/n 13500 Puertollano, Ciudad Real T +34 926 420 682 info@cnh2.es

www.cnh2.es/

4.4.4 **AHMUR** - Asociación Sectorial del Hidrógeno Verde de la Región de Murcia Green Hydrogen Sector Association of the Murcia Region

Together with Soltec, its main objective is to "Promote the recovery of the Mar Menor through industrial decarbonisation and transformation of an economy based on oil and fossil gas into a green and sustainable economy with solar photovoltaic energy as a resource and hydrogen as the main energy vector".

The partners are: Andamur, Enagas, PrimaFrio and Soltec.

#### AHMUR

Polígono Industrial "La Serreta"
Calle Gabriel Campillo, s/n
30500 Molina del Segura, Murcia
T +34 968 603 153
info@ahmur.es
www.ahmur.org/

4.4.5 Fundación Para el Dasarrollo de las Nuevas Tecnologías del Hidrógeno en Aragón - Foundation for the Development of New Hydrogen Technologies in Aragon

A private, non-profit research centre that promotes the use of hydrogen as an energy vector. It is a board of trustees made up of more than 70 members. Its main objective is to organise, manage and execute all types of actions related to hydrogen in order to generate, store and transport hydrogen for use in a few fuels, transport applications or distributed energy generation.

# Parque Tecnológico Walqa

cria. N-330a, km. 566 22197 Huesca T +34 974 215 258 www.hidrogenoaragon.org/es/

4.4.6 **Asociación Empresarial Eólica (AEE)** - Wind Energy Business Association

Calle de Sor Ángela de la Cruz, 2 28020 Madrid T +34 917 45 12 76 aeeolica@aeeolica.org www.aeeolica.org/

4.4.7 **Asociación de Empresas de Energía Eléctrica** - Association of Electricity Companies

Edificio Cuzco IV
Paseo de la Castellana, 141, Planta 12
28046 Madrid
T +34 915 67 48 00
info@aelec.es
www.aelec.es/

4.4.8 Asociación Empresarial Small Scale Gas Natural (AEGAN) - Small Scale Natural Gas Business Association

Avda. de Pío XII 96-A, 1º Izda 28036 Madrid T +34 618 742 931 manuel.lage@aessgan.es www.aessgan.es/

4.4.9 Asociación Española de Energías Renovables (APPA Renovables) - Spanish Renewable Energy Association

Calle del Dr. Castelo, 10, 2ºC 28009 Madrid T +34 914 00 96 91 appa@appa.es www.appa.es/

4.4.10 Asociación de Empresas Innovadoras CAR-EX - CAR-EX Association of Innovative Companies

Cria. Nacional 521 - Km. 41.8 T +34 607 080 180 info@carex.es www.carex.es/

4.4.11 Asociación Española de Almacenamiento de Energía (ASEALEN)

- Spanish Energy Storage Association

C/ Alberto Aguilera, 7, 4ºD 28015 Madrid T +34 910 075 373 info@asealen.es www.asealen.es/

# 4.4.12 **Asociación de Empresas Eléctricas** - Association of Electricity Companies

Av. Diagonal 389, 4º 08008 Barcelona T +34 93 414 22 77 info@aseme.org www.aseme.org/

# 4.4.13 Asociación Andaluza de Hidrógeno - Andalusian Hydrogen Association

C/N San Rosendo, nº 2, 3ºA 18013 Granada T +34 669 67 92 85 info@hidrogenoandalucia.org www.hidrogenoandalucia.org/

# 4.4.14 Ente Vasco de Energía - Basque Energy Agency

Edificio Plaza Bizkaia
Urkixo Zumarkalea, 36
48011 Bilbao, Bizkaia
T +34 944 03 56 00
comunicacion@eve.eus
www.eve.eus/?lang=es-ES

# 4.4.15 **Fundación Asturiana de la Energia** - Asturian Energy Foundation

C/ Fray Paulino, s/n 33600 Asturias T +34 985 46 71 80 info@faen.es www.faen.es/

# 4.5 HYDROGEN FAIRS IN SPAIN

## Genera - International Energy and Environment Trade Fair

Its objective is to showcase some of the main lines of current research in the field of renewable energies and energy efficiency.

When:

16 - 18 November 2021

#### Where:

IFEMA
Avda. del Partenón, 5
28042 Madrid
T + 34 902 221 515
lineaifema@ifema.es
www.ifema.es/genera

# Marine Energy Week

When:

23 - 24 March 2021

Where:

Bilbao Exhibition Centre Ronda de Azkue 1 48902 Ansio-Barakaldo T +34 94 404 00 00

bec@bec.eu

www.bilbaoexhibitioncentre.com/

# ICREPQ - Conferencia Internacional sobre Energías Renovables y Calidad de la Energía International Conference on Renewable Energy and Energy Quality

When:

28 - 30 July 2021

Where:

Universidad de Almería
Calle Universidad de Almería, s/n
04129 La Cañada, Almería
T +34 950 01 55 50
info@ual.es
https://www.ual.es/

# ECOFRIA - Feria Internacional de Soluciones Medioambientales y las Energías International Trade Fair for Environmental Solutions and Energies

When:

05 - 07 October 2021

Where:

Feria de Valencia avenida de las Ferias, S/n 46035 Valencia

T +34 96 386 11 00

feriavalencia@feriavalencia.com www.feriavalencia.com/

## **SMART CITY EXPO 2021**

Exhibition and convention focusing on the concept of sustainable cities and related services, including environment and energy.

When:

16 - 18 November 2021

Where:

Fira de Barcelona - Recinto Gran Vía Av. Joan Carles I, 64 08909 L'Hospitalet de Lobregat T +34 902 233 200 info@firabarcelona.com www.firabarcelona.com/gran-via/

# 5. LEGISLATION AND POLICIES

# **5.1 REGULATORY INSTRUMENTS**

- Administrative simplification and removal of regulatory barriers to hydrogen production

Hydrogen production is an industrial activity due to its classification as a chemical industry for the production of inorganic gas. It therefore involves the construction of infrastructures that can only be carried out on land classified as industrial, activities that are subject to environmental impact assessments regardless of the source used for hydrogen generation.

Within the Spanish Hydrogen Roadmap, the measures to address hydrogen production are:

- "To distinguish the production of hydrogen from industrial processes from the production of green hydrogen, given that its environmental impact is radically different, in accordance with Royal Decree 815/2013, of 18 October, approving the Regulation on industrial emissions and development of Law 16/2002, of 1 July, on integrated pollution prevention and control."
- 2. Analyse the different processes for the operation and implementation of small-scale green hydrogen production facilities and thus assess their simplification without undermining environmental protection and ensuring sustainability criteria.
- 3. Promote the development of regulatory measures to simplify and facilitate the deployment of direct electricity lines dedicated to the production of green hydrogen within the regulatory framework of the electricity sector, as well as hydrogen products transporting green hydrogen within the framework of the hydrocarbon sector regulations.
  - a. "Initially, the deployment of this type of infrastructure should take into account criteria of proximity between the points of production, storage and supply of renewable hydrogen. It requires a modification of sectoral legislation, avoiding undermining the economic and financial sustainability of the electricity and gas systems.".

#### - Establishment of a system of Guarantees of Origin (GoO5)

In order to utilise renewable sources in the production of green hydrogen, a mechanism of Guarantees of Origin is required to define the procedures and requirements, as well as the responsible body, for issuing Guarantees of Origin for renewable hydrogen, regardless of its storage route, its transport, and its end use.

4. Create a system of Guarantees of Origin for renewable hydrogen in collaboration with European institutions in order to provide adequate price seals to consumers.

#### - Promoting the competitiveness of green hydrogen

The cost of production is one of the main obstacles to the development of projects within the renewable hydrogen value chain, which is why it is necessary to identify levers and incentives to promote pilot projects, and once the potential and efficiency of these projects have been demonstrated, to promote and

encourage the technology capable of developing these projects on a larger scale so that costs can gradually decrease. At the moment, in Spain and Europe there is a lack of tax exemptions and economic/environmental incentives capable of promoting the development of hydrogen projects.

- 5. Consider the positive environmental effects of renewable hydrogen within the framework of green taxation and indirect taxation. Likewise, taxation should provide incentives for renewable hydrogen as opposed to hydrogen of untraceable origin.
  - a. "In this respect, within the framework of the Plan to Boost the Value Chain of the Automotive Industry, a measure has been promoted on the comprehensive reform of vehicle taxation in coordination with the Territorial Administrations (Road Tax and Registration Tax), in order to introduce a greater environmental orientation in the determination of taxation."

# **5.2 SECTORAL INSTRUMENTS**

- Monitoring of hydrogen production and consumption

To guarantee knowledge of the sector and its traceability in production, logistics and uses, it is necessary to have a data collection system monopolizing the evolution of the deployment of green hydrogen and to evaluate the degree of success of the measures implemented, and thus provide greater knowledge on its uses. The system will be aligned with the needs for reporting hydrogen consumption and production information to the European Commission and the International Energy Agency.

- 6. Establish a national statistical system on hydrogen consumption and production in Spain, differentiating by type of hydrogen and by consumption sector.
- Boosting the application of renewable hydrogen in industry

In Spain, the application of hydrogen is currently concentrated in industrial sectors such as oil refining, the iron and steel industry and the chemical industry. These sectors provide a reliable demand and favour a greater use of hydrogen.

For economic reasons, the growth of the renewable hydrogen market should be selective and gradual, and encouraged in those sectors where there is no alternative option to decarbonisation. Based on the above, the proposed actions are summarised as follows:

- 7. Assess the feasibility of setting renewable hydrogen penetration targets for the period 2025-2030, following the path set out in the European Hydrogen Strategy, in those sectors where electrification is not the most efficient option and where there is no viable sustainable alternative.
- 8. Design financial instruments to support Spanish hydrogen-intensive industry in adapting its processes and infrastructures to the continuous supply of renewable hydrogen.

- 9. "The current financial instruments of the Ministry of Industry, Trade and Tourism offer loans for investment in assets in production lines, as well as for innovation, which also includes any aspect of energy improvement, as long as it is directly related to the production process".
  - a. Develop long-term national decarbonization strategies based on renewable hydrogen in the most difficult to electrify sectors. These will be based on sector-specific dialogue. Identify the current hydrogen consumption poles, promoting and encouraging the creation of "hydrogen valleys or clusters". The constitution of Industrial Hydrogen Committees will be promoted together with autonomous communities, local administrations, hydrogen consumers and promoters of renewable hydrogen production projects, encouraging the development of pilot projects.

"The desirability of creating Industrial Hydrogen Committees has been identified in the petrochemical poles of Huelva, San Roque-Los Barrios, Cartagena, Sagunto, Tarragona, Bilbao, Avilés-Gijón, A Coruña and Puertollano."

# - Boosting the application of renewable hydrogen in transport

Promoting the use of renewable hydrogen in the transport sector through the transposition of the DER  $\scriptstyle\rm II$ 

"A favorable regulatory framework for the production and consumption of synthetic fuels produced from renewable hydrogen shall be established."

#### - Inland transport

- 10. Collaborate in international fora to promote the development of a harmonised methodology for the determination of consumption in hydrogen-powered heavy-duty vehicles.
- 12. Supporting the Spanish automotive industry to favour the production of hydrogen-powered fuel cell electric vehicles. This production of hydrogen fuel cell electric vehicles will have a tractor effect on the automotive equipment and components industry. This measure is endowed with €25 million.

- 13. Promote feasibility studies and trials on the replacement of diesel trains by hydrogen fuel cell trains for running on partially or non-electrified lines, in line with the proposed European Hydrogen Strategy..
- 14. Identifying measures for the development of a national hydrogen refuelling rail infrastructure.
- 15. Develop specific legislation for hydropower plants, specifying the administrative requirements and delimiting the permits necessary for their construction and management.
- 16. Include the implementation of hydrogenerators within the actions eligible for subsidies in future MOVES Plans or similar, with special emphasis on the construction of strategic hydrogenerators that favour the progressive penetration of hydrogen in logistical fleets.
- 17. Equate the consideration of hydrogenerators to traditional filling stations from a land-based perspective, so that hydrogen dispensers can be introduced in existing filling stations.

#### - Maritime transport

- 1. Create rules to clarify and simplify the type approval and/or certification process for ships with fuel cells and hydrogen combustion chambers for maritime use, and bring them into line with European regulations on the subject.
- 2. Identifying measures for the development of a national hydrogen refuelling port infrastructure.
- 3. Establish actions to promote and encourage the use of new zero emission technologies in national coasts and ports.
- 4. To allocate aid from the SGIPYME to the naval sector to promote the use of hydrogen technology in the construction of ships in our country, in R&D&I projects with the participation of shipyards..

#### - Air transport

- 1. Encourage the development of production plants for synthetic paraffin produced from renewable hydrogen or new generation biofuels to decarbonise air transport.
- 2. Analyse the necessary conditions for redesign and modifications to allow the use of aircraft using synthetic fuels from renewable hydrogen or new generation biofuels.
- 3. Establish environmental requirements in the technical specifications governing the contracts of handling agents providing airside handling services at airports.

### - Integration of energy vectors

- 1. Establish a legal basis for Power to X (P2X) power plants and electrolysis facilities.
- 2. Clarify the operational framework for electrolysers to participate in the adjustment services necessary to ensure an adequate supply of the electricity sector, as well as the legal basis for their participation.
- 3. To make the use of green hydrogen in engines of generation and cogeneration plants more flexible, providing a greater guarantee of supply to the electricity system.
- 4. Review the technical, regulatory, and quality aspects of the gases required for the injection and use of hydrogen in the natural gas grid, with particular emphasis on the use of certain existing facilities for the dedicated transport and/or storage of renewable hydrogen.
- 5. Simultaneously assess the need to modify gas-fired devices in industry and power generation to allow safe operation with higher concentrations of renewable hydrogen.
- 6. Conduct a prospective analysis of the needs for retrofitting domestic gas equipment (boilers, heaters etc.) to allow for the gradual integration of renewable hydrogen.
- 7. Jointly assess the implications for natural gas vehicles arising from the use of a hydrogen-enriched mixture (HGNC).
- 8. Analyse the feasibility of renewable hydrogen production from waste.

## 6. CONCLUSIONS

If the hydrogen panorama in Spain leaves us with some clear ideas, they are that we have in our hands an ideal sustainable solution for the decarbonization of the economy, not only in Spain, but also in Europe. With our sights set on 2050, green hydrogen is key to achieving climate neutrality and the development of innovative industrial value chains in Spain and the European Union, as well as a green economy with high added value.

Did you know that...? Hydrogen was used as a fuel and power generator during Apollo 11's first trip to the Moon.

Green hydrogen is destined to be a valuable energy vector whose end uses where it is the most efficient solution in the decarbonization process, whether in hydrogen-intensive industry or in high-temperature processes, long-distance heavy transport, maritime transport, aviation or rail transport.

Furthermore, the current Spanish government is going to allocate more than 1.5 billion euros to the development of renewable hydrogen, which is evidence of the Spanish government's commitment to decarbonizing the country. Spain is a potential hydrogen exporter thanks to the country's high renewable resources and its geographical location. The production potential is sufficient to meet local energy needs and export surpluses.

The specialized business network is an advantage, as it includes the entire hydrogen value chain. Another strength is the technological capabilities, which are necessary to face the growth of the sector expected in the coming years, in order to meet the objectives, set out in the Roadmap. Spain has clear competitive advantages for the development of hydrogen in the coming years.

However, the creation of an environment that favors the supply and demand of green hydrogen is necessary, and priority must be given to the deployment phases, hydrogen production projects in industry and its mobility. In this context, the best option are clusters or business valleys that concentrate production, transformation and consumption using economies of scale and the development of pilot projects.

Furthermore, any regulatory framework must recognize the potential of green hydrogen, as it should involve common standards in the European Union, such as objectives, product labelling or guarantees of origin, with the aim of facilitating its development.

With regard to COVID-19, the green hydrogen market can help to reactivate, redefine and transform the Spanish economy, generating employment, economic development and an industrial fabric that increases the country's energy security.

# 7. ANNEX: SPANISH ECOSYSTEM OF COMPANIES WITH REPRESENTATION THROUGHOUT THE HYDROGEN TECHNOLOGY VALUE CHAIN

There are many Spanish companies and institutions, as well as foreign companies based in Spain, that have already worked and are working with hydrogen, so another of the great advantages for Spain is based on experience.

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# 8. REFERENCES

Aleasoft Energy Forecasting. (2020, 22 enero). *El hidrógeno verde es el combustible del futuro*. El periódico de la energia. <a href="https://elperiodicodelaenergia.com/el-hidrogeno-verde-es-el-combustible-del-futuro/">https://elperiodicodelaenergia.com/el-hidrogeno-verde-es-el-combustible-del-futuro/</a>

Asociación Española de Hidrógeno. (s.f.). https://www.aeh2.org/en/

ARIEMA. (s.f.). Inversiones en hidrógeno. https://www.ariema.com/inversiones

Barrero F., A. (2021, 3 marzo). *Mapa español del hidrógeno*. Energías Renovables, el periodismo de las energías limpias. <a href="https://www.energias-renovables.com/hidrogeno/la-geografia-espanola-del-hidrogeno-20210303">https://www.energias-renovables.com/hidrogeno/la-geografia-espanola-del-hidrogeno-20210303</a>

Camós, J. (2020, 8 diciembre). *La primera planta de hidrógeno verde de España se estrenará en 2022 con 20 MW de fuentes renovables.* Motorpasión. <a href="https://www.motorpasion.com/industria/primera-planta-hidrogeno-verde-espana-se-estrenara-2022-20-mw-fuentes-renovables">https://www.motorpasion.com/industria/primera-planta-hidrogeno-verde-espana-se-estrenara-2022-20-mw-fuentes-renovables</a>

Casas, J. D. L. (2021, 4 marzo). *Por qué el hidrógeno verde es la llave para la descarbonización*. EXPANSION. https://www.expansion.com/economia/2021/03/04/603ff268e5fdeace358b45e5.html

Departamento de análisis de Estrategias de Inversión. (2020, 29 octubre). El hidrógeno, la energía clave del futuro para Candriam. Estrategias de Inversión.

https://www.estrategiasdeinversion.com/analisis/bolsa-y-mercados/informes/el-hidrogeno-la-energia-clave-del-futuro-para-n-459981

Domingo, I. J. (2020, 24 diciembre). *El hidrógeno gana posiciones en la carrera por el liderazgo mundial de las renovables.* Estrategias de Inversión. <a href="https://www.estrategiasdeinversion.com/analisis/bolsa-y-mercados/informes/el-hidrogeno-gana-posiciones-en-la-carrera-por-n-464107">https://www.estrategiasdeinversion.com/analisis/bolsa-y-mercados/informes/el-hidrogeno-gana-posiciones-en-la-carrera-por-n-464107</a>

Energía solar en España. (s.f.). En *Wikipedia, la enciclopedia libre*. https://es.wikipedia.org/wiki/Energ%C3%ADa\_solar\_en\_Espa%C3%B1a

Europa Press. (2021, 16 febrero). *Acciona compromete 2.000 millones para alcanzar una cuota del 20% de hidrógeno verde en la Península*. EXPANSION.

https://www.expansion.com/empresas/energia/2021/02/16/602bbf9ce5fdea61478b45ad.html

Fujikin. (2015). Hydrogen economy has hit the ground running. https://www.fujikin.co.jp/en/brandstory/technology/y2015.html

Gobierno de España. (2020, 18 junio). *PLAN MOVES II | Idae*. Idae plan Moves II. https://www.idae.es/ayudas-y-financiacion/para-movilidad-y-vehiculos/plan-moves-ii

González García-Conde, A. & Departamento Aerodinámica y Propulsión – INTA. (2007, 17 octubre). *La economía del hidrógeno* [Diapositivas]. UPM. <a href="http://www.fundacionenergia.es/PDFs/Hidrogeno%2010-07/AGonz%C3%A1lez.pdf">http://www.fundacionenergia.es/PDFs/Hidrogeno%2010-07/AGonz%C3%A1lez.pdf</a>

Hernández, N. (2020, 11 diciembre). *La hoja de ruta del hidrógeno en España: ¿podemos cumplir los objetivos?* Ethic. https://ethic.es/2020/12/hoja-ruta-hidrogeno-espana-objetivos/

CHFCA. (2019, 26 noviembre). *Hydrogen and Fuel Cell Solutions*. <a href="http://www.chfca.ca/fuel-cells-hydrogen-the-hydrogen-and-fuel-cell-solution/">http://www.chfca.ca/fuel-cells-hydrogen-and-fuel-cell-solution/</a>

Iberdrola. (2020, 25 junio). Hidrógeno Verde. https://www.iberdrola.com/sostenibilidad/hidrogeno-verde

LePan, N. (2020, 17 junio). 6 Ways Hydrogen and Fuel Cells Can Help Transition to Clean Energy. Visual Capitalist. https://www.visualcapitalist.com/6-ways-hydrogen-and-fuel-cells-can-help-transition-to-clean-energy/

M., S. (2020, 7 febrero). España podría convertirse en el gran exportador de hidrógeno renovable para el norte de Europa. abc. https://www.abc.es/motor/reportajes/abci-espana-podria-convertirse-gran-exportador-hidrogeno-renovable-para-norte-europa-202002070221\_noticia.html

Ministerio para la Transición Ecológica y el Reto Demográfico. (2020, octubre). *Hoja de ruta del hidrógeno: una apuesta por el hidrógeno renovable*. miteco.gob.es. https://www.miteco.gob.es/es/ministerio/hoja-de-ruta-del-hidrogeno-renovable.aspx

Perejón, A. E., & Martínez, D. T. S. (2020, diciembre 8). *La hoja de ruta del hidrógeno en España: ¿podemos cumplir los objetivos?* The Conversation. <a href="https://theconversation.com/la-hoja-de-ruta-del-hidrogeno-en-espana-podemos-cumplir-los-objetivos-150469">https://theconversation.com/la-hoja-de-ruta-del-hidrogeno-en-espana-podemos-cumplir-los-objetivos-150469</a>

Pfeifer, S. (2021, 19 marzo). *Hydrogen: can the lightest gas turn heavy industry green?* Financial Times. https://www.ft.com/content/7a83309e-1dbd-4651-a6fc-52f9be72def7

Raso, C. (2020, 25 junio). *España se suma a la fiebre del hidrógeno.* elEconomista.es. https://www.eleconomista.es/energia/noticias/10627911/06/20/Espana-se-suma-a-la-fiebre-del-hidrogeno.html

Roca, R. (2020, 6 octubre). Estos son los proyectos de hidrógeno verde más significativos que se están haciendo en España. El periódico de la energía. <a href="https://elperiodicodelaenergia.com/estos-son-los-proyectos-de-hidrogeno-verde-mas-significativos-que-se-estan-haciendo-en-espana/">https://elperiodicodelaenergia.com/estos-son-los-proyectos-de-hidrogeno-verde-mas-significativos-que-se-estan-haciendo-en-espana/</a>

SandriBarcelona, P. M. (2020, 27 septiembre). *El hidrógeno creará un valor añadido de 23.600 millones en España en el 2030.* La Vanguardia.

https://www.lavanguardia.com/economia/20200927/483689810156/transicion-energetica-hidrogeno-valor-anadido-espana.html

Zúñiga, E. D. (2020, 12 noviembre). *Las empresas de hidrógeno que cotizan en bolsa*. IG. https://www.ig.com/es/estrategias-de-trading/las-empresas-de-hidrogeno-que-cotizan-en-bolsa-201112

Zuriaga, I. G. (2020, 19 octubre). *La oportunidad de la economía del hidrógeno*. Cinco Días. https://cincodias.elpais.com/cincodias/2020/10/16/opinion/1602859084\_295346.html

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