Hydrogen and renewable energy

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Fuel has always powered humankind"s technological advances, from the wood-burning fires first used to cook food to the fossil fuels that propelled the Industrial Revolution and have made modernity possible. But the use of fossil fuels has come under scrutiny in light of their role in climate change.

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Yet hydrogen"s potential contribution to achieving net zero is not lost on organizations and governments. As of December 2023, more than 1,400 large-scale hydrogen projects have been announced globally, amounting to $570 billion in direct investments. In Europe, where $193 billion worth of investments in hydrogen projects has already been made, McKinsey expects hydrogen to play a significant role in meeting decarbonization targets.

How, exactly, might hydrogen play a role in decarbonizing industries? What are the types of hydrogen energy, and what"s standing in the way of widespread adoption? Read on to find out.

Renewable hydrogen is hydrogen derived from water. It"s created using a process called electrolysis, wherein electricity from renewable sources is used to split the hydrogen molecules from the oxygen molecules in water. Because the electricity used here comes from renewable sources, there are no greenhouse gas emissions. Renewable hydrogen is also known as green hydrogen.

Renewable hydrogen is a relatively new technological development. Traditionally, most of the world"s hydrogen has been derived from fossil fuels, such as coal or natural gas. Traditional production methods, such as steam reforming (where natural gas is treated with steam in the presence of a catalyst, such as nickel), produce greenhouse gases (called "gray hydrogen") that will need to be captured or offset in the future. If the carbon produced in these processes is captured and stored, the resulting hydrogen is called "blue hydrogen."

Renewable hydrogen will be critical to the energy transition. Production costs are expected to fall by approximately 30 percent by 2030. After 2024, nearly all new hydrogen production is expected to create clean (that is, green or blue) hydrogen. By contrast, the production of gray hydrogen is projected to be significantly more expensive with the inclusion of carbon costs. As a result, McKinsey anticipates that by 2050, clean hydrogen could account for 75 to 90 percent of total hydrogen demand.

The aviation sector also faces serious pressure to meet its goal to decarbonize by 2050, and hydrogen energy can help. This industry is expected to account for up to 15 percent of hydrogen-based energy demand by 2050, due to the high demand for synthetic kerosene that can be used as jet fuel.

For the long-haul transport industry, the hydrogen combustion engine could potentially help it meet regulatory challenges. While we"re still a long way from widespread adoption, hydrogen combustion engines could represent a relatively easy switch from internal combustion engines--as opposed to engines that run on batteries or fuel-cell technology. What"s more, these engines could draw on the automotive industry"s existing supply chains, production capacities, and skills and knowledge within its workforce.

The hydrogen value chain is both complex and capital-intensive. Many segments of the value chain are not yet developing at the same rate--for those technologies and regulations that are developing quickly, staying up to date can be a challenge. There is also a significant degree of uncertainty around hydrogen demand in new applications, which stems from a lack of clarity in government incentives, slow development of infrastructure, and competition with other decarbonization technologies.

What"s more, hydrogen energy does produce emissions, but the amount varies widely and is easier to control than that of other energy production methods. For example, green hydrogen can be produced from 100 percent solar and wind power in renewables-rich regions and delivered to any refueling station.

That said, the reason hydrogen is not currently making a meaningful contribution to decarbonization is because of too little investment. By 2030, $460 billion in further investment in hydrogen is needed to achieve a pathway to net zero. This investment gap breaks down into three categories: