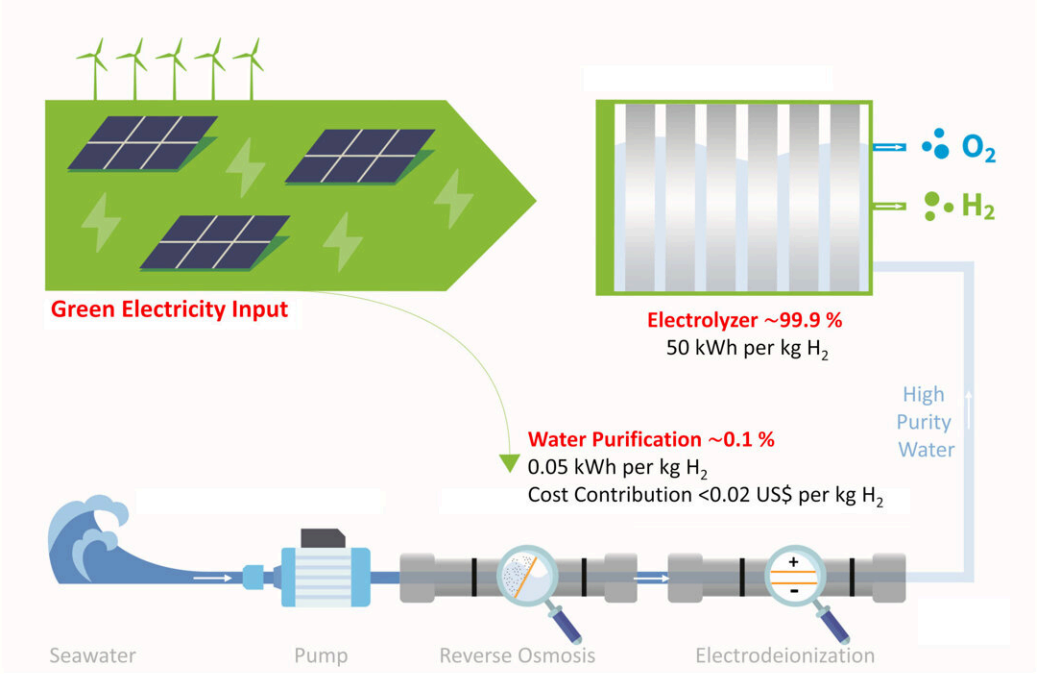
Experts warn against hype for deriving green hydrogen from direct seawater electrolysis

July 26 2024



Comparison of the energy and overall costs of seawater purification and electrolysis. Credit: N. Hausmann/HZB in Joule

At first glance, the plan sounds compelling: invent and develop future electrolyzers capable of producing hydrogen directly from unpurified seawater. But a closer look reveals that such direct seawater electrolyzers would require years of high-end research. Furthermore, DSE electrolyzers are not even necessary—a simple desalination process is

sufficient to prepare seawater for conventional electrolyzers.

In a commentary in *Joule*, international experts compare the costs and benefits of the different approaches and come to a clear recommendation.

Fresh water is a limited resource; more than 96% of the world's water is found in the oceans. If seawater could be fed directly into a future electrolyzer to produce green hydrogen using renewable energy from the wind or sun, it could be a feasible solution. Hundreds of millions of dollars in research funding are spent on this idea, and in 2023 alone, there were more than 500 publications (this number is growing exponentially) on direct seawater electrolysis.

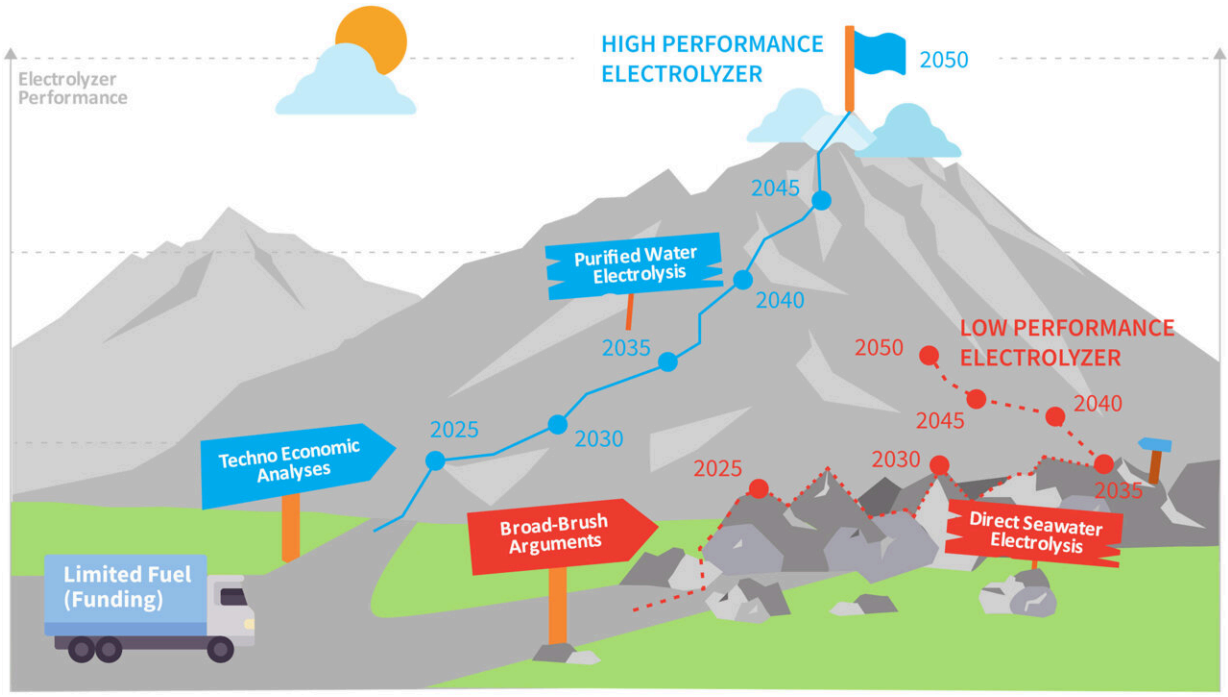
No need for new development

However, a techno-economic analysis shows that this argument collapses as soon as the costs and benefits are analyzed in more detail.

"There is no convincing reason to develop DSE technology because there are already efficient solutions for using seawater to produce hydrogen," says Dr. Jan Niklas Hausmann, electrolysis researcher at HZB and lead author of the *Joule* commentary. International experts from various disciplines from renowned research institutions such as Yale University, universities in Canada, Germany and HZB contributed to the commentary.

It is already possible to use seawater to produce hydrogen. Proven processes such as reverse osmosis can be used to purify seawater for "normal," commercially available electrolyzers. From a thermodynamic point of view, the purification of seawater needs only 0.03% of the energy required for its electrolysis. This is also reflected in the current cost: purifying seawater to produce one kilogram of hydrogen costs less

than two cents. However, one kilogram of hydrogen costs 13.85 euros at German filling stations.



Focusing on the development of direct seawater electrolysis misspends limited funding resources. Credit: N. Hausmann/HZB in Joule

Investing money wisely

The development of new types of electrolyzers that can operate steadily in seawater would only save this cheap purification step. In contrast, the development of DSE electrolyzers is extremely challenging and it is highly questionable that they would ever be able to match the efficiency and long-term stability of today's electrolyzers.

Experts see major challenges here: Seawater contains a wide variety of

organic and inorganic substances that can cause corrosion and fouling, affecting all parts of the electrolyzer. DSE is currently being advertised as a real-world solution for hydrogen production—a promise that cannot be kept and could swallow up a lot of taxpayers' money, the researchers warn.

"We can compare this with the direct use of crude oil to run cars," explains Hausmann. "It is possible to develop such cars, but they would just not be as efficient and long-lasting as ones running on purified petrol. This is despite the fact that the cost of purifying crude oil (via refinery) is up to 16% of the final price of the fuel, which is significantly higher than the relative cost of purifying seawater for electrolysis (