Renewable Hydrogen is to become a prevailing energy carrier for the success and acceleration of the energy transition

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Elon Musk would probably not say anymore what he declared 3 years ago, that hydrogen was incredibly dumb. Elon Musk was specifically referring to electrolysis, because in 2015 electrolysis was the only credible and publicly known way to produce renewable hydrogen.

Yet, in 2018, there is an alternative way to produce massive quantities of pure and quite competitive hydrogen (compared to fossil energies): the use of biomass.

In fact, +95% of the hydrogen currently produced in the world is issued from natural gas, a fossil energy directly derived from biomass produced millions of years ago. The production of hydrogen from biomass today actually reproduces in few seconds the combination of millions of years of natural transformation and a reforming reactor. All from biomass!

Until now, biomass was not considered as an option due to crippling technological and economic barriers. HYNOCA®, a disruptive process developed by HAFFNER ENERGY, changes completely the situation. Reliable continuous pure and quite competitive hydrogen, fully compatible with fuel-cells, is now clearly accessible.

After operating several prototypes enabling a technological proof of concept, HAFFNER ENERGY will carry out the construction in 2018 of the first HYNOCA® station, thanks to public support by the French Environment agency ADEME and French Government through PIA program. The total investment amounts 4.9 million euros (6.1 million USD). Startup will occur in 2019.

Why electrolysis cannot cope with the ever-increasing demand of hydrogen?

Until now, renewable energies are mainly used for electricity generation. Electricity is indeed an energetic carrier that makes it very easy to exploit energy from the wind, the sun, and the water. And in fact, electricity generation accounts for almost 90% of the current development in renewable energies.

However, electricity accounts for only 18.5% of the world's final energy. The remaining 81.5% is supplied at 86.2% by CO2 emitting and polluting fossil fuels.

The current electricity demand can be relatively easily and quickly provided by renewable energies, but it will be very difficult, not to say impossible, to ask electricity to replace fossil fuels for uses currently unserved by electricity.

The only known energy carrier that can massively and almost universally replace fossil fuels for applications not using electricity is renewable competitive hydrogen, either in its H2 form or after conversion to green methane.

The main economic and production issues with renewable hydrogen until recently were that electricity had first to be produced, then its energy converted into hydrogen through electrolysis, then again re-converted again into electricity, resulting in a poor overall energetical efficiency.

Electrical consumption for electrolysis comes in addition to electricity consumption to feed pure battery electric vehicles. It is therefore an additional drain of electricity in a situation where it will be difficult to replace all fossil fuels with renewable energies to produce electricity for the current demand.

The only way hydrogen produced by electrolysis could justify a renewable hydrogen status would be to use only renewable electricity produced during off-peak hours, with a demand lower than the offer.

The annual world production of electricity is 24,100 TWh in 2015. If 50% of this total was produced by renewable energies, and 10% of this renewable electricity dedicated to electrolysis, this would only feed 4.3% of the road mobility, with no other use for renewable hydrogen.

What is the advantage of biomass compared to electrolysis?

Biomass is a very economic and abundant primary energy source, typically less than US $ 20 per MWh LHV, which is well below the average price of electricity or even oil. Just to compare, crude oil at 65 USD per barrel costs 40 USD per MWh LHV.

Considering conversion efficiencies of biomass into hydrogen close to 70% with HYNOCA, i.e. at a level comparable to that of electrolysis, the impact of the price of primary energy on the cost of Hydrogen is much lower than that of electrolysis.

This given will allow hydrogen prices to reach the same prices of currently used fossil fuels (now equivalent to 3.5 USD per kg of hydrogen without taxes) in no more than 8 years, whereas hydrogen today on the market is more than twice the price, hindering the move towards hydrogen, especially for mobility.

Another major interest of biomass is that it originally produces syngas, a step before hydrogen, with a cost comparable to that of natural gas. This results in several alternative uses (electricity production, biomethane, boiler feed) that makes such hydrogen production units profitable before the massive deployment of fleets of vehicles. This avoids the well-known chicken and egg problem, which also hinders the development of hydrogen mobility.

What are the limits of biomass?

The earth produces each year more than 73 Giga TOE (ton oil equivalent) of renewable biomass. In comparison, the yearly consumption of Oil is 4,2 Giga TOE.

50% of global worldwide road mobility powered by fuel cells would consume only 2.2% of the total produced biomass, while all the biomass used for food (including livestock), energy and industrial uses (timber, furniture, pulp and paper etc.) represent yearly 7.9% of the total biomass produced on earth each year.

Biomass is often confused with the sole forest and agricultural residues, while it encompasses a much broader whole, and is a perfectly feasible source of energy for massive renewable hydrogen production.

Biomass, in the general sense, will not constitute either a technical or economic limit to the massive development of a renewable hydrogen sector. This sector will be a formidable economic lever in addition to a substantial contributor and accelerator to energy transition.

Can biomass kill electrolysis or battery powered mobility?

Obviously neither of them, quite the reverse.

Electrolysis is a particularly relevant, useful, and effective way to consume intermittent renewable electricity during off-peak hours, providing a good solution to store electricity. This will all the more be necessary with increasing share of intermittent renewable energies, even if electrolysis will surely never, for the reasons mentioned above, supply hydrogen for more than 5 to 10% of the road mobility.

Electrical batteries mobility is ideal for short-distance urban travel and is another relevant solution for consuming electricity during off-peak hours. However, the low energy density of the batteries, implying a reduced autonomy, the charging time which remains higher than 30 minutes, the difficulties in recycling used batteries, and the limited reserves of lithium are as many brakes for a universal development of the pure battery electric vehicles. More lithium would be needed (19 million tons) than all proven reserves (14 million tons) around the world to ensure full mobility worldwide by pure battery electric vehicles.

Hydrogen from biomass, with HYNOCA, paves the way to renewable mobility based on non-fossil hydrogen. The combination of the 3 technologies (batteries, hydrogen by biomass, and hydrogen by electrolysis) are synergetic and will mutually accelerate their growths. New generations of electric vehicles will become increasingly competitive, accelerating the unavoidable end of the more than secular hegemony of vehicles operating with fossil energies.

How long will it take to equip a territory on a countrywide scale?

Early 2020, the first commercial station producing per hour 5kg of fully renewable hydrogen from biomass, fully compatible with fuel-cells, will be commissioned in France.

A period between 10 and 20 years is sufficient to mesh a country when the two following conditions are met:

a) An appropriate regulatory and legislative framework and a strong political drive to do so.

b) An active partnership with at least a large energy or oil company.

A correct territorial mesh of a country like France able to feed 35% of the road mobility, implies the installation of approximately 4000 Hydrogen stations, most of them in urban areas.

Should we create a biomass collection channel?

This channel already exists in most developed countries. It will be necessary to progressively strengthen it, and is in no way likely to “exhaust” or even destabilize the biomass sector, as far as the sector is correctly organized.

Strengthening this sector will generate a strong decentralized circular economy, which for the sole biomass collection and conditioning sector, would create around 68,000 net jobs in France to satisfy 35% of the road mobility with hydrogen from biomass.

Moreover, in a country like France, one third of the road mobility fueled by Hydrogen would result in an economy of 40.2 Mtoe oil importation, which corresponds to a reduction of a yearly 16 billion USD trade balance deficit with the current barrel of oil price.