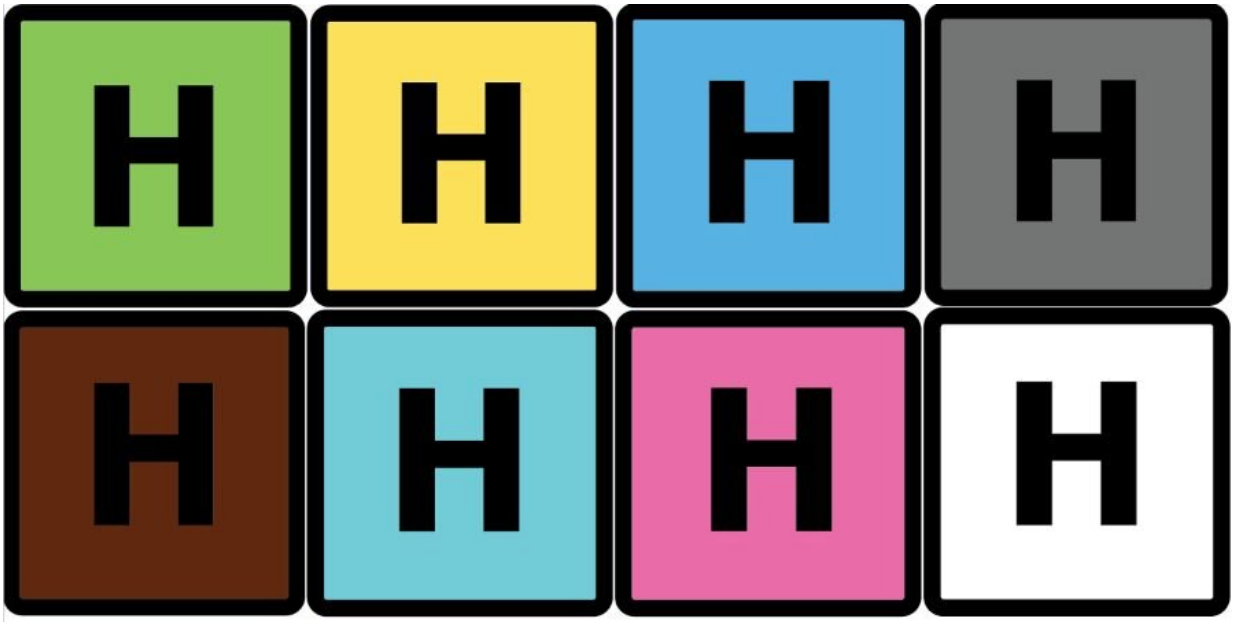
The colors of hydrogen explained

May 17 2022



There are eight colors within the hydrogen rainbow, determined by the source it was produced from and the process used to separate it from that source. Credit: Swinburne University of Technology

Hydrogen has emerged as the energy technology that could help nations like Australia to decarbonize their economies. But did you know that, beyond green and blue hydrogen, there's a whole rainbow of hydrogen types?

Swinburne University of Technology's Victorian Hydrogen Hub (VH2) is delving deeper than anyone has before to explore the extreme limits of

what hydrogen can deliver, including investigating the capabilities of the hydrogen rainbow.

Hydrogen is the most common element in the universe, a colorless, odorless, tasteless yet flammable substance. Despite its massive abundance throughout the universe, it is virtually non-existent in its original form on Earth and requires energy to release it from the material forms where it is found. It forms part of other common chemical compounds such as water (H_2O), methane (CH_4) and ammonia (NH_3), which is often found in fertilizer and cleaning products.

Several chemical processes have been invented to harness the energy of hydrogen, all of which have environmental strengths and weaknesses. The hydrogen industry has assigned colored nicknames to each hydrogen process, based on the source it was produced from and the process used to separate it from that source.

One of the VH2's leading hydrogen experts, Dr. Kim Beasy, takes us on a journey over the rainbow, starting with some of the most commonly-discussed types of hydrogen, ordered from most sustainable to least, before exploring a few more experimental and emerging types.

Green hydrogen

Green hydrogen is produced through electrolysis, a process where electric currents from surplus renewable energy sources (such as solar or wind power) separate water into hydrogen and oxygen molecules. The hydrogen is then stored as an energy vector, which allows the transferring, in space and time, of a quantity of energy.

Because the energy used in this process comes from renewable sources, the process does not release any carbon emissions into the atmosphere. However, green hydrogen is more expensive than gray hydrogen, another

promising form in the industry.

Yellow hydrogen

Yellow hydrogen is a relatively new concept, referring to hydrogen that is specifically produced through electrolysis using solar energy.

Blue hydrogen

Blue hydrogen is produced through steam reformation, a process that uses steam to separate hydrogen molecules from natural gas. This process produces carbon emissions, though most are stored underground or repurposed.

It is sometimes described as "low-carbon hydrogen" as the steam reforming process doesn't actually avoid the creation of greenhouse gases. But unlike gray hydrogen (described below), it promises the cost benefits of steam reformation without the pollution.

Gray hydrogen

Gray hydrogen is produced through steam reformation of natural gas in the same way as blue hydrogen. However, none of the carbon is captured in this process. Instead, all of the carbon emissions are released into the atmosphere.

Brown hydrogen

Brown hydrogen is produced by gasification, where carbonous materials are heated into a gas. This extraction process involves turning coal into gas and produces large quantities of carbon emissions that are released into the atmosphere.

Any hydrogen made from fossil fuels via gasification is often called black hydrogen or brown hydrogen interchangeably.

Turquoise hydrogen

Turquoise hydrogen is extracted through methane via a process called methane pyrolysis, where fossil fuels are heated to such high temperatures that the fuel decomposes into hydrogen and solid carbon, emitting no carbon emissions.

Turquoise hydrogen is similar to blue hydrogen but has only been used experimentally. The hydrogen is captured as a gas, and the solid carbon that falls to the ground can be buried underground or used in industrial processes. The entire process still results in fugitive methane emissions from natural gas extraction.

Pink hydrogen

Pink hydrogen, also known as purple hydrogen or red hydrogen, uses the electrolysis method. However, instead of being powered through renewable energy, it is powered through nuclear energy.

While there are few carbon emissions produced with this method, there can be other environmental impacts such as the production of radioactive nuclear waste.

White hydrogen

White hydrogen is naturally-occurring geological hydrogen found underground through the by-product of industrial processes such as oil or natural gas extraction (fracking).

There is not much known about white hydrogen, with research currently

underway. In its production, there are few carbon emissions created. But, like pink hydrogen, there can be other environmental impacts.

Provided by Swinburne University of Technology