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Evidence synthesis also needs long-term funding, international acceptance and an institutional home, as Joachim von Braun, an agricultural economist at the University of Bonn in Germany, tells *Nature*. "These initiatives need legitimacy, otherwise governments will not listen to their advice," he says. The FAO said in a statement that it will "explore synergies and potential partnerships" in this area.

There is growing recognition of the need to tackle climate, nutrition and agriculture in an integrated manner, rather than in silos. The UN Food Systems Summit of 2021 brought together organizations from across these fields, and COP27 has an unprecedented focus on agriculture. As those working in the food system tackle challenges ranging from climate change to soil erosion to population growth, the need for more, better and more-systematic evidence to underpin their efforts is only going to increase.

Use hydrogen wisely, not indiscriminately

Hydrogen is touted as a wonder fuel for everything from transport to home heating. But alternatives are often better for the climate.

As governments across the world scramble to find ways to reform energy systems to meet climate commitments, hydrogen looms large. The fuel is now seen as a pillar of most net-zero emissions scenarios. Production is expected to at least quintuple by mid-century.

On one level, the enthusiasm is understandable. If hydrogen were freely available, it would be something of a decarbonization wonder. It can make carbon-free fuels for transportation and heating, and power some energy-intensive industries that can't easily be electrified, such as the manufacture of steel or fertilizer (see Feature, page 440).

The problem is that hydrogen is not freely available. On Earth, it exists mostly in molecules bound to other elements, from which it must be extracted at huge energetic cost. Policymakers should beware potential unintended negative consequences for both people and the planet from an overwrought dash for hydrogen.

Most hydrogen is currently made by processes — such as steam reformation of natural gas (methane) — that produce large amounts of CO_2 as a by-product. Although 'green' hydrogen can be made by using electricity from renewable sources to split water molecules, this process is costly compared with more conventional production methods.

"Policymakers should beware potential unintended negative consequences for both people and the planet."

It can also be an inefficient use of renewable resources. Using green electricity to make hydrogen at times of peak demand, when that energy could be feeding the grid and displacing electricity generated from fossil fuels, could result in higher overall emissions than intended. Making hydrogen with electricity generated from unabated use of fossil fuels would be even worse.

All this means that hydrogen should be used judiciously, to address emissions that can't be eliminated in other ways. Many of the uses being touted do not tick that box. For example, some groups are advocating burning hydrogen to heat homes, as an alternative to natural gas, but this is much less efficient than using electricity directly. Most immediately, this means higher costs for consumers. But it also means that using even truly green hydrogen to heat homes displaces a smaller chunk of current CO_2 emissions than would using it for other tasks, for which there are no alternatives.

Hydrogen-powered cars and vans are another case in point. The European Union has just joined many countries in reaching a deal to ban the sale of cars and vans powered by internal-combustion engines. By 2035, all new cars in the bloc will be zero-emission, as part of the 'Fit for 55' drive to reduce carbon emissions by 55% by 2030. But industry groups and some governments would like to continue to allow vehicles that run on hydrogen-based 'e-fuels'. These fuels could one day be an effective tool for decarbonizing certain heavy-duty lorries, large ships, aeroplanes and other forms of transport for which battery technologies are not currently fit for purpose. But they are a distraction when it comes to personal vehicles, for which efficient batteries are already available.

The EU is also under pressure from industry to water down the definition of green hydrogen, and to subsidize ways of making the gas that still carry unacceptable rates of emissions, as part of Fit for 55. That smacks of past occasions when the bloc has adopted policies that looked environmentally sound on paper but came with considerable small print. Counting energy from wood derivatives as renewable, for example, has caused the destruction of woodland in Europe and elsewhere, without a positive impact on carbon emissions.

The United States has set a better example with August's passage of the Inflation Reduction Act, which subsidizes the production of true green hydrogen by up to US$3 per kilogram, and gives lower subsidies to dirtier versions. Globally, however, hydrogen production and trade would benefit from clear, uniform rules for how hydrogen should be made and under what circumstances its use is beneficial. The Hydrogen Council, an industry group based in Brussels, is pressing for international standards and certification systems for green-hydrogen production.

Such standards should be fast-tracked. But, when setting net-zero strategies, policymakers should not lose sight of the ultimate aim: to stay within a total carbon budget compatible with the Paris climate agreement. Attractive as it may look — and as real as the opportunities may be, for example in decarbonizing heavy industry — often the answer is not hydrogen.