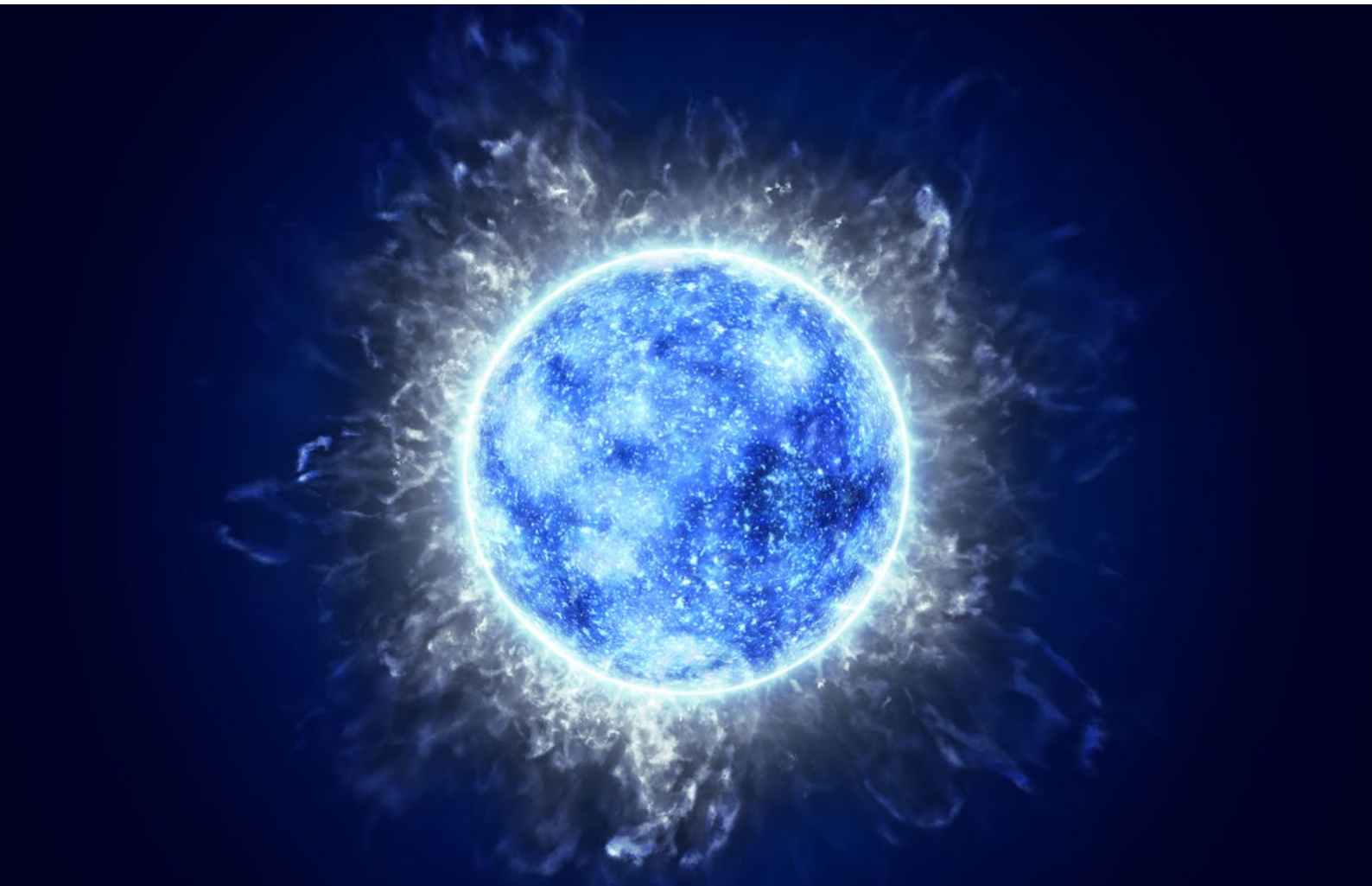
WORLD ENERGY COUNCIL

Innovation Insights Brief | 2019



NEW HYDROGEN ECONOMY - HOPE OR HYPE?

NEW HYDROGEN ECONOMY, HOPE OR HYPE?

Hydrogen and fuel cell technologies have experienced cycles of high expectations followed by impractical realities. This time around, however, falling renewable energy and fuel cell prices, stringent climate change requirements and the discrete involvement of China are step changes. The combination of these factors is leading to realistic potential for hydrogen's role in the Grand Transition.

Having conducted exploratory interviews with leaders from all around the globe, the World Energy Council is featuring eight use cases which illustrate hydrogen's potential. These range from decarbonising hard-to-abate sectors such as heat, industry and transport to supporting the integration of renewables and providing an energy storage solution. Still, their success is not only based on the step changes described above, but also depends on the following factors:

1 RECOGNISING HYDROGEN AS A WHOLE SYSTEM TRANSITION SOLUTION
Whether hydrogen's full potential is deployed or remains limited to niche applications depends on the adoption of long-term energy strategies and cross sector cooperation.

2 UNLOCKING SUSTAINABLE PRODUCTION PATHWAYS
Economically viable and less carbon-intensive processes alternatives to steam methane reforming and coal gasification are emerging. They still face considerable cost challenges.

3 BUILDING AN INTERNATIONAL HYDROGEN MARKET
There are growing opportunities for international hydrogen production and trade on a global scale, for which several countries are well positioned to participate. Long distance transportation challenges remain to be answered.

4 ACHIEVING COST EFFECTIVENESS
Considerable improvements are still required for hydrogen to become truly cost competitive. Recent government commitments for large-scale production and consumption of hydrogen are rapidly establishing deep foundations for a hydrogen economy.

5 DEVELOPING INFRASTRUCTURE
The successful adoption and commercialisation of hydrogen and its role in succesful energy transitions relies on strategically integrated infrastructure and storage solutions. The most important elements of the hydrogen infrastructure are points of production, transmission and distribution systems and refuelling station networks.

This brief digs deeper into each use case, followed by a detailed analysis for each success factor. The brief will also provide a future outlook based on different current uncertainties and end with next steps for the Council.

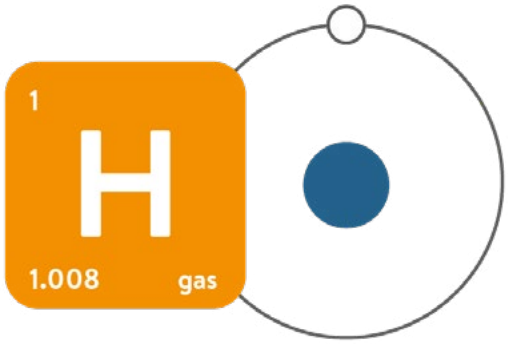
“THE MOMENT HAS COME TO DEVELOP AND DEPLOY RENEWABLE HYDROGEN AT INDUSTRIAL SCALE. WITHIN ENGIE, WE EXPECT TO DEVELOP A VALUABLE AND SUSTAINABLE BUSINESS FOR THE WHOLE HYDROGEN ECOSYSTEM. WE THINK THAT IN ORDER TO FULLY UNLOCK THE POTENTIAL OF RENEWABLE ENERGY WE NEED TO STORE LARGE QUANTITIES OF IT.”

MICHELE AZALBERT,
ENGIE

“THERE USED TO BE A CONCEPTION THAT A LOW CARBON ENERGY SYSTEM WOULD BE BUILT AROUND ONE PARTICULAR ENERGY VECTOR. TODAY, WE RECOGNISE THAT THE ROLE OF HYDROGEN IS A MORE NUANCED AND SOPHISTICATED ONE.”

NIGEL BRANDON,
IMPERIAL COLLEGE LONDON

WHAT IS HYDROGEN?



LIGHTEST AND MOST ABUNDANT

Hydrogen is the first element in the periodic table. It is the lightest, most abundant and one of the oldest chemical elements in the universe.

NEVER ALONE

On Earth, hydrogen is found in more complex molecules, such as water or hydrocarbons. To be used in its pure form, it has to be extracted.

FUEL OF STARS

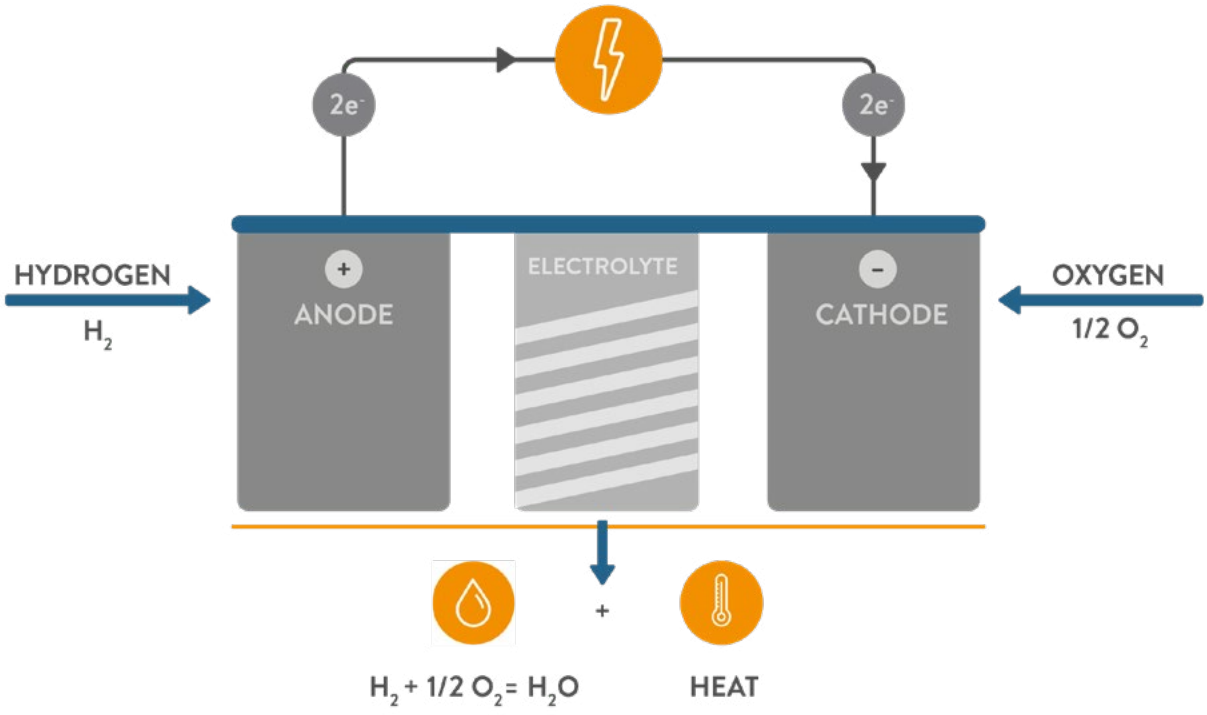
Hydrogen fuels stars through nuclear fusion reaction. This creates energy and all the other chemicals elements which are found on Earth.

HOW IS IT USED?

Hydrogen is not a source of energy but an energy carrier. It must be produced and stored before use. This molecule of gas that stores energy can restore it in several ways:

1. COMBUSTING IT: combusting one kilo of hydrogen releases three times more energy than a kilo of gasoline and produces only water.

2. FUEL CELL: a fuel cell is an electrochemical cell that converts the chemical energy of hydrogen and oxygen into electricity through a pair of redox reactions. The waste product of the reaction is water. Fuel cells can produce electricity continuously for as long as hydrogen and oxygen are supplied.



HOW IS IT PRODUCED?

Hydrogen can be produced using a number of different processes. The source of energy used and the method define whether it is informally considered grey, blue or green.

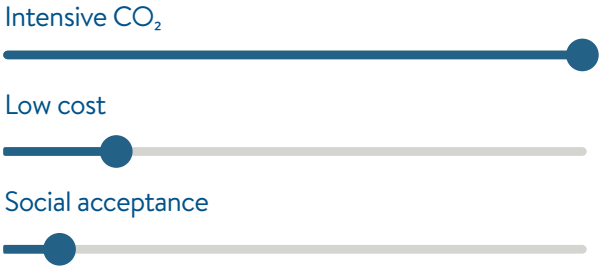
GREY HYDROGEN

Currently, 96% of hydrogen is produced from fossil fuels via carbon intensive processes.

Main production routes

- Steam Methane Reforming (SMR)
- Coal Gasification

Characteristics



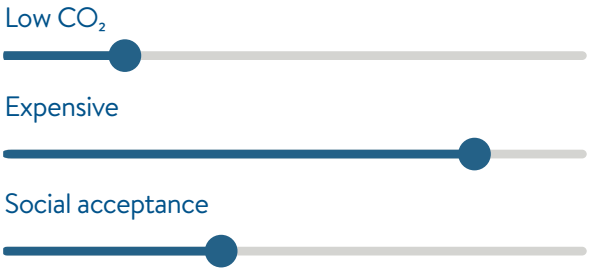
BLUE HYDROGEN

Grey hydrogen whose CO_2 emitted during production is sequestered via carbon capture and storage (CCS).

Main production routes

- \+ SMR + CCS
- \+ Coal gasification + CCS

Characteristics



GREEN HYDROGEN

Low or zero-emission hydrogen produced using clean energy sources.

Main production routes

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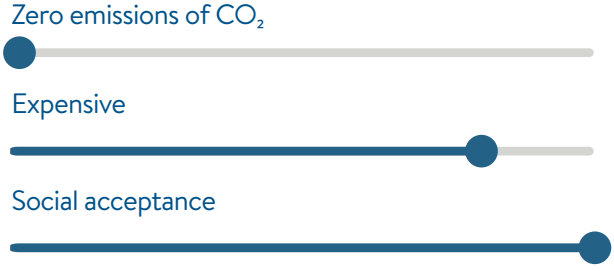
Electrolysis using renewables

Characteristics

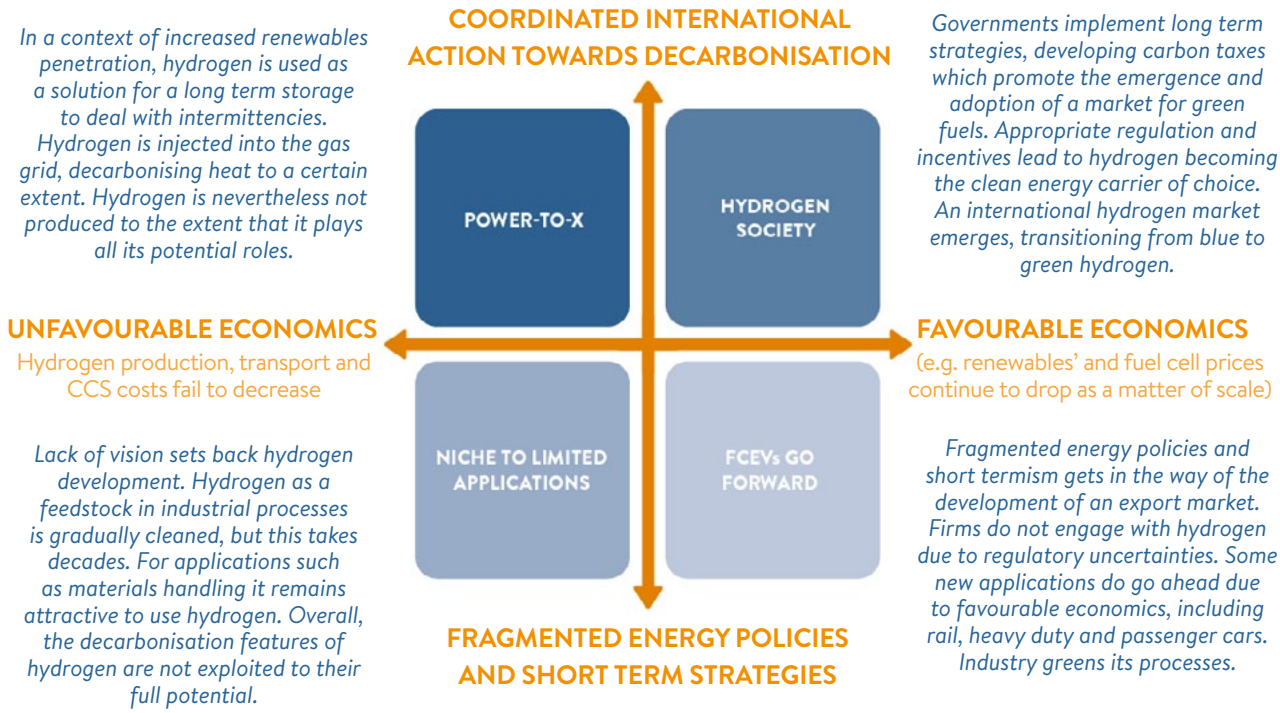


FUTURE OUTLOOK FOR HYDROGEN

Hydrogen is a potential paradigm shifter. Hydrogen can play a major role alongside electricity in future low-carbon economies, with the versatility to provide mobility, power system, heat and industrial services. Whether hydrogen becomes the energy carrier of choice in several decades or delivers specific energy services, it has a role to play in future energy systems.

The intelligence gathered as a result of this work provides a means of setting the scene for the outlook of hydrogen. Given the diversity of production, transport and consumption pathways, a clear government strategy will reduce the costs of introducing hydrogen and fuel cell technologies. The single greatest challenge in realising the hydrogen and fuel cell potential is predictable and consistent energy policy. In addition, cost and performance trajectories rely on what we identified as favourable economics, mostly continued falling renewable prices, performance and cost drop of fuel cells. The combination of sustained government support, technological progress and large-scale investments may well mean that hydrogen is here to stay.

Figure 3: Future outlook for hydrogen



NEXT STEPS

This Innovation Insights brief has touched upon several areas which require further cross-sector and cross-region alignment and cooperation. These include:

- Modernising and harmonising **regulation** to enable hydrogen and fuel cells
- Unlocking large scale **investments** in product development and infrastructure
- Rules of the game for the development of a low-carbon **hydrogen export market**

To progress the discussion on these topics, the World Energy Council will be hosting a series of Innovation Forums (IF) in the upcoming months. To host or join us for this rare opportunity to exchange ideas and challenge assumptions with a diverse group of leaders from around the world, please contact blanc@worldenergy.org.