

Hydrogen Color Theory



GRAEBENER
Bipolar Plate Technologies

Hydrogen is of critical importance

with regard to Germany's climate protection targets, among other reasons based on three aspects:

- 1. Hydrogen** is producible and is therefore not only the most abundant element in the universe, it is also nearly **non-exhaustible**.
- 2. Hydrogen** has a high energy density and consequently can **reduce fuel consumption** in the industrial and mobility sectors in a cost-efficient form.
- 3. Hydrogen** is excellent for **storage**.

Depending on the production process, the hydrogen produced has a very **different energy balance**, indicated by the color codes black, brown, gray, blue, turquoise, orange, white, red or green.

On the following slides
we explain what the
different colors are all
about.

Black hydrogen is produced by **hard coal**, brown hydrogen by **lignite**, which is also eponymous.

Even today, over 90% of usable hydrogen is produced using fossil fuels. According to IKEM, around

70 to 100 million tons of CO₂ are released each year in this process

just in the EU.

Gray hydrogen is produced by **steam reforming of coal or natural gas**.

The fossil fuels are converted into hydrogen and CO₂ using heat, while the resulting

emissions are released back into the atmosphere unused

and burden the climate.

Hydrogen that occurs naturally in the earth's crust

is known as white hydrogen and can be made usable by **fracking**, which is still considered to be controversial. Proponents, however, refer to it as „golden“ because it is produced over and over again when underground water reacts with iron minerals at high temperatures and pressures.

Blue hydrogen is gray hydrogen, but its **CO₂** is captured and **stored** during production (Carbon Capture and Storage, CCS). The CO₂ generated during hydrogen production is therefore not released into the atmosphere, and hydrogen production can be considered CO₂-neutral from a balance sheet perspective.

Red hydrogen is produced from **nuclear energy**. On the one hand, „by using electricity through electrolysis, and on the other hand, by using its high-temperature wastewater via the TWS process.“ The latter uses high-temperature heat (e.g., solar and nuclear waste heat) to produce hydrogen from water.

The main disadvantage here is the mining of the required **uranium**, as the **radioactive** element is also **non-renewable** in addition to its hazardous radiation.

Orange hydrogen is produced using **biomass** and is present in organic forms such as accumulating municipal waste. Although **CO₂ is released** again after the usage of orange hydrogen, it is nevertheless more harmless to the environment than hydrogen produced from fossil fuels. However, orange hydrogen does not appear to be very suitable for mass production, as **deforestation, land scarcity and the impact on water resources**, among other things, are major points of criticism.

The process of **methane pyrolysis** generates turquoise hydrogen. In this way, **natural gas** can be separated into hydrogen and solid carbon. Even though **CO₂ is not produced directly** in this process, the required and likewise expensive extraction of natural gas as a basis for this process is a disadvantage.

Using electrolysis, a **water molecule** can be split into hydrogen and oxygen. This method is green because **only electricity from renewable sources** is used. In the long term, this is the only sustainable way of generating hydrogen.

We at Graebener® strongly agree that the future belongs **above all to green-produced hydrogen.**



This is the reason, why we are investing in the development of high-performance **production technology for bipolar plates**, which are also used in electrolyzers to convert electricity from renewable sources into hydrogen and store it.

Do you have any questions
or suggestions?

**Let's meet in the
comments!**



Sources

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