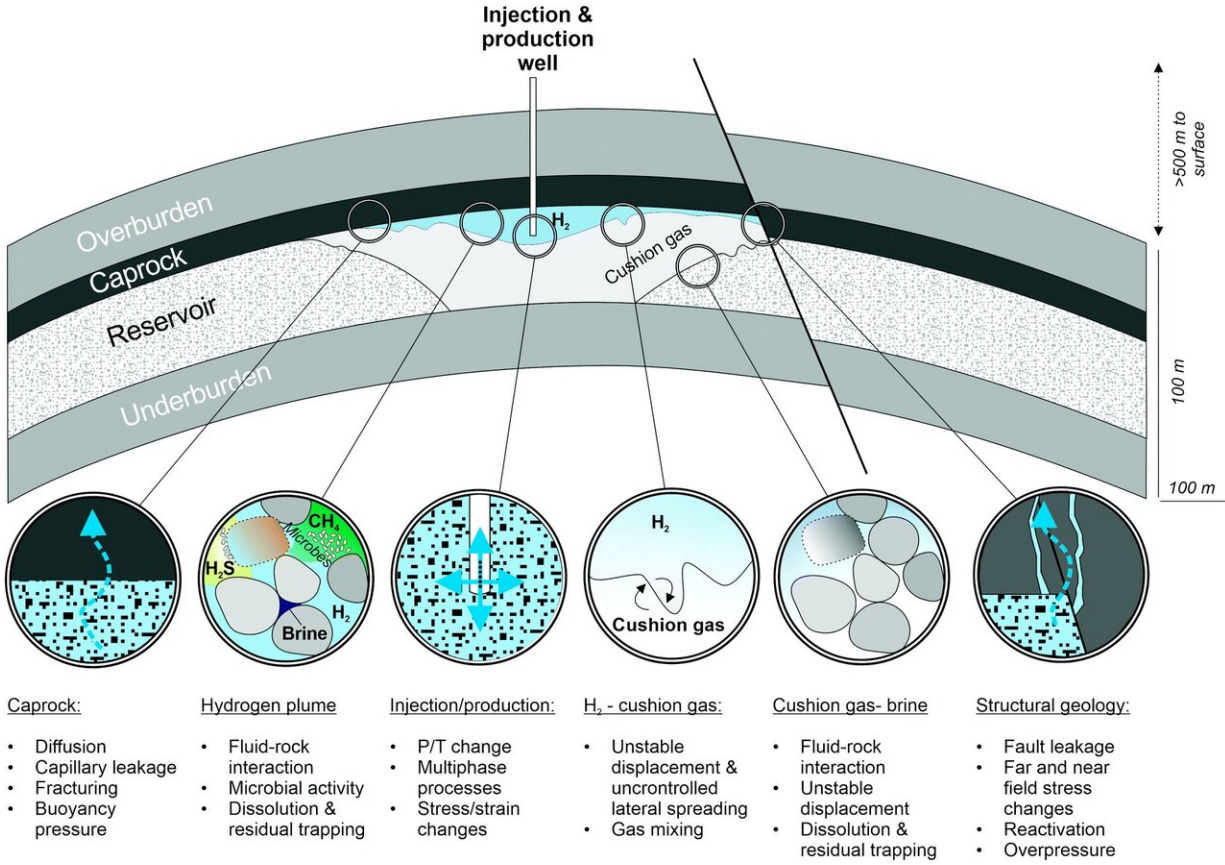


# Study identifies the main scientific challenges of underground hydrogen storage in porous media

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Graphical summary of the geological challenges related with underground hydrogen storage. Credit: Heinemann et al. Energy Environ. Sci., 2021

Large-scale storage of hydrogen remains largely untested but is essential if hydrogen is to realize its potential to make a significant contribution to achieving net-zero emissions. A new perspectives paper sets out the key scientific challenges and knowledge gaps in large scale hydrogen storage in porous geological environments. These underground hydrogen reservoirs could be used as energy storages to face high demand periods. The article, authored by Niklas Heinemann and co-authored by GEO3BCN-CSIC researchers Juan Alcalde and Ramon Carbonell, has been recently published in the journal *Energy and Environmental Science*.

Hydrogen is attracting global attention for its potential to help decarbonise transport, heating and energy-intensive industries, such as chemicals and steel-making. Furthermore, it can help alleviate a key drawback of renewable energy generation: its intermittency. Excess renewable energy can be converted to [hydrogen](#) through electrolysis (green hydrogen) and stored to be converted later in electricity to be used in periods of high-energy demand." These energy [storage](#) facilities, for example, could help to keep electricity prices stable in unexpected situations such as cold waves occurring in winter season" says Juan Alcalde, researcher at Geosciences Barcelona—CSIC (GEO3BCN-CSIC) and co-author of the article.

The authors of the study set some of the main uncertainties that need to be addressed by future multidisciplinary research. How can hydrogen be safely stored? What will be the dynamic of the hydrogen once injected in the subsurface reservoir? Which are the chemical processes that will occur inside the reservoir and how will these affect the operations? What happens with hydrogen-consuming microbes in the reservoir?

"The paper evaluates the emerging research on hydrogen storage, identifying the key challenges that must be addressed to enable global deployment," says Niklas Heinemann, leading author of the study and researcher of the University of Edinburgh. "It provides an authoritative

account of the factors that make hydrogen storage in porous geological media unique and addresses the unknowns that are likely to set the research agenda in future."

According to the article, saline aquifers and depleted hydrocarbon reservoirs are the optimal underground geological formations to facilitate hydrogen supply on the required scale for a zero-carbon future. Despite the substantial opportunity provided by such storage, the lack of research means it is associated with uncertainties and challenges, it notes.

"Hydrogen is currently being stored in tanks on the surface, but new storage solutions with larger capacities are needed to enable its large-scale usage. And here is where geological storage should play a key role. It would allow larger and more long lasting storage than surface facilities," says Juan Alcalde.

"We've been exploiting geological resources such as oil and gas for over a century, so we have significant information about some of the processes which occur during these type of operations," explains Juan Alcalde. "However, we have very little experience on the large-scale storage of hydrogen. Dealing with a different fluid bears some uncertainties that must be adressed," adds Alcalde.

The study has been coauthored by scientists from University of Edinburgh, University of Freiburg, University of Groningen, Utrecht University, German Research Centre for Geosciences, Federal Institute for Geosciences and Natural Resources, Clausthal University of Technology and the British Geological Survey. The paper was fostered by the GEO\*8 (European Geosciences Alliance), a grouping of leading European earth sciences research organizations.

**More information:** Niklas Heinemann et al. Enabling large-scale

hydrogen storage in porous media – the scientific challenges, *Energy & Environmental Science* (2021). [DOI: 10.1039/D0EE03536J](https://doi.org/10.1039/D0EE03536J)

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