

JOURNAL REPORT | TECHNOLOGY

# Betting On Hydrogen

Major energy companies and countries see a bright future for the fuel

By Giulia Petroni and Dieter Holger

**A**s the oil-and-gas industry struggles to secure its place in a world shifting away from fossil fuels, major energy companies are making a grab for the rising hydrogen market. Hydrogen is expected to play a vital role in slashing emissions in a number of highly polluting industries that now face strict climate targets. The fuel, which burns clean when mixed with oxygen in a fuel cell, can power households, factories, cars, ships and planes. There are still significant hurdles facing hydrogen, but major oil companies in Europe, including Royal

Dutch Shell PLC, BP PLC and Repsol SA, are ramping up their investments. They're betting that their expertise and infrastructure can give them an edge in this growing market, and they see government aid and profits down the road. "Large-scale usage of hydrogen requires build out and operation of not just production facilities, but also compression, transportation, distribution and conversion facilities," says Olav Junttila, managing director at investment firm Nomura Greentech Capital Advisors. "Oil-and-gas companies generally excel in one or more of these areas, and can translate that expertise

into leadership positions within hydrogen."

## The state of the industry

Hydrogen now supplies less than 5% of the world's energy—most of it used for oil refining and chemical production—but research firm BloombergNEF says it could reach nearly a quarter of global energy consumption by 2050 with strong government policies promoting it. By then, the fuel could generate more than \$2.5 trillion of direct revenue annually, according to the Hydrogen Council, a trade group that includes oil-and-gas majors.

At least for the next two decades, hydrogen will carry higher costs than natural gas because of manufacturing processes that often involve fossil fuels, says Martin Tengler, lead hydrogen analyst at BloombergNEF.

Mr. Tengler says high carbon prices, such as through taxes and credits, are key to making hydrogen profitable and cost competitive over fossil-based sources. This would allow oil-and-gas companies to supply hydrogen to their existing clients in polluting industries—such as steel and cement—contributing to their decarbonization. "This is where the opportunity lies for oil-and-gas companies," he says.

Most hydrogen being produced today isn't carbon free. The majority is made from processing fossil fuels—"gray" or "brown" hydrogen, or "blue," which is made through captured carbon dioxide. Less than 1% is "green," made from renewable resources, and carbon free.

Shell has recently outlined a cost-cutting plan and restructuring of its business to focus more on low-carbon markets—including hydrogen—in the coming years as it grapples with the effects of the pandemic on profit and fossil-fuel demand.

Among other strategies, the Anglo-Dutch company said it plans to increase production capacity for green hydrogen 10-fold at its Rhineland refinery in Germany by 2030.

Meanwhile, Repsol, Spain's largest energy company, is also scaling up investments in renewables and hydrogen. As part of its goal to cut emissions to net zero by mid-century, the company pledged to spend a quarter of its capital expenditure on low-carbon projects through 2025, with the majority going to renewables.

The company said this year it would invest €60 million, equivalent to \$70.5 million, to build a plant in Northern Spain that creates ultra-low-emission fuels by combining green hydrogen from wind power with carbon dioxide captured at a nearby Petronor refinery.

Repsol says the new synthetic fuels could power the combustion engines already in cars, airplanes, trucks and other machinery.

Another oil major that has pledged net zero emissions by 2050—BP—aims to have a 10% share of the blue and green hydrogen market in certain regions by 2030, says Dev Sanyal, the company's executive vice president of gas and low-carbon energy. The company has no plans to make gray hydrogen in new projects.

By 2050, BP expects a mix of both blue and green hydrogen to dominate the hydrogen market, accounting for 6% to 15% of the world's energy consumption. "The next evolution of gas is the decarbonization of it," Mr. Sanyal says.

Oil-and-gas companies will probably first go into blue hydrogen made as a byproduct of natural gas through captured carbon dioxide, due to the cost advantages, says Steve Angel, CEO of Linde, which runs around 600 miles of hydrogen pipelines, mostly in the U.S., and counts oil companies among its top clients.

One big advantage oil-and-gas companies have in the hydrogen effort is infrastructure. Due to its low density, hydrogen is hard to store on a large scale or transport via road or ship, but it flows about three times faster than natural gas in pipelines, making them a good option for large-scale transport, according to the U.S. Department of Energy. That means oil-and-gas majors can use their existing infrastructure—or add pipes to it—to transport the fuel.

But, as was historically the case with renewables, there is a big hurdle involved in the hydrogen efforts—and the cleaner versions of hydrogen are the most expensive. Estimated costs for blue hydrogen are around €2 per kilogram (roughly \$2.35), and for green €2.5 to €5.5 (roughly \$3 to \$6.50). In comparison, brown or gray stands at around €1.5 (about \$1.75), according to the European Commission.

Some analysts caution that profits from hydrogen won't be as lucrative as natural gas or even renewable electricity.

"It is not an attractive option for oil-and-gas companies because of low margins, but it is inevitable" due to government climate-change policy, says Mike Parr, owner of PWR, a small U.K.-based energy consulting firm.

The European Union is taking steps to aid the industry. The bloc has put hydrogen at the heart of its strategy to slash greenhouse-gas emissions by at least 55% by 2030 and become climate neutral by 2050; it says its cumulative investments in renewable hydrogen could reach between €180 billion and €470 billion (roughly \$212 billion to \$552 billion) by midcentury, and €3 billion to €18 billion (roughly \$3.5 billion to \$21 billion) for low-carbon fossil-based hydrogen.

In the U.S., hydrogen could get a boost if Democratic presidential nominee Joe Biden wins come November. His \$2 trillion climate-change plan proposes \$400 billion into new technology, including green hydrogen.

Chevron Corp., one of America's top oil makers, signaled earlier this year it might invest more in the space since regulations, auto-maker goals and technology have improved.

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## Four Shades of Hydrogen

Oil-and-gas majors are ramping up investment in "green" hydrogen, made from renewable sources, as the energy market continues to shift away from fossil fuels. Here's how green hydrogen is made and how it compares with other forms of this clean-burning fuel.

**Green Hydrogen**

- 1 A Clean Start:** Hydro, wind or solar power is used to generate clean, renewable energy to power the production process.
- 2 Electrolysis:** Water is pumped through an electrolyzer that splits water molecules into hydrogen and oxygen.
- 3 Multiple Uses:** Once the hydrogen is collected from the electrolyzer, it can be used to power homes, cars, planes, ships and factories. No carbon emissions are released into the atmosphere.

**Hydrogen color categories**  
Other types of hydrogen include Blue, Gray and Brown, depending on their energy sources, production processes and whether their production releases carbon dioxide into the atmosphere.

**Blue Hydrogen**  
Natural gas or coal is used to produce hydrogen through processes such as steam methane reforming, partial oxidation and coal gasification. The carbon dioxide resulting from the process is captured and stored.

**Gray Hydrogen**  
Natural gas is used to produce hydrogen through steam methane reforming or partial oxidation. The carbon dioxide resulting from the process is released into the atmosphere.

**Brown Hydrogen**  
Coal is used to produce hydrogen through gasification. The carbon dioxide resulting from the process is released into the atmosphere.

**Production processes**

Process	Step 1	Step 2	Step 3	Outcome
<b>Steam methane reforming</b>	1 This process usually uses natural gas as a source of methane to produce hydrogen.	2 Methane reacts with steam in the presence of a catalyst to produce carbon oxides and hydrogen.	3 The outcome: Carbon dioxide and hydrogen are the products. This process produces Blue Hydrogen when the carbon is captured and Gray Hydrogen when the carbon is released into the atmosphere.	Hydrogen Color Category: Blue/Gray
<b>Partial oxidation</b>	1 Methane from natural gas is used to produce hydrogen.	2 A mixture of natural gas and air is partially combusted, creating a gaseous mixture that includes hydrogen, carbon monoxide and carbon dioxide.	3 The outcome: Carbon dioxide and hydrogen are the products. This process produces Blue Hydrogen when the carbon is captured and Gray Hydrogen when the carbon is released into the atmosphere.	Hydrogen Color Category: Blue/Gray
<b>Coal gasification</b>	1 Coal is transformed to produce hydrogen.	2 Coal reacts with oxygen and steam under high pressure and temperature to form a mixture of hydrogen, carbon dioxide, carbon monoxide and water vapor.	3 The outcome: Carbon dioxide and hydrogen are the products. This process produces Blue Hydrogen when the carbon is captured and Brown Hydrogen when the carbon is released into the atmosphere.	Hydrogen Color Category: Blue/Brown