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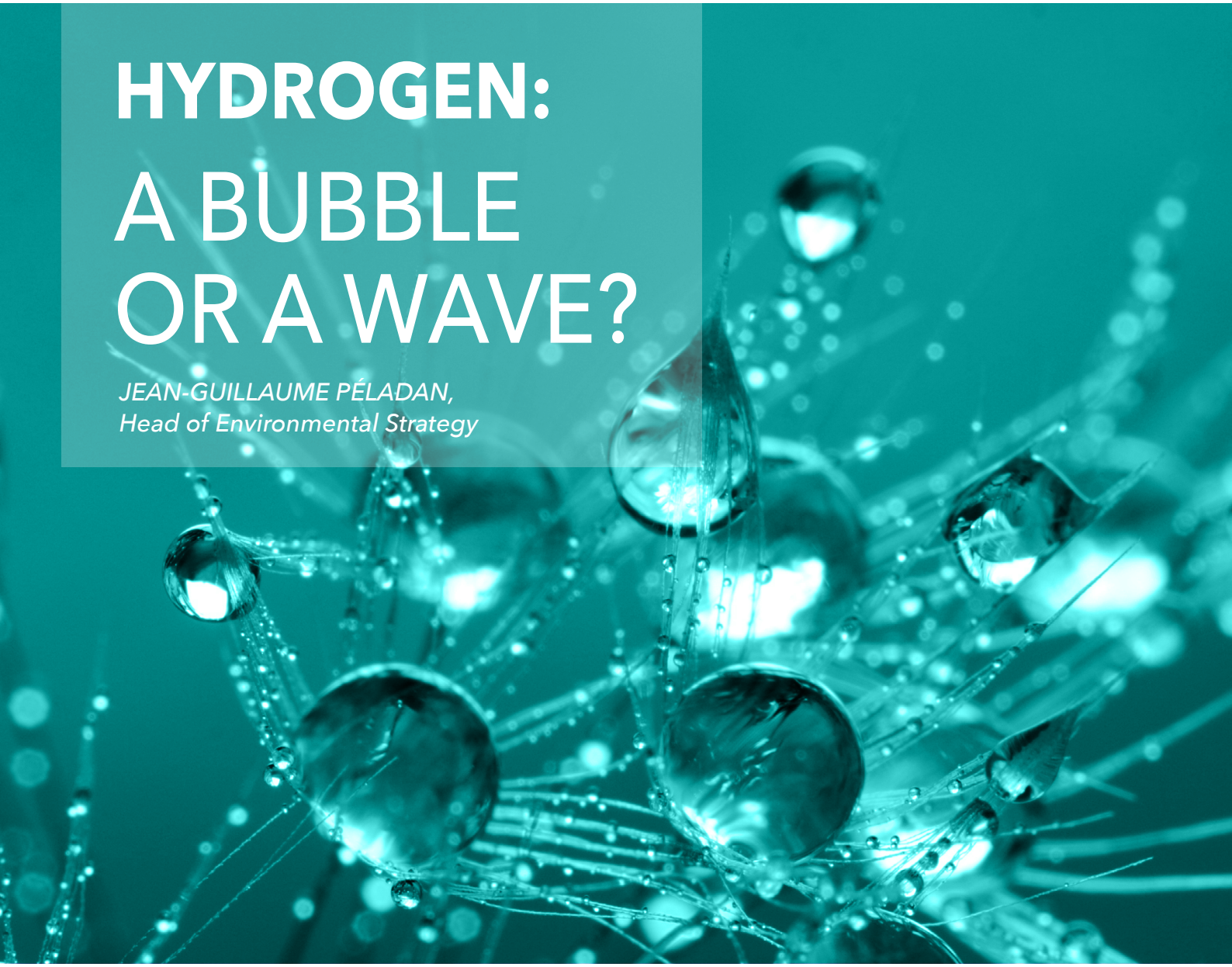
HYDROGEN: A BUBBLE OR A WAVE?

JEAN-GUILLAUME PÉLADAN,
Head of Environmental Strategy



In 2020, markets were in turmoil, hitting record highs and record lows. Our job today is to draw a distinction between the **bubbles that will last** – more akin to waves, and **weaker bubbles** that are eventually doomed to burst. Here, **hydrogen** offers a particularly interesting case study.

Last year saw the emergence of the **4th bubble** on hydrogen after the technology generated much enthusiasm in the 70s, 90s and more recently in 2000. The **share prices** of companies involved in this nascent industry – as shown in the table opposite – surged between 3 and 10-fold and some stocks have already started to fall back to **more reasonable levels**.

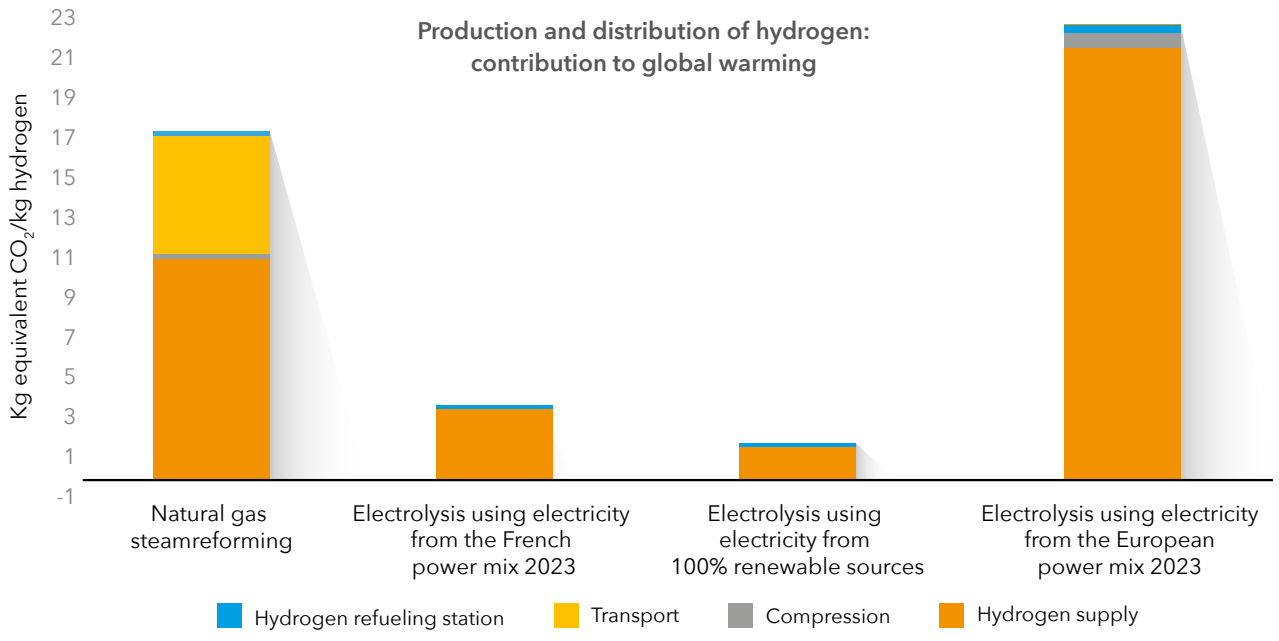
Company	Trend observed in 2020	Multiplying factor
Plug Power Inc.	++	x11
McPhy	++	x9,0
ITM Power plc	++	x5,9
Ceres	++	x4,8
Bloom Energy	++	x3,9
Nel ASA	++	x3,1
Ballard Power System	++	x3,0
Nikola Corporation	++ then --	x 7,7 then division by 6
Hyliion	++ then --	x 5,5 then division by 3,2

++ very sharp rise
++ then – very sharp rise followed by sharp fall

IS HYDROGEN GREEN?

For a clearer insight into this issue, we need to understand whether hydrogen can already deliver proven environmental advantages. Fortunately, the Agency for Environmental Transition[1] recently published the findings of its study on the **impact of hydrogen use for the mobility sector**.

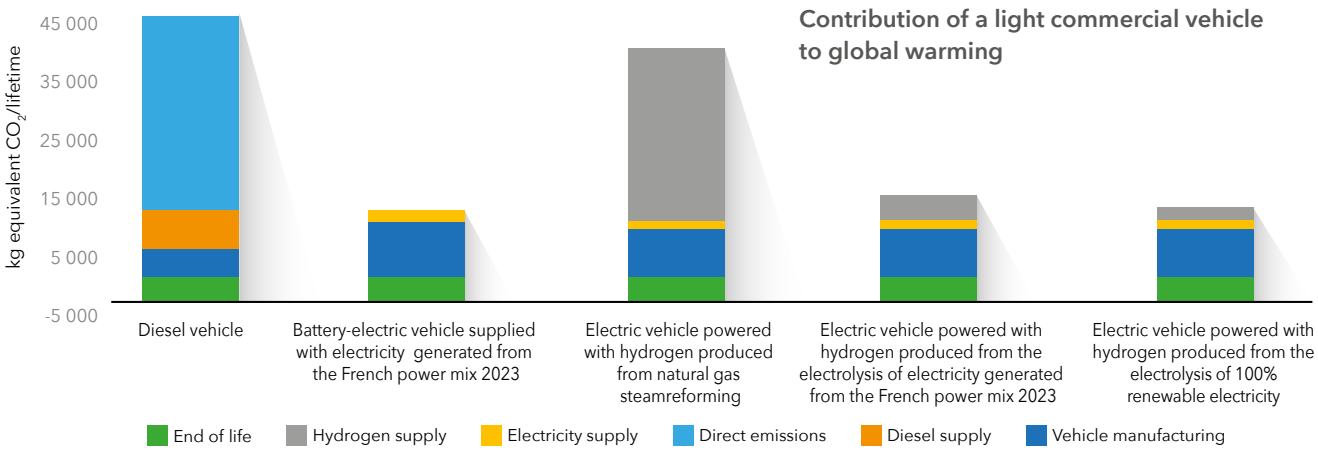
Hydrogen is an **energy vector** rather than a source of energy. Consequently, its environmental impacts – and particularly its greenhouse gas contents – depend on the sources used in its production. This ranges, on the production side, from 1.9 to 22.6 kg of eq. CO_2 per kg of hydrogen, as shown in the table below:



At **the bottom of the scale**: hydrogen produced from electrolysis using 100% **low-carbon** renewable energies, such as **wind farms** or **hydroelectricity**. At the top end: electrolysis using the current European power mix, which has a higher carbon intensity. Finally, **steam-reforming using natural gas is the dominant** practice at present, with 17.5 kg of eq. CO_2 per kg of hydrogen.

1 Formerly ADEME September 2020.

If we add the use by a light commercial vehicle, the results are as follows:



In the case of a D-segment large family car, the results are similar: a car powered by hydrogen produced from the steam-reforming of natural gas will generate 5% fewer greenhouse gas emissions than a petrol-fuelled car. This percentage **shoots up to 74%** if the hydrogen is produced from **electrolysis using electricity from renewable** or low-carbon sources.

We have noted that **light vehicles powered using hydrogen** display a much higher climate impact at the manufacturing stage and that based on a lifecycle analysis, a net gain can only be generated if the electricity is low-carbon. Looking at other environmental impacts, we see rather more **disadvantages** than advantages - with increased pressure on **abiotic** (minerals and metals) **and energy resources** in the case of hydrogen vehicles.

Finally, in both cases – light commercial vehicle and large family car – a comparison with a battery-electric vehicle fuelled by **French power mix 2023 electricity** reveals that hydrogen offers **no actual environmental gain**.

WHAT IS THE OUTLOOK FOR GREEN HYDROGEN?

If the overall **picture** is rather **unfavourable** for **light vehicles**[2] - a segment where electric and plug-in hybrid solutions are natural competitors and are years ahead - the prospects seem rather brighter for **industrial uses** (production of steel, nitrogen fertilisers, glass and cement, refineries, etc) and for **ships, trains and heavier vehicles** (buses, trucks and vans), but only as long as low-carbon electricity is available locally, at a low cost, and that the distribution infrastructure is in place. **But can these conditions be met?**

The availability of cheap and low-carbon electricity has started to become feasible in the long run, but also in the short term, in favourable local situations – for example, close to concentrated intermittent power sources, such as **off-shore wind farms**: the local storage of surplus electricity using the electrolysis of water into hydrogen and oxygen has become an increasingly credible solution. Hydrogen could act as **a "sponge" that would absorb intermittent peaks in production from solar panels or wind farms**.

Timeframes for the distribution infrastructure are much longer and while some hydrogen can be injected into existing natural gas networks, it becomes irreversibly mixed with methane.

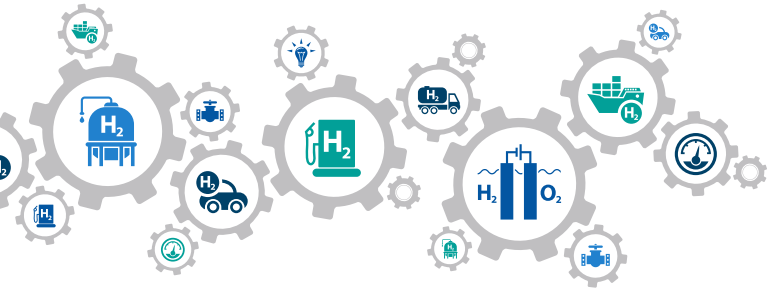
It will be a long road ahead as the **delivery infrastructure simply does not exist**. The first projects were established in the absence of any large infrastructure, as the applications themselves were concentrated: these were local loops, called "hydrogen valleys"[3]. This is the **natural playing field** for the emergence of hydrogen over the short and medium term.

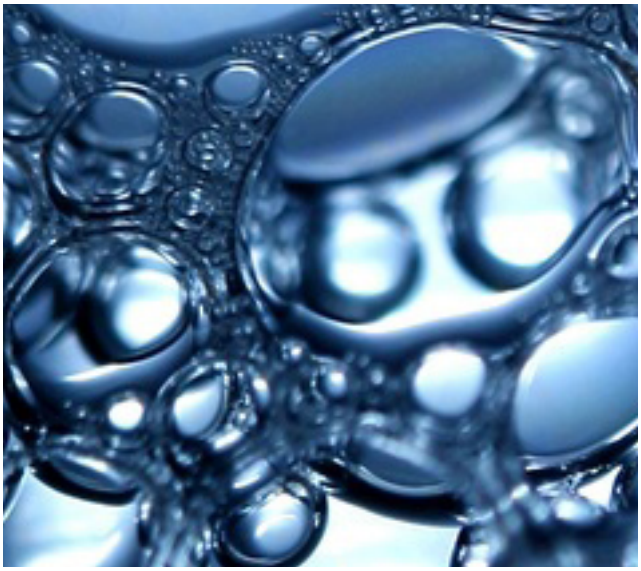
2 Read the October 2020 column by Jean-Marc Jancovici in l'Express
3 Cf. The 32 valleys listed by The Hydrogen Valleys Platform

IN A NUTSHELL

For the time being, the positioning of the hydrogen industry is still **very far from "green"**: 99% of its **current sources** of energy are **fossil-based** (gas and coal) while its current outlets are, on the one hand, oil refineries and desulphurisation (45%) and on the other, the production of nitrogenous fertilisers (40%).

As creativity in marketing knows no limits, **black hydrogen** (produced from coal) or **brown** hydrogen (produced from fossil fuels) is frequently 'rebranded' as **grey** hydrogen, to make it sound more acceptable. New fancies have also appeared with **blue** hydrogen (produced from natural gas with carbon capture and storage), **yellow** and **fluorescent** hydrogen (made from the electrolysis of nuclear power), or **green** (electrolysis of electricity produced from renewable sources) and even **turquoise** (pyrolysis of methane and storage or use of black carbon). **Let's not be taken in by this hydrogen rainbow…**





KEY TAKEAWAYS

- Hydrogen – in all its colours – is undeniably a **fashionable** investment theme. This has led to the formation of a **speculative bubble**;
- The **drastic and long-lasting drop** in **production costs** for renewable electricity, particularly wind-generated electricity, constitutes a material positive change for the economic viability of **green hydrogen** going forward;
- While **hydrogen is an energy vector** that is likely to broaden its **scope**, it is not - and never will be - a source of energy and should not be construed as a technological miracle or a "Holy Grail" for the environmental transition;
- Green hydrogen will have to find its **place among the mix of solutions that will facilitate the environmental transition**, competing with gas, biogas, pumped or battery electricity storage;
- **Many years** will be needed before the uncertainty over industrially-viable technological solutions for each application can be lifted;
- And solving the "chicken and egg" issue of **distribution infrastructure** is more a matter of several **decades**.[4]

Today, we believe it is preferable to **invest very selectively** in applications involving **green hydrogen**, also backed by hydrogen valleys, and in **related peripheral activities**, such as:

- **Robust players in the gas or fuel cells markets** that are considering diversifying from methane to hydrogen, such as GTT which bought Areva H2 Gen in 2020[4],
- **Alternative fuel players**, that can already benefit from industrial infrastructure for production and distribution, such as gas networks, and which are also biogas and hydrogen networks[5],
- The **production of biogas and biofuel** displaying proven environmental performances (for example, avoiding agrofuels derived from palm oil), through companies such as Verbio or Crop Energies AG.

4 The only French manufacturer of electrolysers using Proton Exchange Membrane (PEM) technology.

5 As biogas is simply methane (CH4) produced from renewable sources, and all methane or natural gas networks throughout the world already contain a fraction of hydrogen (in various proportions and with conditions laid down by national legislation) - for example 6% in France, a percentage that could rise to 10% or even 20% by 2030 depending on infrastructure operators.

SYCOMORE AM

14 AVENUE HOCHE
75008 PARIS

WWW.SYCOMORE-AM.COM