



The Hydrogen Trail

An overview of hydrogen development and its impacts in the Spanish state and Chile

Authors:

Josep Nualart Corpas and Marina Gros Breto

Content revision:

Marta Pérez, Nicola Scherer,
Júlia Martí, Clàudia Custodio,
Javier Andaluz, Elena Gerebizza,
María Paz Aedo, Natalia Lueje

**Correction and translation
from Spanish:**

Aula d'Idiomes, SCCL

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Lucía Armijo

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Accés vehicles
Acceso vehículos



Cofinanciado por el Mecanismo
«Conectar Europa» de la Unión Europea

Introduction

Against the backdrop of the current climate crisis, there has been a drive on the part of institutional actors towards an energy transition, in order to reduce CO₂ emissions and, as a consequence, fulfil the aims of the Paris Agreement. This transition can be characterised by a commitment to the decarbonisation of the economy. This translates into the electrification of productive sectors through the implementation of new forms of renewable energy, such as solar and wind power, on a large scale. However, not all sectors are electrifiable, especially those which are significantly energy-intensive, and whose demands cannot be easily met through solar and wind power. This is where hydrogen comes into play as a necessary and essential element for the energy transition.

Hydrogen is an energy vector that has been used since the beginning of the 20th century across a range of industrial sectors, including refining and soil fertilisation. The production of hydrogen has, until now, relied on fossil fuels, something which is incompatible with current proposals for energy transition. As such, efforts are being concentrated on producing it using renewable energy and low-emission processes. Notably, there is an interest in maintaining the sectors and uses that hydrogen has traditionally been provided for, without reevaluating their necessity or their adaptability to meeting the challenges of the climate crisis affecting us.

In practice, the energy transition currently on the table is being spearheaded by the countries of the Global North. These are the very same countries which have historically had the highest energy consumption, and are there-

fore more dependent on fossil fuels. The case of hydrogen is similar, insofar as the European Union is set to become the region with the highest consumption of this energy vector in 2030.

This report aims to provide an overview of the development of hydrogen, focusing particularly on the European Union and the Spanish state. Its analysis focuses on the hydrogen market, the geopolitics implicit in agreements between countries and regions, the financing of hydrogen projects, and the impact of these projects on the ground in both the Global North and the Global South.

The first step in this analysis has been to appraise the state of the hydrogen market and the national and regional strategies for the development of this energy vector around the world. The range of proposals which constitute the regulatory framework concerning hydrogen and the corporate interests behind its development also fall within the scope of this report.

Geopolitics is an indelible part of the energy agreements that are made between different countries. The third section of this report considers the European Union's strategy for hydrogen supply via both domestic production and importations from third countries. In the case of imports, there is an interest in establishing new relationships – as well as consolidating existing ones – with countries of the Global South, reproducing the neocolonial practices that have historically underpinned fossil fuel supply.

Public financing is one of the key elements behind energy developments, enabling their construction and reducing the risks for the private companies behind them. A range of institutional bodies have developed funding schemes for hydrogen projects. This report studies those developed by the European Union and identifies the projects that stand to benefit, as well as the companies behind them and the money they are set to receive.

Last but not least, the negative consequences that green hydrogen projects can cause on the ground are analysed from an ecofeminist perspective. Current projects are either small-scale or in a pilot phase, making it difficult to determine the extent of the impact of large-scale projects. Social and gender impacts, those related to water consumption and renewable energy, and material and climatic repercussions are all considered as part of this analysis, the result of fieldwork undertaken by the ODG in northern Chile in November 2022 and the ODG and Ecologists in Action in the Spanish state in December 2023.

1

What is hydrogen?



Hydrogen is an energy vector rather than a resource. This means that a primary source of energy is needed to generate it. It allows us to store energy, like a battery. Depending on the primary energy source used, and the form of production, it can be designated with a colour according to what is known as the hydrogen rainbow (see Figure 1).

Currently, more than 99% of the hydrogen we use comes from fossil fuel sources (such as oil, gas or coal derivatives), while less than 1% comes from renewable energy. Blue and green hydrogens are expected to dominate in the coming years. Blue hydrogen is obtained through a process of reforming fossil gas, just like grey hydrogen. The difference is that, in the case of blue hydrogen, Carbon Capture, Utilisation and Storage (CCUS) technology is used to obtain the CO₂ produced. Green hydrogen is generated through electrolysis, a process which involves separating hydrogen from the oxygen present in water molecules by means of an electric current.

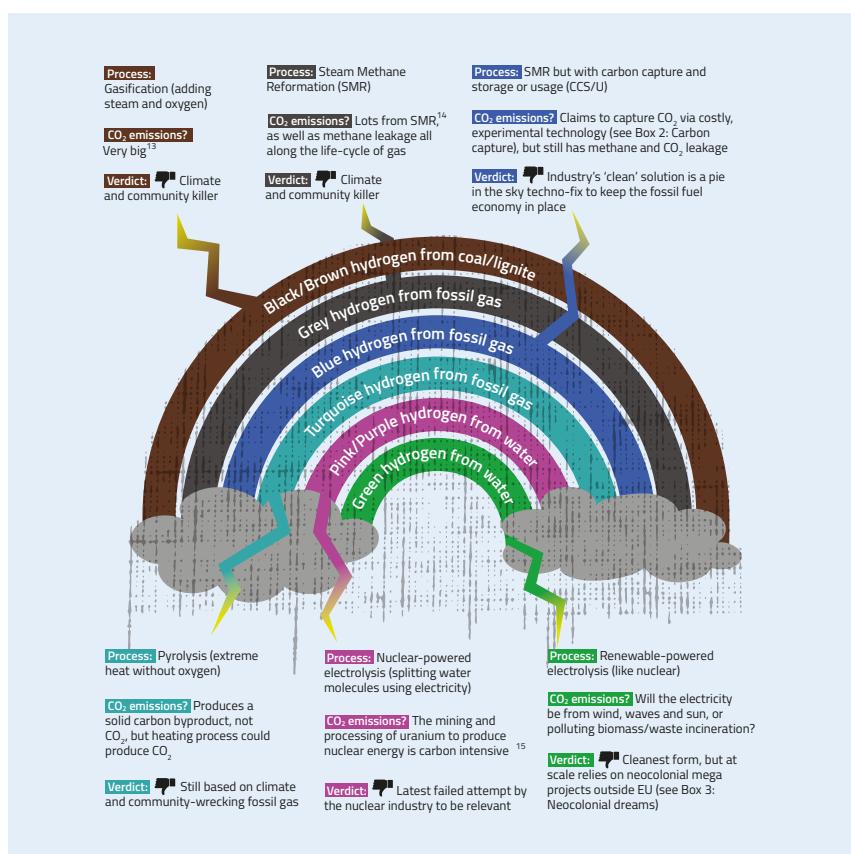
Additional categories have been created to arrange the different types of hydrogen which exist. Low-emission hydrogen and renewable hydrogen are the most widely used. Low-emission hydrogen – used as a standard by the International Energy Agency (IEA) – brings together green and blue hydrogen. Renewable hydrogen refers to green hydrogen and hydrogen obtained through the reforming of biogas produced from biomass. The Eu-

ropean Union refers to both two categories in its delegated acts¹.

However, there is also another type of hydrogen whose colour does not depend on the energy used to generate it. This is golden hydrogen – also known as white or natural – which emerges from geological processes and is found in the subsoil. This is obtained through extraction, as per fossil gas. This represents a paradigmatic change in terms of hydrogen as a concept, insofar as this type can act not just as an energy vector, but also a resource.

Figure 1:
HYDROGEN RAINBOW.

Source: Food and Water Action Europe, Corporate Europe Observatory and Re:Common



1 European Parliament – EU rules for renewable hydrogen: [https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/747085/EPRS_BRI\(2023\)747085_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/747085/EPRS_BRI(2023)747085_EN.pdf)

2 The hydrogen market



2.1 Hydrogen uses and transport

The development of the hydrogen market shares similarities with that of fossil gas, in that it operates more according to regional configurations than global ones. Proof of this is that Hydrix², the first reference index created for hydrogen³, operates at a European and not a global level. This could enable the creation of a single market for hydrogen in Europe, given the large number of production and transport projects that have been proposed on the continent. The Spanish state also plans to create its own index⁴.

Hydrogen is used in the production of fertilisers, chemicals and steel, and in petroleum refining. In these sectors, hydrogen has traditionally been used either as a raw material or as an indispensable element in the manufacturing process. While 99% of hydrogen is currently produced using fossil fuels – in the main, grey hydrogen – the need to reduce greenhouse gas emissions has led to a shift towards its replacement with green hydrogen.

² A reference index for the energy market serves to determine the price of a resource or product for sale. Price updates can be made at a variety of stages: on the spot, hourly or daily.

³ El Economista - "La mayor bolsa de energía europea lanza Hydrix, el primer índice mundial de hidrógeno verde" (24/05/2023); <https://www.eleconomista.es/energia/noticias/12290515/05/23/la-mayor-bolsa-de-energia-europea-lanza-hydrix-el-primer-indice-mundial-de-hidrogeno-verde.html>

⁴ El Economista - "España contará con su propio índice de precios para el hidrógeno" (31/01/2024); www.eleconomista.es/energia/noticias/12650974/01/24/espana-contara-con-su-propio-indice-de-precios-para-el-hidrogeno.html

In addition, new sectors and processes have emerged in which hydrogen could be used instead of fossil fuels. These include transport, the steel industry, the storage and generation of electrical energy and the production of fuels derived from hydrogen, such as ammonia and synthetic hydrocarbons. The International Energy Agency (IEA) stated in its *Global Hydrogen Review 2023*⁵ that these applications will have a very small role.

It should be noted that the IEA review was produced by the Clean Energy Ministerial Initiative⁶, a platform for the promotion of a clean energy-based economy. It is made up of 50 countries from different continents, especially the Global North. One of its lines of work is hydrogen⁷.

There are two ways to transport hydrogen: via a hydproduct⁸ or by boat. Hydrogen is held in a gaseous state and transported by hydproduct, while there are different options for its transport by boat. Each option has its pros and cons; however, some are more technologically advanced than others, and provide greater security in terms of the development of the hydrogen market.

One option involves transporting hydrogen in a liquid state to reduce its volume and, therefore, enable its transport in larger quantities. However, very low temperatures are required to maintain it in a liquid state (-253 °C), and it thus entails high energy expenditure. The other options are chemical and organic compounds that use hydrogen as a feedstock, such as methanol and Liquid Organic Hydrogen Carriers (LOHCs), synthetic hydrocarbons and ammonia. Transporting hydrogen through these products/vectors can benefit the sectors that will end up consuming them, as they are raw materials and elements that are used in fertiliser production processes, refining, steel production and metallurgy.

In the case of LOHCs and ammonia, the technology required to transport them by boat has existed for decades, thanks to earlier market development within the sectors that use them. Consequently, many of the hydrogen export projects proposed for 2030 and 2040 plan for it to be transported via ammonia, LOHCs and synthetic hydrocarbons (see Figure 2).

⁵ International Energy Agency – Global Hydrogen Review 2023:
<https://www.iea.org/reports/global-hydrogen-review-2023#overview>

⁶ Clean Energy Ministerial:
<https://www.cleanenergyministerial.org/initiatives-campaigns/hydrogen-initiative/?cn-reloaded=1>

⁷ Clean Energy Ministerial – CEM member participation:
<https://www.cleanenergyministerial.org/content/uploads/2023/04/2023-march-matrix-.pdf>

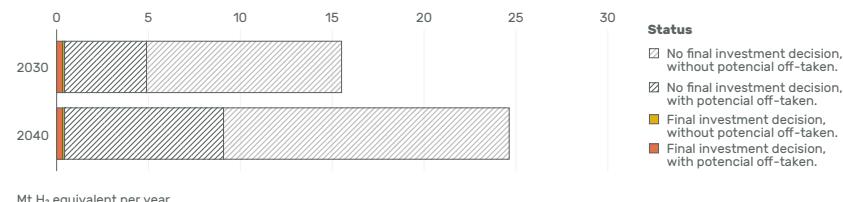
⁸ A hydproduct is a pipeline that allows the transport of hydrogen in its gaseous state. Currently, hydproducts are used to transport hydrogen from production points to consumption points, mostly located in industrial complexes and areas. The distance they cover is usually a few hundred kilometres.

Figure 2:

LOW-EMISSION HYDROGEN TRADING ACCORDING TO PROJECT DEVELOPMENT PHASE AND CHEMICAL OR ORGANIC COMPOUND, 2030 AND 2040.

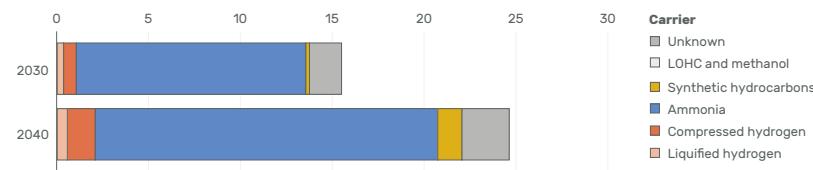
Source: International Energy Agency.

BY STATUS



Mt H₂ equivalent per year

BY CARRIER



Mt H₂ equivalent per year

IEA. CC BY 4.0.

One of the indicators that tells us that the hydrogen market is at an early stage of development is that existing production and transport projects in different parts of the world are small-scale or at the pilot phase. The majority of low-emission hydrogen production projects⁹ announced for 2030 remain at the feasibility study (48%) or early development phases (46%). Only 6% of projects are operational or have investment agreements for their construction and start-up.

⁹ In the regulations derived from the delegated acts corresponding to hydrogen, blue and green are defined as low-emission hydrogens. See description in the section "What is hydrogen?" [https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/747085/EPRS_BRI\(2023\)747085_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/747085/EPRS_BRI(2023)747085_EN.pdf)

2.2 National and regional strategies for hydrogen development around the world

By the end of 2023, 41 countries had approved strategic plans for hydrogen development¹⁰. Europe, Australia, New Zealand, Latin America, India, the United States and China are the regions and countries with the most significant low-emission hydrogen forecasts. It should be noted that the type of hydrogen involved varies by region and country. While Australia, New Zealand, Latin America and India are concentrating their efforts on green hydrogen, Europe and, above all, the United States are focused on blue hydrogen (see Figure 3). Taking into account the plans of the different countries and regions, Europe stands to become the region with the highest green hydrogen production capacity in the world by 2030. This represents something of a shift in comparison to recent years, since China – which has gone from having 10% to 50% electrolyser power in three years – is the largest producer of green hydrogen worldwide at present¹¹. It remains to be seen whether or not we are at the outset of a new race for energy hegemony – in this case, for hydrogen – between the world's major economic powers.

The distribution of electrolyzers across the European continent will not be uniform, with 55% set to be positioned in the Spanish state, Denmark, Germany and the Netherlands. Similar imbalances can be seen in other parts of the world. In the case of Latin America, Chile stands to become the country with the largest electrolyser capacity, housing 45% of the regional total.



Europe stands to become
the region with the
highest green hydrogen
production capacity in
the world by 2030.

¹⁰ International Energy Agency – Policies database:
<https://www.iea.org/policies?qs=hydro&technology%5B0%5D=Hydrogen>

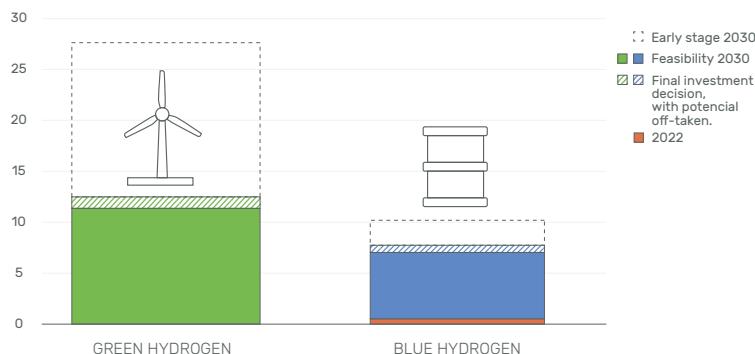
¹¹ International Energy Agency – Global Hydrogen Review 2023:
<https://www.iea.org/reports/global-hydrogen-review-2023#overview>

Figure 3:

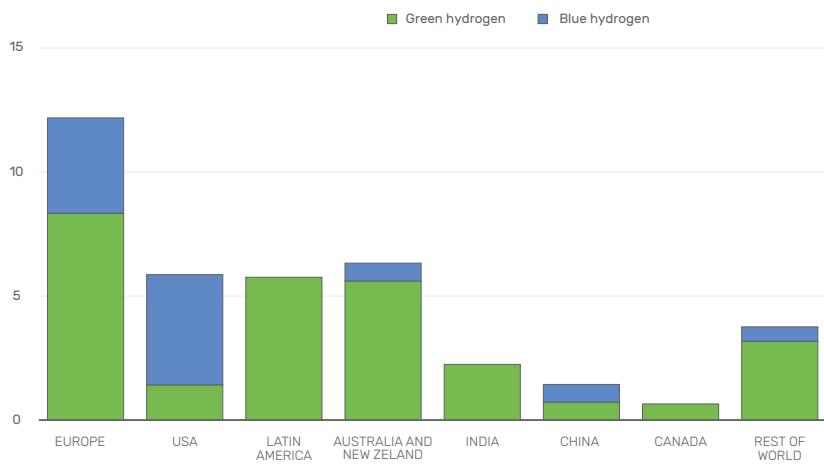
LOW-EMISSION HYDROGEN PRODUCTION BY 2030 ACCORDING TO TECHNOLOGY, MATURITY AND REGION, BASED ON ANNOUNCED PROJECTS AND THE INTERNATIONAL ENERGY AGENCY'S NET ZERO EMISSIONS SCENARIO FOR 2050.

Source: International Energy Agency.

MADURITY OF TECHNOLOGY BY 2030



LOW-EMISSION HYDROGEN PRODUCTION BY 2030



2.3 Hydrogen regulations

Hydrogen technology has been utilised since the early 20th century, but expansion of its use on a larger scale has only occurred in recent years, meaning that it remains at an early stage of development¹². In addition, the interests of the different stakeholders involved, such as governments and private energy and fossil fuel companies, have complicated the unification of regulatory concepts and categories. The use of the concepts “low-emission hydrogen” or “renewable hydrogen” across a range of institutional forecasts may lead to confusion as to how the market for this energy vector will develop, since they do not have the same implications.

For this reason, the European Clean Hydrogen Alliance¹³, a public-private partner body formed by the European Commission and the energy and fossil fuel companies promoting hydrogen, has established the following bases for the development of a global hydrogen market¹⁴:



1. creation of certifications and standardisation of concepts;
2. guarantee of origin and
3. rules to measure CO₂ emissions produced along the supply chain.

In addition, in the case of the regulatory frameworks developed by authorities, it is requested that they:

1. are clear, consistent and support the development of the hydrogen market;
2. set safety and quality standards and environmental regulations (including analysis of leaks in the life cycle over different periods of time) and
3. are harmonised ahead of implementation in the case of the European Union and Member States.

¹² International Energy Agency – Hydrogen:
<https://www.iea.org/energy-system/low-emission-fuels/hydrogen>

¹³ European Clean Hydrogen Alliance: https://single-market-economy.ec.europa.eu/industry/strategy/industrial-alliances/european-clean-hydrogen-alliance_en

¹⁴ European Clean Hydrogen Alliance – Learnbook: Hydrogen imports to the EU market:
https://www.entsog.eu/sites/default/files/2023-12/European%20Clean%20Hydrogen%20Alliance%20TD%20RT_Learnbook%20Hydrogen%20Imports%20to%20EU%20market_20231219.pdf

There are currently no approved standards or certificates to determine how hydrogen should be produced. This lack of standards is particularly serious where it concerns theoretically lower-impact forms such as low-emission and renewable hydrogen. The methodology being developed by the International Partnership for Hydrogen and Fuel Cells in the Economy will serve as the basis for the technical document expected to be issued by the International Organization for Standardization (ISO) at the end of 2024.

The Green Hydrogen Organisation has also made a proposal to standardise the production of green hydrogen¹⁵. It is the main lobbying body for green hydrogen worldwide, and is critical of the rest of the colours that this energy vector falls under. Its mission is to accelerate the development of green hydrogen as a means of decarbonising the sectors which use hydrogen, without questioning whether such uses are necessary or whether these sectors should reduce their consumption. Its advisory board includes presidents and directors of energy and hydrogen companies and associations, the financial sector, executives from the steel and transport sectors, and representatives of trade unions and international institutions such as the United Nations.

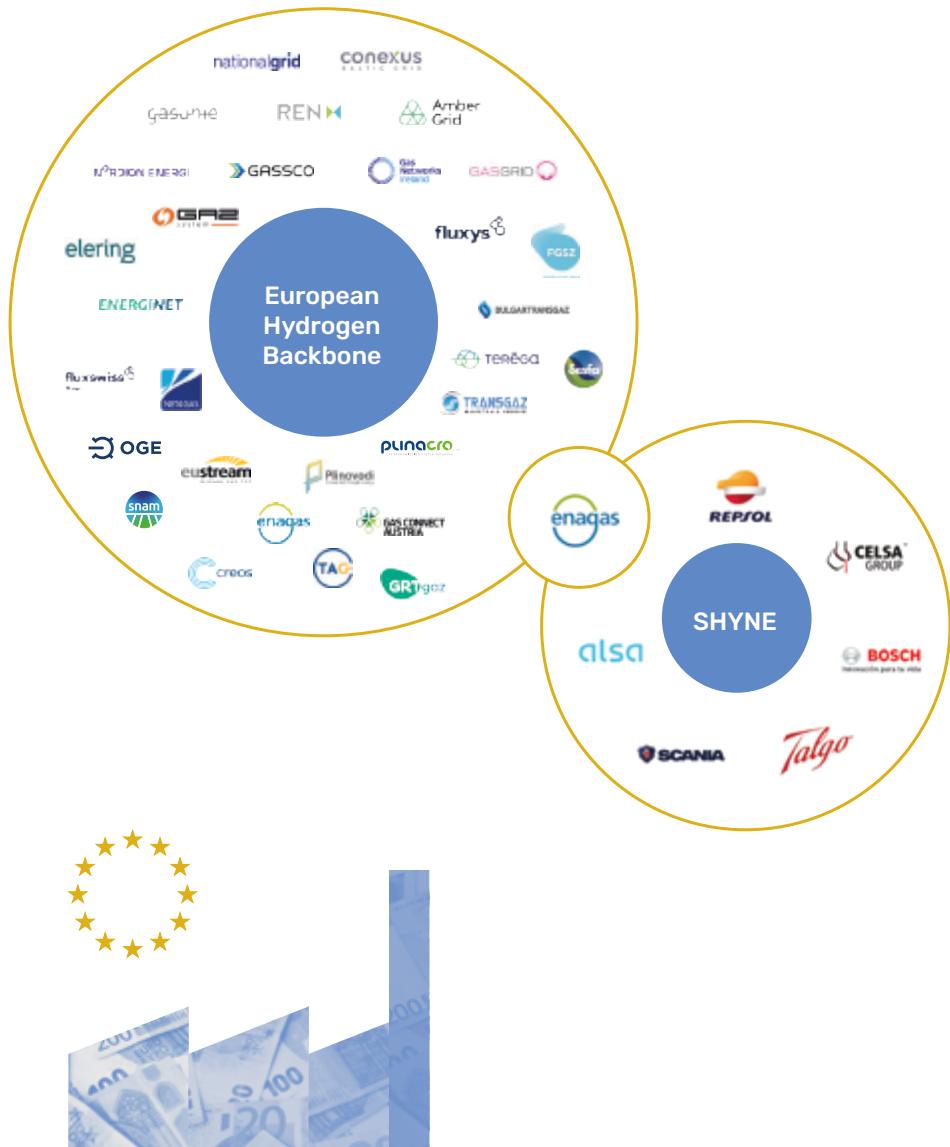
A range of different regulatory frameworks and certificates have been created by governmental organisations. The European Commission published two delegated acts in February 2023 to unify renewable hydrogen production criteria, both of which have since been approved by the European Parliament and Council.

These standards, subject to a transition phase until 2028, are based on three pillars:

1. the principle of additionality: renewable electricity must be generated within new or near-new facilities;
2. time correspondence: renewable electricity must correspond to the hydrogen produced by electrolyzers every hour and
3. geographical correspondence: renewable facilities and the corresponding electrolyser must be in the same location.

¹⁵ Green Hydrogen Organisation – Green Hydrogen Standard: <https://www.greenhydrogenstandard.org/>

2.4 Corporate interests in hydrogen development



Governments are not the only ones promoting hydrogen: it is also being promoted by the private sector, and particularly by major energy and fossil fuel companies. There are several production and transportation projects underway across the world. One of the most ambitious is the European Hydrogen Backbone¹⁶, an initiative of 32 European fossil gas transport operators that aims to weave a 53,000-kilometre network of hydroproducts across the continent by 2040. They propose that the majority (60%) of this be carried out using existing gas pipelines adapted to transport hydrogen, with the rest being newly constructed hydrogen pipelines. An investment of between 80 and 143 billion euros is expected.

In the Spanish state, Enagás, operator of the fossil gas transport network, presented its national Hydrogen Backbone plan in January 2023 to connect the points of production and consumption of green hydrogen within the country. By 2030, this core network is expected to encompass a total of 2,750 kilometres composed of two vertical axes, one in the east and one in the west of the Spanish state, with an additional horizontal axis connecting the country with Portugal and France¹⁷. This last axis is part of the H₂Med project¹⁸, one of the hydrogen corridors defined as a priority (See table 1: REPowerEU) in the REPowerEU plan which aims to supply energy to northern and central Europe and offset the cut-off of Russian gas supply after the Russian invasion of Ukraine, and is also included in the European Hydrogen Backbone project.

In terms of green hydrogen production, Repsol and six other companies lead the SHYNE (Spanish Hydrogen Network)¹⁹. It aims to install 2 GW of electrolyser capacity for hydrogen generation by 2030 to be used across a number of sectors such as land and rail transport and the metalworks and electronics industries. This consortium is made up of 22 companies and 11 associations, technology centres and universities. Endesa has also made its own drive towards green hydrogen, and has presented proposals for 23 projects which aim to replace grey hydrogen as a raw material in a range of industrial processes²⁰.

¹⁶ European Hydrogen Backbone: <https://ehb.eu/>

¹⁷ Hidrógeno verde - "H2Med y la Red Troncal Española del Hidrógeno se presentarán al Consejo y Parlamento Europeos para su aprobación a principios de 2024" (28/11/2023): <https://hidrogeno-verde.es/h2med-y-red-troncal-espanola-hidrogeno-pci/>

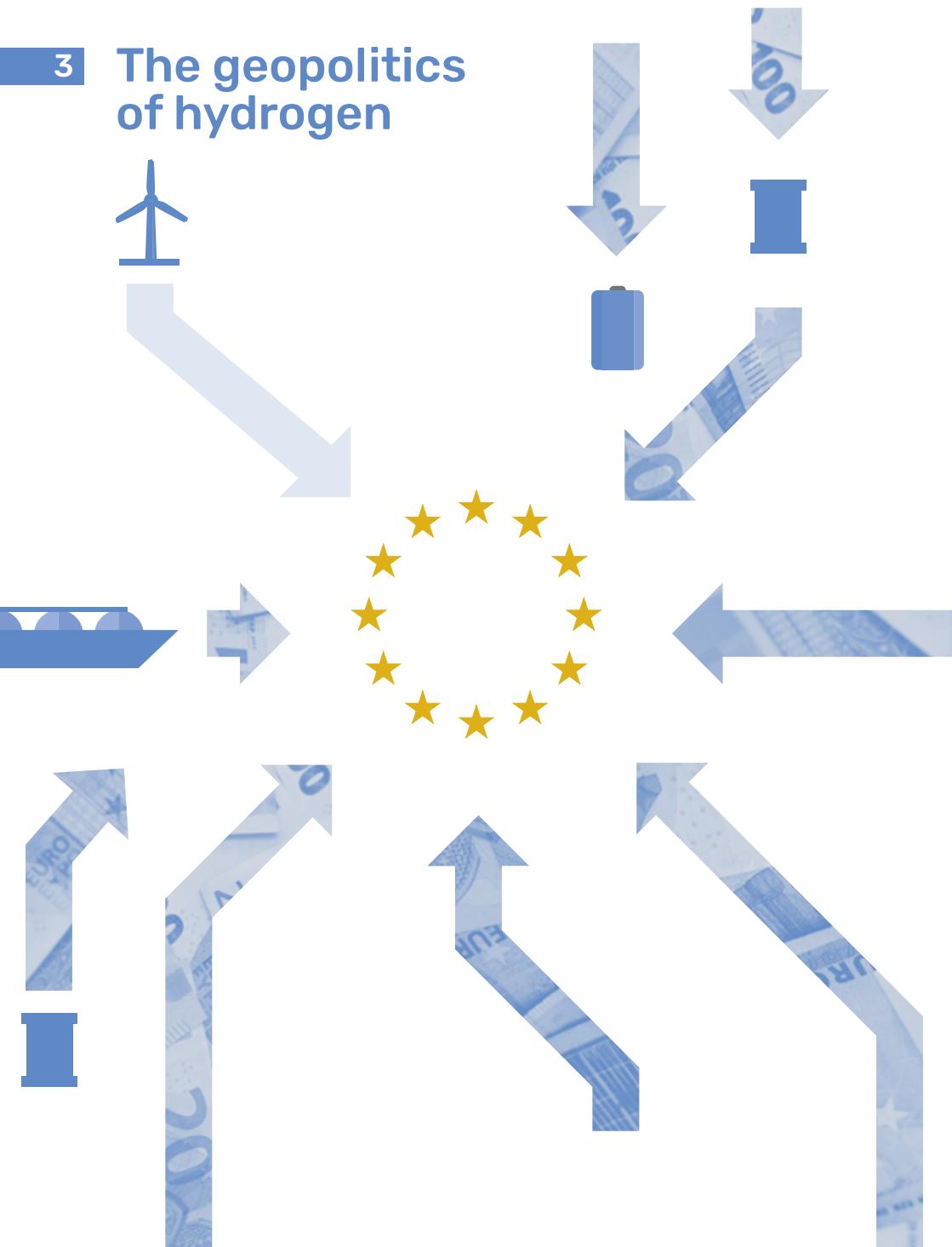
¹⁸ H2Med project: <https://h2medproject.com/the-h2med-project/>

¹⁹ REPSOL - "Nace SHYNE, el mayor consorcio en España para impulsar el hidrógeno renovable" (19/01/2022): <https://www.repsol.com/es/sala-de-prensa/noticias/prensa/2022/nace-shyne--el-mayor-consorcio-en-espana-para-impulsar-el-hidrogeno/index.cshml>

²⁰ Endesa - El hidrógeno renovable, la revolución del verde: <https://www.endesa.com/es/proyectos/todos-los-proyectos/transicion-energetica/hidrogeno-verde>

3

The geopolitics of hydrogen



3.1 Europe, in search of hydrogen across the planet

TABLE 1: REPowerEU

REPowerEU is a strategic plan set out by the European Union to move away from dependence on fossil fuels imported from Russia following the invasion of Ukraine.

In terms of hydrogen, it has doubled the amount that the European Union requires to meet its needs by 2030, from 10 to 20 million tonnes. This is to be imported from third countries, with a regulatory framework being created for the coordination of renewable hydrogen projects with countries in other parts of the world, in addition to incentivising the production of this energy vector inside and outside the continent²¹.

The REPowerEU strategy has also informed the delegated acts concerning hydrogen, with the incorporation of the principle of additionality designed to ensure the achievement of between 500 and 550 TWh of renewable energy production by 2030.

²¹

European Commission - "REPowerEU Plan (18/05/2022):
<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022SC0230>

Previously, the European Commission approved a hydrogen strategy in July 2020²², which set out the goal of generating 10 million tonnes of hydrogen within the European Union by 2030. Through the REPowerEU proposal, this amount has been doubled, with the intention of importing half from third countries.

Among the mechanisms designed to achieve this are the Green Hydrogen Partnerships, which promote the import of renewable hydrogen from third countries and encourage the decarbonisation and development of renewable energies in countries of origin, in addition to supporting the development of policies aligned with sustainability goals. This is complemented by the Global European Hydrogen Facility (see section 4.1).

In October 2022, the Hydrogen Council carried out an analysis of the hydrogen production potential of different regions of the planet by 2050 (see Figure 4). It categorised the economic profitability of exporting hydrogen according to production cost. If analysed from a European perspective, North Africa, North Asia, Russia, and China are the best-positioned potential exporters. This is mainly due to the cost of production, which depends – among other factors – on the type of hydrogen produced, the reserves or availability of energy resources and the degree of sophistication of the technology used. Another factor to be taken into account is transport, which is conditioned by the mode (pipeline or boat), the chemical or organic compound and the distance travelled.

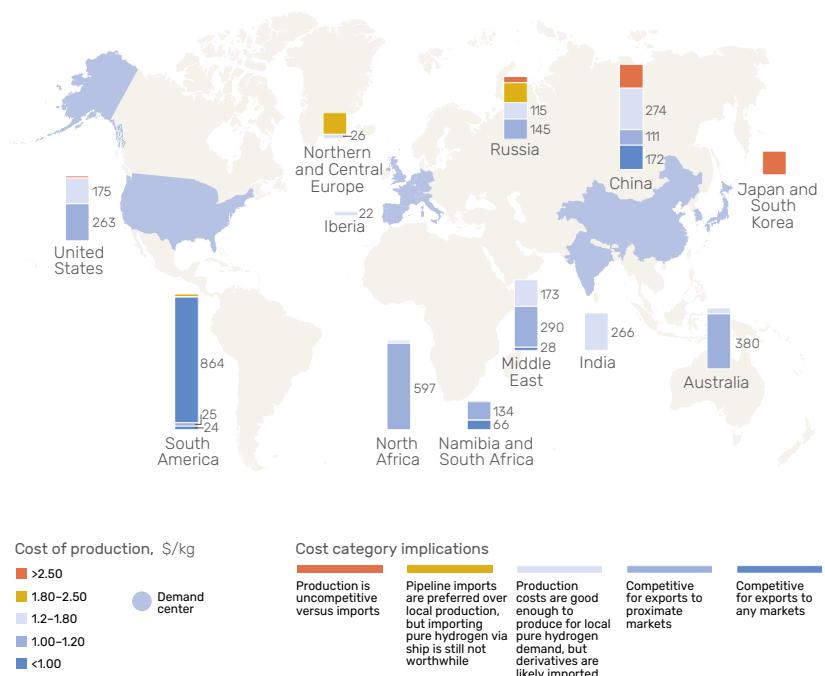
The above having been considered, North Asia is seen as having less potential to export to the European continent than North Africa, although it does offer good export conditions to nearby regions. Russia has less potential still, while China is the country best-positioned over all to export to any region worldwide. Although Latin America is the region with the greatest export potential, the combination of different factors in production costs means that it is only competitive as regards domestic demand.

22 European Commission - "A hydrogen strategy for a climate-neutral Europe (08/07/2020): <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0301>

Figure 4:

HYDROGEN PRODUCTION POTENTIAL BY 2050, ACCORDING TO MILLIONS OF TONNES PER YEAR, PRODUCTION COST AND CATEGORISATION FOR TRANSPORT.

Source: European Clean Hydrogen Alliance



The European Clean Hydrogen Alliance, in its report Learnbook: Hydrogen Imports to the EU Market²³, identified 17 possible candidate countries for hydrogen export to Europe. Of these countries, twelve have expressed their intention to do so by 2030, but only seven have indicated how much hydrogen they plan to produce (see table 1). In the case of Chile, Oman, Saudi Arabia, South Africa and the United States, the only option for transport is by boat. All of these countries plan to export hydrogen in the form of ammonia.

²³ European Clean Hydrogen Alliance – Learnbook: Hydrogen imports to the EU market: https://www.entsog.eu/sites/default/files/2023-12/European%20Clean%20Hydrogen%20Alliance%20TD%20RT_Learnbook%20Hydrogen%20Imports%20to%20EU%20market_20231219.pdf

Figure 5:

**ANALYSIS OF POTENTIAL HYDROGEN EXPORTERS TO THE EUROPEAN UNION
ACCORDING TO THE STRATEGIES ANNOUNCED FOR 2030.**

Source: European Clean Hydrogen Alliance



European Union imports from Algeria and the United Kingdom are expected to be made by hydrotuct, but they are not the only countries with the potential to do so. A range of hydrogen transport projects that have been publicly announced are now at the planning or the study phase (see table 2). Some of these include the reconversion of preexisting gas pipelines, as well as the construction of those which were planned but remain to be built,

such as the SouthH₂Corridor which will connect Algeria with Germany, crossing the Mediterranean Sea, Italy and Austria. This is one of the corridors set out in the REPowerEU plan to meet the needs of northern and central Europe in addition to H2Med, which seeks to expand the sourcing of hydrogen to Morocco. Although its capacity has yet to be specified, it is expected to become operational in 2040.

Domestic production of green hydrogen is the most economically viable option

Hydroproducts have also been planned to connect Europe with North Asia, such as the Gulf to Europe Pipeline, which will bring hydrogen from Qatar via Saudi Arabia and Egypt to Greece. The Southern Gas Corridor – a controversial gas pipeline that currently imports fossil gas from Azerbaijan, whose totalitarian government systematically violates human rights within the country's borders – currently transports fossil gas and blended hydro-gas from North Asia to Greece via Georgia and Turkey.

Table 1:

LIST OF PLANNED HYDROPRODUCTS AND ROUTES, IN ADDITION TO THOSE IN THE STUDY**PHASE, PUBLICLY ANNOUNCED TO IMPORT HYDROGEN INTO THE EUROPEAN UNION.**

Source: European Clean Hydrogen Alliance

ORIGIN -> EU ENTRY COUNTRY	NAME	CAPACITY	START-UP DATE
ALGERIA -> ITALY	SunsHyne	106 TWh (2030)	2030
ALGERIA -> ITALY	South H ₂ Corridor	363 TWh (2040) Import capacity up to 448 GWh/day Export capacity up to 200 GWh/day	2030
AZERBAIJAN -> EU	Southern Gas Corridor	H ₂ blend	2030s
CASPION -> EU	Green Energy Corridor	-	2030s
MOROCCO -> SPANISH STATE	H ₂ Med (extension)	-	~2040
NORWAY -> GERMANY	H ₂ pipeline (RWE, Equinor)	2GW (2030), 10 GW (2030)	2030
QATAR - SAUDI ARABIA -EGYPT -> GREECE	Gulf to Europe Pipeline	2,5 Mt/y	2030s
UK -> GERMANY	Hydrogen Backbone Link	35 TWh/y (2030), 94 TWh/y (2050)	Mid 2030
UKRAINE -> SLOVAKIA/HUNGARY	East H ₂ Corridor	12 TWh/y (2030), 100 TWh/y (2050)	2030

To carry out its hydrogen import plans, the EU will need to make investments in infrastructure²⁴. As the majority of hydrogen export projects are projected to take the form of ammonia, the main entry routes must be industrial ports. Currently, the Port of Rotterdam is involved in signing memoranda of understanding (MoUs) for supply from a range of countries. A number of liquefied fossil gas import plants are also planned, but must be built from scratch following the Russian invasion of Ukraine. These are concentrated in central and northern Europe (Belgium, the Netherlands, Germany and Poland) and in the west (France).

The European Clean Hydrogen Alliance report points to planning as key to ensuring the hydrogen market in the European Union reaches its full development potential in the long term. This is relevant given that 2030 looms over the strategies of governments and companies promoting hydrogen use. The objectives set are ambitious, and in many cases neither the technology nor the technique is sophisticated enough to achieve them. In addition, it would appear that it is often the companies and industrial sectors that have set the uses that should be made and the quantities that should be produced. One of the recommendations of the report is to focus on the reconversion of existing fossil transport infrastructures instead of the construction of new ones.

According to IEA analysis, domestic production of green hydrogen is the most economically viable option for the northwestern region of the European Union only when importation via hydroproducts from North Africa are taken out of the equation. This is because the costs of hydrogen production in North Africa are lower than domestic ones; additionally, the cost of transport via hydroproduct remains low if converted gas pipelines are used. It should be noted that the viability of this type of infrastructure is subject to technical and geopolitical challenges (see Figure 6). In the case of import from Latin America, this may be more economically profitable if it is imported in the form of ammonia and used as raw material in certain industries rather than being transformed back into hydrogen.

²⁴ Hydrogen Infrastructure Map: <https://www.h2inframap.eu/>.

Figure 6:

COST COMPARISON BETWEEN DOMESTIC PRODUCTION AND IMPORT OF HYDROGEN AND AMMONIA FOR THE NORTHWEST REGION OF THE EUROPEAN UNION.

Source: International Energy Agency.



3.2 How green hydrogen development reproduces neocolonial practices and leads to sacrifice zones



As noted above, the renewal of the European hydrogen strategy via the RepowerEU plan prioritises the importation of hydrogen from other parts of the world as a means of ending reliance on Russian fossil fuels as quickly as possible. It should be noted that neither the previous nor the current strategy call the existing uses of hydrogen into question and, as such, do not spell out the need to reduce consumption. The analysis carried out by the European Clean Hydrogen Alliance to identify the most economically competitive markets for the import of hydrogen and the Green Hydrogen Partnership and Global European Hydrogen Facility schemes created by the European Commission are clear examples of European institutions' neocolonial outlook.

There is every reason to believe that North Africa will become the main regional provider of the 10 million tonnes of hydrogen that the European Union expects to import from other parts of the world. The agreements reached by Germany with a number of countries²⁵, Italy's proposal to maintain Algeria as a strategic partner – importing hydrogen via the SouthH2Corridor – and the African Summit held in Rome at the end of January 2024, as well as the expansion of H2Med to Morocco by 2040,²⁶ are just a few examples.

In February 2024, the President of the European Commission, Ursula von der Leyen, and the President of the Spanish Government, Pedro Sánchez, visited Mauritania to show their interest in the country's mineral resources and renewable energy production²⁷. Sánchez pledged 200 million euros to support the development of hydrogen projects. Executives from the major Spanish companies involved in hydrogen production project development also participated, benefiting from the diplomatic nature of these visits.

²⁵ Corporate Europe Facility - Germany's great hydrogen race:
<https://corporateeurope.org/en/GermanysGreatHydrogenRace>

²⁶ El Periódico de la Energía - "La UE estudia extender el H2Med a Marruecos para 2040" (22/12/2023):
<https://elperiodicodelaenergia.com/la-ue-estudia-extender-el-h2med-a-marruecos-para-2040/>

²⁷ Hydrogen insight - "Spain offers up to €200m in financial support for green hydrogen projects in Mauritania" (09/02/2024): <https://www.hydrogeninsight.com/production/spain-offers-up-to-200m-in-financial-support-for-green-hydrogen-projects-in-mauritania/2-1-1596527>



The ample availability of renewable resources such as solar power in Mauritania and its large tracts of desert land provide favourable conditions for large-scale green hydrogen production. This, together with the fact that it is an impoverished country rich in energy and mineral resources, has led to interest from foreign energy companies, who have put forward proposals for projects worth tens of billions of euros.

Despite its plentiful renewable resources, it remains to be seen whether the desired quantities can be produced in such an arid country with low water availability, another essential element for the production of green hydrogen. In this regard, there are certain similarities with the Antofagasta region in northern Chile. Being one of the driest regions in the world, thermoelectric desalination plants are scheduled to be used for the production of green hydrogen (see section 5.2).

Multilateral banks have set up schemes to finance hydrogen projects in “emerging or developing” countries²⁸. The European Investment Bank (EIB) offers the Global Gateway, while the World Bank has created the Hydrogen for Development Partnership (H4D)²⁹. These schemes are intended more to finance feasibility studies, training and support for project developers than technical operations or direct participation in projects. The EIB has allocated 1 billion euros for hydrogen projects in Brazil, 1 billion more for India and 500 million for Namibia.

²⁸ Term used by the authorities.

²⁹ World Bank – “World Bank Group Announces International Low-Carbon Hydrogen Partnership”: <https://www.worldbank.org/en/news/press-release/2022/11/15/hydrogen-for-development-partnership-h4d-launch>

4

Financing hydrogen



Financing mechanisms

Grants and guarantees

Mechanisms chosen by the EU



Important Projects of Common European Interest (IPCEI)

Projects of Common Interest (PCI)

Global European Hydrogen facility

Next Generation EU

Spanish state

↳ Renewable Energies, Renewable Hydrogen and Storage PERTE

↳ Industrial decarbonisation PERTE

Bids and tenders

European Hydrogen Bank

Tax credits

Contracts for difference

4.1 Finance and aid for hydrogen projects

In the Global Hydrogen Review 2023 report, the IEA set out four mechanisms for financing and providing aid to support national and regional strategies to reduce investment risks in hydrogen projects: 1) Grants and guarantees; 2) Bids and tenders; 3) Tax credits and 4) Contracts for difference.

The majority of these are or have been used in the development of other strategic sectors and technologies, while contracts for difference represent a more novel approach. The purpose of this particular mechanism is to equalise – using public money to make up the difference – the price of green hydrogen production with that of fossil hydrogen, which is currently cheaper due to the maturity of the technology involved.

In the case of the European Union, the finance and aid available for hydrogen projects continues to follow the existing guarantees-based model³⁰. The logic is that guarantees reduce the risks for private investment insofar as that, in the event that a project goes undeveloped or the sector does not expand as expected, public institutions act as guarantors to cover the costs. This provides an incentive for private companies to invest in productive and/or strategic sectors. The only European scheme that does not follow this model are the NextGenerationEU funds, through which beneficiary projects receive grants or loans.

The most notable financing and aid mechanisms made available by the European Union are:

³⁰ European Commission - About Connecting Europe Facility:
https://cinea.ec.europa.eu/programmes/connecting-europe-facility/about-connecting-europe-facility_en

European Hydrogen Bank³¹:

The European Hydrogen Bank is a finance scheme created by the European Commission in March 2023 to provide support for hydrogen production projects. It works through a reverse bidding system, that is, awards are granted to the project with the lowest budget, as long as it meets the European regulatory criteria for the production of renewable liquids and gases of non-biological origin³².

It has a budget of 3 billion euros, obtained through the Innovation Fund. Bidding was opened on 23 November 2023, with a budget of 800 million euros, and closed on 8 February 2024³³. A total of 132 bids were submitted³⁴. A second bidding period is expected to open in spring 2024 with an available budget of €2.2 billion. This scheme complements the Important Projects of Common European Interest (IPCEI).

Important Projects of Common European Interest³⁵:

The Important Projects of Common European Interest in Hydrogen is an initiative agreed upon by 22 EU Member States and Norway in December 2020 for the development of projects throughout the supply chain: renewable and low-emission hydrogen production, transport and distribution, storage and industrial applications. Its aim is to provide support for private-sector projects by avoiding the risks involved in investing in under-developed sectors and technologies such as hydrogen. Projects are approved and funded by Member States. This is one of the most controversial schemes in relation to free competition within the European Union, since selection by state governments could be considered state aid. As such, selected projects must comply with climate, environmental protection and energy guidelines³⁶ or the General Exemption Regulation or the General Exemption Regulation³⁷.

³¹ European Hydrogen Bank: https://energy.ec.europa.eu/topics/energy-systems-integration/hydrogen/european-hydrogen-bank_en

³² European Commission - "Delegated Regulation by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin" (10/02/2023): <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3A0J.L...2023.157.01.0011.01.ENG&toc=0...3AL%3A2023%3A157%3ATOC>

³³ European Commission - "Competitive bidding": <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3A0J.L...2023.157.01.0011.01.ENG&toc=0J%3AL%3A2023%3A157%3ATOC>

³⁴ LinkedIn - European Climate, Infrastructure and Environment Executive Agency (CINEA): <https://www.linkedin.com/feed/update/urn:li:activity:716168799431427685/>

³⁵ European Commission - Important Projects of Common European Interest: https://single-market-economy.ec.europa.eu/industry/strategy/hydrogen/ipceis-hydrogen_en

³⁶ European Commission – Legislation (Energy & Environment): https://competition-policy.ec.europa.eu/sectors/energy-environment/legislation_en

³⁷ European Commission – General Exemption Regulation: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02014R0651-20210801>

In total, this initiative has provided 17.5 billion euros of financing using public money through three tenders, with awards made in July³⁸ and September³⁹ 2022 and February 2024⁴⁰. In addition, 21.5 billion euros of private investment is expected.

List of Projects of Common/Mutual Interest (PCI/PMI list)⁴¹:

The list of Projects of Common/Mutual Interest is made up of energy transportation projects which are renewed every two years. Initially, fossil gas and electricity projects could be included, although the latest list has discarded fossil gas projects and opened up to hydrogen projects as well as those involving electrolyzers and smart grids for gas, electricity and CO₂.

The sixth PCI list is set for approval in 2024, and must be ratified by the European Parliament at the beginning of March. Two gas pipelines have been included: the Melita, which connects Malta and Italy, and the EastMed, which runs from Israel to Italy via Cyprus and Greece. Despite being a gas pipeline designed initially for transporting fossil gas, the project has been accepted because, in theory, it will be “hydrogen ready”; in other words, it is expected to be able to transport hydrogen without the need for any technical modification.

The financing scheme behind the project is the Connecting Europe Facility (CEF)⁴², which serves for the development of energy, transport and digital infrastructure. Its budget for 2021-2027 is 5.8 billion euros. Funding can also be obtained through the European Investment Bank's cross border infrastructure project programme⁴³, which between 2010 and 2022 provided 60 billion euros worth of investment.

³⁸ European Commission – State Aid: Commission approves up to €5.4 billion of public support by fifteen Member States for an Important Project of Common European Interest in the hydrogen technology value chain (15/07/2022): https://ec.europa.eu/commission/presscorner/detail/en/IP_22_4544

³⁹ European Commission – State Aid: Commission approves up to €5.2 billion of public support by thirteen Member States for the second Important Project of Common European Interest in the hydrogen value chain (21/09/2022): https://ec.europa.eu/commission/presscorner/detail/en/ip_22_5676

⁴⁰ European Commission – Commission approves up to €6.9 billion of State aid by seven Member States for the third Important Project of Common European Interest in the hydrogen value chain (15/02/2024): https://ec.europa.eu/commission/presscorner/detail/en/ip_24_789

⁴¹ European Commission – Projects of Common Interest: https://energy.ec.europa.eu/topics/infrastructure/projects-common-interest_en

⁴² European Commission – Funding for Projects of Common Interest: https://energy.ec.europa.eu/topics/infrastructure/projects-common-interest/funding-projects-common-interest_en

⁴³ European Investment Bank – Cross-border Infrastructure Projects: https://www.eib.org/attachments/lucallii/20230107_cross_border_infrastructure_projects_en.pdf

Global European Hydrogen Facility:

The Global European Hydrogen Facility is a financial scheme designed to provide security to businesses for investment in the European Union and in countries which offer renewable hydrogen for import. It also has processes for verifying production standards and the use of hydrogen in the European Union. One of the challenges of the Global European Hydrogen Facility is maintaining consistency with the current operating regulations of the European market.

NEXT GENERATION EU:

In December 2022, the Spanish government submitted an addendum to the European Commission titled **“Plan de Recuperación y Resiliencia. España Puede”** seeking to raise 160 billion euros from NextGenerationEU European funds. These are public grants and loans to be spent over a period of between 3 and 7 years on projects for the modernisation of industry – mainly in digitalisation, the energy sector, the automotive sector and transport – in order to offer an “express” route to meeting the aim of a green and digital transition in the European economy. 84 billion euros are set to take the shape of loans that must be repaid to Brussels. Of the 76 billion euros in public subsidies, more than half will be delivered via PERTEs⁴⁴, which are large public-private partnerships or consortia led by major companies such as Repsol, Enagás and Seat. Energy transition plays a central role in these transition plans, especially following the Russian invasion of Ukraine and the need to end dependence on Russian fossil fuels as quickly as possible. The strategy on how to achieve this – and how to finance it – is written into the RePowerEU plan, entailing an “extra” chapter in national recovery and resilience plans.

In the Spanish state, several schemes have been created to finance hydrogen projects:

⁴⁴ ODG, OMAL, colectivo XXK and ESF – Los PERTE: How public investment undermines ecofeminist transition: <https://odg.cat/es/publicacion/los-perte-como-la-inversion-publica-socava-la-transicion-ecofeminista/>.

- **Renewable Energies, Renewable Hydrogen and Storage (ERHA) PERTE⁴⁵:**

With the second-largest budget of all PERTEs behind that of micro-chips, it offers 10.475 billion euros of sunk cost investment. Funding for hydrogen projects through this PERTE is provided in the form of both public tenders and direct allocation. Tenders are managed by the Institute for the Diversification and Saving of Energy (IDAE) which, to date, has launched seven tenders, two as part of the H₂ Pioneers programme⁴⁶ and five as part of the H₂ Value Chain programme⁴⁷. These tenders also extend to projects for design, innovative use and pilot tests in the production and industrial uses of hydrogen. Their total budget reaches more than 600 million euros, with 300 million going to the H₂ Pioneers programme, and the rest to the H₂ Value Chain programmes.

- **Industrial Decarbonisation PERTE⁴⁸:**

The Industrial Decarbonisation PERTE has a budget of 6.1 billion euros and will provide finance for hydrogen projects as part of transformative measures to decarbonise energy sources through the electrification of processes and the incorporation of hydrogen. Specifically, finance will be provided through a scheme linked to the IPCEI, with a budget of 450 million euros. Like the ERHA PERTE, funding will be awarded to projects through a range of schemes, including tenders and direct assignments. On 4 April 2023, 450 million euros were assigned directly to ArcelorMittal⁴⁹, although the development of this project remains in the air, with the developer demanding better conditions and guarantees from the government⁵⁰.

⁴⁵ Plan de Recuperación, Transformación y resiliencia – PERTE de energías renovables, hidrógeno renovable y almacenamiento: <https://planderecuperacion.gob.es/como-acceder-a-los-fondos/pertes/perte-de-energias-renovables-hidrogeno-renovable-y-almacenamiento>

⁴⁶ Instituto para la Diversificación y el Ahorro de Energía – Programa H2 Pioneros: <https://sede.idae.gob.es/lang/modulo/?refbol=tramites-servicios&refsec=programa-h2-pioneros>

⁴⁷ Instituto para la Diversificación y el Ahorro de Energía – Programas H2 Cadena de Valor: <https://sede.idae.gob.es/lang/modulo/?refbol=tramites-servicios&refsec=cadena-valor-hidrogeno-renovable>

⁴⁸ Plan de Recuperación, Transformación y resiliencia – PERTE de descarbonización industrial: <https://planderecuperacion.gob.es/como-acceder-a-los-fondos/pertes/perte-de-descarbonizacion-industrial>

⁴⁹ Boletín Oficial del Estado - Real Decreto 251/2023 por el que se regula la concesión directa de subvenciones a la empresa ArcelorMittal España S.A para la ejecución del proyecto Hidrógeno circular DRI" (05/04/2023): https://www.boe.es/diario_boe/txt.php?id=BOE-A-2023-8579

⁵⁰ La Nueva España - "Jarro de agua fría: las razones por las que Arcelor congela su planta de hidrógeno verde" (14/01/2024): <https://www.lne.es/economia/2024/01/14/jarro-agua-fria-razones-arcelor-96869946.html>

4.2 Level of investment, type of projects and companies that stand to benefit

A total of 35 projects from 15 Member States benefited from the first Important Projects of Common European Interest tender. In the Spanish state, four projects were approved, with a total investment of 74 million euros⁵¹. The projects chosen were H2B2 (€25 million), Nordex (€12 million), SENER (€10 million) and Iveco ES (€27 million). A second tender saw investment awarded to 35 projects from 13 Member States. In the Spanish state, the beneficiary companies were Petronor/Repsol, EDP, Iberdrola, Enel Green Power/Endesa and IAM Caecius.

The projects approved in the sixth list of Projects of Common/Mutual Interest stand to receive a total investment of more than 50 billion euros for development. When operating costs for the next 20 years are taken into consideration, the amount exceeds 100 billion euros. This is significant insofar as the costs of energy transport and distribution activities tend to be regulated and, therefore, paid through invoices or national budgets. In the case of the Spanish state, the main companies that stand to benefit are Enagás, Enagás Renovables and CEPSA.

A number of large energy and fossil fuel companies have benefited from the H2 Pioneers and H2 Value Chain programme tenders. Those which received the most funding were CEPSA, with 30 million euros, ENEL, Repsol and BP, with 15 million euros each, Iberdrola, with 9 million, and Enagás Renovables, with 4 million euros. It should be noted that many of these companies posted either record profits in 2022 or consistently high profits over the last five years as a consequence of the increase in energy prices. This being taken into account, the question therefore remains as to whether it is right that such companies receive public financing.

Among the beneficiaries, there are also limited companies created ad hoc for project development, limited companies in the energy sector and joint-stock companies in sectors that are difficult to decarbonise, and in which hydrogen could play a role in energy transition. Companies such as EDP, Clean Energy Venture S.L. and Industrias Químicas del Óxido de Etileno S.A. (Iqoxe) are among those involved in these enterprises.

⁵¹ Instituto para la Diversificación y el Ahorro de Energía – Concesión directa de subvenciones a los proyectos españoles por su participación en el Proyecto Importante de Interés Común Europeo de tecnología de hidrógeno: <https://sede.idae.gob.es/lang/modulo/?refbol=tramites-servicios&refsec=proyectos-es-hy2tech>

5 Impact of green hydrogen projects on the ground: Chile and the Spanish state



AREAS AND COMMUNITIES
AFFECTED BY GREEN HYDROGEN
PROJECTS IN CHILE AND THE
SPANISH STATE

Author: ODG

The extraction, transport and use of energy sources have historically led to serious environmental harm – pollution, deforestation and habitat destruction – as well as social effects such as the displacement of communities, armed conflicts and wars. The most widespread and profound consequence of this is climate change, with millions of people already at risk of its effects.

To date, the tangible effects of the development of the green hydrogen economy remain unknown, with the majority of green hydrogen projects still at the feasibility study phase. Only 6% of these projects are operational or have investment agreements for their construction and start-up (ver section 2.1). Nevertheless, reasonable conclusions can be drawn as to hydrogen development which aims to replace the uses of fossil fuels like-for-like without reflection or appraisal of the need for ecosocial transition. Insofar as this development is undertaken within the logical framework of a capitalist, neocolonial, patriarchal and extractivist socioeconomic system, its tools, trends and impacts are likely to be similar to those seen both in the past and in other sectors.

Similar conclusions can be drawn from current portfolio projects, based on previous experiences of fossil fuel development, mining and the implementation of renewable energy.

This section includes the results of field work carried out in the Spanish state and in Chile and Argentina, which represents a non-exhaustive yet qualitative sample of experiences on the ground. Over the course of November and December 2022, the Observatory of Debt in Globalisation (ODG) carried out fieldwork on the impacts related to lithium mining and green hydrogen in Chile and Argentina. Additionally, at the end of December 2023, the ODG and Ecologistas en Acción travelled through Catalonia, Aragon, the Basque Country and Cantabria to investigate a number of projects located along the first axis of the Spanish state's projected Hydrogen Backbone. Through these two trips, a series of experiences and interviews with groups and organisations have been gathered that attest to the same impacts, albeit in different forms, affecting each area and the people who live there.

In the case of Chile, in June 2019, the government presented its energy grid decarbonisation plan⁵² the implementation of which it sees as an opportunity to position the country as a leader in the “green transition” through the promotion of green hydrogen. In November 2020, it adopted the National

⁵² Library of the National Congress of Chile – Plan de descarbonización y Estrategia transición justa y sostenible: https://obtienearchivo.bcn.cl/obtienear-chivo?id=repositorio/10221/29300/1/BCN_Plan_de_descarbonizacion_y_Estrategia_de_transicionJusta_Dip.R.Gonzalez_2020_FINAL.pdf

Green Hydrogen Strategy⁵³, which identified the regions of Antofagasta in the north and Magallanes in the south of the country as the two poles of the nation's green hydrogen production.

At present, Chile obtains more than 47% of its electricity generation mix from renewable energy sources, and expects to reach 70% decarbonisation by 2030. The country also produces about 58,000 tonnes of hydrogen, mainly from industrial gas production to be used as a raw material.

The Piñera and Boric administrations both signed agreements with different countries for the export of green hydrogen. The most significant of these is the agreement with Germany, through which a cross-border working group has been created to identify viable green hydrogen projects in Chilean territory⁵⁴. The Chilean government and a range of companies also signed an agreement with their counterparts in the Netherlands⁵⁵ to boost the export of hydrogen to the port of Rotterdam. In addition, European companies such as Engie, Siemens and Enagás are involved in projects being developed in Chile, while RWE, Iberdrola, Enel and Snam have shown their interest⁵⁶.

In Catalonia and the rest of the Spanish state, major energy companies and fossil fuel lobbies have worked to ensure that hydrogen plays a central role in the energy transition, enabling them to benefit from the European Recovery, Transformation and Resilience funds, otherwise known as the NextGenerationEU package. The green-lighting of such projects represents a missed opportunity to assess which sectors are really necessary for society, and to what extent (in terms of degrowth/sufficiency). In both regions, there are notable problems related to the use of water and land for the implementation of renewable and hydrogen projects.

In the Spanish state, the Spanish Hydrogen Association has identified almost 140 hydrogen projects across the country⁵⁷. The purposes of these projects include production, distribution, combined use and provision for transport and industrial use, in addition to hydrogen valleys. The organi-

⁵³ Government of Chile – Estrategia Nacional de Hidrógeno Verde:
https://energia.gob.cl/sites/default/files/estrategia_nacional_de_hidrogeno_verde_-_chile.pdf

⁵⁴ Government of Chile – Chile y Alemania firman acuerdo para impulsar el hidrógeno verde en Chile:
<https://energia.gob.cl/noticias/nacional/chile-y-alemania-firman-acuerdo-para-impulsar-el-hidrogeno-verde>

⁵⁵ H2news – "Rotterdam 2023: Empresas chilenas y holandesas entregaron una declaración que impulsa la cadena de valor internacional de hidrógeno en la zona de la bahía de Mejillones" (08/05/2023).
https://h2news.cl/2023/05/08/empresas-chilenas-y-holandesas-trabajan-en-una-declaracion-que-impulsa-la-cadena-de-valor-internacional-de-hidrogeno-en-la-zona-de-la-bahia-de-mejillones/?utm_source=pocket_saves

⁵⁶ Government of Chile – El nuevo mapa del Hidrógeno Verde en Chile:
https://fch.cl/wp-content/uploads/2021/11/Ministerio-de-Energia_Mapa-Hidrogeno-Verde-en-Chile.pdf

⁵⁷ Asociación Española del Hidrógeno – Censo de proyectos de hidrógeno:
<https://www.aeh2.org/censo-de-proyectos-de-hidrogeno/>

sation also indicates the phase at which projects find themselves: the feasibility study, initial development, final investment decision or operational phase. Its map enables us to identify which hydrogen projects follow the route of section 1 of the Hydrogen Backbone, which stretches from Gijon to Cartagena, passing through Tarragona.

Other criteria used to select the projects visited as part of the field trip were:

1. those financed through NextGeneration funds or other public finance schemes;
2. those owned by large companies;
3. those linked to decarbonisation of industry, and
4. those which had faced opposition from the local population.

The Petrochemical Complex in Tarragona, the former Andorra thermal power plant in Teruel, the geological hydrogen deposit in Monzón, the Basque Hydrogen Corridor and the Besaya H₂ project in Torrelavega were all chosen on the basis of meeting at least some of the criteria defined above.

The authors wish to point out that, throughout the fieldwork carried out in the Spanish state, the overwhelmingly majority of those interviewed were men. While it is true that workers' representation in the sector is heavily masculinised, women are also involved, and it would have been ideal to provide them with a platform to voice their experiences. Nevertheless, despite our ecofeminist research methodology, limitations in terms of time, the preparation of the route and researchers' availability for fieldwork were key factors in not having been able to do so. In the evaluation of the work carried out, improvement measures have been noted for future research.



5.1 Social impact from an ecofeminist perspective

In order to avoid replicating bloated models based on financial speculation that increase the ecological and energy debt to the countries of the Global South, hydrogen production ought to respect the planet's environmental capacity and be carried out according to a model conducive to energy sovereignty. The emergence of green hydrogen infrastructure and regulation is a golden opportunity for the European Union to set degrowth in motion, based on the principles of equity and social justice. This new model could enable those living in Europe to enjoy a high standard of living while, at the same time, ensuring respect for the rest of the world and meeting the continent's historical responsibility for the extraction of resources from the regions of the Global South. Moreover, it could provide the resources and guarantees needed for the decarbonisation of the economy and, therefore, ensure that any loss of the negotiating muscle on the part of producer countries does not lead to internal conflict or a weakening of their standing.

This, however, is precisely the opposite of what the European Union is doing in relation to hydrogen. Instead, hydrogen is emerging as one of the elements that will mark international relations within the global energy transition (ver section 3). Hydrogen is an energy vector required by the countries of the Global North to enable the decarbonisation of the economy without sacrificing the mantra of growth. This situation may give rise to new forms of North-South energy neocolonialism.

IN CHILE, HYDROGEN PROJECTS ARE
DISTRIBUTED ALONG THE COAST,
CONCENTRATED IN THE NORTH,
IN ANTOFAGASTA, AND IN THE SOUTH,
IN MAGALLANES.

Author: ODG



Contemplating a fair energy transition model means respecting regional ecological limits and avoiding the plunder of resources and the draining of other lands. Such practices increase the energy and ecological debt that the Spanish state and Europe have with the communities and peoples of the Global South, whose per capita energy consumption is lower than those in the economies of the Global North. They also lead to significant economic, energy, climate and ecosocial debt within extractivist countries themselves.

The European Union has identified North Africa, North Asia, Russia and China as potential providers of the 10 million tonnes of hydrogen it needs to import in order to meet REPowerEU objects, although the countries that have shown the greatest willingness to export are located in North Africa, North Asia and Latin America. The remaining 10 million tonnes required will need to be produced in-house, leading to intra-European extractivism, such as is the case in the Spanish state and Italy. The Spanish government's commitment to becoming a green hydrogen hub for the rest of Europe sees the country scheduled to take on 20% of the intra-European production objectives set out in the REPowerEU plan (2 million tonnes of hydrogen per year), further encouraging large-scale infrastructural development for the transport of hydrogen. This embeds the prioritisation of the export market and the productive economy to the detriment of policies that take society's needs for quality of life and respect for the environment into account.

If such plans go ahead, they will represent the latest neocolonial and patriarchal appropriation of resources at a time when renewable resources should be used for local energy needs and achieving climate goals instead of merely enabling the EU to deliver on its climate strategy.

From an ecofeminist perspective, it is also worth raising the question of who controls the expertise and decision-making involved, given that tech and industrial sectors are still heavily masculinised environments. In 2022, only 16% of those employed in these sectors were women⁵⁸. Furthermore, women tend to occupy lower ranks within industries across the globe, with less involvement in decision-making and lower salaries. The pay gap is just one example of how power continues to be held in the hands of men. Inequality is not only evident in the distribution of labour; it can also be seen in each and every one of the phases of the industrial process. Although initiatives such as Women in Green Hydrogen⁵⁹ are interesting insofar as they afford visibility to women in the sector, without a profound rethink of how the

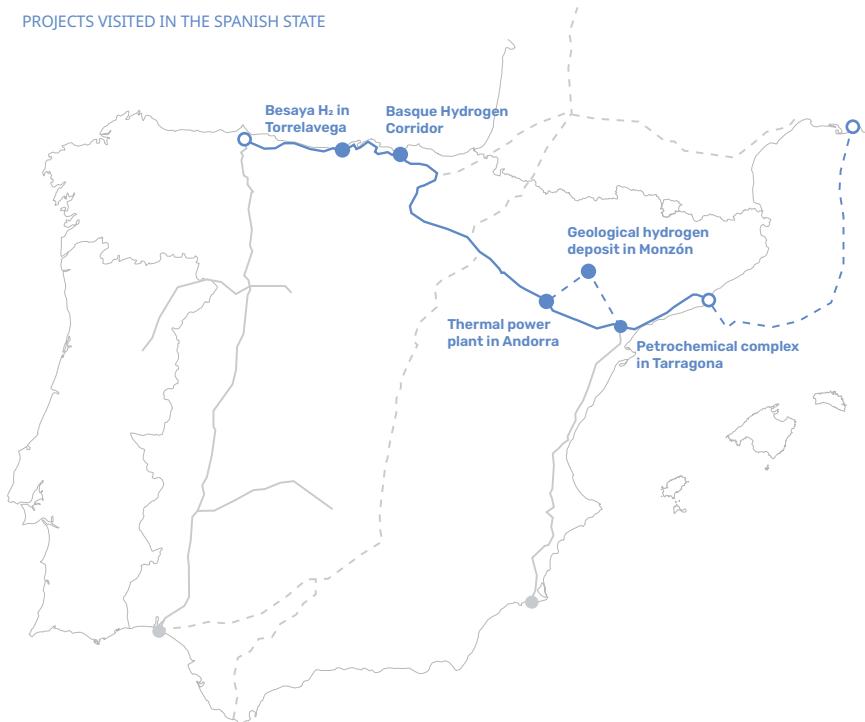
⁵⁸ Fundación La Caixa - "El ámbito de las STEM no atrae el talento femenino"
<https://elobservatoriosocial.fundacionlaica.org/es/-/el-ambito-de-las-stem-no-atrae-el-talento-femenino>

⁵⁹ Women in green hydrogen: <https://women-in-green-hydrogen.net>

industry operates – and in the absence of any reflection on who is able to make decisions, who is in charge of the major companies, and which sectors are set to supply energy – this may be little more than a purplewashing strategy⁶⁰.

It is worthy of note that, in the regions visited as part of the research undertaken in northern Chile and the Spanish state, many of the hydrogen production projects are planned in what are known as sacrifice zones. These areas have already suffered the serious social, economic and environmental industrial consequences of industrial operations, such as pollution, depopulation and despoliation.

PROJECTS VISITED IN THE SPANISH STATE



60 Purplewashing is a term used in feminist circles to refer to the variety of political and marketing strategies aimed at promoting institutions, countries, people, products or companies by appealing to their commitment to gender equality.

Tarragona Petrochemical Complex

IQOXE

Companies:

Enagás renovables, IQOXE,
Alter Enersun and Biotech

Sector:

Chemical industry

Status:

Planned

Budget:

€ 32.258.000

Aid:

€10.794.000€ from the H₂ Pioneers convo 1 programme

Description:

This project aims to decarbonise the industrial processes involved in the production of ethylene oxide and the IQOXE transport fleet in Tarragona. The green hydrogen produced (15MW) will be used primarily as a replacement for natural gas in existing industrial furnaces. A small part of the hydrogen will be used for transport purposes. The oxygen produced will also be used in the ethylene oxide plant.

T-HYNET

Companies:

Repsol, Enagás renovables,
IQOXE and Messer

Sector:

Chemical industry

Status:

Planned

Budget:

€ 320.000.000

Aid:

€62.000.000 via the European Innovation Fund programme

Description:

This project proposes, in its initial phase, the installation of 150MW electrolyzers, to be commissioned in the year 2026. In a second phase, from 2027 onwards, renewable hydrogen production capacity is to be increased to 1 GW. Green hydrogen would be used to replace grey hydrogen derived from fossil gas currently being used as raw material in local industry, industrial fuel and as part of the transport network.

One of the sacrifice zones visited is the Tarragona Petrochemical Complex, the largest industrial estate in southern Europe. The projects that are scheduled to be developed here form part of what has been dubbed the Catalan Hydrogen Valley.

Those interviewed – Ecologistes en Acció Tarragona and the Cel Net Platform – have raised concerns that this transition model has been planned without public debate regarding the need for the use of many of the petrochemical products in question. They also highlight the difficulty in addressing this problem and others in a context in which green hydrogen is seen as a positive force for reducing pollution, one of the most serious problems related to this industry at present.

The Cel Net Platform has alerted that, as a result of industrial secrecy, “it is impossible to know what is really being produced in the complex and for whom”. This has a particular impact in terms of pollution, since, as the activists say, for the purposes of regulating pollutants, the companies themselves communicate to the Government of Catalonia the chemicals which must be measured. “It has always been this way, the regulations are adapted to the needs of companies”, they point out.

In addition, Rafa Marrasé, journalist and environmental researcher, claims that “under the guise of hydrogen, polluting companies are ensuring they can continue to do business as before”. He details that hydrogen is being used as an excuse to extend the useful life of oil companies, and that its use will coexist with that of oil: “There is an attempt to combine two models, exacerbating the impacts in sacrifice zones such as the Camp de Tarragona has historically been.”

One of the characteristic features of this is that, after so many years of active promotion by companies, there is broad social acceptance of petrochemical activity in the area. Among other factors, this is the result of employment and economic dependence. Chemical employers are so deeply embedded in the fabric of the local area that a Repsol engagement officer was issued with an award by public authorities upon retirement. The same goes for the education sector, with the petrochemical industry offering vocational training courses and, in the case of Repsol, even holding a chair at the Rovira i Virgili University in Tarragona.



PETROCHEMICAL COMPLEX IN
TARRAGONA, VIEW FROM PUIGDELÍ.
Author: ODG

Andorra Green Hydrogen Project, Teruel

Proyecto de Hidrógeno Verde de Andorra

Company:

Endesa SA

Status:

Planned

Sector:

Green hydrogen production

Budget:

€ 38.500.000

Description:

Endesa S.A. is developing a renewable hydrogen production plant on the site of the former Andorra thermal power plant. The hydrogen it produces will be used in sectors in which emission reduction is challenging. The Andorra Green Hydrogen Project will consist of a 15 MW PEM (Proton Exchange Membrane) electrolyser forecast to produce approximately 1,450 tonnes of green hydrogen. This electrolyser will be directly connected to renewable generation plants, enabling it to provide power to the grid.

Catalina I Project

Company:

Copenhagen Infrastructure

Partners (CIP) and Enagás Renovable

Sector:

Green hydrogen production

Status:

Planned

Budget:

€ 2.000.000.000

Description:

The aim of the Catalina I Project includes the development of an industrial-scale renewable hydrogen plant in Andorra (Teruel province, Aragon) with a capacity of 2GW, which will enable the production of up to 336,000 tonnes of renewable hydrogen and 2,640,000 tonnes of oxygen per year, encouraging the development of new industrial processes and uses of hydrogen in Aragon. It will have a capacity of 500 MW its initial phase, with a further seven wind farms, seven solar plants with an installed power of 1.7 GW and the corresponding power lines scheduled to be put in place. The plant will enter into commercial operation in December 2027, with a maximum production of 84,000 tonnes of renewable hydrogen and 660,000 tonnes of oxygen per year.

A paradigmatic case is the just transition of the former thermal power plant located in Andorra (Teruel). To provide for the Mudejar node following the closure and dismantling of the plant, the Ministry for Ecological Transition and the Demographic Challenge announced a tender for the remaining 1,200 MW capacity. Endesa's project, included in the Just Transition Plan, was the winning bid. The company plans to build more than 1,800 MW of new capacity, two battery storage plants and a 15 MW electrolyser for green hydrogen production.

However, the construction of the electrolyser is postponed until 2030, following the president of Endesa's announcement that the company had ruled out investments in hydrogen since "at least for the time being" this technology "has not reached market maturity" and requires "many subsidies". The Plataforma a favor de los paisajes de Teruel has decried that "the hydrogen plant was one of the fundamental pillars on which the tender was won, given the promise of jobs it would provide". However, with the tender already won, it is no longer clear whether or not the project will be carried out.

The Catalina I green hydrogen production project has also been announced in the same region. As of the final production date of this report, it remains at the environmental approval stage. Copenhagen Infrastructure Partners (CIP) presented the Catalina project during the first grid access tender as a solution for the Mudejar node. While the bid ultimately lost out, the proposal was redesigned.

LOS ARCOS SOLAR PLANT,
ANDORRA.

Author: ODG



In less industrialised areas affected by depopulation, announcements of large projects are received with great interest, as they are accompanied by promises of investment and job opportunities. Critical groups say that such claims are commonplace, but that "the local population is very tired of promises". They claim that, "in the midst of subsidy fever, buccaneers have come from all over the world". European funds are not the only ones available: support is also provided by local authorities, who designate projects as being of public interest in order to facilitate their implementation. For example, the INAGA (Aragonese Institute of Environmental Management) has recently been reported for irregularities in the granting of permits for renewable projects⁶¹.

The Platform points out that, in order to combat depopulation, "investments are also needed in other sectors: in the primary sector we need to move towards agroecology, promote sustainable tourism and proper forest management". They demand social housing and redevelopment policies, as well as better medical services provision. Depopulation is an increasing threat due to the lack of basic medical and educational services and digital coverage, as well as low wages and lack of housing. In addition, they affirm that "society has to prioritise rail transport in order to connect the country and facilitate the transport of goods". In the past, there was a rail connection to the thermal power plant. As such, the Platform believe one potentially project of interest for the area would be a dry port.



SURROUNDINGS
OF THE FORMAL
THERMAL PLANT
IN ANDORRA.
Author: ODG

"Act local, think global. Whatever we do here, whatever it is and however small it is, it has to make sense on a global level. Any investment has to be made with durability and a vision of the future in mind."

Moisés Falo, Plataforma a favor de los paisajes de Teruel.

⁶¹ Arainfo - "Denuncian en juzgados y fiscalía "Irregularidades del INAGA y el MITECO en las autorizaciones de la líneas eléctricas asociadas a megacentrales renovables"" (22/01/2024): <https://arainfo.org/denuncian-en-los-juzgados-y-fiscalia-las-irregularidades-de-inaga-y-miteco-en-las-autorizaciones-de-las-lineas-electricas-asociadas-a-megacentrales-de-energias-renovables/>

Geological hydrogen deposit in Monzón

Company:

Helios Aragón S.L.

Sector:

White hydrogen extraction

Status:

Awaiting permits

Budget:

€ 900.000.000

Description:

Exploratory research project of hydrogen reserves, the initial presentation documents of which indicate the possibility of extracting around 55,000 tonnes per year over a period of "20 or 30 years" from 2028 onwards.

Also in Aragon, the town of Monzón (Huesca province) is facing a controversial project to tap into hydrogen reserves, the first of its kind in the Spanish state. This project would fall into the category known as "golden hydrogen" (see section 1). Spearheaded by Helios Aragón S.L., the project has been declared an investment of regional interest by the Government of Aragon. The company, which was formerly affiliated with BP (British Petroleum), intends to explore possible hydrogen and helium deposits, which could also enable a hydrogen storage facility in the future. The company has announced plans to install a gas pipeline to transfer hydrogen to the heavy industry (steel) complex in the north of the town. However, at present, no industry in the area uses hydrogen.

Ecologistas en Acción activists in the Cinca area are monitoring the project, which has caused concern among local residents. The environmental organisation argues that "at present, there are no legal grounds on which the project could operate, since the company does not hold the required exploration permits". The project is on hold pending the passing of European legislation on hydrogen – in what is known as the hydrogen and gas package – and its subsequent application via national regulations. It is believed that, if this legislation is passed, the project is very likely to receive public funds.

The organisation stated that, prior to the launch of this project and others like it, "we need to discuss the socioeconomic model we want in Monzón, and ask ourselves if we want to continue growing in population and what type of industry we want". Historically, local industry has caused significant pollution and environmental damage to the Cinca river. Activists have also decried the lack of investment in public services such as rail passenger transport, ambulances and a second high school for the town.

Basque Hydrogen Corridor

Petronor 2.5MW electrolyser (Muskiz, Vizcaya)

Company:

Petronor SA

Sector:

Refining

Status:

Built

Budget:

Confidential

Description:

Construction of a renewable hydrogen production plant using water electrolysis, with a capacity of 2.5 MW. It is forecast to produce 350 tonnes of renewable hydrogen for industrial use per year, primarily in refining, to replace the grey hydrogen used in oil desulphurisation. Transported via a Nortegas hydproduct, renewable hydrogen would also be used in the transport and distribution centre located in the Abanto Zierbana Technology Park, 1.5 kilometres from Muskiz, to power buses and heavy transport. The facilities are also scheduled to include pressurised hydrogen storage. In addition, renewable oxygen is forecast to be obtained as a by-product.

Bilbao Large Scale Electrolyzer 100MW (Bilbao)

Company:

Bay of Biscay Hydrogen S.L.
(Petronor Alba)

Sector:

Refining

Status:

Planned

Budget:

€ 200.000.000

Description:

Construction of a renewable hydrogen production plant using water electrolysis, with a capacity of approximately 2.5 MW. The plant will host a full range of facilities and associated systems required to be able to operate 24 hours a day. The facilities are also scheduled to include pressurised hydrogen storage. In addition, renewable oxygen is forecast to be obtained as a by-product.

As part of what is known as the Basque Hydrogen Corridor, which comprises more than 50 projects and 80 organisations, Repsol-Petronor has constructed a 2.5 MW electrolyser at the refinery located in the town of Muskiz in the Basque Country. This is the first phase of a larger 100 MW electrolyser, the Bay of Biscay Hydrogen project, which is set to receive funding from the European Commission through IPCEI funds. According to statements by the president of Repsol, both



INVERTIMOS EN FUTURO
NUEVOS PROYECTOS DE DESCARBONIZACIÓN:
TECNOLOGÍA Y MEDIO AMBIENTE

PETRONOR REFINERY CAR PARK,
IN MUSKIZ, BILBAO.

Author ODG

this project and the industrial-scale synthetic fuel production plant in the port of Bilbao are currently on hold, pending a more stable and “accommodating” regulatory framework.

The groups interviewed – including Ekologistak martxan, Greenpeace, the Gas No Es Solución network, the Gatika Interkonexio Elektrikorik Ez! platform, the Euskal Gune ecosocialist group, Juventud por el Clima/Fridays for future of Bilbao and the ESK trade union – demand better design of these projects in order to enable them to respond to local concerns. There is a significant spread of projects along the Basque Hydrogen Corridor centred primarily on the services of the Petronor refinery, one of the major economic motors in the region. This company stands to benefit significantly from investments, with funding enabling it to extend the life of its facilities without calling into question either their production model or their raison d'être. “Petronor, anticipating the decline of fossil fuels, is diversifying and creating small companies, using a strategy that it knows better than anyone in the world, which is to take money from the Basque Government”, according to Ekologistak martxan.

Activists lament that there is an evident lack of planning, and that the aid provided is aimed at propping up a large-scale model instead of small projects with greater social integration which are more able to focus on real needs. “It is a strategy that is based on creating hype to generate demand and then being able to market the product. The majority of projects, with the exception of Petronor, are small and missed out on European funding.” Activists highlight that this large-scale production and transport infrastructure model, of which the Basque Hydrogen Corridor is an example, is also making its way into the deployment of renewable energies and trans-European interconnection networks. “A more local-minded model would allow us to address local needs and would be much more efficient in terms of reducing energy losses”, according to proposals made by the Gatika Interkonexio Elektrikorik Ez! platform.

Besaya H₂ in Torrelavega

Company:

Copresa and RIC Energy

Sector:

Green hydrogen production

Status:

Planned

Budget:

€ 750.000.000 (initial phase)

Description:

Announced in May, the projected Besaya H₂ hydrogen plant is forecast to create around 250 jobs during its initial phase, with a capacity of 500 MW and investment of €850 million. It is scheduled to be developed in several phases, with construction of the plant to begin in 2025 and the aim of entering into operation by 2027.

In Cantabria, the announcements of major hydrogen production projects are being received with scepticism. Spearheaded by Copresa (a Cantabrian construction company) and RIC Energy (an energy company with a renewable energy and hydrogen portfolio in Castilla y León), the Besaya H₂ project has been presented as the largest hydrogen production project in Europe, with electrolyzers with an initial capacity of 500 MW due to come into operation in 2027. The plant is planned to be located on the land occupied by the now-closed Sniace factory in Torrelavega (Cantabria). The companies involved have purchased 70 hectares that will have to be decontaminated due to previous industrial use.

Ecologistas en Acción in Cantabria have been following these announcements and have highlighted that forecasts that it will be the largest investment in the history of Cantabria have been made without any project in place. At present, one of their main concerns is the lack of transparent and reliable information to enable in-depth analysis of the project.

Question marks exist as to where the renewable energy and water needed to power the electrolyser will come from. There is also doubt about where the hydrogen produced at the plant will ultimately end up, insofar as that industries in the surrounding area have no apparent need for it. Activists point to the Government of Cantabria's lack of an energy strategy: "Energy policy here is completely outsourced; a Cantabrian energy agency is needed to address the energy transition."

They also decry the lack of public investment in projects with low energy consumption. Another major problem in Cantabria is the ageing population and a lack of services, such as transport, which go unaddressed.

In Antofagasta, in northern Chile, the implementation of hydrogen projects in the local area is also set to have a serious social impact. It is one of the driest regions on the planet, in which part of the Atacama Desert is located, and, as such, offers little water availability. To obtain the water necessary for the production of green hydrogen, proposals have been made to set up desalination plants or use thermal power plants, which poses a threat to the Pueblo Chango, an indigenous group on Chile's northern coast. Their livelihood is based on small-scale fishing and the collection of algae and small molluscs at shallow depths.

Patricia Paez, president of the Fisher's Union of Tocopilla and leader of the Mujeres Changas association asserts that the green hydrogen industry has come to the area to stay. She bemoans the impact it will have on the local area's resources, way of life and health as a result of pollution. Shellfish are already contaminated as a result of the heavily salted water which, unfortunately, permeates the entire surrounding area.

In addition, indigenous communities feel abandoned by local authorities, and believe that they lack the necessary support to maintain the cold chain required to ensure products collected the same day or the day before reach the market. Marcelo Silva, regional councillor of the Pueblo Chango, fisherman and president of the Caleta Hornitos Fisher's Association laments the fact that, although his fishing area is located 17 kilometres from the first of the seven thermal power plants in Mejillones, he nevertheless has to depend on an oil-powered generator with limited operating hours. He has also spoken out against the malpractice of large energy companies that operate the thermal power plants and outwardly claim to enjoy a respectful relationship with local communities, despite this not being the case.

HORNITOS SMALL BAY, CHILE.

Author: ODG



5.2 Impact of water consumption

MEJILLONES INDUSTRIAL
DISTRICT, IN CHILE.

Author: ODG



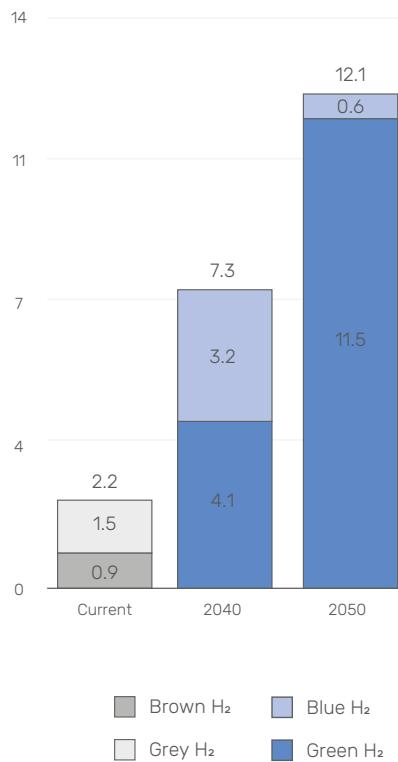
Water is one of the key inputs for green hydrogen production, along with renewable energy. According to the IRENA (International Renewable Energy Agency), freshwater withdrawals for global hydrogen production could triple by 2040, and multiply by six by 2050, in comparison to present values⁶².

Figure 7.

CURRENT AND FORECASTED FRESHWATER USE AND FOR GLOBAL HYDROGEN PRODUCTION (IRENA SCENARIO 1.5°C) ACCORDING TO PRODUCTION TYPE IN BILLIONS OF M³.

Source: IRENA.

Globally, this consumption is estimated to represent only 2.4% of that which is destined for the energy sector in 2050. However, at a local level, hydrogen projects consume significant volumes of water; as such, local and regional effects cannot be ignored when planning hydrogen development, especially in areas subject to chronic water stress. The large-scale transition to hydrogen has the potential to create competitive demand for water resources, particularly in parts of the world already facing significant water security challenges. It is estimated that more than 35% of the world's green and blue hydrogen production capacity (operational and planned) is located in high-water stress regions.



⁶² IRENA and Bluerisk (2023) - Water for hydrogen production, International Renewable Energy Agency, Bluerisk, Abu Dhabi, United Arab Emirates: https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Dec/IRENA_Bluerisk_Water_for_hydrogen_production_2023.pdf?rev=4b4a35632b6d48899eb02bc54fd1117f

TABLE 2: How much water is needed for hydrogen production?

At a chemical level, for every kilogramme of hydrogen produced, 9 kg of water is needed. In practice, the water consumption required is significantly higher, as electrolysis demands pure flows of demineralised water. Depending on input quality, between 30 and 40% of the water used could end up going to waste. Water is also required for cooling electrolyzers, in addition to other factors such as evaporation losses.

IRENA estimates that between 25.7 and 32.2 litres are needed for every kilogramme of hydrogen produced, depending on the electrolysis technology used. Estimates of the water needed to produce green hydrogen by the engineering consultancy firm GHD are higher still: consumption would sit within a range of 60 to 95 litres of water per kilogramme of hydrogen produced⁶³. In addition to the water needed to power electrolysis, this estimate includes the cooling and raw water treatment required to ensure the purity which electrolyzers demand, as well as the management of wastewater which is high in salt and other impurities. In terms of total water demand, the type of hydrogen carrier used (ammonia, liquefied hydrogen or Liquid Organic Hydrogen Carriers) must also be taken into account.

If the water used is brackish, seawater or industrial wastewater, the volume of raw water will increase, as will the effluent/saline output. The use of seawater is estimated to require between 2.5 and 5 times more raw water, and the capital cost and energy consumption of the desalination process are small compared to those of electrolyzers.

International agencies recommend seawater desalination as a sustainable source of water for large green hydrogen plants located on the coast and in water-scarce territories. However, the reality on the ground is different: the saline discharged by the desalination plants in the Antofagasta region has led to problems for the communities of the Pueblo Chango and their livelihoods.

Waste water from desalination which is dumped into the ocean can pose risks to aquatic life due to its high salt content and the temperature difference. If it is not diluted, it is heavier than seawater and tends to settle to the bottom, suffocating marine fauna.

⁶³ Coertzen, R.; Potts, K.; Brannock, M.; Dagg, B. Water for Hydrogen—GHD. Available online: https://www.ghd.com/en/_perspectives/water-for-hydrogen.aspx (accessed on 10 May 2023).

Impact on water consumption in Chile

According to Chile's long-term climate strategy plan, in the last 30 years the country has suffered a decrease in water availability of 20% in southern areas and 50% in north-central regions. This problem is related to increasing temperatures, which causes faster melting and reduces the water held in the country's glaciers. Rainfall patterns have also changed, making the situation worse⁶⁴.

This poses a challenge when it comes to sourcing local fresh water for hydrogen production without aggravating existing water stress. Of course, Chile has 6,437 km of coastline, offering the opportunity to use seawater electrolysis to reduce or eliminate the need for fresh water. Chile has the largest desalination system in Latin America, and the government has proposed policy measures to promote the use of desalinated water in agriculture and mining⁶⁵.

In the fieldwork carried out by the ODG in northern Chile in November 2022, we were able to gather testimony from a range of members of the Chango community, who detailed the impact that desalination plants have on their livelihoods. Among them was Raúl Riquelme, an underwater fisherman from the Punta Cuartel peninsula, who explained that divers on the seabed use their own biosensors measuring size, texture and presence, and detected that something bad was happening in the bay where he lives.

Other activities, such as trawling, only add to the problem. Marcelo Silva notes that marine stock such as molluscs or fish are no longer abundant nor can they be encountered at the depths at which they were found before. Fishermen now have to dive deeper and further out to find them, which carries risks to which they are not accustomed.

⁶⁴ Government of Chile – Estrategia climática de largo plazo de Chile: <https://cambioclimatico.mma.gob.cl/wp-content/uploads/2021/11/ECLP-LIVIANO.pdf>

⁶⁵ Herrera León, Sebastián & Cruz, Constanza & Kraslawski, Andrzej & Cisternas, Luis. (2019). Current situation and major challenges of desalination in Chile. Desalination and water treatment. 171. 93-104. 10.5004/dwt.2019.24863.

Impact of water consumption in the Spanish state

Although hydrogen production represents a small fraction of overall industrial water demand, Europe's ambition to grow and decarbonise its hydrogen sector means even greater competition for water. Demand must be properly managed, especially in regions already suffering from water stress or in times of drought.

According to the IRENA, more than 46% of all planned hydrogen projects in the Spanish state are to be located in areas likely to experience severe water shortages by 2040. Portugal and Italy have the highest percentages of projects located in areas with high or extremely high water stress (71% and 69 %, respectively). This suggests that hydrogen production in southern European countries is set to face a high degree of competition for water from other sectors.

The results shown in Table 3 are an estimation of possible water consumption arising from the range of strategies, plans and forecast activity in the Spanish state, applying the range proposed by the consultancy firm GHD (60 to 95 litres per kg of hydrogen).

Table 2.

**ESTIMATED WATER CONSUMPTION OF HYDROGEN PRODUCTION FORECAST
IN THE SPANISH STATE.**

Source: Authors' work, using IDAE data. In the absence of hydrogen production data in the Government forecasts (Hydrogen Roadmap 2020 and the PNIEC Review dated September 2023), approximate figures have been drawn from production figures in Enagás' forecasts as per planned electrolyser capacity. Likewise, water consumption has been estimated in the range of 60 to 95 l/kgHz, as per GHD range.

			Electrolyser capacity [GW]	Hydrogen production (Mt/year)	Estimated water consumption (hm ³)
2030	Government forecasts	Hydrogen Roadmap (2020)	4	0,6	36 - 57
		PNIEC review September 2023	11	1,3	78 - 123,5
	Enagás forecasts	"Baseline" Forecast	13,4	1,6	96 - 152
		"Call for inter- est" Forecast	23,3	2,5	150 - 237,5
2040	Enagás forecasts	"Maximum potential" Forecast	74,3	7,9	456 - 750
		"Max. potential 2040" Forecast	84,3	8,7	522 - 826,5

Any such consumption will be additional to that which already exists in the Spanish state, where water availability is under growing threat, with the water system moving ever-closer to breaking point, especially in regions such as Andalusia, Castilla-La Mancha, the Valencian Community, the Region of Murcia and Catalonia. The latter declared a state of emergency due to drought on 1 February 2024⁶⁶. Rivers, aquifers and wetlands are highly overexploited, with climate change aggravating the problems caused by this.

Rising average temperatures have reduced the water circulating in rivers and aquifers by around 20% over the past 25-30 years, and the trend is set to continue. Added to this are increasingly frequent and more intense droughts. At the same time, water demands, concentrated mainly in irrigation – more than 85% of water consumption – continue to grow, affecting the availability of water in protected natural areas.

⁶⁶ Diario Oficial de la Generalitat de Catalunya – Resolució ACC/220/2024 per la qual es declara l'estat d'emergència i per sequera hidrològica a les unitats d'explotació Embassaments del Ter-Llobregat, Embassaments del Ter i Embassaments del Llobregat, es declara la sortida d'alerta de la unitat d'explotació del Consorci d'Aigües de Tarragona i s'actualitzen diversos estats de sequera pluviomètrica:
<https://dogc.gencat.cat/ca/document-del-dogc/?documentId=977626>

In the interviews carried out, Ecologistes en Acció in Tarragona emphasised the need to prioritise public use of natural resources such as water, and to evaluate the impacts of additional consumption – and, therefore, greater pressure on the environment – at a time when lack of water and drought are reaching alarming proportions. They bemoan the fact that the Government of Catalonia is considering reducing the minimum flow level of rivers in the region.

In Andorra, the Plataforma a favor de los paisajes de Teruel has pointed out that Endesa holds a 18hm³ water licence for the Andorra thermal power plant. This water comes from the Guadalupe river, and specifically from the Santolea reservoir (Castellote), the reconstruction and grid connection of which were paid for in part by Endesa. "This is a resource that everyone wants to stake a claim to" claims the Platform, with irrigation companies also having an interest in the very same water, meaning that competition would be stiffer still were its use for hydrogen to be required. Moreover, activists emphasise that, due to the arid conditions of the area, "the priorities of water use need to be outlined".

There is also concern in the Basque Country about the use of water, water quality and the management of wastewater. "These projects all sound very nice, but on a practical level there is a great deal of complexity." If seawater were used at the industrial scale intended, saline water treatment would have to be carried out properly, otherwise it could cause serious environmental harm.

5.3 Implementation of renewable energies

The next key factor for green hydrogen production is renewable energy. The energy system as it is currently designed favours the accumulation of capital and profit for businesses over the sustainability of the lives of the majority of the population. A just and feminist transition, among other things, entails critical analysis of how we use energy and the inequalities this gives rise to, as well as who ultimately consumes the most energy and at whose expense⁶⁷. Historically, renewable forms of energy – due to their potential for geographical spread – have been seen as an opportunity to pave the way towards greater democratisation of energy and energy sovereignty. However, opting for an export and mass consumption-based green hydrogen model would lead to precisely the opposite.

According to the Hydrogen Science Coalition, decarbonising the hydrogen that is used at present – 120 million tonnes (99% from fossil fuel sources) – would require almost three times the amount of wind and solar power that was produced globally in 2019⁶⁸.

It should be noted that green hydrogen incurs significant energy losses at each stage of the value chain⁶⁹. Total energy loss depends on the end use of hydrogen⁷⁰. The greater the energy loss, the more renewable electricity capacity will be required to produce green hydrogen. Besides this need for renewable electricity production capacity, there is also that which is required to decarbonise the electricity mix in order to achieve strategic energy objectives.

While such objectives may be necessary, renewable energy presents a series of challenges which must be taken into account, including the impact of mining the materials required for manufacture, the transformation and use of the spaces in which they are to be set up, and the competition for space in areas designated for the protection of biodiversity and organic farming. These impacts cannot be ignored in hydrogen development, and those involved must study them, carry out adequate planning and implement environmental impact assessment procedures.

⁶⁷ Amigas de la Tierra - Si no es feminista no es justa- Voces análisis y acciones de mujeres en pos de una transición energética justa" Amigas de la Tierra Internacional 2020. <https://www.tierra.org/si-no-es-feminista-no-es-justa/>

⁶⁸ Hydrogen Science Coalition: <https://h2sciencecoalition.com/data-resources/>

⁶⁹ According to the IRENA, energy losses are estimated at between 30 and 35% in electrolysis, 13-25% in conversion to other carriers, 10-12% in transport and 40-50% if used in fuel cells.

⁷⁰ IRENA - Making the breakthrough: Green hydrogen policies and technology costs, International Renewable Energy Agency, Abu Dhabi. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Nov/IRENA_Green_Hydrogen_breakthrough_2021.pdf?la=en&hash=40FA5B8AD7AB1666EBCDE30EF458C45EE5A0AA6

This issue is especially concerning against a backdrop of possible neocolonialism, with there being a high risk of land grabbing, eviction of communities, unfair debt agreements, loss of biodiversity and land use conflicts in the renewable hydrogen projects in the Global South. In the case of Chile, the main obstacle encountered in the implementation of the National Green Hydrogen Strategy is the material basis of the planned hydrogen and renewable projects. The aim is to provide 1,800 GW of renewable energy, 70 times more than the country's current demand (see table "The material basis of green hydrogen production").

In the Spanish state, a dearth of dimensioning and planning together with a lack of meaningful citizen participation and an uneven roll out has led to tension and confrontation between local residents and projects in some areas.

Furthermore, there is a risk that renewable energy, instead of being used to decarbonise the electricity mix, will be used for hydrogen production, in disregard of the principle of additionality (see section 2.3). According to the texts put forward by the Commission, from 2028, a renewable energy plant will be considered additional if it is up-and-running up to 36 months before hydrogen production.

The calculable renewable energy output necessary to satisfy the production of hydrogen as per the range of government and Enagás forecasts (see table 3) occupies a markedly high range. This is especially the case in the forecasts offered by Enagás, which far exceed the PNIEC wind power capacity target of 62 GW, and 76 GW for solar power, for 2030 (revision 2023).



VERY HIGH VOLTAGE LINES
CONNECTING THERMAL
POWER STATIONS ON THE
COAST WITH THE MINING
AREA IN THE INTERIOR OF
THE ANTOFAGASTA REGION.
Author: ODG

TABLE 3: The material basis of green hydrogen production

An increase in the demand for hydrogen production as has been proposed will increase the demand for a range of materials needed for the construction of electrolyzers, in addition to further renewable energy necessary for the production of electricity. This is in addition to the increased extraction and use of raw materials forecast for the green and digital transition of the Global North.

The roll out of necessary infrastructure continues to depend on destructive and polluting industries such as mining for the manufacture of basic components. Solar panels, wiring, motors, inverters and power lines entail the use of large amounts of iron, copper, zinc, nickel, silicon, lead, silver, molybdenum and other materials, extracted at an enormous environmental cost and involving systematic human rights violations, mainly in the Global South, but which are also occurring at a growing rate in the Spanish state.

Among the most widely-used electrolyzers in green hydrogen production are those that operate using proton exchange membrane electrolysis (PEM). These require iridium and platinum anodes and cathodes, in addition to other noble metals such as gold. Iridium and platinum are very expensive and scarce, and their extraction comes at a significant environmental and social cost. Production of these elements is centred around mines in South Africa, with a limited market dominated by the major industrial powers.

At present, there is almost no recycling of critical metals, and rare earths barely reach a 5% average recovery and reuse rate. Exhaustive regulation is required to prevent unnecessary extraction, ensure human rights compliance and protect the local environment in the areas where mines are located. Africa is the most affected continent in terms of mining for use in technology.

Table 3.

**ESTIMATION OF ADDITIONAL RENEWABLE ENERGY INSTALLATION CAPACITY
REQUIRED TO MEET FORECAST GREEN HYDROGEN PRODUCTION TARGETS..**

Source: Authors' work based on available data, assuming a capacity factor of 75% for electrolyzers, equivalent hours for onshore wind of 2,035 per year and 1,490 for solar panels.

			Electrolyser capacity (GW)	Hydrogen production (Mt/year)*	Required energy (GWh)**	Power to be installed GW	
2030	Government forecasts	Hoja de ruta hidrógeno (2020)	4	0,6	26.280	12,91	17,64
		Revisión PNIEC sept 2023	11	1,3	72.270	35,51	48,50
	Enagás forecasts	Horizonte "Base"	13,4	1,6	88.038	43,26	59,09
		Horizonte "Call for interest"	23,3	2,5	153.081	75,22	102,74
		Horizonte "Potencial máximo"	74,3	7,9	488.151	239,88	327,62
2040		Horizonte "Potencial máx. 2040"	84,3	8,7	553.851	272,16	371,71

There is also a great sense of injustice concerning the introduction of renewables in local areas, something which is reflected in the demands of the groups interviewed as part of the research for this report in the Spanish state.

According to provisional data for 2023 provided by Red Eléctrica⁷¹, 50.3% of electricity generation came from renewable sources, the largest of which was wind power, surpassing nuclear and gas. Approximately 5% of this electricity was exported.

Analysis of data from 2022 offers a point of comparison with those of the autonomous communities visited. 42.2% was generated from renewable sources. However, combined cycle power plants, which produce electricity from fossil gas, contributed 24.7%. Of this electricity generated, approximately 7% was exported. This distribution changes enormously according to local area.

71 Red Eléctrica de España – Balance eléctrico: <https://www.ree.es/es/datos/balance-electrico>

In Catalonia, only 14.1% of power generation comes from renewable sources, and there is a high dependency on nuclear energy (57.6%) and combined cycles (19.1%). In addition, 8% of demand is met by imports. In Tarragona, the groups interviewed stressed that, at present, two of the three operational nuclear reactors (Ascó I, Ascó II and Vandellòs II) are totally unnecessary, as has been shown during incidents which have required production to be stopped, without such stoppages causing problems at a nationwide level. They stress that there is a danger that nuclear energy overproduction could be given over to the production of hydrogen, were European regulations to allow this. There is also a risk that energy imports from other autonomous communities such as Aragon will be increased.

In the case of Aragon, 75% of power generated comes from renewable sources, with almost half of the total electricity production destined for export. Endesa's project in Andorra is set to be carried out with the main aim of supplying renewable energy to the Mudejar Node substation (1,200 MW), with hydrogen production a secondary objective. The Platafroma a favor de los paisajes de Teruel has raised concerns that the introduction of such hydrogen projects brings with it the large-scale installation of wind and solar farms, which already produce more renewable energy than is consumed in the region, leading inevitably to mass export to other areas. They contend that Teruel is on its way to becoming a sacrifice zone for the export of energy, either in the form of renewables or hydrogen. They nevertheless believe that "it makes sense for hydrogen to be manufactured where there is electricity production", especially if it is possible to take advantage of times at which production is high, in order to avoid loss.

In the Basque Country, 11.2% of energy is produced from renewable sources, 70.8% from combined cycles, and 38% of demand is met through import. The groups interviewed concur as to the need to properly measure and scale the resources available: "there needs to be rescaling to the local level and a reappraisal of energy limits". In order to ensure respect for local interests "relocalisation of supply chains is essential. We have to take responsibility for the material basis of our [energy] transition". Activists bemoan the fact that hydrogen generation is replicating wholesale the previous electricity generation model: large companies are in charge of energy, and citizens are being left out. All funding is directed to large-scale production and distribution projects. They believe that a social conversation should be started to determine which models for the energy industry and consumption are the most desirable. "If the Basque Country is so industrial and an energy drain, it begs the question: is what we produce consumed here?"

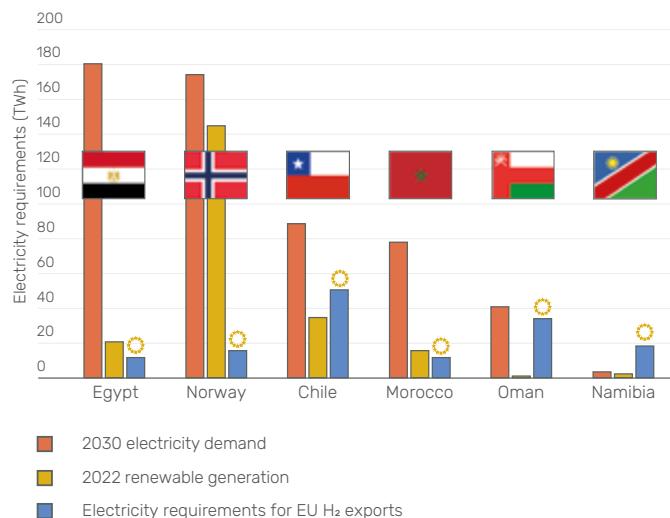
In the case of Cantabria, renewable production reached 24.1% in 2020, with two thirds of electricity consumption being met by imported energy. Ecologistas en Acción Cantabria have questioned where the renewable energy required to power the project located at the former Sniace factory is going to come from when there is so little existing capacity in the autonomous community. “The companies have not announced where the energy will come from, (...). Thermodynamically, it is impossible: with as little renewable energy capacity as there is, in all likelihood it will have to be imported from other areas.”

With regard to hydrogen imports, the European Union’s plans may encourage countries in the Global South to export renewable energy for the production of hydrogen instead of devoting their efforts to decarbonising their electricity production, putting their own energy transition at risk. According to analysis by Transport and Environment, based on a study carried out by the consultancy firm Ricardo (2023)⁷², the notably high electricity demand for the production of green hydrogen for export to Europe is a cause for concern in at least three of the six countries analysed. These countries had practically no renewable electricity in 2022; even so, they planned for high domestic demand for electricity as well as for the export of hydrogen in 2030 (see Figure 8).

Figure 8.

**DOMESTIC DEMAND
FOR ELECTRICITY
AND FOR THE EXPORT
OF HYDROGEN TO
THE EUROPEAN
UNION.**

Source:
Transport &
Environment,
based on analysis
by Ricardo (2023).



⁷² Transport & Environment – Europe’s hydrogen plans reliant on uncertain imports <https://www.transportenvironment.org/discover/europees-hydrogen-plans-reliant-on-uncertain-imports-report/>

TABLE 4: Climatic impact of hydrogen

Hydrogen is not a greenhouse gas (GHG). However, it is a small, leak-prone molecule that can indirectly heat the climate through chemical reactions with greenhouse gases such as methane, ozone, stratospheric water vapor and aerosols, increasing its permanence in the atmosphere. The latest studies indicate that its 20-year global warming potential (GWP) is 37 times greater than that of carbon dioxide. That is, it stands to contribute 37 times more to global warming⁷³.

The amount of hydrogen that can be emitted (through leaks or vents⁷⁴ via infrastructure is uncertain, since it has not been measured systematically. Nevertheless, this is estimated at a range of between 0.2% and 20%. An emission rate of 10% over a 20-year period would only halve the climate impact of the fossil fuel technologies that it is intended to replace, far from the common perception that green hydrogen is climate-neutral. This notwithstanding, over a 100-year period, climate impacts could be reduced by around 80 %⁷⁵. In addition, it should be remembered that the leakage rate may increase as a result of the interaction of hydrogen with the materials used in production and transport infrastructure, since – due to its physicochemical properties – in gas form it can cause damage to certain materials, especially steel.

⁷³ Sand, M., Skeie, R.B., Sandstad, M. et al. A multi-model assessment of the Global Warming Potential of hydrogen. *Commun Earth Environ* 4, 203 (2023). <https://doi.org/10.1038/s43247-023-00857-8> <https://www.nature.com/articles/s43247-023-00857-8>

⁷⁴ Venting is a technique used in a range of energy sector facilities that consists of emitting the gas that is processed or obtained as a by-product of the main activity directly into the atmosphere. It is normally used as a safety measure.

⁷⁵ Ocko, I. B. and Hamburg, S. P.: Climate consequences of hydrogen emissions. *Atmos. Chem. Phys.*, 22, 9349–9368. <https://doi.org/10.5194/acp-22-9349-2022>, 2022. <https://acp.copernicus.org/articles/22/9349/2022/>

Conclusions

The conclusions that can be drawn from this report are as follows:

- 1** **The development of the global hydrogen market remains at a very early stage, with funding green-light for only 6% of projects.** In any case, the forecasts made by governments and private energy and fossil fuel companies, the main figureheads promoting this energy vector, do not question call into question energy use or consumption. This could lead to a perpetuation of a centralised, oligopolistic and opaque energy model, and afford hydrogen a greater role than it ought to have as part of a just energy transition.
- 2** **The majority of projects geared towards hydrogen production are low-emission and concentrated in Europe, Australia and New Zealand, Latin America, India, the United States and China.** The development of a global market based on exports could see hydrogen become a commodity, as has happened with other energy resources. This is a problem insomuch as it places the emphasis on the economic profitability, and not on meeting the needs of society.
- 3** **The European Union has developed the REPowerEU plan as a strategy to end reliance on Russian fossil fuels.** The amount of hydrogen set to be consumed in 2030 has been updated from 10 to 20 million tonnes, with half of this total to be imported from other parts of the world. The studies and schemes behind this strategy are an entrenchment of the neocolonial practice that the European Union has historically exercised in the field of energy, with the countries identified as potential exporters located in North Africa, North Asia and Latin America.



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The most widely used finance schemes for hydrogen projects in the EU take the form of guarantees, which encourage the participation of the private sector by reducing investment risk through the use of public institutions as guarantors. Guarantees are a dangerous financial mechanism given the risks that may arise in the future, long after agreements have been signed.

5

The European Union has approved a range of financing and aid schemes for hydrogen projects, while the Spanish state plans to do so through use of Next-GenerationEU funds, more specifically, PERTEs. The total budget for hydrogen projects covered by these schemes exceeds 25 billion euros of public funding. Although hydrogen is required for the energy transition, there is a risk that many of the projects could end up as stranded assets, be this due to their speculative nature or the fact that the technology required – and, moreover, the development of the hydrogen market – may never meet current expectations. Were this to be the case, scandals similar in nature to that of Proyecto Cas-tor could end up being the order of the day⁷⁶.

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- 6** Major Spanish companies have profited from the IP-CEI HyUse fund and the ERHA and Industrial Decarbonisation PERTEs, including ArcelorMittal, CEPSA, Iveco ES, H₂B2, ENEL, Repsol, BP, Nordex, SENER, Iberdrola and Enagás Renovables, in descending order. It should be noted that all of these are large energy and fossil fuel companies, and leaders in their sector. This confirms the hypothesis that it is large companies, together with governments and public institutions, that are leading the energy transition. In this sense, the development of the hydrogen market and infrastructure is geared towards meeting their interests, and not the basic needs of society.
 - 7** There is little if anything to indicate that plans and strategies designed to promote green hydrogen include an ecofeminist perspective. Beyond reducing the gender gap in the technical and industrial sectors, a profound change is needed in patterns of production and consumption. Factors such as depopulation are all the more pronounced in areas where support is not available for women's work or the care economy.



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- 8 Grassroots activists believe hydrogen projects in the Spanish state lack the necessary planning and scalability to encourage a social engagement and jointly address degrowth and local sufficiency as a means of building a future free from the thinking that has led us to the critical situation in which we find ourselves today. They also believe that an opportunity has been missed to determine which sectors are socially necessary in each local area, and to what extent communities want to see them maintained.
- 9 Critical groups are already involved in defending local interests and have seen how this problem adds another layer of complexity to local issues and causes even greater harm. However, in general, the perception is that investments in hydrogen production projects are seen as a priority – a consequence of a market mentality and focus on green growth, resulting in yet more despoliation of local areas – while the funds needed for sustaining life are increasingly being cut back.

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- 10** **The large-scale transition to hydrogen has the potential to create competitive demand for water resources**, particularly in parts of the world already facing significant water security challenges.
 - 11** **Countries such as the Spanish state are faced with the clear need to reduce demand for water to avoid the system being overwhelmed and, in turn, to be able to continue to uphold the human right to water supply and sanitation.** Green hydrogen projects must therefore be properly planned and scaled according to the water capacities of the local area in which they are to be carried out. Moreover, priority must be given to meeting the needs for hydrogen use in these areas.
 - 12** **EU plans may pose a threat to the energy transition of third countries**, to the extent that these countries end up transferring the renewable electricity needed for their own transition to green hydrogen production for export.
 - 13** **In the Spanish state, priorities must be made according to a hierarchy of needs in order to determine where hydrogen is produced and used, and for what purposes.** If we are to avoid undesired effects in the form of additional harm caused by renewable energies, production and use must be scaled in accordance with the needs and capacities of local areas.



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The increase in the need for materials to meet the demand for hydrogen is likely to deepen the extractivism practiced by the Global North. Adequate scaling of local hydrogen needs is required in order to avoid this, as well as ensuring that human rights and environmental protection standards in mining areas are upheld.

15

Hydrogen's effectiveness as part of a decarbonisation strategy depends directly on how its emissions and leaks are managed. Strategic environmental assessments of hydrogen plans and infrastructure should be carried out to assess their potential climatic repercussions.





OBSERVATORI DEL DEUTE
EN LA GLOBALITZACIÓ