The Drivers of Hydrogen's Waves of Hype: Between Security and the Environment

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Proponents continue to frame hydrogen as the "Swiss army knife" of the energy transition due to its versatility. Like most energy carriers, its presumed vitality to the basic functioning of economies in capitalist society makes it a resource that will mediate international political relations. Ambitions to introduce it in the past certainly did so, as the waves of enthusiasm surrounding it in the 1960s/1970s and the 1990s/2000s were deeply interfused with geopolitics. Past attempts to substantiate its role fizzled out, but the chances that a "hydrogen society" will materialise seem much more likely today. With this a new set of politics reflecting goals of greater strategic autonomy emerge.

The extent of hydrogen's penetration of the energy system remains to be seen and by extension its effect on geopolitics as well, but this will be fundamentally shaped by the form it takes. After all, it is an energy carrier that one must produce, which currently relies on the steam methane reforming of fossil gas that can be decarbonised were it paired with carbon capture and storage (CCS)—this is so-called blue hydrogen. Alternatively, electricity can power electrolysers. In a low carbon setting this would either be renewable or nuclear power yielding green and pink hydrogen, respectively. Which sort of hydrogen various actors pursue is driven by an intricate interplay of industrial policy and geopolitics.

The first wave of the hydrogen hype was prompted by a combination of three forces: the idea that nuclear power will be "too cheap to meter", the 1973/1974 oil crisis, and an environmental agenda. The enthusiasm towards the civil applications of nuclear were enormous in the 1950s/1960s, as a number of countries developed the technology to provide citizens with abundant and cheap electricity. However, it did not scale at a pace that would have allowed it to substitute other sources of energy as energy demand also grew quickly. Moreover, it had strong competition from oil propelled by the acceleration of consumerism and the associated democratisation of passenger vehicles. The import-dependence of Western Europe and the USA increased steeply, which would become a huge issue in the 1970s.

The "Western way of living" came crashing down when OPEC imposed an embargo in 1974, leading importers to structurally adjust their economies and the energy upon which energy they relied. Increasing the role of nuclear power seemed to offer a straightforward answer, which they paired with a growing interest in hydrogen. The latter could potentially meet energy needs in sectors that could not readily be electrified, such as transportation. Technologies were available as the US' bid to dominate space exploration led investments into proton exchange membrane (PEM) fuel cells by General Electric for NASA, which General Motors followed with a fuel cell vehicle in 1966. Energy policy decisions were also informed by environmental policy, as the 1972 Stockholm Conference and the *Limits to Growth* raised the matter on government and company agendas.

Thus, the means to pivot from oil were available prior to the energy crisis, but the influence of "Big Oil" and the structural entrenchment of a petroculture impeded radical change. Responses to the shock of the oil crisis would remain within the confines of a deeply fossil fuel reliant global energy regime that was paired with the neoliberalisation of oil's trade. France was a prominent only exception that sought to establish energy sovereignty with the expansion of a vast nuclear programme. Other European countries turned to natural gas imports, diversifying their energy mix, but perpetuating reliance on hydrocarbons. Any impulse to lead change was undermined by

economic hardships and the subsequent boom in oil investment that led to plummeting crude prices during the 1980s.

The second wave began when the Clinton Administration somewhat reinvigorated enthusiasm towards hydrogen by making public funding available for the development of advanced fuel cells. Despite the administration being a preacher of free trade, its interest was largely strategic, as the role of oil imports was increasing and this jeopardised the geostrategic position of the country. This poured onto the Bush Administration's agenda as well, prompting it to launch the National Energy Policy Development Group in 2001 to explore and promote the fuel's potential. The goal was obvious: find a solution to the US' dependence on imported oil. It may have also reduced emissions, but this was secondary.

Europe also dabbled with hydrogen in its bid to lead the global climate agenda, a consideration interwoven with economic and geopolitical drivers as well. The Icelandic Parliament was a trailblazer launching the first comprehensive inquiry on the particularities of a hydrogen society in 1998 to shake its reliance on imported oil and move to an entirely self-sufficient and green economy, but this has been a long, dragged-out undertaking with limited results. Meanwhile, the EU proposed that nuclear and renewable energy-based hydrogen could help reconcile economic growth and environmental destruction, while also allowing for the bloc to reduce its dependence on imported hydrocarbons at the turn of the millennium.

Leaders in Europe may have had high hopes for hydrogen, but the 2007/2008 economic crisis and the subsequent euro crisis forced leaders to focus on containing financial and economic turmoil. Moreover, the high oil price environment unlocked the US shale potential, fundamentally reconfiguring the global oil scene. The US realigned energy policy to firmly prioritise domestic hydrocarbon production, while the EU would benefit from the global reduction in oil and natural gas prices. Hydrogen's ability to ensure low carbon and secure energy was, once again, overshadowed by the deep entrenchment and competitiveness of oil.

The third wave of hydrogen's hype began with the EU's rising climate ambitions that were first embodied in the 2015 Paris Agreement. The UK was a leader on pilot studies and European policy-makers followed with an EU Hydrogen Strategy somewhat later. These were followed by similar ambitions articulated by the USA and China, amongst others. The relative weight of environmental considerations was much larger than in the past, given the pertinence of climate action.

The EU and the UK opted to pursue a blue-to-green pathway for hydrogen. Leaders reasoned that blue hydrogen could be scaled much quicker, but it was evident that the fossil gas sector lobbied extensively to carve a role for itself in the energy transition. These plans maintained the EU's import dependence on Russian natural gas, which only become an issue on 24 February 2022 when Russia invaded Ukraine. The war underscored that the EU had to reduce its energy import dependence, since stable trade relations allowed Gazprom to grow and weaponise its market share.

The wholesale securitisation of energy affairs followed, pushing the EU to fast-track a green industrial policy at the heart of which was hydrogen. Domestically produced green hydrogen emerge as a key enabler of European energy sovereignty. Its potential offered the lure of allowing the EU to become self-sufficient; albeit, this ambition had to be watered down as the scale of the endeavour led the bloc's leaders to explore the importation of blue hydrogen from a host of countries ranging from the UK to Qatar.

Meanwhile, the UK's strategy is based on similar ambitions to those of the EU—ensure energy autonomy and address emissions—but it plans to do while drawing on its (and Norway's) natural gas reserves and know-how in the hydrocarbon sector. Government strategy leaves more room for blue hydrogen, which may be scalable more quickly than the development of the entire green hydrogen value chain from the deployment of renewables to the large-scale manufacturing of electrolysers. Its goals may also allow for nuclear-based hydrogen to play a larger role, given recently announced ambitions to construct additional power stations.

Other major economies driving the energy transition also pursued energy autonomy amidst their climate-driven

action. The USA introduced the Inflation Reduction Act (IRA) to boost its industrial competitiveness and ensure a self-sufficient low carbon energy system—deeply reliant on blue and green hydrogen. This effectively provides it the means to sustain energy independence, while also providing a lifeline to its natural gas sector and boosting the competitiveness of green tech companies.

Hydrogen is at the centre of the Chinese leadership's agenda, as they have sought to limit China's reliance on imported oil and natural gas—it has little of either. The environmental and health implications of coal combustion have pushed the country to pursue decarbonisation at a scale that far overshadows any other country, driving investment into renewables, batteries, electric vehicles, but, also, hydrogen technologies. While it is among the leaders of greening its electricity supply and electrifying, the government has recognised a need for hydrogen to sustain economic competitiveness which they can achieve in a green and secure manner with the energy carrier.

Energy markets are frequently heralded due to their ability to interconnect various regions and reduce supply security risks, increasing the overall security and well-being of those living within the given state. Ambitions to establish hydrogen as a pillar of the energy system tell another story. Interconnected markets are the next best thing, but self-reliance on energy resources has been the panacea of energy and foreign policy among most states. This had been seen as possible with nuclear power and the scaling of hydrogen, when oil supply outlooks and prices prompted importers to look for alternatives. Supply security was the driving force of energy policy in the past, but collapsing oil prices continuously derailed substantive change.

The current setting is fundamentally different, given that the initial driver of hydrogen's uptake was environmental in its nature—climate change. Society may be shaping the Globe—hence our stepping into the Anthropocene—but climate change is also shaping the energy policy decisions leaders make. This offers a force large enough to deter any back-pedalling to an oil-based society.

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