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HYDROGEN ON THE RISE: NAVIGATING CHINA'S ELECTROLYZER DOMINANCE AND GLOBAL RISKS

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The global energy landscape is on the cusp of a profound transformation, with low-carbon hydrogen emerging as a critical pillar in the quest for decarbonization. Though the majority of hydrogen produced currently is from fossil fuels, the surging global demand for low-carbon hydrogen is projected to reach a market size from $26.39 billion (in 2024) to 113.1 billion by 2034. This burgeoning hydrogen economy, however, is increasingly being shaped by a rising, dominant force: China.

An electrolyzer is the key to producing hydrogen, and China dominates the global supply market. For the last six years, the manufacturing capacity of Chinese firms has increased from 5% to 60%, leading China to gain an appreciable edge in the green hydrogen production supply chain. Nowadays, six of the top ten hydrogen electrolyzer manufacturers in the world are Chinese.

China's dominance is particularly pronounced in the mature alkaline (AWE) technology, where it has over 40 years of experience, leading to a highly vertically integrated and cost-competitive supply chain. This has allowed Chinese firms to capture a staggering 85% of the global manufacturing capacity for AWE. While European and US companies have historically held a technological edge in the more flexible proton exchange membrane (PEM) technology, which is better suited to the intermittent nature of renewable power sources but is more expensive, China is rapidly closing the gap. Through substantial state subsidies, Chinese PEM electrolyzer prices have plummeted by 40% between 2022 and 2024, signaling a clear intent to occupy a strong position for potential growth in the future through its production capacity and strategic cost advantage.

China has established itself as a critical player in the global electrolyzer market by leveraging its scale, rapid innovation, and supportive government policies to offer both AWE and PEM electrolyzers at prices that are often a fraction of their Western counterparts. By 2024, China became not only the world's leading hydrogen producer, but also produced nearly half of the global green hydrogen output.

This article explains how China's growing dominance in the hydrogen electrolyzer market is a deliberate national strategy, reflecting a pattern of industrial policy previously seen in China's rise in the solar PV and wind turbine sectors. However, this expansion also brings familiar challenges, including overcapacity, low efficiency, and limited technological adaptability, while simultaneously creating openings for alternative technologies and international partnerships.

PRC's bet on hydrogen

Since 2019, China has made hydrogen fuel a pillar of its EV and clean-energy strategy. That year's State Council Work Report first mentioned "charging and hydrogen refueling facilities," signaling central recognition. By 2023, Beijing designated hydrogen as one of six "industries of the future," alongside AI and advanced materials, to drive industrial modernization. As a result, 22 of 31 provincial work reports explicitly included hydrogen. In 2022, the Hydrogen Industry Medium-and Long-Term Plan (2021–2035) codified this strategy. By this year, China aims for 50,000 fuel-cell vehicles, a nationwide refueling network, and 100,000–200,000 tons of low-carbon hydrogen output annually. Hydrogen

is now framed as a clean fuel and an enabler of industrial transformation and energy security.

National directives have spurred a surge of investment into China's hydrogen sector. State-owned conglomerates such as Sinopec and CNPC have made hydrogen a strategic business focus, with Sinopec launching a ¥5billion ($690 million) venture fund in 2025 to back projects across the hydrogen value chain. Major automakers, including SAIC Motor and BAIC Group, have also incorporated hydrogen fuel-cell development into their broader new-energy strategies. Venture capital and government-guided funds are expanding support for clean-tech startups, reflecting rising investor confidence in hydrogen production and fuel-cell technologies.

Public R&D programs target breakthroughs in fuel-cell stacks and PEM/ALK electrolysis efficiency, while provinces subsidize local pilot fleets and refueling infrastructure. Chinese firms have also begun exporting hydrogen technology. Equipment manufacturers like Hygreen Energy now ship electrolyzers to nearly 30 countries. Engineering giants such as China National Chemical Engineering Group are taking the lead in green hydrogen–green ammonia integrated project projects in Namibia, building a plant with an annual capacity of 2.4 million tons of green ammonia. These deals leverage low-cost Chinese manufacturing and turnkey Engineering, Procurement, and Construction (EPC) packages that bundle technology, workforce training, and financing.

China's electrolyzer industry now dominates globally for roughly 68% of installed manufacturing capacity. Yet, its existing manufacturing capacity of 20 GW per year is significantly above current demand. This has triggered a price war, especially in AWE and PEM units, as firms slash margins to secure contracts, accelerating cost reductions and global diffusion.

The PRC's hydrogen-EV strategy is a textbook case of state-orchestrated industrial policy. Central planning, performance-based subsidies, local competition, and capital mobilization have produced both domestic leadership and international expansion. While overcapacity poses risks, it also ensures Chinese technology sets global price benchmarks.

Potentials for developing alternatives to mitigate the supply chain risk

While China's mass production of AWE and PEM electrolyzers offers a tempting path to affordable green hydrogen, a closer examination reveals critical limitations in these technologies, creating significant opportunities for other nations to innovate and lead in next-generation solutions.

China's own experience highlights these challenges. The country's technologies for both AWE and PEM electrolyzers are mature, but the claimed efficiency was not achieved. A prime example is the world's largest green hydrogen project, Sinopec's 260MW facility in Kuqa, which has reportedly been operating at less than a third of its installed capacity since 2023. The Chinese-made AWE electrolyzers at the site have struggled with a narrower-than-promised operating range, meaning they cannot safely produce hydrogen when solar power input drops below a certain threshold, a frequent occurrence with intermittent renewables. This safety issue highlights the risk of hydrogen mixing with oxygen at low power loads, leading to shutdowns and wasting valuable renewable electricity, thereby making the low-carbon hydrogen produced more expensive.

As one fuel cell industry expert noted during the interview with DSET: "Electrolyzers manufactured in China are affordable, but they exhibit relatively low efficiency. In situations where excess electricity is frequently curtailed or electricity prices are low, conventional AWE can still be a viable option. In other words, although Chinese products are currently affordable, they are not suitable for more demanding operating conditions." This performance gap opens the door for further strategic investment in alternative technologies that are better suited to complex demands like industrial decarbonization. For example, high-temperature environments or scenarios with rapidly fluctuating loads present challenges that these systems cannot effectively handle with AWE and PEM technologies.

Solid oxide electrolyte (SOE) is an emerging hydrogen technology that can leapfrog the current Chinese-dominated scenario. SOE must operate at high temperatures to generate hydrogen, which used to be regarded as the limiting factor due to its narrow application. However, for hard-to-abate industrial sectors, such as steelmaking, SOE is exceptionally promising by utilizing waste heat from industrial processes. A pioneering example is the collaboration between CSIRO, Australia's national science agency, and BlueScope Steel begun in October 2024. CSIRO has successfully trialed its game-changing hydrogen production technology at BlueScope's Port Kembla Steelworks in New South Wales, Australia, and reduced electricity consumption by up to 30%. This demonstrates a pathway for decarbonizing heavy industry that leverages industry symbiosis rather than relying solely on cheap but inefficient electrolyzers.

The growth of AI is also creating another rapidly energy opportunity due to the surge in electricity consumption from data centers. As the leading time of traditional power generators is too long to fit the growing demand of data centers, SOE fuel cells are emerging as a compelling on-site solution to provide the steady, scalable, and grid-independent power crucial for these facilities. Major tech companies like Microsoft and Amazon are already exploring SOE fuel cells to replace diesel generators to ensure operational resilience without fossil fuels. This creates a massive new market for hydrogen technology, not just low upfront cost.

Overcapacity and the repeating logic of China's green-tech dominance

China's dominance in the hydrogen supply chain marks yet another strategic success in its green-tech ascent—driven by rapid state-led expansion, cost compression, and global market capture. In less than a decade, Beijing has seized control of most of the world's electrolyzer manufacturing capacity, particularly in AWE and PEM units. By scaling far ahead of demand and flooding global markets, China has consolidated its influence through affordability and volume. Yet this success comes with familiar trade-offs: over 20 GW of annual output chasing limited demand, and technologies that often underperform in efficiency and adaptability.

The hydrogen sector thus encapsulates the recurring logic of China's green-tech dominance, industrial overproduction as both a tool of global influence and a constraint on technological diversity and system resilience. As hydrogen's role expands from industrial decarbonization to powering data centers and other emerging energy-intensive sectors, investing in alternative technologies and trusted partners will be essential to ensure a secure, diversified, and resilient hydrogen future.

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