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Geological Hydrogen – An Overlooked Energy Source?

Geological hydrogen – what is it?

Geological hydrogen refers to molecular hydrogen occurring in the Earth's subsurface. In the last few years, research interest in this potential resource has strongly increased, and globally over a hundred companies – mostly start-ups – have become involved. Geological hydrogen can be distinguished by whether its generation occurs naturally or is deliberately stimulated.

Natural hydrogen (also white or gold hydrogen) is generated by naturally occurring geological processes without human intervention. It may occur as diffuse seepage or, where geological conditions allow, as subsurface accumulations. Interest increased following the discovery of a natural hydrogen-rich gas in Mali, which was used to supply electricity to a nearby village. This represents the first documented case of sustained hydrogen extraction and use.

Stimulated hydrogen (also orange hydrogen) is produced by deliberately inducing subsurface reactions, for example, through the injection of fluids or catalysts. This concept remains at an early research stage.

Existence of mineable deposits of natural hydrogen uncertain

It has not yet been established whether natural hydrogen occurs in volumes that are economically recoverable at scale, nor whether it can make a meaningful contribution to long-term climate-neutral energy systems. While the geological processes responsible for hydrogen generation are principally understood, significant uncertainties remain regarding its generation rates, migration and accumulation. Hydrogen generating rock types are quite widespread. However, no large, economically viable deposits have yet been confirmed and expert estimates of potential resources vary widely. Elevated hydrogen concentrations alone do not demonstrate the presence of a sustained subsurface accumulation or economically recoverable resource.

Natural hydrogen potentially cheaper than green hydrogen

If economically viable deposits are identified, natural hydrogen could be produced at lower cost than green hydrogen from electrolysis. Under favourable geological and operational conditions, production costs may approach todays cost of grey hydrogen. However, costs will be highly site specific and depend on factors such as drilling depth, flow rate and hydrogen concentration.

Most promising for local and decentralised applications

Most experts view the role of natural hydrogen in the energy transition as complementary rather than transformative, underscoring the need to maintain investment in hydrogen infrastructure and green hydrogen production. Especially in the short and medium term, natural hydrogen might be confined to certain local and decentralised applications. Potential use cases include integration with helium production or geothermal energy projects to diversify revenue streams, as well as local power generation for remote communities or mining operations.

Need for regulatory clarity and targeted research funding

Regulatory frameworks for exploiting natural hydrogen vary significantly across jurisdictions and in the mining codes of most countries, it is not considered at all. Further investment needs clear legislation that facilitates exploration and potential extraction. In addition, targeted public funding for research could help to obtain data for a more secured evaluation of the potentials and generate the scientific evidence needed for informed policy decisions.