The Geopolitics of Hydrogen in Europe: The Interplay between EU and Member State Policies

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Abstract Drawing on the findings of the case studies presented in this edited volume, this final chapter summarizes and discusses the geopolitical challenges of hydrogen development in the European Union. The chapter provides a review of how the interplay of national and EU-level politics and policies is shaping the EU's domestic and international hydrogen policy. It presents key insights from the evolution of hydrogen policy in the EU, as well as at the national level in Germany, France, Poland, Hungary, Spain, Italy, the Netherlands, Sweden, and Norway (as a member of the European Economic Area). After reviewing important commonalities and differences across these cases, the chapter examines their interplay with policies at the EU level as well as potential synergies and sources of tension between the selected countries. It discusses how domestic politics and energy policy legacies shape differing policy approaches and priorities, including chosen technology pathways for hydrogen production, priority hydrogen uses and positions towards the development of cross-border infrastructure and trade. The chapter concludes with a reflection on how Europe's strengths and vulnerabilities shape its role in the global geopolitics of hydrogen and inform its international engagement on the transition to net zero more broadly.

1 Geopolitical Challenges of Hydrogen in the EU

Hydrogen has been in the global spotlight, and nations and blocs around the world are rushing to stake their claim in the future hydrogen economy. As a region, Europe has been at the forefront of these developments. The EU and a number of its Member States are investing large amounts of public resources in hydrogen R&D and early

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R. Quitzow and Y. Zabanova (eds.), *The Geopolitics of Hydrogen*, Studies in Energy, Resource and Environmental Economics,
https://doi.org/10.1007/978-3-031-59515-8_12

industrial deployment. They are developing ambitious policies and are collectively shaping international hydrogen governance. The EU and selected Member States, most notably Germany, are also making hydrogen a prominent component of their external energy and climate policy, eager to develop hydrogen partnerships with a wide range of partners.

The reason for this is clear. While the EU has been a global frontrunner in energy and climate policy, it also exhibits important vulnerabilities within a future net-zero economy. Most significantly, Europe as a continent is scarce in renewable energy resources (Eicke & De Blasio, 2022). The EU—without the relatively abundant wind, hydropower and biomass resources in the UK, Norway and Ukraine, respectively—is even more constrained. Hence, developing reliable access to renewable hydrogen resources for the future development of the EU's net-zero economy is a crucial pillar of its future energy and economic security (Ansari & Pepe, 2023; Quitzow, Mewes et al., 2023). In this, the EU differs from the US and China who have the potential to produce sufficient domestic renewable energy to decarbonize their economies.

While only a few years ago, the EU relied on the efficiency of open global markets to secure the needed resources to ensure its standing in a global economy, this has fundamentally changed following, first, the supply chain crises of the Covid-19 pandemic and then the energy crisis in the wake of the invasion of Ukraine by Russia (Quitzow et al., 2022). This not only raises the stakes for developing a diversified and reliable supply of renewable hydrogen. It also further highlights the need to develop a leadership position in hydrogen and other net-zero technologies. Given the EU's scarcity in renewable resources, this is the only pathway towards securing a strong economic stake in a climate-friendly energy future (Quitzow, Triki et al., 2023). But also here, the EU faces vulnerabilities. After Europe led the world in the build-up of renewable energy markets in the 2000s, China has emerged as the undisputed leader in solar energy technologies, while Europe is struggling to preserve its competitive edge in the wind industry (Quitzow & Hughes, 2018; Quitzow et al., 2017). This further underlines the urgency to retain Europe's leadership in hydrogen-related technologies.

Moreover, these developments are raising awareness within the EU and its Member States that the EU's past reliance on open markets—and its ability to influence these markets via its unrivalled regulatory power—has reached its limits. Concepts like open strategic autonomy have emerged in the effort to reconcile the EU's prized single market as the driver of prosperity within a liberal economic order, on the one hand, with the need to secure its economic, technological and energy security in an increasingly hostile and insecure geopolitical context, on the other (Helwig & Sinkkonen, 2022; Miró, 2023; Prontera & Quitzow, 2022). The EU faces the difficult task of maintaining the benefits of European economic integration, while responding to the challenges coming from the state-dominated Chinese economic model as well as the emerging subsidy-driven climate and energy policy in the US (Kleimann et al., 2023).

This delicate balance is also reflected in EU hydrogen policy. The EU's nature as a supranational entity and a union of 27 Member States is both an asset and a liability in this context. The EU's large and attractive single market is essential for generating the needed economies of scale for its innovative electrolyzer manufacturers, and

EU regulatory development retains an important role in setting global trends. There is a developed cross-border gas infrastructure, which can be repurposed to carry hydrogen. Its well-developed R&D funding landscape and public–private cooperation on technology and standards are also key assets. All these factors make the EU more than the sum of its parts and help place the bloc on a strong footing vis-a-vis other large players such as the US or China.

However, it is increasingly clear that this will not suffice to sustain its competitive advantage in an emerging hydrogen economy. The EU's limited ability to generate its own resources and the need to find a compromise among 27 Member States on key policy directions have undercut the ambition of some of its plans, resulting in internal disagreements and delays (Quitzow, Triki et al., 2023). This is particularly pronounced in all energy-related areas, where the EU lacks the competence to interfere with national decision-making. In this vein, the interests and positions among the EU Member States are crucial to the development of the EU hydrogen policy, emerging at the interface between national and EU-level decision-making.

Building on the case studies presented in this book, this final chapter provides a review of how this interplay of national and EU-level politics and policies are shaping the EU's domestic and international hydrogen policy. It highlights how the positions and interests of key Member States are both enabling and constraining the EU's ambitions to develop its position as a major player in a global hydrogen economy. It draws on in-depth insights on the evolution of EU-level policy development and national developments in Germany, France, Poland, Hungary, Spain, Italy, the Netherlands, Sweden, as well as Norway. Though Norway is not an EU member state, it is a member of the European Economic Area and is closely aligned with EU energy policy. Its abundant gas and renewable energy resources give Norway a central role in European hydrogen developments. After reviewing important commonalities and differences across these cases, the chapter will examine their interplay with policies at the EU level. It then identifies potential synergies as well as sources of tension between the selected countries. Finally, it discusses implications for Europe's role in the emerging global hydrogen economy.

2 Domestic Politics and Energy Policy Legacies

While the various Member States discussed in this volume are developing—at different paces—their own national hydrogen policy visions and strategies, these policy trajectories are embedded in pre-existing energy policy legacies, domestic climate and energy politics as well as broader political developments shaping their relationship to the EU and other Member States. These play a decisive role in shaping emerging policy approaches.

France, where nuclear power has a high political and symbolic importance, has been lobbying hard for including nuclear-based technologies and hydrogen as strategically important technologies at the EU level. France's desire to provide state support to its nuclear power plants has led to a row with Germany over the final shape of

the electricity market reform in the EU, a key element of the EU's Fit-for-55 policy package (Simon & Kurmayer, 2023). Its insistence on energy sovereignty has created an aversion to imports and trade, including its intra-European dimension.

In Poland and Hungary, right-wing populist governments—before the change in government in Poland after its 2023 elections—have frequently confronted the European Commission and disrupted EU decision-making on climate-related issues (Huber et al., 2021). Both countries voted against the updated Renewable Energy Directive (RED III), citing concerns that compliance with the more ambitious targets would place too heavy a burden on their economies (Council of the European Union, 2023, p. 4). In addition, challenges to democratic governance and the rule of law have constrained their access to funds from the EU's Recovery and Resilience Facility (RRF). As the RRF is a major source of funding for green transition measures, including hydrogen-related ones, this has a direct impact on the development of a hydrogen economy in these countries.[1] Yet, despite important commonalities between Hungary and Poland, their positions on the relationship to Russia and related energy security issues are at opposite ends of the spectrum (Kopper et al., 2023; Szabo & Fabok, 2020). Poland has been very critical of European dependence on Russian natural gas and is currently not willing to entertain the prospect of new hydrogen import dependencies. Hungary in turn has gone out of its way to retain its energy ties to Russia and is considering blue hydrogen production based on Russian natural gas.

In Italy, the economic crises of recent years have led the government to roll back support for renewable projects, resulting in lagging deployment rates. This is further exacerbated by cumbersome local permitting procedures and emerging public resistance to wind energy deployment. Public opposition related to land use issues or other concerns is common in other countries, too. Norway, in particular, has witnessed a public backlash against wind power deployment, as citizens are concerned that large wind farms would negatively affect the country's prized natural landscapes, endanger the local fauna, and disrupt the indigenous lifestyles of Sami reindeer herders. Coupled with its abundant natural gas reserves, this has made Norway a strong proponent of blue hydrogen as it builds hydrogen partnerships with its Northern European neighbors, in particular Germany. In the Netherlands, the environmental legislation aimed at tackling the country's high nitrogen emissions from agriculture and the construction industry has repeatedly led to protests by farmers and construction workers. It also emerged as a serious legal obstacle to the construction of Porthos, the country's largest and most important CO_2 transport and storage project at the Port of Rotterdam with implications for blue hydrogen production. In the end, the project did receive the green light in August 2023 following a ruling by the Dutch Council of State.

Spain, on the other hand, sees its large renewable energy potential as an important asset within a future net-zero economy, both for the development of exports and for the build-up of climate-friendly industrial production. Despite its limited renewable energy resources, Germany has a similarly positive stance, reflecting its

[1] The change of government in Poland following the autumn 2023 elections will bring important changes in this regard.

strong renewable energy policy legacy and public opinion opposing both nuclear and carbon capture and storage technologies (Brunnengräber & Di Nucci, 2014; Sturm, 2020). This, however, is counterbalanced by a vocal industry that is concerned about the availability of hydrogen, especially in the short term. This has created openings for more flexible German positions. Sweden, due to a combination of ample renewable potential, the continued use of nuclear power and a robust industrial base, is interested in developing renewable and nuclear-based hydrogen production but lacks strong domestic drivers in support of hydrogen trade.

3 Competing Hydrogen Technology Pathways in Europe

As already alluded to, these distinct policy legacies and domestic political constellations have translated not only into different hydrogen strategies but also at times diverging positions at the EU-level. The European Commission has invested significant political capital in prioritizing renewable hydrogen both for domestic production and import. As part of this effort, it has developed a stringent set of criteria for renewable hydrogen and derivatives within its Renewable Energy Directives (RED) and related delegated acts (Directorate-General for Energy, 2023). By contrast, nuclear-based hydrogen or blue hydrogen produced with natural gas with carbon capture and storage still lack a detailed definition in the EU regulatory framework. The only benchmark is included in the Gas Markets and Hydrogen Directive adopted in May 2024, which states that low-carbon hydrogen should ensure GHG emissions savings of at least 70% as compared to the use of unabated fossil fuel alternatives. The methodology for calculating emissions savings is still under development and will be adopted in a separate delegated act at a later stage (Martin, 2024).

This EU policy approach, however, is met by a diverse set of technology preferences among individual member states. Spain, with its large renewable energy endowment and a developed renewable energy industry, has consistently advocated an emphasis on renewable hydrogen—complete with strict sustainability requirements. Driven by its ambitious climate agenda—and the imperative to decarbonize its hard-to-abate industrial sectors—Germany has also supported renewable hydrogen. It has also been apprehensive about the potential role of blue hydrogen. This stems both from its major miscalculation regarding its reliance on natural gas from Russia as well as its longstanding scepticism about carbon capture and storage technologies. Nevertheless, the prospects of sourcing such hydrogen from Norway, considered a safe partner, have led to an increasing willingness to not only accept but even support the use of blue hydrogen in Germany.

Many states with a strong role of fossil fuels—including Hungary, Italy and Norway—envision a much more prominent role for blue hydrogen. Hungary, which is an EU outlier in continuing to maintain close energy relations with Russia, aims at blue hydrogen production at the scale that even somewhat exceeds the projected levels of renewable and nuclear hydrogen production. Italy is also interested both in renewable and blue hydrogen. Norway, in turn, has a two-pronged strategy. It aims to export blue hydrogen—or even natural gas as a feedstock for blue hydrogen—to

the EU, while producing green hydrogen for domestic decarbonization. Germany's gradually growing openness to considering blue hydrogen imports serves as a reinforcing factor in these plans. In addition, the demand targets adopted by the EU as part of the updated Renewable Energy Directive (RED III) in October 2023 are likely to increase demand for hydrogen-based maritime fuels, which matches Norway's interest in providing green solutions for the maritime sector.

Finally, there is France, which has been leading efforts in the EU to endorse a special status for nuclear-produced hydrogen. When the EU was still debating the definition of renewable hydrogen, France mobilized a coalition of allies—including Finland and selected Central and Eastern European countries, where nuclear power contributes a significant share of electricity production—to support nuclear-based hydrogen. In response, Austria led the formation of an informal rival "renewable" alliance. The European Commission has not gone so far as to recognize nuclear-based hydrogen as renewable. However, France succeeded in obtaining significant concessions. For instance, the RED III's 42% renewable hydrogen use target in industry by 2030 can be discounted by 20% if the share of hydrogen from fossil fuels in the member state does not exceed 23% in 2030 and 20% in 2035 (Martin, 2023b). In other words, if a Member State uses a sufficiently large share of non-fossil (e.g., nuclear-based) hydrogen, it will only have to meet a reduced target of renewable hydrogen use in industry. Hungary with its strong reliance on nuclear power generation and plans for expanding its nuclear fleet is also interested in having nuclear-based hydrogen play an important role.

These diverging positions are part of a larger debate on the role of nuclear energy in the decarbonization of Europe's energy sector. France in particular has been leading efforts in gaining recognition for nuclear power as a strategically important net-zero technology eligible for support at the European level. These efforts have been opposed by Germany, Austria and several other Member States. It was largely through French efforts that the European Parliament and the Council of Ministers reinstated nuclear power on the list of "strategically important technologies" in the Net-Zero Industry Act in December 2023, in contrast to the Commission's original proposal dated March 2023 (Messad, 2023).

4 Prioritizing Different Types of Hydrogen Use in the EU

At the EU-level, the use of hydrogen to decarbonize the industrial sector is clearly the priority. The revised Renewable Energy Directive adopted in October 2023 (RED III) includes an ambitious target of 42% of renewable hydrogen use (as a fuel and feedstock) in industry by 2030. The transport target, by contrast, is much more modest, aiming for only 1% of renewable fuels of non-biological origin (RFNBO) by 2030. Over the past years, the range of priority uses identified has been reduced, as there is a growing concern that the scaling-up of renewable hydrogen will take considerably longer than initially expected and than suggested by current targets for the year 2030 (Martin, 2023a, 2023b). As a result, a number of hydrogen uses considered in the

past—such as in residential heating, power storage or personal mobility—are now increasingly viewed as inefficient, given expected supply constraints.

Yet at the Member State level, the clear prioritization that is evident in EU policies is often missing. Some countries do largely follow the EU's priorities. These include Germany and the Netherlands with their focus on the steel and chemical industry as well as Sweden, which is intent on decarbonizing steel production. Spain, in turn, combines a strong emphasis on decarbonizing existing uses—such as hydrogen use in refineries and the fertilizer sector—but it is also supporting the steel industry. Italy and France also prioritize decarbonizing existing uses, such as in refineries and ammonia production.

Mobility has been a more contentious arena. While support for hydrogen-based mobility was a common element of national support schemes in Europe in the past, there is growing evidence that battery electric mobility may well come to dominate even sectors previously viewed as hard-to-electrify, such as heavy-duty trucks. Still, both France and Italy maintain a strong focus on hydrogen for mobility. This includes trains in Italy's case and light duty vehicles in France, which are meant to complement battery electric mobility. Furthermore, a number of countries, especially those where hydrogen ambitions are relatively recent, either list a very wide range of potential applications without clear prioritization or are facing significant domestic divisions regarding the role of hydrogen in the future. Some examples in the first group include Poland and Hungary. Finally, Spain faces a slightly different question. It has to consider the trade-offs of concentrating on decarbonizing its domestic industry, which was the original motivation behind its hydrogen strategy, and developing exports of renewable hydrogen to the rest of Europe.

5 Renewable Energy Deployment and Hydrogen: Up to Speed?

Producing renewable hydrogen at scale requires large amounts of renewable energy capacity installed and accelerated deployment rates. Yet the degree to which hydrogen plans and ambitions are integrated into energy and climate policy planning at the national level differs significantly from country to country. In a number of cases, hydrogen ambitions are essentially declarative and are not reflected in the plans for adequate expansion of the renewable energy capacity. Poland, which lists a wide range of potential hydrogen uses, is a case in point. Introduced in 2016, the highly restrictive distancing rules for onshore wind ("10 h") have largely stalled wind power development in the country. The rules have since been revised only slightly, falling short of the hopes of energy transition supporters. In addition, Poland's right-wing Law and Justice (PiS) government, in power between 2015 and 2023, was generally sluggish on energy transition. It placed itself in opposition to the EU's ambitious goals in the Fit-for-55 package, going as far as challenging some of its aspects in the European Court of Justice (Weise & Posaner, 2023). Italy has also suffered from

a slow pace in developing new renewable energy capacity for years. In the wake of the economic crisis in the mid-2010s, the government dismantled several support measures for renewable energy deployment (Prontera, 2021). Sweden also faces the challenge of integrating its hydrogen plans with the rest of the energy sector. Sweden's hydrogen plans have been driven by business actors, including very prominently the steel industry, with a lack of coordination and steering efforts by the government. While Sweden has abundant renewable energy resources, there is still a question of where new renewable energy capacity (such as wind power) will be built and which actors will get preferential access to hydrogen production sites. Finally, there is the issue of technology competition. Even in Sweden and Norway—two countries with the most decarbonized grids in Europe and ambitious national climate policies–demand for green electricity is expected to rise steeply in coming years. This raises the question of how much renewable energy will be available for green hydrogen production, given the growing electrification demands (Kilpeläinen et al., 2023).

6 Funding Hydrogen Policy in the EU: Up to the Task?

A key source of contention in the EU has been about the funding for green industrial policy measures, especially against the backdrop of the intensifying subsidy race internationally. The Recovery and Resilience Facility (RRF), the central part of the NextGenerationEU pandemic recovery package, has emerged as an important source of funding for the green transition in Member States. RRF funding includes approximately 10 billion EUR for hydrogen development in Member States (European Commission, 2023). In some countries, such as Poland or Hungary, the opportunity to receive EU funding was a strong motivator behind these nations' interest in clean hydrogen development. Even though RRF funds come from joint EU borrowing, they are allocated and spent at the Member State level with little coordination taking place.

Despite the intensifying cleantech competition following the United States' Inflation Reduction Act (2022), the EU has not taken significant steps towards scaling-up EU-level funding. While some Member States have called for more external debt to better equip the EU to face the key challenges, leading countries like Germany and several Nordic states have opposed new EU-level borrowing at a large scale. Instead, they have called for a more efficient use of remaining funds in the NextGenerationEU package (Martinez & Strupczewski, 2023). As a result, the Commission's attempt to create a "European Sovereignty Fund" to fund investments in net-zero technologies did not materialize and has been replaced by the strongly reduced concept of a Strategic Technologies for Europe Platform with hardly any new funding (Bourgery-Gonse, 2023).

Instead, the EU's main response to the global subsidy race has been to relax its traditionally strict rules on granting national subsidies (called state aids) (Quitzow, Triki et al., 2023). This has been supported by countries like Germany and France, which see this as an opportunity to support domestic industry. Available data on

spending corroborate the highly unequal distribution of subsidies. Under the Temporary Crisis Framework 2022, which allowed Member States to grant state aids to help overcome the economic impact of the war in Ukraine, Germany alone accounted for 53% of the total volume of state aid approved, France for 24% and Italy for 7% (Allenbach-Ammann, 2023). The resulting risk is that new subsidies will undermine the European single market and that less well-to-do countries will not be able to compete, skewing the playing field within the EU. For this reason, a number of Member States—including Central and Eastern European states but also Sweden, the Netherlands and Belgium—have repeatedly called on the Commission to proceed with utter caution. In their position paper dated February 2023, they warned of likely negative effects, such as "the fragmentation of internal market, harmful subsidy races and weakening of regional development" (Reuters, 2023). As the RRF funding is scheduled to run out in 2026, the issue of financing European industrial policy is likely to remain on the agenda for years to come.

7 The Politics of Connectivity: Hydrogen Infrastructure in the EU

To bring green hydrogen from renewables-rich sites—whether in the EU or from abroad—to demand centres, the EU will need to develop some form of cross-border hydrogen infrastructure. Constructing such infrastructure will require large private and public investments on the scale of many tens of billions of euros, with estimates routinely revised upwards. Among Member States, the momentum behind the push for a European hydrogen infrastructure comes mainly from the Member States with an interest in hydrogen trade and their gas transmission system operators (TSO). This includes potential importers (Germany), future hydrogen hubs (Netherlands, Italy) and hydrogen export hopefuls (Spain, Norway). These countries are already now mapping out plans for their national hydrogen backbones and their interconnections to neighbouring states.

This stands in contrast to French interests. Similar to the government's stance on gas interconnections with Spain (Crisan-Revol, 2017), France initially did not support plans to develop hydrogen infrastructure between the two countries. Rather, its aim is to establish its own hydrogen production based on domestic nuclear and renewable energy generation and to avoid exposure to imports of hydrogen from outside the EU altogether. In this vein, it opposed Spanish efforts to promote the H2Med pipeline. The planned project would connect the renewables-rich Iberian peninsula with central and northern Europe and is the linchpin of Spain's efforts to become a key hydrogen supplier for Europe. It is also strongly supported by Germany who sees it as the key to importing hydrogen, not only from Spain but also Morocco and potentially other North African countries, at a later stage. France finally agreed to the project, though only after plans were presented that would have rerouted the pipeline project via Italy, thus avoiding French territory altogether.

An important pioneer in pipeline development in Northern Europe is the Netherlands, which is targeting a role as a European hydrogen hub. Its state-owned company Gasunie has been given the task to develop a national hydrogen grid, consistent with the Dutch ambitions to position the country as a clean energy hub for Northwest Europe. The Netherlands is thus investing both in adapting port infrastructure and repurposing gas pipelines to import decarbonized fuels and to export hydrogen to neighbouring states such as Germany or Belgium. In October 2023, Gasunie launched the construction of the national backbone. Germany is following suit with its vision of a core hydrogen grid (*Wasserstoff-Kernnetz*), which would be some 9700 km long and consist of some 60% repurposed pipelines and 40% new pipelines. Importantly, Germany is emphasizing the future network's European dimension. It is required that projects within the *Wasserstoff-Kernnetz* have the status of a European Project of Common Interest (PCI) or Important Project of Common European Interest (IPCEI). Moreover, Germany and Norway have already launched concrete plans for the construction of pipelines, not only for the export of hydrogen to Germany but also the export of CO_2 to Norway for subsurface storage in the North Sea (Kilpeläinen et al., 2023).

Like the Netherlands, Italy hopes to become a hub for clean energy imports from the African continent. It has, therefore, shown interest in developing stronger infrastructure links with non-EU countries. However, given Italy's dependence on gas imports, there is a risk that these pipelines, while nominally required to be hydrogen-ready, are mainly used for gas imports for years to come. Overall, Italy's level of engagement does not match that of the Netherlands or Germany. Similarly, Sweden, which has significant export potential, has for now prioritized efforts to develop hydrogen for domestic decarbonization and localized use for the development of new, climate-friendly industries. The lack of a pre-existing gas distribution grid also favour this stance by the Scandinavian country (Kilpeläinen et al., 2023).

8 The Politics of International Hydrogen Trade

These positions on infrastructure development are mirrored in how Member States have approached the development of international hydrogen trade more broadly. In the REPowerEU (2022) package, the EU unveiled its plans to import large amounts of clean hydrogen and derivatives, in addition to increasing domestic production (European Commission, 2022). Unsurprisingly, this is most relevant to Member States positioning themselves as future importers or import hubs. Germany is expected to be the largest future hydrogen importer in the EU. In its updated national hydrogen strategy (BMWK, 2023), Germany estimates that it will need to import some 50–70% of its future hydrogen demand. It was in anticipation of these imports that Germany has initiated its national H2Global scheme to procure clean hydrogen and derivatives from abroad. The Netherlands, which has a significant energy-intensive industry, has also acknowledged that it will likely need hydrogen imports and has been investing into the relevant infrastructure.

Both countries have spearheaded European efforts to develop an international hydrogen market by investing actively in bilateral and multilateral hydrogen diplomacy. Germany has signed a wide range of agreements with nations all around the globe, including both likely early suppliers and hydrogen hopefuls that are only making their first steps. It has also developed a prominent import scheme for hydrogen and derivatives called H_2 Global. From the outset, the Netherlands became a partner in the H_2 Global scheme, and the Netherlands has been an important ally of Germany in the sphere of international hydrogen diplomacy. It has also signed similar agreements with a wide range of partners, both within Europe and beyond. German and Dutch hydrogen diplomacy and bilateral outreach have also preceded the EU's own fledgling efforts in this area. It was only in late 2022 that the EU signed cooperation agreements with several countries like Egypt, Namibia, Kazakhstan, and Japan. Since then, however, the pace has accelerated, as the EU began actively integrating hydrogen into its bilateral cooperation with a number of African and Latin American countries, as well as with Ukraine and Norway.

Next to Germany and the Netherlands, there are a number of hydrogen export hopefuls, most notably Spain and Norway, who support hydrogen trade, albeit with a more European approach. Spain, with its ambitious plans to supply hydrogen to other EU member states, has put a strong emphasis on cooperation with fellow Member States, including Portugal and Germany. It has also been critical of what it perceives to be Germany's choice to prioritize non-EU countries as partners in the emerging hydrogen market. Indeed, despite its geographic proximity to Morocco, Spain has not yet developed a strong engagement with its neighbor, preferring to concentrate on EU partners. As alluded to above, Norway has pursued an active policy to promote exports of blue hydrogen to Germany, accompanied by a corresponding pipeline project. It is not strongly supporting the development of renewable hydrogen exports, signalling the potential for future tensions with Germany's ambition to replace blue with renewable hydrogen.

On the other end of the spectrum is France. With its emphasis on energy sovereignty and nuclear-based hydrogen, it is opposed to large-scale hydrogen imports and has instead put an emphasis on the development of regional hydrogen valleys or clusters that pool demand locally. Similarly, its hydrogen diplomacy in non-EU countries focuses on the development of hydrogen for domestic use rather than exports. While this may contradict the German import-oriented diplomacy in principle, it can also be seen as complementary, filling a gap left by Germany's primary focus on supporting larger, export-oriented investments.

Poland has not positioned itself openly against hydrogen imports but has largely side-stepped the discussion in its domestic hydrogen strategy, as this could spark fears of new energy dependencies. This does not mean that such imports may not be necessary in the future to pursue the decarbonization of hard-to-abate sectors. However, the domestic politics is not conducive to a pro-active development of import-oriented policies. Other countries, like Sweden, lack gas infrastructure links to neighbouring countries. Its plans, therefore, prioritize on-site, domestic uses, coupled with visions to export green industrial goods produced with domestic clean hydrogen.

Finally, in selected countries, it is large corporate actors from the oil and gas sector that are engaged in international outreach, seeing this as a future substitute for their business in international oil and gas markets. In France, this compensates for the scepticism of their national governments with its emphasis on energy sovereignty. Leading energy companies like Engie and Total are actively involved in exploring opportunities for hydrogen development in Africa and other potential export regions. In Italy, the idea of imports is generally viewed positively. Similar to the past idea of becoming a natural gas hub—which did not materialize—Italy is now seeking to position itself as a hub for energy imports from the Southern Mediterranean region. However, instead of strong government-led diplomacy, Italian energy corporations, like Snam, Enel and Eni, are pursuing their own corporate hydrogen diplomacy in Latin America and Northern Africa.

9 European Hydrogen Politics: The Art of the Possible

The wide diversity of positions, approaches and priorities attached to hydrogen by Member States has been a challenge for hydrogen policy making in the EU, often resulting in delayed and complex regulatory outcomes and in a relatively slow-moving international hydrogen policy. However, the EU's unique nature as a supra-national body and its large single market can also be viewed as a source of synergies that need to be identified and proactively harnessed. For instance, some of the lower-income Southern Member States, such as Greece, Bulgaria and Romania, have excellent renewable energy potentials that remain underutilized. With the right amounts of investment, they could help produce competitively priced renewable hydrogen for the European market. Specialization along the hydrogen value chain could also generate benefits for the entire EU. For instance, Norway's emphasis on decarbonizing marine transport and development of clean marine fuels can spur cooperation in the Nordic region and help Member States achieve their climate goals in the area of maritime shipping.

More broadly, experimentation and policy learning at the national level can be an important asset for EU hydrogen policy. Several proactive Member States are already experimenting with support schemes that are yet to be adopted at the EU level. The Netherlands and Germany have introduced their national versions of carbon contracts for difference to decarbonize their industry. This is something the EU is planning to do as part of the ongoing reform of its emissions trading system (EU ETS). The Netherlands is laying the groundwork for meeting the RFNBO quotas for industry adopted as part of RED III by introducing so-called purchase obligations. Norway, as a member of the European Economic Area, is implementing national zero-emission procurement standards, which have the potential to stimulate demand for green, climate-friendly products. Similar public procurement schemes for low-carbon products have been under discussion in the EU but have not been introduced yet. Given the large volumes of public procurement within the Union, they could have a significant impact on creating lead markets for green products in Europe. Finally,

Germany's innovative hydrogen import scheme H2Global has an important role in testing and improving mechanisms for concluding offtake contracts. It is now being extended to other Member States, with plans to fully Europeanize the mechanism in the future.

Internationally, the EU can and does already benefit from the activities of selected Member States. Germany's successful track record of active international engagement on energy transition in the Global South (Quitzow & Thielges, 2022) and in emerging economies can prepare the ground for follow-up engagement on behalf of Team Europe (i.e., the EU, Member States and European financial institutions). Germany's national development bank, KfW, is a prominent financial institution and a partner in Team Europe initiatives. It invests into a hydrogen economy in several countries, including Chile. Similarly, France has launched efforts in a number of African countries, albeit with a primary focus on domestic hydrogen production and use. As alluded to above, this may offer an important complementarity to Germany's import-oriented strategy.

That said, harnessing synergies for clean hydrogen and the broader energy transition in the EU will require skilful governance. One of the most important challenges the EU is facing is the fact that its climate governance is not well-aligned with that of energy policy. While climate policy is a shared domain of the EU and Member States and has been strongly Europeanized since the 1990s, energy policies fall mainly within the remit of Member States (Pisani-Ferry et al., 2023, p. 3). According to Article 194 of the Treaty on the Functioning of the European Union, each Member State has the right to "determine the conditions for exploiting its energy resources, its choice between different energy sources and the general structure of its energy supply." In principle, hydrogen policy, whose main thrust has been to decarbonize hard-to-abate sectors, is rooted in European climate policy. At the same time, hydrogen development exhibits important overlaps with energy policy and thus leads to tensions between the two levels.

These governance challenges are a broader issue that affects not only the EU's climate and energy policy (Pisani-Ferry et al., 2023). One of the biggest obstacles to developing a strong green industrial policy in the EU is the lack of coordination (Tagliapietra et al., 2023). At the moment, instead of a unified green industrial policy, there is a fragmented landscape of various industrial policy initiatives at EU, member state and regional level. They may come into conflict with each other or even undermine the single market. The EU's recent turn towards relaxing guidelines on granting state aids pushes it further along this trajectory, as Member States implement national measures to protect and support their industry, with little to no coordination taking place (Quitzow, Triki et al., 2023).

This raises more fundamental, political questions regarding the limits of the EU in its current form as a vehicle for harnessing the opportunities of the hydrogen sector for building a net-zero economy. Countries with strong renewable energy potential have an interest in attracting investments, not only in the production of renewable hydrogen but also in new climate-friendly industrial production. Conversely, existing centres of industrial production, notably in Germany, are keen on retaining industrial value creation in existing locations. These diverging interests add to the manifold

uncertainties surrounding the hydrogen economy, from the development of transport infrastructure to the prioritization of hydrogen uses or production pathways. As outlined in this volume, many of these aspects are subject to intense political negotiations within the European Union. In the sphere of investment support, the EU has not been able to assume a prominent role, instead relaxing its restrictions on state-aid as a means of relegating this to the level of Member States.

The result has been the concentration of investment support in those countries with the largest fiscal space (Quitzow, Nunez et al., 2023). Where this coincides with a relatively abundant potential for renewable energy generation, this points to a virtuous combination of assets, opening up a clear pathway to net-zero industrial production. Within the EU, Sweden represents such a case. In the absence of such a fortuitous convergence of fiscal and natural resources, however, this points to the need for political negotiation across countries over the distribution of costs and benefits within a future hydrogen economy. Such a politicization of supply chain development is not only likely to slow down the pace of investment and reduce the efficiency of final outcomes. It may also exacerbate pre-existing economic imbalances within the EU, with risks for political stability within the Union. A large-scale EU-level investment support scheme could overcome such risks and inefficiencies, but would likely suffer from the typical woes of EU policy making, i.e. complex yet highly politicized rules riddled with exceptions and exemptions catering to individual Member States. Nevertheless, even incremental steps in the direction of a European investment agenda are essential for securing the EU's leadership in a global hydrogen economy, while safeguarding the single market.

10 The EU in the Global Geopolitics of Hydrogen

Finally, these questions facing the European Union's internal governance closely mirror similar challenges at the global level. The EU and its Member States confront a similar set of questions when negotiating with potential hydrogen exporting countries. As these partners consider the promise of an international hydrogen economy, they will closely weigh the opportunities and risks and the future costs and benefits of renewable hydrogen production. For the time being, Germany has taken the lead in developing a host of bilateral partnerships focused on research and development, capacity building and knowledge and information sharing, while regulatory developments at the EU-level are largely defining the terms of hydrogen trade. Indeed, here the bloc's constrained renewable energy potential has pushed the EU and its largest Member State, Germany, to the forefront of the international hydrogen economy. Even US renewable hydrogen standards have followed key elements of the EU regulatory regime, providing an important indication of a continued "Brussels effect" (Bradford, 2019).

Indeed, the European Union's role as a renewable energy scarce region may well position it as a champion of international trade and continued economic interdependence. While an important vulnerability to be carefully managed, this also provides

a strong impetus for international engagement that offers important synergies with other aspects of its international agenda. European demand for hydrogen from the Global South is not only a liability, but also an entry-point for broader engagement with these countries. Hydrogen trade can function as a vehicle for engaging on broader questions of decarbonization as well as cooperation on technology or critical minerals. Not least, it promises to position European technology suppliers as potential leaders in supplying its trading partners with hydrogen-related technologies, both upstream and downstream. Coupled with a strong and coordinated European approach to climate finance, this could provide the EU with important leverage in pursuing not only its narrow economic interests but also the development of a robust framework for promoting global decarbonization efforts.

Acknowledgements Research for this chapter was financially supported by the German Federal Foreign Office within the framework of the project "Geopolitics of the Energy Transformation—Implications of an International Hydrogen Economy" (GET Hydrogen), funding reference number AA4521G125.

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