Low-hanging fruit

The fastest wins for hydrogen decarbonisation

By Edward Laity

After years of hype around new-build blue and green hydrogen capacity, more questions are being raised about decarbonising existing assets.

Today, approximately 100 million tonnes of unabated hydrogen are produced per year, accounting for around 2.5% of global carbon dioxide emissions. Against this backdrop, attention is shifting toward the fastest and cheapest ways to cut emissions from existing hydrogen assets.

Next year, two large-scale hydrogen plants in the Port of Rotterdam are due to bring carbon capture and storage (CCS) capacity online, potentially cutting more than half of their CO_2 emissions.

The installations at Air Liquide and Air Products' existing plants show the potential of cleaning up existing assets. But where else are the opportunities for CCS in existing hydrogen infrastructure?

Early CCS wins

Ammonia production is where CO_2 can be captured fastest, cheapest and with the least disruption, according to sbh4's Stephen B. Harrison.

"Existing grey ammonia production is definitely the best place to start for maximum impact and the biggest bang for our buck," he said.

Ammonia production is among the most emissions-intensive industrial processes globally, responsible for around 450 million tonnes of direct CO_2 emissions each year, according to the International Energy Agency. This is because over 70% of global production relies on natural gas reforming, while coal gasification makes up most of the rest.

© Air Products | Hyco4 plant

"After hydrogen production, CO_2 is already captured with existing equipment and an existing energy requirement. This CO_2 can be conditioned, transported and stored at minimal additional cost."

A large-scale ammonia plant can generate more than two million tonnes of CO_2 per year, Harrison told H2 View. And because CO_2 removal is essential to protect the synthesis catalyst, there is effectively no additional capital or operating cost associated with capture itself.

In standalone ammonia plants that aren't integrated with urea production, this high-purity CO_2 stream is normally vented. In blue ammonia production, the same pre-combustion CO_2 is instead captured, compressed and sequestered rather than released to the atmosphere.

Harrison estimates the incremental cost of full CCS integration at around $120 per tonne of ammonia, covering CO_2 drying, compression, transport and storage – far lower than discretionary post-combustion capture schemes.

In the US, while compression, transport and storage add cost, incentives such as 45Q and 45V make ammonia one of the lowest-cost CCS opportunities in heavy industry.

The 45Q tax credit pays up to $85 per tonne of CO_2 stored, while 45V provides up to $3/kg for low-carbon hydrogen to offset most of the added cost of CCS for blue ammonia.

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Beyond ammonia

Ammonia is not the only CCS opportunity. Steam methane reformers (SMRs) used across refining and chemical production also generate high-pressure, high-purity pre-combustion CO_2 streams that can be captured at around half the cost of post-combustion systems.

Capturing CO_2 from the syngas upstream of the pressure swing adsorption unit delivers the lowest unit cost, typically enabling around 70% recovery without modifying the furnace.

Methanol plants and ethylene oxide units also sit within what industrial gas companies see as part of the technical sweet spot, which includes familiar kit, familiar feedstocks, and capture projects that could enhance the existing hydrogen business model.

In both cases, CO_2 must already be removed to maintain catalyst performance and process efficiency, creating another source of high-purity, low-cost CO_2 for CCS.

While hydrogen plays only a minor role in ethylene oxide production, the CO_2 removal step remains essential and represents a similarly straightforward capture opportunity.

Policy-infrastructure gap

Yet even these low-hanging CCS opportunities, face commercial and policy barriers. While experts say it is technically straightforward, it has stalled commercially in some regions.

Despite strong policy intentions in the UK, companies have warned that unclear funding timelines and limited access to government schemes are delaying investment in blue hydrogen and CCS projects.

The UK's Track-1 and Track-2 cluster system determines which industrial regions receive government-backed CO_2 transport and storage infrastructure first, meaning projects cannot advance until their cluster is formally approved and funded.

Norway's Equinor, which has spent millions on advancing CCS-based hydrogen proposals in Teesside and Humberside, has said the absence of firm timelines for the Track-1 expansion processes has left projects uncertain.

Meanwhile, Scotland's Acorn and the Humber's Viking CCS clusters remain in limbo while awaiting funding clarity. Operators have warned that if decisions continue to slip, investment could simply migrate to markets offering faster, more predictable progress.

Combining blue hydrogen, bioenergy, gas-fired power and industrial CCS, both projects sit in the UK's Track-2 programme and are set to come online by the mid-2030s.

Even in the easiest CCS opportunities, technical feasibility does not guarantee investment. As Harrison told H2 View, "Business cases lead investment and deployment." Without clear incentives and shared CO_2 transport infrastructure, even low-cost capture opportunities struggle to progress.

He added that CCS only becomes viable when there is "a clear cost of the CO_2 emissions or clear incentive for mitigation," and that governments must prioritise shared CO_2 pipeline networks to bring transport costs down.