Feature

Why natural hydrogen could pay off – if the risks are managed correctly

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Natural (white) hydrogen's potential as a low-cost supply is only growing. The number of exploration companies has increased from a handful at the turn of this decade to more than 40 in 2026. Early activity suggests strong upside – but also significant commercial risk.

Several projects may commence commercial operations before 2030, with early estimates suggesting wellhead production costs could be about 50% less than grey hydrogen, along with a very low carbon intensity.

Natural hydrogen's carbon intensity is primarily driven by energy use in extraction, purification, compression, and transportation, as well as fugitive hydrogen emissions.

Even so, lifecycle emissions are expected to be lower than blue hydrogen in favourable cases.

High stakes

Much of the cost of natural hydrogen production is incurred before any revenue is generated, making natural hydrogen a high-risk, high-reward proposition. Exploration and drilling are capital-intensive, and unsuccessful wells can result in substantial sunk costs and no return.

Additionally, the natural hydrogen source may be more dilute than expected, making commercialisation marginal or non-viable. The costs of exploratory failure must also be borne by the revenues generated by commercially viable natural hydrogen sources.

Depreciation of the exploration and extraction capital investment over the lifetime of the reserve is a major contributor to the cost of natural hydrogen. Wellhead operating and capital costs of purification and transmission infrastructure must also be accounted for.

Ultimately affordable

Natural hydrogen companies claim the gas can be recovered at less than $1 per kilogramme from some reserves. This would be about 30% to 50% less expensive than blue or green hydrogen.

There may also be upside surprises, such as a commercially viable helium concentration in the natural hydrogen. The Australian company Gold Hydrogen has discovered a natural hydrogen source in South Australia's Yorke peninsula which contains more than 5% helium. This far exceeds the 0.2 and 2% helium concentration range typically found in helium-rich natural gas sources.

The simultaneous extraction and recovery of helium can be a revenue and profit multiplier which will transform the financial outlook of some natural hydrogen projects.

The how and where of natural hydrogen

Australia is not the only location where natural hydrogen has been found. In Europe, sources are being investigated in France and Spain. In the US, multiple locations are being drilled to verify the nature of the underground geology and validate the purity of natural hydrogen reserves and to estimate the total amount of hydrogen they may contain.

The chemical and geo-mechanical mechanisms of natural hydrogen formation vary. One proposed reaction that produces natural hydrogen is between underground water and rocks which are not fully saturated with oxygen.

Under the right conditions of temperature and pressure deep underground, the rocks pull oxygen out of water molecules to leave hydrogen gas. Some types of minerals in the rocks may catalyse this sub-surface reaction.

Over thousands of years, natural hydrogen may have been formed in this way. The resultant hydrogen may rise to the surface,. Alternatively, it may be trapped in gas-tight underground geological formations, such as a rock dome or a salt dome. This is similar to how a natural gas or crude oil reservoir is trapped under non-porous rock.

Natural regeneration

Fighting against the formation of natural hydrogen is the underground conversion of hydrogen to energy by certain types of bacteria. When they consume hydrogen, it will neither have the chance to accumulate nor rise to the surface. On the other hand, the byproduct of these biochemical reactions can be methane and other hydrocarbons.

The sustainability of a natural hydrogen source depends on four factors: the amount of hydrogen stored in the rock formation; the rate at which fresh natural hydrogen is formed; the rate at which natural hydrogen is consumed through biological or other means underground; and the rate at which it is extracted during exploitation of the reserve.

Recent exploration has indicated that there are significant reserves of natural hydrogen under the ground. However, their replenishment rate is a lesser-known phenomenon. The sustainability question remains imprecisely answered.

Stimulated geological hydrogen

Natural or white hydrogen also has a cousin – so-called 'orange' hydrogen. Orange hydrogen is produced when industry and nature work in harmony. Water is injected at high pressure underground into rock areas that rip oxygen from the water molecules to leave hydrogen.

It is speculated that certain catalysts can be added to the water to enhance the stimulated orange hydrogen production.

A question regarding this practice is whether the ground would need to be fractured, or 'fracked', to generate porosity and allow the water to flow through the rock.

Fracking has been used with great commercial success in the US to drive the shale gas revolution, while other regions have restricted the practice. The Middle East has also experimented with carbon dioxide (CO2)-based fracking.

Purification

Natural hydrogen exploration has much in common with oil and gas exploration, or the search for minerals that mining companies excel at. This upstream activity is the focus of the natural hydrogen sector at present.

As more sources are identified with commercial potential, there will be an increasing need for midstream activities.

Natural hydrogen at the wellhead is not pure, and purification is therefore necessary. Learning from the oil and gas sector, this can either be done close to the wellhead or at the other end of a pipeline, if the gas mixture is safe for compression and pipeline transmission.

Natural hydrogen is generally mixed with CO2 and methane. The gas separations are therefore similar to those used in steam methane reformers, where a similar cocktail of gases is present in the reformate, from which pure hydrogen is extracted.

If natural hydrogen is contaminated with hydrogen sulphide – and natural gas often is – this too can be removed using desulphurisation techniques known to natural gas processing and natural gas purification prior to steam methane reforming.

There is therefore hope that there is a solid foundation of midstream technologies which can be adapted to the specific needs of natural hydrogen.

Conversion technologies

If the natural hydrogen source is extremely remote, pipeline transmission might not be viable. In this case, natural hydrogen can be converted at the well head to a product that is more readily transported. If this were the case, a local water source would be required to enable such a process.

Natural hydrogen could, for example, be converted to ammonia by reaction with nitrogen from the air. Ammonia is readily transported by train or truck as a liquid. Or, it could be fed to the sophisticated ammonia pipeline network that exists in the US.

Small-scale distributed ammonia production would be required to enable such a conversion. Modern low-pressure ammonia production techniques, such as those being developed by Nium, Ammobia and Tsubame BHB, might prove to be the ideal fit in this application.