WATER RESOURCE CONSIDERATIONS FOR THE HYDROGEN ECONOMY

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Hydrogen Alert

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Earlier in 2020, K&L Gates released *The H_2 Handbook: Legal, Regulatory, Policy, and Commercial Issues Impacting the Future of Hydrogen*.[1] There, the firm detailed governmental and commercial issues related to molecular hydrogen's critical role in a decarbonized energy future for the world.[2] One such issue involves using water as a feedstock for developing molecular hydrogen as a fuel and energy storage medium.

Clean water is a precious resource globally, and it is subject to an array of competing demands. The United Nations has observed that "[m]ore than 2 billion people live in countries experiencing high water stress. The situation will likely worsen as populations and the demand for water grow, and as the effects of climate change intensify."[3] Yet, because hydrogen production requires water, it could also add to water stress while addressing climate change's adverse effects. Indeed, producing grey and blue hydrogen requires large amounts of water for steam in the reformation process, and producing green hydrogen by electrolysis can require as much as nine kilograms of high-purity water per kilogram of hydrogen.[4] On the other hand, with sufficient supportive infrastructure – e.g., desalination and reverse osmosis plants to purify sea and wastewater as a hydrogen feedstock – as well as legal mechanisms facilitating changes in place and purpose of water use, water availability may ultimately prove to be a lesser concern in hydrogen production.[5]

Nevertheless, the tension among many potential needs and uses for clean water is one of several to keep in mind as the hydrogen economy continues to emerge. Below, we address a few water-related issues from around the world to keep in mind when considering hydrogen production projects: (1) In the United States, water use as a hydrogen feedstock will run into water-use regimes that differ, depending on the jurisdiction involved, dictating where hydrogen production facilities are located; (2) in Australia, water use diverted to hydrogen production will impact both agricultural and certain coastal communities that could be home to hydrogen export infrastructure; and (3) in the United Kingdom, the costs of using water to produce domestic hydrogen will be weighed against the costs of importing hydrogen.

UNITED STATES

In the United States, using water as a feedstock for hydrogen production raises unique issues depending on the jurisdiction where the hydrogen is produced. Water use in the eastern United States is primarily managed as a riparian resource, which means that if water runs through or abuts the land on which production occurs, it may be "reasonably used" as long as it does not harm other users.[6] Compared to the mixed riparian or pure appropriative regimes of the Midwest, Mountain States, and West Coast, riparian regimes have generally offered more water and more flexible water-use arrangements. While this may weigh in favor of siting more hydrogen production facilities in the eastern United States, increasing demand and tightening restrictions will require hydrogen producers to carefully ascertain the limits on water resources for potential production facility siting.

In most states west of the Mississippi River, riparian use is either more regulated, mixed with prior appropriation principles, or eliminated entirely. Prior appropriation is a more restrictive water rights regime, requiring water rights or permits for nearly every type of use of groundwater or surface water.[7] These “paper” rights have specific points of withdrawal and places and purposes of use and are subject to relinquishment for periods of non-use. They are also highly regulated in times of scarcity—those with more “senior” rights have priority over those who obtained their rights later in time. During droughts, “junior” rights holders in a prior appropriation jurisdiction may see their water reduced significantly, sometimes to none at all. Thus, obtaining “paper” water rights for hydrogen production could be costly and draw political scrutiny from those opposed to hydrogen as a fuel or energy storage medium. Hydrogen producers need to consider resource and transactional costs of acquiring water rights in these jurisdictions; while they may be more costly and time-consuming initially, the fairly well-established appropriative rights regimes that have evolved from water scarcity may offer more regulatory certainty. Further, innovations such as water banks are well suited to accommodate a shift to hydrogen because they offer the legal mechanisms necessary to facilitate changes in places and purposes of use as water demands shift from agricultural to urban needs or traditionally water-intensive fossil fuel needs to renewable energy baseloads.

Finally, it is worth noting the interstate water use is governed by interstate compacts, several of which have been under legal challenge for many years.[8] These cases will set a precedent regarding the management of large watershed resources, weighing interests, and ever-changing economic needs. As an emerging large-scale industry, then hydrogen production will likely be impacted by these decisions given the number of rivers and aquifers throughout the country that are interstate in nature.

AUSTRALIA

In Australia, accessibility to water will be a key consideration for producing hydrogen via electrolysis—i.e., green hydrogen. Australia is the driest continent on earth (apart from Antarctica), and water rights are a controversial and often politicized issue.

The relatively intensive use of high-purity water has the potential to generate community concerns around water uses. Indeed, focus groups routinely indicate that water concerns are particularly significant for Australian farming communities as well as the broader community, given frequent droughts and associated water restrictions in many parts of Australia. Accordingly, water security is a key issue that needs to be addressed to gain social acceptance and community support for Australian hydrogen projects that will divert water use from agricultural enterprises and other uses to hydrogen production for fuel and energy storage.[9]

However, the overall amount of water needed to be diverted for hydrogen production in Australia is not large. It is estimated that, by 2040, Australian-exported hydrogen could require approximately 5.6 to 28.6 billion liters of water annually.[10] Contrast that with the total consumption of water in Australia in 2015–2016—i.e., 16.1 ***trillion*** liters—with industries using about 2 trillion liters of that amount,[11] and it is reasonable to conclude that hydrogen production for Australian export[12] demands far less water than other industries.

Despite this, the use of water as a feedstock in Australian hydrogen production will remain a key focus of the assessment of approval applications for new hydrogen projects, particularly for projects located in areas experiencing water shortages. Given Australia's aims for hydrogen production for export to countries such as

Japan and others, local social acceptance and community support where electrolysers and other related infrastructure are proposed to be located (typically along the coastline) will be critical to build and grow a sustainable hydrogen production industry in Australia and has the potential to create commercial and reputational risks to hydrogen producers.

From a legal perspective, industrial water rights can be obtained (at a cost) in all Australian states and territories, and water access licenses are unlikely to impose a constraint on operations as a result of relatively liberal policies. However, the purchase of water allocations will add to baseline hydrogen production costs, which may fluctuate dramatically depending on rainfall in a given year.

Further, to maintain social license and community support for projects, it may be necessary for hydrogen producers to rely on non-potable sources of water to ensure they retain community acceptance and support. This may result in additional production costs to purify the water to a suitable standard for hydrogen production, for example, via reverse osmosis or desalination.

As a result, it will be very important for any hydrogen producer setting up operations in Australia to carefully consider water availability and prepare detailed contingency plans to account for potential water restrictions and fluctuations in wholesale water prices during periodic droughts that can sometimes last for several years.

UNITED KINGDOM

In the United Kingdom, hydrogen can be produced from water electrolysis using any power source, including nuclear, wind, and solar power. Hydrogen production may be limited by both available inland and coastal water resources. The large amounts of water needed for hydrogen production could constrain the process within the United Kingdom, depending on where production facilities are located. In practical terms, a connection to the local water supply will be needed for inland hydrogen production facilities.[13]

From a legal perspective, the Department for Environment, Food & Rural Affairs has overall responsibility for setting the policy and regulatory framework for water in the United Kingdom. Its policy expects water companies to provide resilient water supplies supported by robust water resource management plans. To deliver these, the department oversees a complex delivery landscape of multiple regionalized regulators and privately owned water companies. By the nature of this regionalized approach, regional water companies may diverge with respect to how water is diverted for hydrogen production unless a centralized framework is imposed upon them by the regulator. It is unclear whether such a centralized approach will emerge alongside the emergence of hydrogen production within the United Kingdom.

Further, the Water Services Regulation Authority regulates the water services that the water companies provide, and the Environment Agency regulates abstraction licenses relating to surface water and groundwater sources to ensure that abstractors do not impinge on other abstractors' rights and leave enough water for environmental needs.[14] These actors will almost certainly need to consider hydrogen production as it gains a footing in the United Kingdom and respond accordingly. Otherwise, these agencies risk leaving unanswered many regulatory questions around water use for the novel purpose of hydrogen production.

If such a project is located near a coast, a desalination unit could be installed, and seawater could be drawn for consumption.[15] Although both solutions are possible for hydrogen production in the United Kingdom, it remains to be seen whether importing hydrogen produced elsewhere is more viable, given the country's size and available water resources. In the United Kingdom, low-carbon hydrogen could be produced at a cost of around £15–25/MWh in countries with cheap gas and renewable resources. However, transporting this hydrogen to the United Kingdom is likely to add around £20/MWh to the cost of hydrogen. This is a similar cost range to the costs of producing hydrogen in the United Kingdom, implying that imported hydrogen could play a complementary role to—but is not necessarily cheaper than—domestic hydrogen production.[16]

Conclusion

As the world seeks to decarbonize energy production and economic development, hydrogen will likely play a central role in that process. However, because producing hydrogen as fuel demands large amounts of water, the hydrogen economy and energy base's growth will add strain to water resources. This reality will shape hydrogen markets in different nations due to their various legal, political, and economic environments. The water use issues described above are just a few that are certain to arise as the hydrogen economy itself continues to emerge.

FOOTNOTES

[1]K&L Gates LLP, *The H_2 Handbook*, https://www.klgates.com/epubs/h2-handbook/index.html (last visited Nov. 19, 2020) (the “H_2 Handbook”).

[2]*The H_2 Handbook* is subdivided by global regions: United States, the European Union (including a more detailed discussion related to Germany), the United Kingdom, Japan, and Australia.

[3]United Nations, Sustainable Development Goal 6: Synthesis Report 2018 on Water and Sanitation, https://www.unwater.org/app/uploads/2018/12/SDG6_SynthesisReport2018_WaterandSanitation_04122018.pdf (last visited Nov. 19, 2020).

[4]Sam Bruce, et al., National Hydrogen Roadmap: Pathways to an economically sustainable hydrogen industry in Australia, CSIRO xix (Austl.) (2018), https://www.csiro.au/en/Do-business/Futures/Reports/Energy-and-Resources/Hydrogen-Roadmap (follow “Main report [pdf • 5mb]” hyperlink).

[5]Hydrogen Europe, Hydrogen Production & Water Consumption, https://hydrogeneurope.eu/sites/default/files/Hydrogen%20production%20%26%20water%20consumption_fin.pdf (Dec. 2020) (“busting” myths about water consumption and hydrogen production).

[6]See, e.g., Jowers v. S.C. Dep't of Health & Envtl. Control, 423 S.C. 343, 355 (2018) (describing riparian rights and reasonable use of same).

[7]Cf. Baker v. Ore-Ida Foods, Inc., 95 Idaho 575, 579 (1973) (describing prior appropriation doctrine).

[8]See, e.g., Molly K. Barker, Natalie J. Reid, Alyssa A. Moir, Supreme Court's 2020–2021 Preview: Interstate Water Rights, K&L Gates (Aug. 4, 2020), https://www.klgates.com/supreme-courts-20202021-preview-interstate-water-rights-8-4-2020 (discussing four water rights cases before the United States Supreme Court for the 2020–2021 term).

[9]COAG Energy Council, Australia's National Hydrogen Strategy 60 (Nov. 2019), https://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf.

[10]Acil Allen Consulting for Australian Renewable Energy Agency, Opportunities for Australia from Hydrogen Exports 37 (Aug. 2018), https://arena.gov.au/assets/2018/08/opportunities-for-australia-from-hydrogen-

exports.pdf.

[11]See id., n.6.

[12]Projections for water use to satisfy domestic demand for hydrogen in Australia are less certain.

[13]*H_2 Handbook* at [PDF p.] 17.

[14]Dep't for Env't, Food & Rural Affs., Water supply and demand management (June 11, 2020), https://www.nao.org.uk/wp-content/uploads/2020/03/Water-supply-and-demand-management-Summary.pdf.

[15]See id.

[16]Comm. on Climate Change, Hydrogen in a low-carbon economy (Nov. 2018), https://www.theccc.org.uk/wp-content/uploads/2018/11/Hydrogen-in-a-low-carbon-economy.pdf.

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