Hydrogen storage but not necessarily storing hydrogen

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The idea of pairing intermittent renewable energy sources such as wind and solar with hydrogen production and storage seems like a perfect match - creating the green hydrogen through electrolysis that is a preferred form of H2 in low carbon energy markets around the world.

But does storing energy in the form of pure hydrogen always make sense?

The challenge of compression & liquefaction

As a gas at ambient temperatures, hydrogen must be concentrated to create viable energy reserves and here lies the challenge.

Compression

One solution is compression, which can be stored at moderate pressure levels but then further compressed for transportation deployments.

This creates some combination of a technical challenge in converting the pressure at the pump and, more notably, a cost / energy expenditure problem in maintaining the storage hydrogen at high pressure.

Liquefaction

The other pure hydrogen option is liquid hydrogen storage. The costs of hydrogen liquefaction are significant in light of the cryogenic temperatures needed to convert pure hydrogen from a gas (-253°C).

Further, liquid hydrogen suffers losses through boiling off, which are exacerbated during transport and containerizing. Losses in hydrogen volumes, particularly over mid to long-term storage, have caused some industries to consider alternatives to pure hydrogen storage.

Underground storage - Where available

One alternative to maintaining compressed or liquefied hydrogen in surface vessels is to store hydrogen under pressure in subsurface areas, specially lined to ensure gas preservation. There has been proven success with this strategy in Europe in both salt and rock caverns.

If the cavern is proximate to its point of use, this hydrogen storage strategy may make sense. But it's less attractive when substantial transportation prior to usage is still necessary. And, of course, subsurface storage isn't available everywhere.

The Rise of PtX

Growing in importance internationally, with Germany arguably at the forefront, Power-to-X, the conversion of electricity to other energy carriers such as gases, liquids or chemicals, offers a range of alternatives to pure hydrogen storage:

Ammonia energy

Ammonia energy is a hydrogen-derived product commonly identified as a leading alternative to hydrogen for both storage and transportation. Ammonia gained significant market importance when Japan endorsed it as both a preferred form of hydrogen import and as a direct fuel in applications such as co-firing a commercial power plant.

Ammonia liquefaction storage and transportation costs are a fraction of pure hydrogen, marking it as a viable low carbon fuel in its own right and ammonia has been endorsed by the International Maritime Organization as part of its decarbonisation strategy.

Methanol

Methanol has also been gaining acceptance in the marine shipping industries as a lower, but not zero, emissions combustion fuel. And like ammonia, the industrial infrastructure for its storage already exists, with methanol's added benefit of being a liquid at ambient temperatures.

Low carbon or "e-Methanol" will no doubt continue to gain prominence in the energy transition regardless of how it reconciles its place alongside ammonia in industries for which pure hydrogen storage does not make economic sense.

MCH and other LOHCs

Other PtX options include Liquid Organic Hydrogen Carriers such as Methylcyclohexane (MCH), a two-way hydrogen storage and transmission energy which has been regularly considered as one of the alternatives to pure hydrogen.

Created from toluene and hydrogen, MCH has a safe liquid form at ambient temperatures. MCH has been transported within Asia as a demonstration hydrogen storage and transportation project and there have been technological developments in its dehydrogenation at point of use, as well as LOHC fuel cell technology.

PtX as hydrogen economy 2.0?

Where PtX technologies have been challenged is the cost and energy loss necessary in the conversion back to hydrogen at point of usage. But this is where PtX has shown the most promise as fuels themselves, with the growth of deployments in reciprocating engines, turbines and fuel cells without the need for dehydrogenation.

For some industries, maybe the best hydrogen energy storage strategy does not include (pure) hydrogen at all.

Regardless of which form of hydrogen carrier deployed, these fuels have more similarities than differences: each can be produced using renewable energy and they are generally complimentary and even co-generational, in the overall push to towards the effective storage and deployment of hydrogen energy.

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