

Introduction



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Abstract This introductory chapter provides an overview of the emerging geopolitics of hydrogen. The geopolitics of hydrogen describe the interplay of political, economic, technological as well as resource-related considerations as countries and economic blocs navigate the development, production, distribution, and use of hydrogen in the transition to a net-zero economy. It encompasses the influence of geographical factors essential for hydrogen generation, transport and use, technological choices and their implications for national competitiveness as well as questions of political and economic power—both domestic and international—that shape hydrogen strategies. In the following, we review how these factors are beginning to play out in the development of an international hydrogen economy. We sketch out seven critical dimensions, in which the geopolitics of hydrogen are taking shape: the politics of hydrogen production pathways; competition in clean hydrogen technologies; security of hydrogen supply and shifting energy geographies; hydrogen trade and infrastructure; industrial decarbonization and green industrialization; the uncertainty of hydrogen demand and the politics of risk; and sustainability and global equity. We conclude by presenting how the remainder of this book contributes to our understanding of the geopolitics of hydrogen.

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1 Understanding the Geopolitics of Hydrogen—Why It Matters

As the world grapples with the imperative of transitioning toward a climate-friendly energy and industrial system, hydrogen has emerged as a key protagonist in the unfolding narrative of a future net-zero economy (Kovac et al., 2021). Beyond being a mere energy carrier and potential fuel of the future, hydrogen's role in the transition to net-zero touches on central facets of the international political economy of energy. With nations around the world aiming to strategically position themselves in the pursuit of cleaner and more efficient energy systems, energy transition narratives are being reshaped by the promise and potential of hydrogen as a climate-friendly technology that can help decarbonize global supply chains, enhance energy resilience and security, and foster economic growth and industrial upgrading (Noussan et al., 2021; Quitzow & Zabanova, 2024a; van de Graaf et al., 2020).

The COVID-19 pandemic and its repercussions across the global economy have helped in accelerating the international 'hydrogen race,' presenting it as an important entry point for addressing the 'twin challenge' of decarbonization and economic recovery in some of the leading countries (IRENA, 2022). Similarly, the invasion of Ukraine and the ensuing energy crisis have functioned as an additional driver of European hydrogen ambition, reframing it as a substitute for Russian gas imports (Zabanova, 2024).

Indeed, hydrogen and its derivatives, like ammonia or methanol, can function as versatile energy carriers within a future net-zero economy. They allow for the long-term storage and transport of renewable energy and have the potential to replace hydrocarbons as feedstocks for the production of chemicals and basic materials. These properties allow this molecule to assume similar functions to those performed by hydrocarbons in today's high-carbon economy. In this vein, hydrogen raises similar energy security questions as traditional energy commodities, pertaining to its supply and exchange within a global trading system. The development of infrastructure for the production and transport of hydrogen comes with important implications for the control over future energy flows. That said, increased electrification of end-uses coupled with the challenges of producing renewable hydrogen at scale as well as storing and transporting hydrogen makes it unlikely to occupy the dominant position of today's hydrocarbons (Riemer et al., 2022).

Moreover, with every country having access to some form of renewable energy resources such as wind, hydro, and solar power, the geopolitics of hydrogen will be different in nature than the geopolitics of oil and gas (Scholten & Bosman, 2016). While the relative abundance of renewable energy resources will play a role in the development of future hydrogen production hubs, geographical factors will not constrain its production in the same way as for oil and gas. Hydrogen production will also hinge on other factors, like access to technologies, the industrial capacities underpinning production and innovation, the economic and political conditions for enabling investment in a hydrogen economy, and, last but not least, geopolitical alliances and strategic partnerships. Moreover, large-scale production centers may

be supplemented by decentralized local production sites (IRENA, 2022; Quitzow & Zabanova, 2024b).

Nevertheless, hydrogen has assumed an important role in debates on the interplay of nations' long-term energy security and their efforts in meeting climate objectives. Hydrogen's requirements for its efficient production and transport have significant implications for the way in which countries seek to (re)position themselves within a future carbon-neutral economy, in which areas they will likely compete and collaborate, and how they balance strategic decision-making to secure both a sustainable and reliable energy future (IRENA, 2022; Quitzow & Zabanova, 2024b). The emerging hydrogen economy will also likely be closely intertwined with the (re)location of energy-intensive industries (Eicke & De Blasio, 2022).

Against this background, the geopolitics of hydrogen provides important insights into how countries around the world are likely to shape—and be shaped—by the evolving dynamics of the global energy transformation. The transition away from trading traditional fossil resources such as oil and gas to trading hydrogen alongside clean technologies and critical raw materials can alter geopolitical dynamics associated with the control and exchange of energy resources in the international system (Blondeel et al., 2021). Countries' pursuit of green industrialization and emerging trade relations between future importers and exporters of hydrogen come with geopolitical and economic implications (Pflugmann & De Blasio, 2020). The resulting geography of international hydrogen value chains is likely to co-evolve with the reconfiguration of broader geopolitical and geoeconomic fault lines within the world economy. Hydrogen as a future energy carrier and important arena for clean energy innovation is likely to influence the geopolitical map of the global energy economy, with both 'old' and 'new' economic powers including China, the European Union (EU), Brazil, Japan, and the United States (US) striving to place themselves at the forefront of this transformation (IRENA, 2022).

2 Key Dimensions of the Geopolitics of Hydrogen

The geopolitics of hydrogen describe the interplay of political, economic, technological as well as resource-related considerations as countries and economic blocs navigate the development, production, distribution, and use of hydrogen in the transition to a net-zero economy (Pflugmann & De Blasio, 2020; Van de Graaf et al., 2020). It encompasses the influence of geographical factors essential for hydrogen generation, transport and use, technological choices, and their implications for national competitiveness as well as questions of political and economic power—both domestic and international—that shape hydrogen strategies (Blondeel et al., 2021; Scholten, 2023). In the following, we review how these factors are beginning to play out in the development of an international hydrogen economy. We sketch out seven critical dimensions, in which the geopolitics of hydrogen are taking shape: the politics of

hydrogen production pathways; competition in clean hydrogen technologies; security of hydrogen supply and shifting energy geographies; hydrogen trade and infrastructure; industrial decarbonization and green industrialization; the uncertainty of hydrogen demand and the politics of risk; and sustainability and global equity.

2.1 The Politics of Hydrogen Production Pathways

The different methods with which hydrogen can be produced present a central point of contention in the emerging hydrogen economy. Today, hydrogen is predominantly derived from natural gas through emissions-intensive steam methane reforming (SMR), referred to as ‘gray hydrogen,’ or, in some cases, via coal gasification, which still plays an important role in countries like China and South Africa. The combination of SMR with carbon capture and storage (CCS) technologies produces so-called blue hydrogen, while renewable or ‘green’ hydrogen, produced through water electrolysis using renewable electricity, is the least CO₂-intensive production pathway (Hermesmann & Müller, 2022).

With current hydrogen value chains mainly relying on fossil fuels, the path toward less emissions-intensive hydrogen will depend not only on overcoming technical challenges but also on establishing standards and benchmarks for the classification of production pathways and the measurement of their emission-intensities (Noussan et al., 2021). Standards and regulations will determine the competitiveness of these different production methods and hence the strategic position of different countries or firms. While countries with abundant renewable energy resources may favor the prioritization of renewable hydrogen and strict emission standards, those with access to low-cost fossil fuels may prefer an approach that relies on multiple production pathways, accepting the residual emissions of blue hydrogen production. Not only fossil fuel-producing countries strongly support blue hydrogen, including countries in the Middle East and Norway, but also the US and Japan are pursuing pragmatic approaches with support for fossil-based production pathways.

Additionally, the debate on hydrogen production technologies extends to the contested role of nuclear energy in the power system. A number of European countries reject the risks of the technology and hence oppose the use of hydrogen produced via electrolysis using nuclear power. For other countries, nuclear power is not only a viable low-carbon energy option, but a source of prestige and strategic importance, given its close links to nuclear defense technologies. While the European Commission and prominent EU member states, like Germany or Spain, have championed hydrogen production using renewable electricity, this has faced resistance from other member states, most notably from France who wants to see the inclusion of nuclear energy as a power source for electrolysis (Quitzow & Zabanova, 2024a). Further afield, biofuel champion Brazil is keen to include hydrogen production from biomass as an additional variation of low-carbon hydrogen (Lira, Kramer, Quitzow, this volume). Each pathway has differing political, economic, and environmental

implications, creating relative winners and losers (Quitow & Zabanova, 2024a, 2024b, 2024c).

2.2 Competition in Clean Hydrogen Technologies

Competition over technological leadership in a future hydrogen economy adds an additional layer to the geoeconomics of the sector. The hydrogen sector represents an important sphere of technological competition, both between rival technologies and between the major economic blocs vying for technological leadership. Europe has long held a leading position in the field of hydrogen technologies, and firms and politicians are determined to retain their competitive advantage in the face of Chinese competition. Similar to cleantech sectors like wind and solar energy and electric vehicles, China has rapidly emerged as a low-cost competitor, most notably in traditional alkaline electrolyzers (Gong and Quitow, 2023; van de Graaf et al, 2020).

Moreover, technological competition is also linked to questions of raw material supply. Critical minerals, like nickel and platinum, are important inputs for the production of hydrogen-related technologies. Concerns over asymmetric dependencies are driving efforts to secure technological sovereignty and to diversify the emerging supply chain relationships. Uncertainty regarding future supplies may also influence technological pathways. Due to their flexibility, proton-exchange membrane (PEM) electrolyzers offer important benefits for use in a power system dominated by variable renewable energy supplies. However, they rely heavily on so-called platinum group metals (PGM), a scarce mineral resource, adding a risk and hence cost to their development (Pepe et al., 2023).

Finally, technological competition also extends to the sphere of hydrogen trade, with different players experimenting with different options for the transport of hydrogen over longer distances. The options are manifold, ranging from pipelines to different options for ship-based transport. Each technology option comes with distinct challenges and implications. While ammonia has emerged as one of the favored options for transporting hydrogen by ship, it is not only a highly toxic substance but also raises the challenge of reconversion for applications that require hydrogen in its pure form. Alternatively, it could shift part of the value creation process upstream as ammonia production and relocate to exporting countries (Eicke & De Blasio, 2022).

2.3 Security of Hydrogen Supply and Shifting Energy Geographies

As countries transition from fossil fuels to an energy geography dominated by renewables and hydrogen, this also raises important new energy security questions. On the

one hand, renewable hydrogen is viewed as an option for breaking fossil fuel dependencies, offering both options for domestic production and a new and expanded set of potential partners for sourcing hydrogen. It provides countries with an opportunity to diversify their energy sources and trading partners, thereby reducing vulnerabilities and asymmetrical dependencies associated with the fossil fuel-based energy economy. On the other, these new supply partnerships may lead to a new set of dependencies, along with tensions over who has access and on what terms. It raises questions regarding the rules and practices that will shape international hydrogen trade and which actors will influence or even dominate a future hydrogen market. Clearly, this will also be influenced by the choice of production technologies outlined above (Quitzow et al., 2023; Scholten et al., 2020; van de Graaf et al., 2020).

Hydrogen also provides the possibility of enhanced energy independence in ‘prosumer’ countries, including China and the US, who possess sufficient production capacities to meet their domestic hydrogen consumption needs and possibly even export to international markets. In particular, China could become significantly less dependent on energy imports, with significant implications for energy geopolitics (Quitzow & Gong, 2024). How these actors engage in the global hydrogen market depends on their national hydrogen strategies and industrial policies and to what extent they will choose to promote exchanges within an international market place. Developments in large future import markets, such as Japan and the EU, will shape the recalibration of global interdependencies, arising from the quest for energy diversification and independence and the need for globally integrated infrastructure development. This includes geopolitical competition over trade partners and control of supply chains (Pepe et al., 2023; Quitzow & Zabanova, 2024a, 2024b, 2024c).

Countries in Latin America, Sub-Saharan Africa, and Oceania could emerge as central hubs for hydrogen production. For example, renewable resource-rich countries like Spain, Chile, or Morocco hope to transition from their roles as net energy importers to major exporters of green hydrogen. The prospect of such energy ‘newcomers’ to become central hydrogen export markets underscores the potential for increased influence in the new geography of trade underpinning the changing global energy landscape. Similarly, coastal areas and ports play a crucial role in the scale-up of clean hydrogen production, pointing to the potential for countries like Brazil to evolve from historically ‘minor’ energy powers into future hydrogen hotspots. At the same time, historic fossil producers like Australia or Saudi Arabia are well-positioned to leverage their existing know-how and trade relations to position themselves as important exporters of hydrogen (IRENA, 2022).

2.4 Hydrogen Trade and Infrastructure

As hydrogen emerges as an important dimension of energy security, hydrogen trade and the infrastructure needed for this will also emerge as an important geostrategic dimension of the energy system. Changing energy import and export relationships

can influence the balance of trade, economic dependencies, and diplomatic relationships between countries. Global power competition over major value chains and central export markets could lead to the regionalization of trade relations and a fragmented global hydrogen market that capitalizes on unequal terms of trade and rivalry over supply (Pepe et al., 2023).

In this context, control over infrastructure, including physical infrastructure for storing and transporting hydrogen as well as institutional infrastructure shaping market exchanges, assumes strategic importance. This is particularly important for importing countries, dependent on foreign suppliers of hydrogen to fuel their net-zero economies. Developing diversified transport routes has emerged as a key consideration as countries like Japan or Germany begin developing plans for the development of transport infrastructure. It has also become a point of contention between countries dependent on imports and those strategically positioned en route between potential export and import hubs. France, a potential transit country between Germany and the Iberian Peninsula, for instance, has expressed important reservations regarding the development of pipeline connections across its territory (Bouacida, 2024). Shipping routes provide a more costly alternative to the politically cumbersome development of pipeline transport, with ports like Rotterdam, Kobe, or Port of Pecém in Brazil seeking to position themselves as major hydrogen trading hubs (Lira, Kramer, Quitzow, this volume).

This build-up of physical infrastructure is complemented by the development of international standards and rules governing international hydrogen value chains. These rules of the game will determine the trajectory of hydrogen trade and the formation of markets, constituting another central dimension in which nations seek leadership and influence. As an international hydrogen market takes shape, pricing and market access will assume geoeconomics importance, with countries likely striving to control these aspects to gain a strategic advantage (Flath et al., 2023).

2.5 Industrial Decarbonization and Green Industrialization

Ultimately, the geopolitics of hydrogen cannot be separated from its ultimate purpose—the decarbonization of end-use sectors. Here, its role in the decarbonization of energy-intensive industries, most notably steel and chemicals, stands out as a critical arena of geopolitical competition. Nations with access to abundant and low-cost renewable energy resources suitable for green hydrogen production may become attractive destinations for industries seeking to decarbonize. This has the potential to redirect investment from traditional locations in industrialized countries to new production hubs in emerging and developing countries (Quitzow et al., 2025). Such shifts in investment patterns could reshape global economic power dynamics and impact geopolitical relationships as nations seek to secure their positions in emerging green industries (Eicke & De Blasio, 2022).

However, renewable energy resources alone will not suffice to catalyze investment. It will require the needed industrial capacities to translate low-cost energy resources

into competitive industrial production, and it will rely on the financial and political backing from future offtakers to secure such investments. Given the strategic role of steel and chemicals, supplying basic inputs to a wide range of industries, major economies are also keen on retaining their domestic production capacities, despite potential disadvantages in terms of low-cost hydrogen supply. Industrialized countries have begun to provide subsidies and incentives for the decarbonization of domestic production facilities as well as investments in hydrogen production and transport. It remains to be seen how the interplay between cost differentials, pre-existing industrial capacities, and strategic industrial policy will shape the future geography of industrial production.

2.6 The Uncertainty of Hydrogen Demand and the Politics of Risk

Despite the rising global momentum of the hydrogen market ramp-up, the scale and scope of a future hydrogen economy remains highly uncertain. While hydrogen is primarily used in oil refining and chemical production today, the range of possible hydrogen applications in a net-zero economy is both large and highly contested (IEA, 2019). Climate mitigation scenarios suggest a potential role for hydrogen in end-use sectors ranging from industrial production, different parts of the transport sector, domestic heating, and for balancing renewable power generation. Indeed, hydrogen represents a versatile energy carrier that could replace fossil fuels in a diversity of applications (Weißenburger et al., 2024). It is precisely this versatility that has fueled substantial disagreement and uncertainty with regard to the specific applications where hydrogen could and should play a role. This has triggered discussions about cost and environmental efficiency as well as technical feasibility, not only of hydrogen but of competing technologies. It is widely accepted in the scientific community that the electrification of end-uses is the most efficient pathway for decarbonization, so many argue that scarce hydrogen resources should be limited to those applications where electrification is not a viable option (Schreyer et al., 2024). Nevertheless, many hydrogen strategies continue to emphasize applications across various end-use sectors, including transport and heating (Weko; Gong & Quitzow, both in this volume).

As a result, questions persist about where and to what extent hydrogen will be needed, making current estimates regarding future demand highly uncertain (Noussan et al., 2021; Riemer et al., 2022). Contention regarding hydrogen production technologies and rules governing the CO₂ footprint and other dimensions of hydrogen production and trade add to this uncertainty. This also means that investment in the hydrogen sector remains a highly risky endeavor.

This in turn points to questions of who will bear the risks and associated costs of early investments and who will reap the benefits in the case of success. This is a classic question of market vs. state, as firms seek guarantees from their governments

to secure their bets on hydrogen as a promising decarbonization option. It raises questions regarding the efficient and effective use of public spending and how to avoid excessive rents by private actors, as they pursue strategies to maximize the benefit for their shareholders.

But these questions also extend beyond the domestic sphere, as resource-rich countries position themselves to supply industrial demand centers. This is giving rise to high-stakes negotiations between importers and exporters as they consider large-scale investments, not only in hydrogen production but also in trade-related infrastructure, like pipelines, ports, and ships. It remains to be seen how partners from the private and public sectors and from exporting and importing countries find ways to unlock the needed investments, thereby allocating risks and rewards across stakeholders and regions.

2.7 Sustainability and Global Equity

The distribution of the costs and benefits of hydrogen development and its socio-economic and environmental impacts across countries is also at the heart of global discussions of equity and a just transition. From a global equity perspective, it is critical to ensure that the transition to a hydrogen-based economy aligns with broader global goals, including environmental sustainability, social justice, and inclusive economic development. Large-scale deployment of renewable energy infrastructure for hydrogen production may raise concerns about local resource use and the role of local communities and their livelihood (Cremonese et al., 2023). Hydrogen investments may affect local land use and biodiversity and increased demand for water from hydrogen production—not only from electrolysis but also SMR (IRENA, 2023)—may exacerbate challenges in regions facing water scarcity, affecting local livelihoods and food production. Moreover, many regions with high renewable energy potential in the Global South are also characterized by low levels of electricity access, raising questions related to the allocation of costs and benefits across stakeholder groups (Cremonese et al. 2023; Müller et al., 2022).

These challenges represent important points of contention in the development of hydrogen partnerships between industrialized countries keen to secure hydrogen supply to power future net-zero industries and resource-rich countries seeking to industrialize. Governments and local communities in potential exporting countries are raising questions regarding the distribution of benefits both locally and internationally. Concerns regarding the (re)establishment of neocolonial trade relationships and patterns of extractivist economic development have been raised by governments and civil society actors. They are articulating ambitions to increase downstream value creation in net-zero industries like steel making or fertilizers. At the same time, workers and populations in the industrialized world fear loss of jobs and incomes if energy-intensive industries relocate to resource-rich locations. The emerging hydrogen economy is also likely to be closely intertwined with the (re)location of energy-intensive industries (Kalt & Tunn, 2022).

In sum, these sustainability and equity concerns not only play an important role in shaping the willingness of potential exporting countries to pursue ambitious hydrogen strategies, but they also raise fears of deindustrialization and deteriorating quality of life in existing industrial centers, with important political implications. This highlights the indispensable role of international cooperation and dialogue to confront the challenges of hydrogen development. It requires collaboration among governments from different countries, industrial stakeholders across the value chain, local communities, and civil society. Despite increasing geopolitical rivalry, the geoeconomics of hydrogen and decarbonization of industrial value chains is inherently cooperative in nature (Lentschig et al., 2025). It is not only a matter of reducing dependencies and managing supply chain risks. Rather it requires approaches and narratives that can persuade partners to join the global effort of building a sustainable hydrogen economy (Quitzow & Zabanova, 2024c; Quitzow et al., 2023).

3 Objective and Contribution of This Book

In the preceding discussion, we have pointed to the multidimensional nature of the geopolitics of hydrogen, highlighting seven, partly overlapping dimensions affecting cooperation and competition in the sector: the politics of hydrogen production pathways; competition in clean hydrogen technologies; security of hydrogen supply and shifting energy geographies; hydrogen trade and infrastructure; industrial decarbonization and green industrialization; uncertainty of hydrogen demand and the politics of risk; and sustainability and global equity. Each of these dimensions plays a role in how actors in an emerging hydrogen economy position themselves, shaping strategies and engagement with partners.

In this book, we take this as the starting point for an analysis of hydrogen policy-making in a group of major economic powers and hydrogen frontrunners. The book explores how each of these countries is choosing to engage with the different dimensions of geopolitical competition and discusses possible drivers behind these developments. By focusing on the policies in these major economies, the book also acknowledges the important role of governments in shaping an emerging hydrogen economy. Like in other cleantech sectors, the early phases of market and technology development are strongly shaped, if not determined, by government policy-making. Compared to renewable energy technologies—the most important success story to date (Hoppmann et al., 2013)—this is even more pronounced in the hydrogen sector, given the multiple uncertainties across supply and demand outlined above.

The book does not claim to provide a comprehensive review of country strategies. Rather, it constitutes a starting point for understanding how the geopolitics of hydrogen is unfolding. The book examines both domestic and international hydrogen policies in eight countries. It begins with a review of hydrogen policies in the US, China, and the European Union as the three major economies shaping geopolitical rivalry. The latter is informed by analysis conducted in the first volume of this series on hydrogen strategies in the European Union and key member states

(Quitow & Zabanova, 2024a, 2024b, 2024c). It explicitly accounts not only for EU-level policy-making but also the role of important EU member states. This is followed by an analysis of Japan and the UK, both G7 countries with distinct priorities and approaches that diverge significantly from those in the US and the EU. Finally, we cover Australia and Brazil, two G20 countries with rich renewable resource endowments but distinct energy and industrial legacies and geostrategic positions. Each actor's unique approach to hydrogen reflects its strategic priorities, technological and industrial capabilities, and long-term energy security objectives amidst the complex global challenges posed by climate change.

In the *US*, the hydrogen sector is being shaped by a confluence of energy security and decarbonization objectives. The government has promoted hydrogen as a way to further enhance its goal of achieving energy independence, while reducing carbon emissions and stimulating the development of a future-oriented manufacturing sector. The US has been striving for leadership in hydrogen innovation and production by fostering a robust green industry that not only meets domestic demand but also positions it as a potential player in global exports. Given the polarized political landscape in the country, the US stance is also characterized by a high degree of uncertainty. It remains to be seen how hydrogen development will play out under the second Trump administration.

China, currently the world's largest hydrogen producer and consumer, has not made hydrogen a major policy priority so far. Nevertheless, a number of provincial governments are competing for investments in hydrogen production, while the national government supports a number of pilot cities for the development and deployment of fuel-cell electric vehicles. Overseas, it has started to weave hydrogen into its external energy strategy built around global value chain expansion and technological cooperation. By investing in technological collaboration and strategic partnerships around the globe, China seeks to enhance its global reach and role as an economic power in a future net-zero economy.

The *European Union* and its member states are spearheading the majority of transcontinental hydrogen endeavors. Dependent on future hydrogen imports to decarbonize its industry, the EU is promoting international partnerships and cross-border pipeline infrastructure and is seeking to foster a common approach to clean hydrogen production and use, albeit hampered by diverging interests in leading member states. Notwithstanding these internal challenges, the EU is aiming to leverage its single market and regulatory capabilities to establish itself as a leader in the global hydrogen economy.

In *Japan*, we witness an ambitious drive to establish a 'hydrogen society,' emphasizing technological innovation and green hydrogen production as cornerstones of its energy strategy. The nation envisions a future where hydrogen plays a central role in various sectors, ranging from transport to industrial applications. Notably, it also plans not only to use but also to export controversial ammonia co-firing technology to reduce local emissions from existing coal power plants. It seeks to create a self-sustaining hydrogen 'ecosystem' that fosters energy security and decarbonization, with the former taking precedence over the latter for the time being.

The *United Kingdom* stands at the forefront of European ‘hydrogen-in-industry’ initiatives, aiming to blend domestic strategies with regional and international collaboration to advance a hydrogen application in important domestic industry sectors such as chemicals, glass, and steel. Historically a significant European fossil producer, the country seeks to become a key player in local and European hydrogen markets in order to decarbonize its industry while ensuring economic competitiveness and growth.

Australia, endowed with vast renewable energy resources, strives to position itself as a global hydrogen powerhouse, aiming to leverage its natural advantages to become a major exporter of green hydrogen. The focus is to capitalize on its abundant renewable potential to produce low-cost and environmentally friendly hydrogen, although important regional players have insisted on retaining a parallel focus on fossil-based hydrogen production. Despite its skilled workforce and innovative capacities, efforts to promote technological leadership and attract investments in downstream industries have been slow to emerge, though there are signs of increasing ambitions.

In *Brazil*, renowned for its bioenergy capabilities and role as the world’s third-biggest producer of renewable electricity, clean hydrogen has been identified as a strategic asset in the nation’s commitment to energy independence, economic growth, and sustainable development. High shares of renewable energy and a well-developed domestic wind energy industry make it an attractive location for investment in export-oriented hydrogen, especially in the Northeast of the country. Its steel and chemical industries also offer important opportunities for downstream hydrogen use.

Each chapter delves into the unique dimensions of these players’ hydrogen ambitions and their implications in shaping the geopolitics of the emerging global hydrogen economy. The analysis of each actor’s national hydrogen policies and plans offers the backdrop for a discussion of its international engagement in the hydrogen sector within the context of broader climate and energy foreign policies. Each chapter provides an overview of bilateral and multilateral hydrogen cooperation and concludes with a reflection on the countries position in the emerging geopolitics of hydrogen. Given the variance in scope and ambition of actors’ hydrogen strategies, each chapter’s structure and specific focus are tailored to the individual contours of the respective case.

The volume concludes with a chapter that reflects on and contextualizes key findings and themes of each case study against the broader backdrop of international hydrogen politics. It discusses how each country’s hydrogen ambition coupled with its external hydrogen action is shaping the future trajectory of a global hydrogen economy. It reflects on how they relate to the emerging geopolitics of hydrogen and the countries’ potential position and role within it. Through the lens of these cases, this book aims to provide readers with a nuanced understanding of how the ‘hydrogen revolution’ is not only shaping global decarbonization efforts but also influencing geopolitical contours of the twenty-first century.

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References

- Blondeel, M., Bradshaw, M. J., Bridge, G., & Kuzemko, C. (2021). The geopolitics of energy system transformation: A review. *Geography Compass*, 15(7), e12580. <https://doi.org/10.1111/gec3.12580>
- Bouacida, I. (2024). France's hydrogen strategy: focusing on domestic hydrogen production to decarbonise industry and mobility. In R. Quitzow & Y. Zabanova (Eds.), *The geopolitics of hydrogen. Volume 1: European strategies in global perspective*. Studies in Energy, Resource and Environmental Economics (pp. 67–84). Springer. https://doi.org/10.1007/978-3-031-59515-8_1
- Cremonese, L., Mbungu, G. K., & Quitzow, R. (2023). The sustainability of green hydrogen: An uncertain proposition. *International Journal of Hydrogen Energy*, 48(51), 19422–19436. <https://doi.org/10.1016/j.ijhydene.2023.01.350>
- Eicke, L., & De Blasio, N. (2022). Green hydrogen value chains in the industrial sector—Geopolitical and market implications. *Energy Research & Social Science*, 93, 102847. <https://doi.org/10.1016/j.erss.2022.102847>
- Flath, L., Kemmerzell, J., & Knodt, M. (2023). Hydrogen governance in Germany: A challenge for federal coordination. *Regional & Federal Studies*, 1–23. <https://doi.org/10.1080/13597566.2023.2232735>
- Gong, X., Quitzow, R. & Boute, A. (2023). China's emerging hydrogen economy: Policies, institutions, actors. *RIFS Study*. https://publications.iass-potsdam.de/pubman/item/item_6002649
- Hermesmann, M., & Müller, T. E. (2022). Green, turquoise, blue, or grey? Environmentally friendly hydrogen production in transforming energy systems. *Progress in Energy and Combustion Science*, 90, 100996. <https://doi.org/10.1016/j.pecs.2022.100996>
- Hoppmann, J., Peters, M., Schneider, M., & Hoffmann, V. H. (2013). The two faces of market support—How deployment policies affect technological exploration and exploitation in the solar photovoltaic industry. *Research Policy*, 42(4), 989–1003. <https://doi.org/10.1016/j.respol.2013.01.002>
- International Energy Agency (IEA). (2019). The future of hydrogen: Seizing today's opportunities. *Technology Report*. <https://www.iea.org/reports/the-future-of-hydrogen>
- International Renewable Energy Agency (IRENA). (2022). *Geopolitics of the energy transformation: The hydrogen factor*. Abu Dhabi, January 2022. <https://www.irena.org/publications/2022/Jan/Geopolitics-of-the-Energy-Transformation-Hydrogen>
- Kalt, T., & Tunn, J. (2022). Shipping the sunshine? A critical research agenda on the global hydrogen transition. *GAIA-Ecological Perspectives for Science and Society*, 31(2), 72–76. <https://doi.org/10.14512/gaia.31.2.2>
- Kovač, A., Paranos, M., & Marciuš, D. (2021). Hydrogen in energy transition: A review. *Int J Hydrogen Energy*, 46(16), 10016–10035. <https://doi.org/10.1016/j.ijhydene.2020.11.256>
- Lentschig, H., Patonia, A., Quitzow, R. (2025). Multilateral governance in a global hydrogen economy: An overview of main actors and institutions key challenges and future pathways. *International Journal of Hydrogen Energy*, 97, 76–87. <https://doi.org/10.1016/j.ijhydene.2024.11.393>
- Müller, F., Tunn, J., & Kalt, T. (2022). Hydrogen justice. *Environmental Research Letters*, 17(11), 115006. <https://doi.org/10.1088/1748-9326/ac991a>
- Noussan, M., Raimondi, P. P., Scita, R., & Hafner, M. (2021). The role of green and blue hydrogen in the energy transition—A technological and geopolitical perspective. *Sustainability*, 13(1). <https://doi.org/10.3390/su13010298>
- Pepe, J. M., Ansar, D. & Gehrung, R. M. (2023). *The Geopolitics of hydrogen: Technologies, actors, and scenarios until 2040*. SWP Research Paper 2023/RP 13, Stiftung Wissenschaft und Politik, November 2023. <https://www.swp-berlin.org/publikation/the-geopolitics-of-hydrogen>
- Pflugmann, F., & de Blasio, N. (2020). The Geopolitics of renewable hydrogen in low carbon energy markets. *Geopolitics, History, and International Relations*, 12(1), 7. <https://doi.org/10.22381/GHIR12120201>

- Quitow, R., Mewes, C., Thielges, S., Tsoumpa, M., & Zabanova, Y. (2023) Building Partnerships for an International Hydrogen Economy: Entry-Points for European Policy Action. *Fes Diskurs*. Friedrich-Ebert-Stiftung. <https://library.fes.de/pdf-files/a-p-b/19921-20230215.pdf>
- Quitow, R., & Zabanova, Y. (2024a). *The geopolitics of hydrogen: Volume 1: European strategies in global perspective*. Studies in Energy, Resource and Environmental Economics. Springer.
- Quitow, R., & Zabanova, Y. (2024b). Introduction. In R. Quitzow & Y. Zabanova (Eds.), *The geopolitics of hydrogen. Volume 1: European strategies in global perspective*. Studies in Energy, Resource and Environmental Economics (pp. 1–13) Springer. https://doi.org/10.1007/978-3-031-59515-8_1
- Quitow, R., & Zabanova, Y. (2024c). The geopolitics of hydrogen in Europe: The interplay between EU and member state policies. In R. Quitzow & Y. Zabanova (Eds.), *The geopolitics of hydrogen. Volume 1: European strategies in global perspective*. Studies in Energy, Resource and Environmental Economics (pp. 233–249). Springer, Cham. https://doi.org/10.1007/978-3-031-59515-8_1
- Quitow, R., Balmaceda, M., Goldthau, A. (2025). The nexus of geopolitics decarbonization and food security gives rise to distinct challenges across fertilizer supply chains. *One Earth*, 8(1). <https://doi.org/10.1016/j.oneear.2024.12.009>
- Riemer, M., Zheng, L., Eckstein, J., Wietschel, M., Pieton, N., & Kunze, R. (2022). Future hydrogen demand: A cross-sectoral, global meta-analysis. *Hypat Working Paper 04/2022*. Karlsruhe: Fraunhofer ISI. https://hypat.de/hypat-wAssets/docs/new/publikationen/HYPAT_Working_Paper_04_2022_Future_hydrogen_demand.pdf
- Scholten, D. (2023). Introduction: The geopolitics of the energy transition. In Scholten, D. (ed), *Handbook on the geopolitics of the energy transition*. Edward Elgar Publishing.
- Scholten, D., & Bosman, R. (2016). The geopolitics of renewables; exploring the political implications of renewable energy systems. *Technological Forecasting and Social Change*, 103, 273–283. <https://doi.org/10.1016/j.techfore.2015.10.014>
- Scholten, D., Bazilian, M., Overland, I., & Westphal, K. (2020). The geopolitics of renewables: New board, new game. *Energy Policy*, 138, 111059. <https://doi.org/10.1016/j.enpol.2019.111059>
- Schreyer, F., Ueckerdt, F., Pietzcker, R., Rodrigues, R., Rottoli, M., Madeddu, S., Pehl, M., Hasse, R., & Luderer, G. (2024). Distinct roles of direct and indirect electrification in pathways to a renewables-dominated European energy system. *One Earth*, 7(2), 226–241. <https://doi.org/10.1016/j.oneear.2024.01.015>
- Van de Graaf, T., Overland, I., Scholten, D. & Westphal, K. (2020). The new oil? The geopolitics and international governance of hydrogen. *Energy Research & Social Science*, 70.
- Weißburger, B., Wietschel, M., Lux, B., & Rehfeldt, M. (2024). The long term price elastic demand of hydrogen—A multi-model analysis for Germany. *Energy Strategy Reviews*, 54, 101432. <https://doi.org/10.1016/j.esr.2024.101432>
- Zabanova, Y. (2024). The EU in the global hydrogen race: Bringing together climate action, energy security, and industrial policy. In R. Quitzow & Y. Zabanova, (Eds.), *The geopolitics of hydrogen. Studies in energy, Volume 1: European strategies in global perspective*. Studies in Resource and Environmental Economics (pp. 15–47). Springer. https://doi.org/10.1007/978-3-031-59515-8_2

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