hystories
Hydrogen Storage in European Subsurface

Clean Hydrogen Partnership

Co-funded by the European Union

# HYSTORIES

## HYdrogen STORage In European Subsurface

# HYDROGEN, AN ENERGY SOURCE OF THE FUTURE?

### MIRELA ATANASIU
HEAD OF OPERATIONS AND COMMUNICATION UNIT AT CLEAN HYDROGEN PARTNERSHIP

Moving towards a fully renewable system, very large volumes of hydrogen will be needed to be produced and stored. **Hystories** has enormously contributed to understanding whether the EU can rely on depleted gas fields and other geological sites to store the hydrogen. Building on the project results, the Clean Hydrogen Partnership plans to support a large-scale pilot to prove the economic and technical feasibility of a complete underground hydrogen storage system.

### PASCAL BAYLOCQ
CEO OF GEOSTOCK

By 2030, Europe plans to produce approximately 10 million tons of green hydrogen. To achieve this, massive storage capacities will need to be developed to ensure supply, energy independence, and to address the intermittency of renewable energy sources. Underground storage is the only option for storing such quantities, either in salt caverns – a technique that is relatively well-mastered for hydrogen – or in porous environments, which presents some challenges to overcome. Currently, 10% of the world's natural gas production is stored. Applied to hydrogen, it would require approximately 1 million tons of storage capacity, which is significant.

### ARNAUD RÉVEILLÈRE
PROJECT MANAGER

**Hystories** has brought together a team of multidisciplinary researchers and engineers, and has developed techniques and knowledge over two and a half years enabling the deployment of massive storage in depleted fields or aquifers. **Hystories** has also analyzed the European need for storage, its cost, and its social and environmental impact in order to shed light on the deployment of these infrastructures.



# THE PURPOSE OF THE HYSTORIES PROJECT

Green hydrogen is a clean and renewable energy vector. The use of this gas as an energy source could transform our industry and mobility sustainably. Additionally, it can be considered as a solution for storing electricity produced by intermittent renewable energies. For instance, green electricity generated by wind turbines or solar panels could be converted into hydrogen through electrolysis, which could then be stored underground and finally reconverted into electricity, which would be injected back into the grid through fuel cell systems. This "Power to Gas to Power" scheme could mitigate the inherent intermittency of renewable energies. To accelerate the deployment of this value chain, it is necessary to find solutions for massive storage. Storage in porous media would open up very interesting possibilities for the European Union.

## WHAT IS HYSTORIES?

**Hystories** is an acronym that stands for "HYdrogen STORage In European Subsurface". It is a scientific research project on the possibilities of storing hydrogen in porous environments, such as depleted gas or oil fields and existing aquifers. **Hystories** is a collective that brings together public actors (European universities, research institutes) and private actors (consulting firms, industrial and energy storage site operators) to develop technical solutions and produce socio-economic analyses on the possibilities of such geological storage.

This project, funded by the European Union and led by Geostock, ran from January 1st, 2021, to June 30th, 2023.

A conference presenting all the project work was held on May 25th and 26th, 2023, in the main auditorium of the Mines ParisTech.

# A EUROPEAN PROJECT

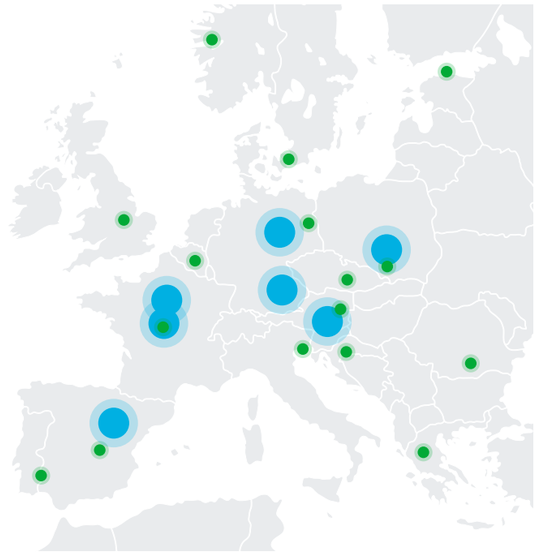
**HYSTORIES** is a research project supported by the European Union.
This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 101007176. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation program, Hydrogen Europe and Hydrogen Europe Research.
https://cordis.europa.eu/project/id/101007176

**Funding : €2,499,911.75**



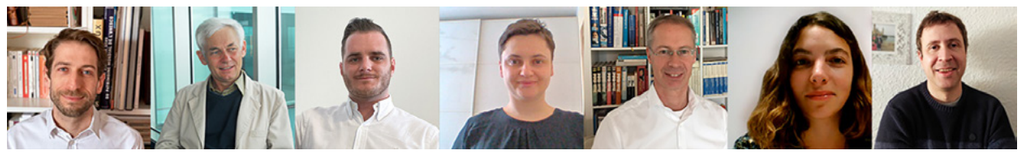
## EUROPEAN EXPERTS
AT THE SERVICE OF OUR ENERGY TRANSITION

**HYSTORIES IS A COLLABORATION BETWEEN PUBLIC AND PRIVATE SECTORS.**



## THE CONSORTIUM

The **Hystories** project stems from a cooperation of European public entities (universities, research centers) and private entities (consulting firms, industrial actors), grouped in a consortium led by Geostock, a French underground engineering company. This European partnership consists of 7 main partners, 17 third-party entities, as well as an advisory board composed of 13 industrial operators in the gas market. These actors come from 17 countries: Austria, Belgium, Croatia, Czech Republic, Denmark, England, Estonia, France, Germany, Greece, Italy, Norway, Poland, Portugal, Romania, Spain, Turkey.



# 7 PROJECT PARTNERS

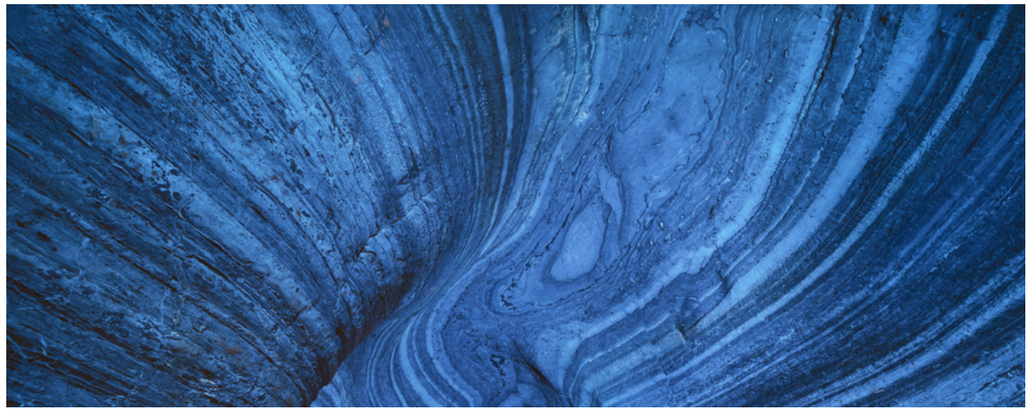
**Hystories** is made up of seven key public and private partners involved in underground storage in Europe: CO2GeoNet, Fundación para el desarrollo de las nuevas tecnologías del hidrógeno en Aragón, Geostock, Ludwig-Bölkow-Systemtechnik GmbH (LBST), MicroPro GmbH, Mineral and Energy Economy Research Institute, Montanuniversitaet Leoben. Some of these entities are experts in underground storage of gas and $CO_2$. Others have extensive experience in strategic evaluation, feasibility, and market analysis. Some partners are also renowned university institutes for their cutting-edge research in mining, minerals, and hydrogen technologies. Finally, a foundation specializing in the valorization of hydrogen as an energy vector is also a key player in the project. Six of these partners are located in five European countries: Germany, Austria, Spain, France, and Poland. The seventh partner, CO2GeoNet, is a network whose members cover nearly 20 European countries.

# 13 MEMBERS OF THE ADVISORY BOARD

The advisory board is composed of 13 industrial operators or suppliers in the gas market: Enagas, Fluxys, Gas System, Humbly Grove Energy, IGS, OGE, Ontras, RAG Austria AG, Storengy Deutschland, Teréga, Uniper, Vallourec, VNG. The role of this board is to express the needs of the industry. Its role is also to provide samples (metallic components, fluid samples, etc.). These 13 industrial operators represent a workforce of several tens of thousands of professionals dedicated to the Oil&Gas industry, with a storage capacity of around 200 TWh and a pipeline network of several tens of thousands of kilometers.

# 17 THIRD-PARTY ENTITIES

17 research institutes or geological services, members of CO2Geonet, participate in the **Hystories** project. They enabled the project to gather geological data from 23 European countries: BRGM, British Geological Survey, CERTH - Centre for research & technology Hellas, Czech Geological Survey, Estonian University TalTech, GeoEcoMar, Geological Survey of Denmark and Greenland, Geologische Bundesanstalt, GIG - Research Institut, Helmholtz-Zentrum Potsdam, Instituto de Ciências da Terra, Instituto Geológico y Minero de España, OGS - The National Institute of Oceanography and Applied Geophysics, Orta Doğu Teknik Üniversitesi, Research Institute NORCE, University of Zagreb.



# A TEAM PROJECT

## ORGANIZED INTO 8 WORK PACKAGES

## SUBSURFACE TECHNOLOGY DEVELOPMENT

**The Hystories team has brought technical developments to enable the deployment of Underground Hydrogen Storage (UHS) in porous reservoirs (aquifers and depleted fields).**

### WP1 GEOLOGICAL ASSESSMENT

**A European database of opportunities.**

WP1 developed and published a database of European geological storage opportunities both onshore and offshore by adding data specifically relevant to the geological storage of hydrogen.

### WP2 RESERVOIR ENGINEERING AND GEOCHEMISTRY

**Evaluation of European porous traps.**

WP2 evaluated the hydrodynamical and chemical capacity related to hydrogen injection of over 800 reservoirs in the 27 EU countries and 4 neighboring countries. This study allows for the determination of the total storage resources in TWh (onshore + offshore).

### WP3 MICROBIOLOGY

**A laboratory and 3D modeling work.**

WP3 involved gathering a dozen samples of brine and rock from gas storage sites to conduct an extensive experimental microbiological investigation, leading to an operational flowchart for evaluating the risk of microbial activity.

These experimental results, along with historical industrial experience in town gas production, were used to develop geochemical models of bio-reactivity in box models prior to applying them to large-scale 3D models to assess the expected impacts at the operational storage scale.

### WP4 MATERIAL AND CORROSION

**Testing phase.**

WP4 focused on testing a dozen grades of casing steel in a hydrogen atmosphere, under constant or cyclic load conditions, analyzing localized corrosion, damage, hydrogen uptake and permeation, and finally assessing their applicability for storage well conditions.

## TECHNO-ECONOMIC FEASIBILITY

**Future UHS and transportation network being infrastructure assets that typically require a decade to develop, it needs planning, social acceptability and financial security. Hystories has developed insights to inform decision makers in government and industry that will face these deployment decisions.**

### WP5 MODELLING OF THE EUROPEAN ENERGY SYSTEM

**Hydrogen storage demand for a minimized energy cost in Europe.**

WP5 developed a comprehensive modelling of the European energy system in various scenarios and time horizons enabled to analyze optimal UHS sizing and operation cycles. Within the investigated scenarios, overall demands for hydrogen storage capacity is between 280 and 325 TWh for EU-27+UK in 2050 (corresponding to about 5 to 18% of overall hydrogen demand. These values are orders of magnitude less than the estimated capacities of 6 900 TWh in onshore porous storage resources (Hystories WP2 result) or 13 800 TWh salt caverns (public result).

### WP6 IMPACT STUDIES

**Regulation readiness, Environmental and public perception studies.**

WP6 assessed the regulation readiness for UHS based on surveys to stakeholders, showing that it was developed or under development for only 6 of the 17 European countries reviewed.

WP6 made an Environmental life cycle analysis of UHS provides a reference assessment for 7 impact categories including Climate change and shows that the main environmental hotspots derive from the use of electricity during operation

WP6 analyzed public perception by both surveying stakeholders having been involved in likely several hundred of projects altogether, finding that two experienced projects affected by public pressure, and by a general public survey that suggested possible “Not in My Backyard” syndrome.

### WP7 RANKING OF GEOLOGICAL SITES

**Parametric UHS cost model development and application to score UHS possibilities.**

WP7 developed a parametric and hydrogen-specific cost model and applied to the hundreds of porous traps and dozens of salt deposit candidate sites for UHS, leading to an estimation of the levelized cost of hydrogen storage of 1.1 to 2.6 €/kg in porous media, and 2.0 to 2.3 €/kg in salt caverns, depending on the cycle considered.

A suitability mark reflecting relatively higher maturity and the lower technical risk was also defined and applied, finding higher marks for salt caverns, and then the existing natural gas storages and depleted gas fields.

### WP8 EUROPEAN CASE STUDIES

**Case studies.**

WP8 studied UHS sites in France, Germany, Italy, Poland and Spain, enabling a more detailed look at the implementation of UHS projects, notably by assessing economic opportunities and identifying most relevant business case-related factors.

WWW.HYSTORIES.EU

## CONTACTS


**OLIVIER DANNENMULLER**
Communication manager
olivier.dannenmuller@geostock.fr
+33 (0)6 07 80 28 58

**ARNAUD RÉVEILLÈRE**
Project manager
arnaud.reveillere@geostock.fr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