The Basics of Hydrogen

Namibia Green Hydrogen Conference

NAMIBIA NATIONAL CONFERENCE ON

GREEN HYDROGEN (GH2)

16-17 August 2022

Windhoek Country Club

Jointly organised by:

economic association *of* namibia

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NIPDB

Namibia Investment Promotion & Development Board

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Hanns Seidel Foundation

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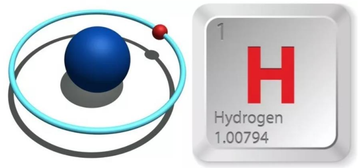
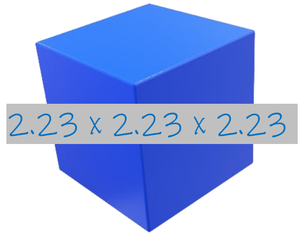
What is Hydrogen?



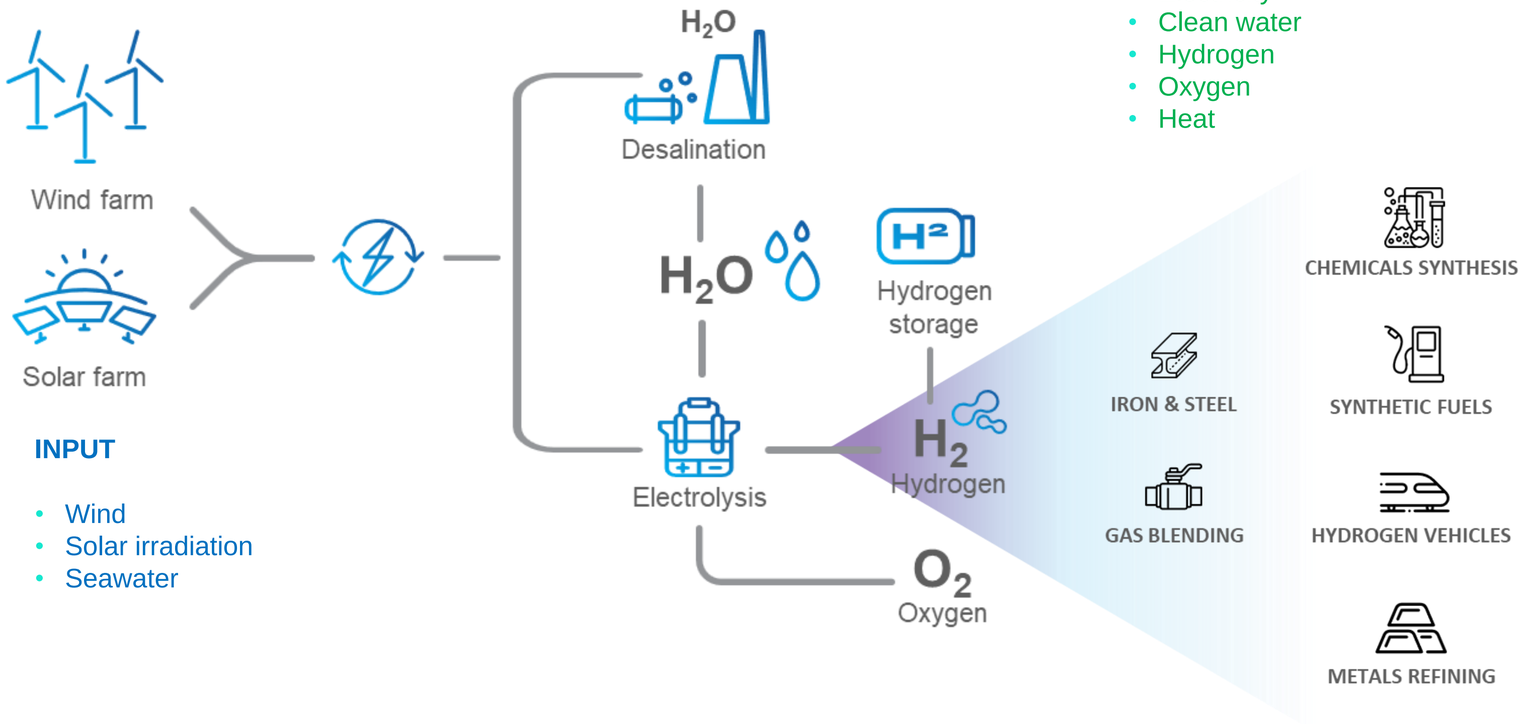


- Density: 89.88 g/m³
  - 1kg at atmospheric pressure ~ 11.125 m³
- Melting point: minus ~ 260 °C
  - Solid to Liquid
- Boiling point: minus ~ 253 °C
  - Liquid to gas

Hydrogen combines with other elements, forming several compounds, including common ones such as

- *water (H_2O),*
- *ammonia (NH_3),*
- *methane (CH_4),*
- *table sugar ($C_{12}H_{22}O_{11}$),*
- *hydrogen peroxide (H_2O_2) and*
- *hydrochloric acid (HCl)*

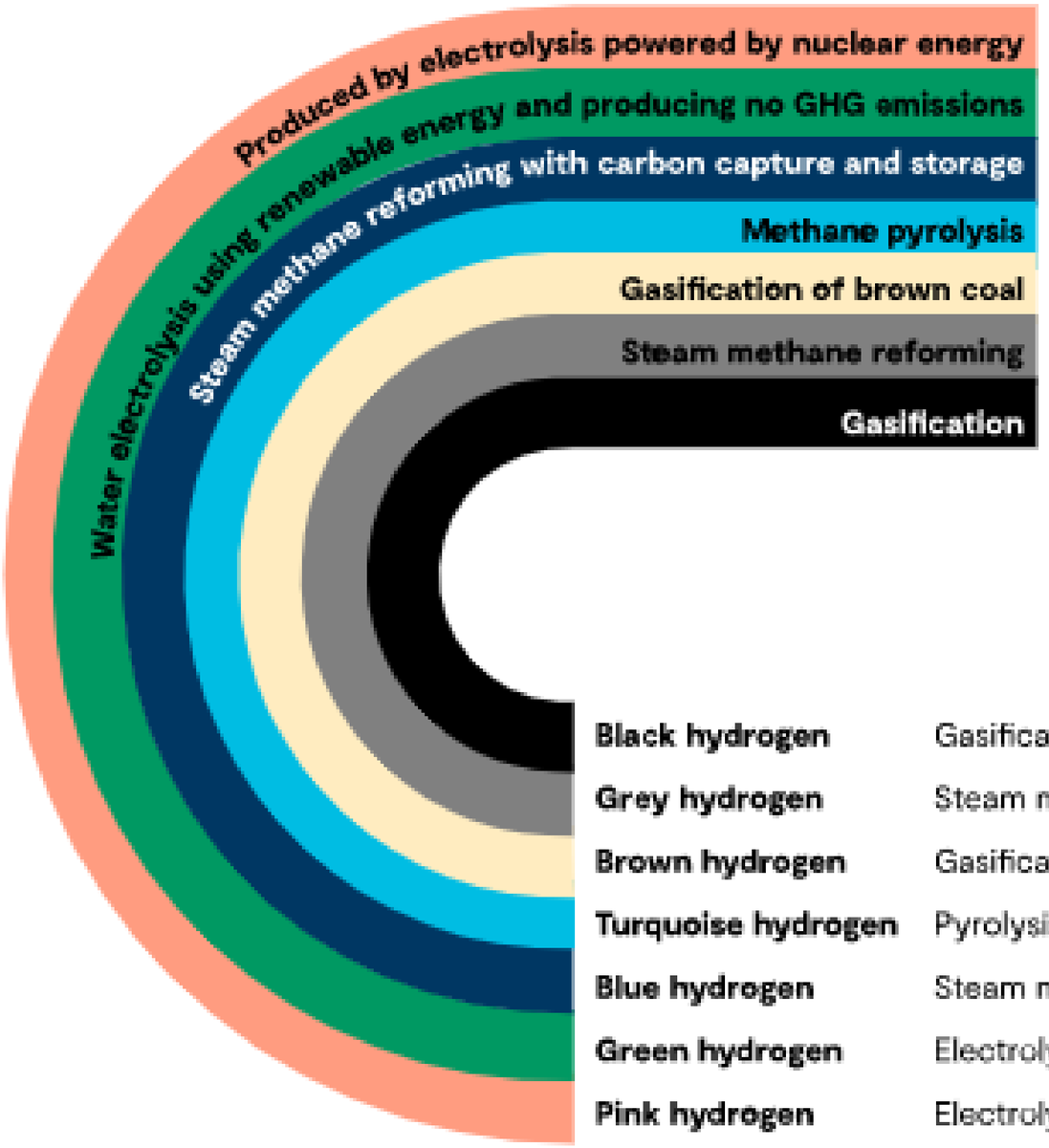
How do we make Green Hydrogen in the desert?



- **9L of clean H_2O per kg of H_2 plus ~51L for cooling, water treatment & wastewater disposal**
- **55kWh of electricity is needed per kg of H_2**

NASA uses hydrogen as **rocket fuel** to deliver crew to space
Hydrogen is an **energy carrier** with no carbon in it, so when burnt, **only produce water**
Hydrogen is used to make **ammonia for fertilizer or explosives, etc**
Or use to reduce Iron-oxide (Ore) to Iron

What is it about all the colours of Hydrogen?



Black hydrogen	Gasification of black coal — emissions to atmosphere
Grey hydrogen	Steam methane reforming, without carbon capture storage
Brown hydrogen	Gasification of brown coal — releases emissions
Turquoise hydrogen	Pyrolysis of natural gas — produces solid carbon as a byproduct
Blue hydrogen	Steam methane reforming, with carbon capture and storage
Green hydrogen	Electrolysis of water powered by renewable electricity, no harmful emissions
Pink hydrogen	Electrolysis of water powered by nuclear energy

IEA (2019). The Future of Hydrogen – Seizing today's opportunities. Prepared for the G20, Japan.

Building our own electrolyser

The overall reaction of the water electrolysis is:

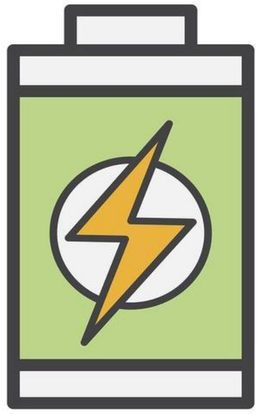
$$H_2O \rightarrow H_2 + \frac{1}{2} O_2$$

The reactions in the cathode and anode sides are:

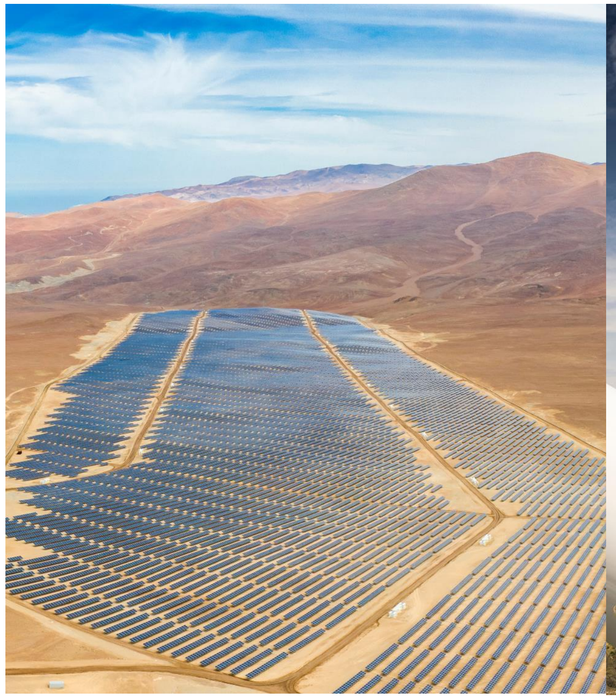
$$H_2O + 2\ e^- \rightarrow H_2\ (g) + O^{2-} \qquad \text{(cathode)}$$

$$O^{2-} \rightarrow \frac{1}{2} O_2\ (g) + 2e^- \qquad \text{(anode)}$$

Warning: Do not do this at home without supervision – hydrogen is EXPLOSIVE and only need a small spark to make a large and damaging BANG!



Thank you for EXPLORING with me!



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