

# Hydrogen Has a Long Way to Go to Be Green

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Despite all the hype over green hydrogen, most of the gas supplied now is decidedly not green. The path to cleaning it up is long.

Hydrogen announcements are coming thick and fast. This week alone, hydrogen-powered double-decker buses arrived in Aberdeen, Britain's oil capital; **Hyundai** delivered seven fuel-cell hauling trucks to Switzerland; and **Toyota** joined with **Hino** to develop hydrogen-powered big rigs for the U.S.

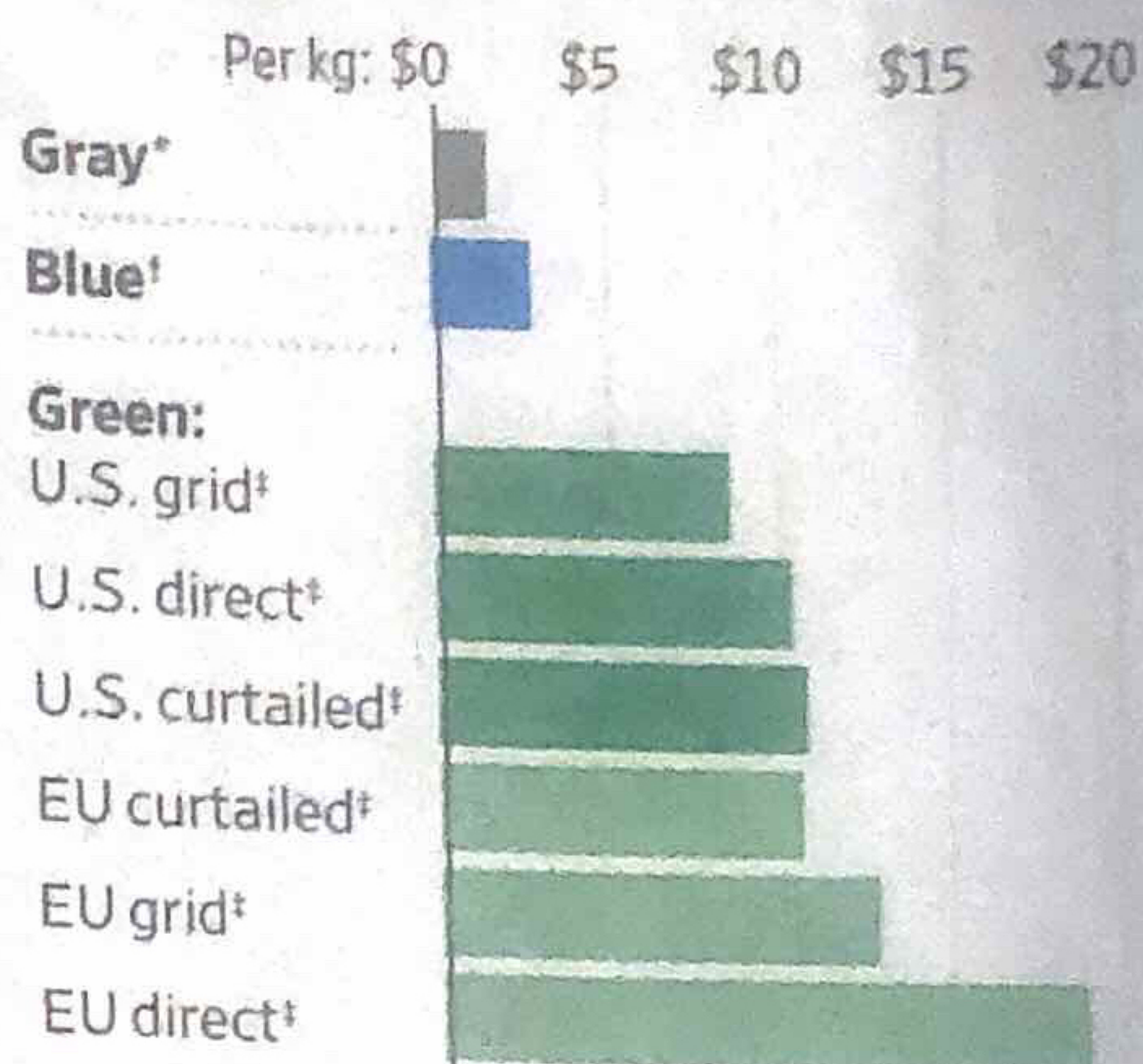
Using hydrogen in a fuel-cell vehicle doesn't create emissions, but producing it can. That means green credentials for these projects rely on the availability of clean hydrogen fuel. In the short run, this is very limited. There are plans for more than 60 gigawatts of green hydrogen production globally, but less than half will be available by 2035, say researchers at Rystad Energy. Making the gas generates more carbon emissions globally than the airline industry, according to Bank of America.

Colors denote how hydrogen is produced. Green versions are made by electrolyzing water using renewable energy—wind, solar or biomass. Gray uses natural gas, which becomes blue if the carbon dioxide is captured and stored. Right now, in most places, green hydrogen is much more expensive to produce, costing between \$9 to \$19 a kilogram, according to an International Council on Clean Transportation study. That compares with \$3/kg for blue and \$1.50/kg for gray, according to Adam Collins at brokerage Liberum Capital.

Whatever the color, making hydrogen is energy-intensive and power accounts for most of the production costs. The competitiveness of the production methods will therefore depend on how local prices of power, gas and carbon evolve. The cost of green hydrogen is expected to halve by 2030 as the technology is scaled up and renewables become more plentiful.

Three industrial gas giants—**Air Liquide**, **Air Products** and **Linde**—

Median production costs of hydrogen



\*Made with gas †Made with gas & carbon capture ‡Renewable energy, which can be a) connected direct to the H2 producer b) taken from the electricity grid, or c) excess electricity that would be curtailed.

Source: International Council on Clean Transportation, Liberum

supply most of the world's hydrogen fuel, nearly all of it gray. It is a small business line for them, supplying mostly refineries and ammonia makers. The Hydrogen Council estimates usage of the gas could increase nearly sevenfold by 2050.

Gray hydrogen is likely to dominate at the start. To reach anything near those growth ambitions while meeting climate goals, however, both green and blue hydrogen will be needed in abundance. Local resources influence the color chosen: Green will be more cost-effective in windy Northern Europe or sunny Australia, while the gas-rich Middle East, Russia and the U.S. will likely focus on blue.

Big rigs and buses are likely to be the first market to mature as they scramble to meet tightening emission standards. Hydrogen-powered trains are being tested in Europe. Even Airbus recently unveiled long-term plans to build hydrogen-power planes. Such projects are getting bigger and appearing in a range of industries. However, it will be years before many reach an industrial scale, and their capacity to reduce emissions depends on the evolving technology. Clean versions of the gas do hold great promise, but there are quite a few stops along the way. —*Rochelle Toplensky*