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Toward a hydrogen import strategy for Germany and the EU

Priorities, countries, and multilateral frameworks

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Executive summary

The European Commission aims to import 10 million tons of hydrogen annually by 2030. Decisionmakers at the EU- and member state-level, including Germany, are developing strategies to select import partners and to craft trade frameworks. This paper aims to assist policymakers in this process by identifying and examining the prospective criteria.

When it comes to discussions of Europe's hydrogen strategy, we have identified five key goals: the successful and swift ramp-up of imports; affordability; consistency with fundamental EU principles; global sustainable development; and strategic autonomy, geopolitical risk, and diplomatic leverage. This paper then elaborates on how these goals can be balanced, assessing trade-offs and proposing a system of weighting priorities. We then analyse what this means when it comes to selecting hydrogen trading partners and highlight the (potential) role of multilateral trade frameworks ("the Hydrogen Alliance").

Key insights and recommendations:

- **A swift and successful market ramp-up must be the primary goal**. When developing strategies, decisionmakers must **factor in know-how in hydrogen and energy** exports as well as existing capacities (including access to finance, infrastructure, and resources), as building this expertise from the ground up takes more than a decade.

- Imports must be **diversified**, regardless of who the exporters are. Aside from clear conflicts and instabilities that inhibit hydrogen imports, import strategies should consider the **reliability of countries and trade corridors as an endogenous outcome achieved through active and costly management.** Overall, **predictability and stability may not coincide with the EU's preferred regime type** or fundamental values.

- Evaluating whether, where, and how hydrogen supports sustainable development is not trivial. Here, sustainable development goals **(SDGs) should be used to assess individual projects rather than countries.**

- The EU will need hydrogen **imports from numerous sources**. **Canada and Norway are natural choices**. The **US bears similar potential but** requires more nuanced considerations due to uncertainties regarding its domestic hydrogen demand, shifting political priorities, and its role as a technological-industrial competitor to the EU. The **GCC states** (especially Oman, Saudi Arabia, and the UAE) **exemplify the role of first movers**—some also align with a value-based approach to trade—but importers should proactively navigate latent uncertainties in hydrogen transport options. **Egypt is geographically close to the EU** and endowed with infrastructure, but it poses **heightened financial risk**. Pipeline imports from the **Maghreb are a strong but distant prospect** contingent on the continuous management of regional conflict. **Eastern Europe and Central Asia are potent producers**, but the security situation and a **complex geopolitical landscape** for new pipelines postpone the possibility of trade. Imports from **Australia cannot be realised** in the short-term. **Latin America** has the potential to become an **important player**

in global hydrogen trade, but its various **stakeholders will need to be convinced**. **Brazil** has the **strongest potential to be a first mover in the region**, in part due to its petrochemical industry. Relying on (low-income) countries **that do not have prerequisites for a swift ramp-up of exports is an existential threat** to the hydrogen transition and, thus, EU climate targets.

- **The establishment of a multilateral agreement between EU hydrogen importers and major exporters** (a "Hydrogen Alliance") is geopolitically, economically, and technologically **beneficial**, as it would decrease market power imbalances and bilateral dependencies. The Alliance would not only catalyse relations between importers and exporters but also among European importers themselves, who need assertiveness and coordination. The prospective Alliance has numerous variables (**the degree of institutionalisation, the mechanism to organise trade, the dimensions to be included, and the list of members**) that decisionmakers need to meticulously define. In this context, two solutions stand out: **1) a supranational solution revolving (mostly) around trade—**it internationalises the idea of the European Hydrogen Bank and uses gradually deepening auction mechanisms to increasingly multilateralise trade—and **2) an intra-governmental solution that incorporates numerous fields** (such as technology and education)—this would be easier to setup but likely falls short of improving trade.

- We propose constructing the Alliance as a **two-tiered entity**; this would represent **a compromise** between the imperative of the **short-term market ramp-**up (accelerator) and the prospects of **long-term expansion** (incubator). **First-tier partners (the accelerator component)** would consist of assertive first movers possessing the numerous capacities required to quickly begin hydrogen exports and **kick-off the hydrogen transition**. They would facilitate the creation of economies of scale by taking part in **trade-focussed agreements** and contribute to a **centralised auction mechanism** administered by a Hydrogen Alliance Bank. Potential members include **Brazil, Canada, Oman, Norway, and similar countries**. **Second-tier partners (the incubator component)** would consist of promising future hydrogen exporters whose various **constraints limit their chances** of entering the hydrogen economy any time soon. They would engage in **bilateral agreements** not focussed on trade but rather on **technology, education, regulatory-technological exchange, and political dialogue**. Action in the second-tier group would resemble previous diplomatic instruments include dedicated (financial) **support schemes**. This approach could foster a more **integrated and task-differentiated collaboration** based on the **relevance of each country without excluding world regions**, and thus it could prevent additional fragmentation of the global order.

- Sustainable transitions present significant trade-offs, debunking the **fallacy that clean technologies only yield win-win outcomes**. First, this implies that **cross-sectoral impacts of energy policy** must be considered. However, and second, misrepresenting these intrinsic trade-offs and **using energy policy as a tool to pursue only unrelated goals leads to policy failures** both within and outside of energy and climate arenas.

- The EU and Germany **cannot assume preferential treatment** when importing hydrogen, as global demand escalates and supply bottlenecks loom. The **shift to a sellers' market** necessitates **regulatory compromise** as well as an openness to negotiate **fair risk distribution** in business models with exporters. To meet 2030 targets, **immediate binding decisions,** rather than mere declarations of intent, **are required**.

Introduction

The transition to a low-carbon economy has become a key priority for Germany and the European Union (EU). The Green Deal Industrial Plan[1] commits to a “massive switch to fossil-free hydrogen” and names the hydrogen economy a necessity. Clean hydrogen plays a central role in maintaining industries while reducing dependence on fossil fuels.[2] Land inside EU borders that boasts climatic conditions favourable for the production of fossil-free hydrogen is limited and cannot meet the demand of European actors. Hydrogen imports will therefore be a central component of the transition. The European Commission’s REPowerEU[3] plan, released in May 2022, quantifies these ambitions, establishing an EU-wide hydrogen import target of 10 million annual tons by 2030. Germany’s Federal Minister for the Economy and Climate Action emphasised in May 2023 that up to 70% of Germany’s hydrogen must be imported and that finding a diversified range of partners will be essential.

Since the potential for renewable energy is more evenly distributed than oil and gas reserves, importers can *seemingly* choose from numerous potential producers around the globe.[4] Various research and policy initiatives aim at identifying exporters and defining frameworks for the selection process—a task complicated by the fact that policymakers often seek to tie hydrogen trade to wider goals, such as sustainable development. Defining strategic import frameworks and choosing export partners therefore requires weighing the various criteria, whether technoeconomic or political.

This working paper is an analysis directed at German and European policymakers, experts, and observers involved in shaping frameworks and partnerships for hydrogen imports. It presents and discusses varying goals connected to hydrogen imports, proposes a framework for weighing trade-offs, and identifies which regions and countries may consequently be best equipped to be hydrogen exporters to the EU. Later, it elaborates on the potential of multilateral import frameworks, sometimes labelled the “Hydrogen Alliance” or “Hydrogen Accord”. It concludes with key insights and takeaways.

By addressing these critical points, this analysis seeks to provide a well-rounded perspective on hydrogen imports, assisting policymakers in navigating the challenges and opportunities that lie ahead in the hydrogen economy. The paper builds on the completed and ongoing work of the research project “Geopolitics of the Energy Transition - Hydrogen (GET H2)”,[5] among other sources.

1 European Commission (2023a), p. 2
2 See Nunez & Quitzow (2023)
3 European Commission (2022a), p. 7
4 Van de Graaf et al. (2020)
5 GET H2 is an applied research project that examines the geopolitics of the global energy transformation with a focus on the emerging hydrogen economy. Funded by the German Federal Foreign Office, the project uses a variety of technological, economic, and political lenses to explore how hydrogen contributes to the re-drawing of the geography of energy trade and shifting relations between traditional fossil fuel exporters, newly emerging hydrogen producers, and continual import markets like Germany and the EU.

Goals of hydrogen imports

Hydrogen imports are intended to provide reliable (secure), sustainable, and affordable energy in the context of European decarbonisation. Owing to the complex nature of climate action and energy security, hydrogen is also intertwined with other goals and policy fields, mainly pertaining to the broader understanding of global sustainability and geopolitics. Energy trade inherently creates a geography of power, and the reliability of energy imports is closely linked to political affairs. Policymakers also consider hydrogen imports as a means to achieve other (sometimes unrelated) goals.

Based on these considerations and ongoing debates, this analysis proposes the following list[6] of conceivable goals connected to hydrogen imports:

- Successful and swift ramp-up of imports
- Affordability
- Consistency with fundamental EU principles
- Global sustainable development
- Strategic autonomy, geopolitical risk, and diplomatic leverage

The multitude of (potential) goals complicates the EU's decision-making process when it comes to selecting potential trade partners. First, it is important to assess whether and how different import setups impact the listed goals—the following subsections therefore elaborate on the goals, their practicability, and their connection to hydrogen. Second, the different goals contain inherent trade-offs and therefore must be weighed against one another, which is discussed in the next chapter.

Successful and swift ramp-up of imports

Despite vast government efforts and investments, the hydrogen transition has been anything but certain. The adoption of hydrogen as an energy carrier is not the result of (unregulated) market forces but a carefully crafted political project: if political forces fail to accelerate the sector, economic ones will not substitute the state's role. Hydrogen presents a 'chicken-or-egg' problem, where both demand and supply must be developed simultaneously and synchronously. However, hydrogen demand is likely more flexible and dynamic

[6] This list reflects central goals from energy, foreign, security, and development policy that are actively discussed by policymakers. Of course, alternative goals and taxonomies are equally possible.

than its supply: progress towards use cases (and firms' willingness to adopt them) has appeared quickly,[7] and the natural gas grid can absorb a limited extent of excess hydrogen. Conversely, the production of large-scale clean hydrogen supply requires more infrastructure, financing, and time. Cutting costs comes with a lengthy and challenging learning curve, so delaying the dawn of the hydrogen economy will cause further setbacks that threaten climate goals at various institutional levels. Further limitations in supply dynamics stem from electrolysers—although REPowerEU will require more than 120 GW in electrolyser capacity by 2030, the global manufacturing capacity amounted to only 2 GW annually in 2021. Manufacturers must be given signals quickly if they are to increase production.
Besides that, an exporter's ability to develop hydrogen rapidly, reliably, and in large scale depends on their:

- Access to financing, infrastructure, and resources
- Experience in energy exports and (conventional) hydrogen production

Developing hydrogen requires extensive capital[8] and builds on certain prerequisites. Exporters will need to have a sufficient standing with prospective borrowers and/or investors, own capital, and have experience with large projects. Infrastructure and resources—including for instance, skilled labour, roads, and ports—must be ready beforehand. Countries without these means need to develop them first, causing additional costs and tremendous delays.

Energy exports and hydrogen production are specialised industries and have shallow learning curves, so know-how is key. Veteran companies, public institutions, and dedicated research units in exporting countries—especially oil and gas producers—bundle the (often tacit) knowledge and structures that hydrogen exports also draw from. Despite employing altered technologies, clean hydrogen producers have a competitive edge and ability to quickly and reliably ramp-up production if they have experience in conventional hydrogen. Newcomers to both sectors will likely need 15 or more years to build up (large-scale) clean hydrogen exports when compared to those already experienced in energy exports or conventional hydrogen.[9]

Affordability

Exorbitant hydrogen prices could jeopardise competitiveness and accelerate deindustrialisation. Low prices, on the other hand, create additional incentives for sectors to switch to hydrogen. The affordability of clean hydrogen is therefore a vital objective.

Import prices are mainly driven by production and transport costs. Consequently, hydrogen exporters that have (i) better conditions for hydrogen production (e.g. vast and constant availability of wind, solar, and land resources) and (ii) closer proximity to the EU should be

[7] This also applies to import infrastructure within Europe. First projects, such as an already completed hydrogen pipeline from the Belgian port of Antwerp to Germany, highlight the remarkable speed at which Europe can adjust.
[8] As an illustration: Costs for Saudi Arabia's hydrogen project in Neom is currently estimated at €7.7 billion, according to the shareholder AirProducts.
[9] See also Mense (2023), Deloitte (2022).

preferred.[10] Perhaps contrary to conventional wisdom, water scarcity is only a limited obstacle[11] if coastlines are accessible, as desalination only raises the cost of hydrogen production by a magnitude of around 1%.[12] In addition, market power dynamics impact pricing: scarcity and insufficient bargaining power on the part of importers can contribute to higher tariffs. Mechanisms to increase competition and transparency are therefore relevant.

Consistency with fundamental EU principles

Value-based approaches to trade are thriving. Within this context, the term refers to the practice of conducting commerce or making agreements—in this case, purchasing hydrogen or entering partnerships—in an attempt to align trade with certain (shared) principles or standards. Current debates on hydrogen trade see a split between those promoting the global sustainable development agenda on the one hand and those applying the EU's fundamental foreign policy principles[13] as a criterion for trade on the other. Overlap between the two sides is seen in the quest for security and resilience in energy, but this approach generally follows a different rationale.

Seeking consistency with fundamental EU principles is derived from the intrinsic motivation to strengthen core principles of the Union and its member states beyond its borders. As such, trade becomes a component of Europe's external action and foreign policy agenda. This approach generates coherence and consistency between the different policy fields, but it also implies and establishes a superiority of foreign policy over economic affairs. Yet, the extent to which hydrogen can help to realise foreign policy goals is limited. First, already operational relations are not subject to the same scrutiny as prospective ones, creating an inconstancy between old and new trade flows. Second, the multifaceted nature of the EU's values predisposes assessments to ambiguity. For example, where is the line between an imperfect democracy and an autocracy, or how can human rights issues be weighed against the presence of the rule of law? Also, the notion that foreign policy trumps other affairs has its own pitfalls. As we will elaborate in the next chapter, the trade-offs in this category are manifold.

Global sustainable development

The second major path towards value-based trade emphasises global sustainable development—a core principle laid down in respective German and European policy documents.[14]

[10] Transport costs increase with distance, but the curve is steeper for (new) pipelines than it is for ships; depending on the technology and derivative used, cost increases due to distance are neglectable (Staiß et al., 2022). However, larger distances require more ships (which are not yet available, let alone built), causing new bottlenecks and, thus, increased prices and delays. Because new pipelines require significant time, capital, and multilateral will, ships will likely dominate early on.

[11] Water scarcity is indeed an issue for countries that both lack sufficient freshwater resources and do not have access to coastlines. Moreover, intragovernmental integrated water resource management may be necessary to prevent the escalation of existing conflicts over transboundary waters.

[12] Further advances in desalination technology and electrolysers are necessary to reduce their environmental impact.

[13] These principles include democracy, the rule of law, the universality and indivisibility of human rights and fundamental freedoms, respect for human dignity, the principles of equality and solidarity, and respect for the principles of the UN Charter. See European Union (2012) and Drieghe & Potjomkina (2019).

[14] Bundesregierung (2021) and European Union (2012): Common Provisions - Article 3.

Aside from decarbonising the EU, hydrogen imports can contribute to Sustainable Development Goals (SDGs) in exporting countries. These exports can stimulate economic growth, job creation, and innovation, which translates to SDGs 8 and 9. However, the degree of the value that is eventually added to the exporting economy is questionable, as hydrogen production becomes a largely automatised business once development is completed. Local benefits might thus depend on associated local industries or a just ex-post distribution[15] of hydrogen rents throughout the economy. This caveat is aggravated by the fact that developing countries will typically require infrastructure, materials, skilled workers, and technology from abroad. Importers would need to identify a sweet spot—if it even exists—between fostering imports, respecting local agency, and preventing (neo-imperialist) dependencies and their adverse consequences on exporters' economies and societies.[16]

Hydrogen certainly advances SDGs 7 (Affordable, Reliable, and Clean Energy) and 13 (Climate Action) in importing countries, but the effect of the hydrogen trade in exporting countries is less clear. Progress towards SDG 7[17] requires that hydrogen also be used in the exporting country's energy mix, e.g. in producing green steel. For countries without universal access to energy, hydrogen production may even aggravate energy poverty unless both technological and legal frameworks are crafted to prevent the public electricity grid from being used to produce hydrogen. Assessing global progress towards SDG 13 through hydrogen is controversial and hardly possible. Quantifying mitigated CO_2 requires a counterfactual baseline without hydrogen trade and production, which includes not only the fuel switch in the importing country but also estimations of if, when, and how the energy system of the exporting country was going to change without hydrogen. However, the platitude that efficient climate action requires countries to decarbonise their own energy systems before exporting hydrogen is overly simplistic, misleading, and dismissive of the agency of exporters.

Strategic autonomy, geopolitical risk, and diplomatic leverage

Energy importation inherently creates a dependency between the importer and exporter.[18] Exporters could decide to use energy exports[19] as strategic leverage or even weaponise energy trade to threaten[20] Europe's strategic autonomy. On the other side of the token, hydrogen imports can also forge new alliances that act as door-openers[21] for cooperation in other

[15] A vast body of scientific literature argues that resource rents can worsen the economic outcomes of a country or exacerbate existing disparities, especially if its institutional framework is not sufficiently developed to absorb the rents. This well-researched phenomenon is labelled the "resource curse" (see, e.g., Ploeg, 2011), and hydrogen exports can cause similar effects if unmitigated (see Leonard et al., 2022).

[16] Aside from the resource curse (see footnote 15), the dominance of foreign actors prevents institutional growth and social development; it also alienates countries from international agendas including attempts to mitigate climate change. See, e.g., Ansari et al. (2022b), Latulippe & Klenk (2020), Mahony & Hulme (2018).

[17] Another avenue towards realising SDG 7 in exporting countries is via climate diplomacy. Germany and the EU can piggyback on hydrogen trade to deepen climate partnerships. See also Bianco (2021).

[18] The dependency can be mutual—importers depend on energy flows and exporters dependent on financial transfers. The distribution of the dependency is characterised by competition and physical infrastructure.

[19] The current debate focusses on risks in energy imports but underrepresents risks and dependencies along the value chain, e.g. in electrolysers, solar panels, and raw materials. See also Ansari et al. (2022a), Grinschgl et al. (2021), Rabe et al. (2017), Pepe (2022a; 2022b).

[20] Aside from assessing these risks through studies and mitigating them through governance mechanisms, the common mitigation strategy is to diversify imports. However, diversification also increases complexity, which is why the benefits of diversification and the cost of complexity must be balanced.

[21] The EU-Russia conflict suggests that *Wandel durch Handel* ("Change through trade") fails in the face of systemic differences or deep geopolitical fault lines. However, the events do not negate the strategy's merit and

sectors, thus endowing importers with new geopolitical leverage. Thus, the ideal hydrogen exporter must not have geopolitical confrontations with the EU and its member states. Still, there are advantages to teaming up with exporters with whom the EU has yet to have developed deep relations.

Aside from strategic moves (the risks from which depend on the arrangement of geopolitical ambitions), disruptions to trade can also result from erratic decision-making or security incidents. As such, the predictability and stability of exporting countries, their policies, and trade routes to Europe are important criteria in determining partners. Prospective partners with a history of regime stability, reliable exports, and stable transport corridors are thus preferable.

efficacy towards helping the EU develop and strengthen partnerships with states that are not in conflict with Europe.

Balancing the goals

This chapter explores the interplay of the five potential goals associated with hydrogen imports (a successful and swift ramp-up of imports; affordability; consistency with fundamental EU principles; global sustainable development; strategic autonomy, geopolitical risk, and diplomatic leverage) that were laid out in the previous chapter. Starting off by outlining the trade-offs between the goals, this chapter concludes by proposing a system of prioritising them.

Trade-offs between the goals

Affordability and a swift ramp-up are interlinked. First movers are countries that fulfil the criteria for a quick ramp-up of exports, i.e. those with solid access to infrastructure, resources, and financing as well as extensive know-how in energy exports and conventional hydrogen. These same characteristics translate to lower costs when compared to countries that lack these conditions, as the development of the above factors will add to the price (most directly if the exporter has poor access to financing).

Prioritising **sustainable development of low-income countries is at odds with the other goals**. While hydrogen trade generally advances SDGs in both importing and exporting countries (SDGs 7 and 13 in importing countries and SDGs 8 and 9 in exporting countries), low-income countries are most in need of new industries to advance growth but least equipped to swiftly and successfully ramp-up hydrogen exports. They often lack many or all of the characteristics of first movers. As elaborated in the previous chapter, it is doubtful as to whether hydrogen is even able to accelerate growth in low-income economies.

A **swift and successful ramp-up has an ambiguous relationship to the geopolitical goals**. Not all first movers are close EU allies. Focussing on these countries might therefore induce some external dependency, but diversifying the suppliers would greatly mitigate geopolitical risk. The stability of exporters and trade routes varies between first movers; there is no generalisation. On the other hand, a swift transition to hydrogen will allow Germany and the EU to stay industrial and climate leaders, thus contributing to the Union's strategic autonomy.

Aligning imports with EU principles usually hinders progress toward the other goals. Advocates argue that exporters sharing the EU's fundamental principles are inherently more predictable and stable, and thus contribute to resilient supply chains and reduce geopolitical risk. However, this is truly more a question of alliances and common goals rather than one of political regimes, and, while certain conditions such as strong rule of law are indeed indicative of predictability and stability, the general nature of the relationship between stability and adherence to EU values is rather spurious. For instance, a democracy can produce erratic decision-making, as exemplified by the US under Donald Trump, and certain non-democratic countries are more stable and predictable than (defective) democracies.[22] Moreover, restricting trade to narrow value-based alliances cements global fragmentation, and therefore diminishes the (remaining) leverage that the EU has in certain regions. The label-based approach often inherent to applying the EU's fundamental principles therefore does not align with building strategic autonomy and mitigating geopolitical risk. Swiftness and affordability have similarly fuzzy relationships: Some first movers may align with EU principles, others will not. There is, however, a benefit to direct, top-down decision-making in potentially expediting the development of hydrogen exports. Lastly, aligning imports with EU principles also torpedoes the goal of bringing sustainable development where it is most needed; many developing countries do not fulfil the criteria of aligning with EU principles. The approach of limiting development policy to likeminded countries forces citizens to be held accountable for their (unelected) governments, which is far from supporting the sustainable development agenda. This is not to say that value-based trade opposes all other goals—the opposite is true—but harmonising it with other objectives requires a more nuanced approach rather than enforcing an exclusionary binary through labels.

The remaining links (connecting strategic autonomy with affordability or sustainable development) show no major characteristics besides the considerations above.

How to prioritise goals?

The above trade-offs show that the goals cannot all be achieved simultaneously. Strategic hydrogen imports need to balance these goals and set priorities.

Based on the discussion presented here, **the swift and successful ramp-up of hydrogen imports should be the sole primary objective.** Whereas different political preferences can alter the weight of the other goals, the importance of a swift ramp-up's is unalterable. First, a delayed onset of (sufficient) hydrogen supply is incompatible with German and European climate targets,[23] particularly if Europe is to maintain its industry. Second, failure to quickly ramp-up production not only delays but threatens the hydrogen transition altogether: If the market is not opened quickly and forcefully enough, the absent response will stifle private sector research, development, and adaptation in the field. Naturally, if the hydrogen economy fails, it can also not serve to achieve any other goals; hence, the swift and successful ramp-up must be the primary objective.

Ensuring the **EU's strategic autonomy and mitigating geopolitical risks is a condition of hydrogen imports** as a whole rather than an objective when it comes to selecting exporters. Regardless of who the exporter is, sufficient diversification of imports is imperative, not just to hedge against geopolitical risk but also natural disasters and "black swan" security events along the supply chain. Countries in direct, evident geopolitical conflict with the EU (such as Russia) or those that have a track-record of erratic decision-making and exploiting energy trade for leverage should not be considered as import partners, or if they are, then only as suppliers of last resort. Apart from this, security risks and instability in

[22] The relationship between regime type and stability, efficiency, and capacity is fuzzy and typically characterised as non-linear. For instance, defective democracies (Gates et al., 2006) or low-income democracies (Collier & Rohner, 2008) perform worse than genuine autocracies or democracies.
[23] Europe's (energy-intensive) industry is not just a foundation for the living standard and well-being of its citizens, but a major of source of Europe's independence and autonomy. Deindustrialisation would therefore not just endanger economic goals but also Europe's sovereignty, eventually limiting Europe's ability to realise other goals such as global sustainable development or the proliferation of its fundamental principles.

countries and/or along trade routes need to be understood as costs. While certain hydrogen imports may be possible, if they require constant diplomatic or military attention, then their true cost is higher.

The affordability of imports should be a secondary goal behind ensuring a quick ramp-up. Low prices facilitate a quicker diffusion of hydrogen use cases and strengthen European industries, which serves both economic and geopolitical objectives. A successful and swift ramp-up of imports is more important than an affordable one; however, as elaborated above, there is hardly any trade-off between speed and affordability.

Value-based criteria can (and should) be considered, but not weighed against the other goals. In this sense, exporter alignment with EU principles should be seen as a tertiary goal; i.e. it should not endanger the affordable ramp-up of imports. To avoid this, value-based criteria should be used to decide between otherwise equivalent exporters, but this approach's ambiguity, limited practicality, and clash with other goals make it burdensome. It needs to be emphasised that, despite a large overlap, the application of EU principles is not the same as an assessment[24] of predictability, reliability, or stability and should not be considered as such. The binarisation of exporters (into democracies and autocracies) constitutes a myopic assessment of trade risks and may harm Germany and the EU beyond the hydrogen sector. Nevertheless, a potential value-based assessment could instead be expanded to include factors such as climate action and the potential to build Germany and the EU's diplomatic leverage.

Sustainable development criteria can be assessed for each individual project but should not be a basis for selecting partners. As discussed above, the individual contributions that different hydrogen import setups have vis-à-vis SDGs is not trivial. Instead, they are dependent on uncertain time-variant counterfactuals and absorptive capacity constraints[25] in the exporting countries. The net effect that hydrogen exports can have on developing countries is ambiguous and could, in certain cases, even be negative. Therefore, countries can hardly be compared based on an SDG framework. Instead, established partnerships and projects should be shaped to be mutually beneficial and in service of SDGs, e.g. by ensuring a sufficient distribution of hydrogen rents throughout the economy, respecting the exporter's agency, [26] and assisting associated industries by way of technology transfers. Compared to the other goals and notwithstanding the importance of development policy, a quick, affordable, and successful ramp-up of hydrogen takes precedence over the use of imports as a means of helping to develop exporting countries. Once a hydrogen economy has materialised and production technology has advanced and sufficiently spread, it will then be easier to connect developing countries to the market.

[24] Various (German) initiatives combine techno-economic aspects and socio-political ones (in the broadest sense) for assessing prospective hydrogen imports (see e.g. Braun et al., 2023; Pfennig et al., 2021; Terrapon-Pfaff et al., 2022). Despite significant progress, many studies show Eurocentric and/or orientalist elements, which future studies should counter with further advances in assumptions, methods, and data. This might require close collaborations with foreign policy research institutions, researchers in/from the prospective export countries, and—at the very least— sufficiently integrating social scientists into the workflow.

[25] See van der Ploeg (2011)

[26] For instance, projects should ensure sufficient local content and job creation. Especially hydrogen—a capital-intensive sector with little labour involved—can hardly yield the same results that other industries can. Similar to petrochemicals in petroleum-rich countries, it may be necessary to develop further industries associated with hydrogen to achieve such goals.

Implications for the choice of exporters

Balancing the goals will have a direct impact on the list of key partners. The following chapter applies the priority-setting framework to Germany and the EU's most relevant prospective hydrogen exporters.

Based on the priority-setting framework from the last chapter, **Canada** and **Norway** are the most relevant prospective hydrogen exporters for Germany and the EU. Both countries are experienced energy exporters, have a domestic hydrogen industry, and enjoy ample access to finance, infrastructure, and resources. Because the countries are among the EU's closest allies and have a longstanding record of predictability and stability, they come with hardly any risk; the same applies to the respective trade routes from Norway and Canada to Germany and the EU. Abundant wind resources allow both countries to produce carbon-free hydrogen from electrolysis ("green hydrogen"), but their shortage of solar irradiation slightly dampens the (economic) efficiency (affecting overall potential and affordability). Therefore, they are likely ideal for producing clean hydrogen from domestically extracted natural gas with carbon capture ("blue hydrogen").

The **United States** (US), on the other hand, requires different considerations. It shows a similar aptitude for exports to Europe, meets the criteria for enabling a quick and successful ramp-up of hydrogen production, and is a close ally of Germany and the EU. However, the US's role as a hydrogen exporter is yet to be seen. The price of hydrogen from the US is generally volatile, linked to varying land costs, construction efforts, and the availability of renewable energy. Current plans suggest that the US might rely on hydrogen for its own industry, limiting the quantities that will be available for export. Most importantly, however, the US is developing its own regulatory system that could prove incompatible with the EU's definition of clean hydrogen. The generous subsidies provided by the US's Inflation Reduction Act may turn the US into a technological-industrial competitor of the EU, meaning that Europe needs to develop a more tailored and nuanced approach to the US and its agency that underlines mutually beneficial partnerships but also individual autonomy.

All in all, even under ideal conditions, Canada, Norway, and the US are unable to meet the EU's hydrogen needs all by themselves. Technological constraints, logistical restrictions, domestic hydrogen demand, and, in the case of the United States, regulatory divergencies and unpredictable political development will all restrict these countries' export capacities, which will in turn not meet the quantities that the EU is seeking. Moreover, even when trading with allies, diversifying energy exporters is a crucial strategy to ensure autonomy. It is therefore imperative to consider other exporters.

The states of the **Gulf Cooperation Council (GCC)—especially Oman, Saudi Arabia, and the United Arab Emirates (UAE)**—are the countries likely closest[27] to realising a hydrogen (export) economy, and they extensively meet the criteria[28] to be considered first movers. The GCC is not a close ally of the EU but a strategic partner,[29] and its member countries have a strong record of stability and reliability so far.[30] However, there is a latent risk of instability along the trade corridor to Europe. Depending on the port of origin, hydrogen transports will need to pass through the Strait of Hormuz, the Gulf of Aden, and the Suez Canal; each stretch has associated risks[31] that are small yet may require monitoring. Apart from this, these countries' abundant wind and solar resources yield the lowest green hydrogen production cost worldwide and have the potential to produce vast exports. If policymakers wish to align GCC imports with EU principles as a tertiary target, trade with Oman generally fulfils the requirements of a value-based approach.[32]

Egypt is another regional supplier that can build on its experience as an energy exporter, complete with infrastructure such as liquified natural gas (LNG) ports and pipelines.[33] Its proximity to European ports further reduces the need for ships, which enhances the country's contribution to a quick ramp-up. The country has proven the resilience of its energy exports despite persistent political instability both domestically and in its neighbourhood (Libya and Sudan). However, Egypt's escalating debt crisis[34] and donor countries' announcement that they would impose further conditions on investments and aid, complicate the country's access to finance. Egypt's economic reality decreases the likelihood that it will provide for a quick and successful ramp-up, and it would likely increase costs.

The Maghreb region (Morocco, Algeria, and Tunisia) is a well-known prospective exporter of hydrogen. Algeria and, to a lesser extent, Tunisia are experienced oil and gas exporters, and Morocco has constructed solar power plants intended to export electricity. Morocco has rather good access to finance but Tunisia and Algeria do not. According to their own plans, all three countries rely on (partially existent) pipeline infrastructure, and there are no current intentions to build new ports for hydrogen exports. Still, a few LNG terminals in Algeria give the country a potential competitive edge. Repurposing pipelines from the EU's neighbourhood is a preferable transport option, but it requires that (a) the pipelines are no longer used for natural gas and that (b) the EU Hydrogen Backbone is already available. Meeting these conditions is unlikely within the next decade. Hence, the Maghreb region might evolve into a fantastic supplier in the long run, but it is hardly the enabler of a

[27] See Ansari (2022a).

[28] The GCC countries have vast infrastructure (including ports and pipelines) and access to resources. They have the highest concentration of know-how in energy exports (including LNG in Oman, Qatar, and the UAE) and conventional hydrogen production and consumption. They have good or very good access to finance, especially Saudi Arabia and the UAE.

[29] In May 2022, the European Commission announced its strategic partnership with the GCC, which explicitly includes increased cooperation for green hydrogen (European Commission, 2022b).

[30] All GCC states are domestically stable and predictable in their exports. Minor differences exist due to variations in the level of external assertiveness and internal checks and balances, with Oman leading in terms of predictability and stability. See Ansari (2022b, 2023).

[31] There are already occasional (Iranian-backed) seizures of oil freighters in the Strait of Hormuz and acts of piracy in the Gulf of Aden. Blockages of the Suez Canal are not impossible and they can be the result of accidents, such as in 2021, or war. An increased reliance on energy imports from the GCC should imply proactive monitoring of the trade corridor and, in the case of unlikely incidents, a swift military response.

[32] Oman is a monarchy but known to be inclusive, pluralistic, moderate, and an invaluable regional peacekeeper (as seen recently in the context of Yemen's truce agreement). See Ansari (2023).

[33] See Ruseckas (2022).

[34] See Roll (2022).

rapid ramp-up. Moreover, persistent geopolitical conflicts in the region, which have already impacted energy trade in the recent past, will require the continuous, intense, and active diplomatic management of the region.[35]

Eastern Europe and Central Asia are intuitive trade partners for Europe, but the war in **Ukraine** has dramatically reshaped these opportunities. Before the war, Ukraine had excellent chances of becoming a hydrogen first mover, building on its existing pipeline infrastructure, know-how, strong regulatory convergence with the EU, financial support, experience with energy exports, and access to solar and wind resources. Ukraine had lofty ambitions to export hydrogen, unlike Central Asia, where discussions on the topic remain fringe—despite the region's ample potential. **Kazakhstan**, similar to other countries in the region, has vast potential to tap solar energy resources and to build on its experience in energy exports.[36] However, its lack of water as well as its unsuitable infrastructure, logistical complexities, and regulatory and financial shortcomings constitute tangible barriers to the country developing hydrogen exports. Most importantly, Russia's invasion of Ukraine poses a significant roadblock to the development of hydrogen exports in both Eastern Europe and Central Asia. The Russian occupation precludes any significant investments in Ukraine, and routing hydrogen to the EU via Russia is out of the question for the foreseeable future,[37] meaning that either region could be a hydrogen export partner later down the line but not any time soon.

Australia, on the other hand, is a quintessential first mover. Ample experience in (various) energy exports, domestic hydrogen production, and good access to finance enable it to quickly and reliably ramp-up its exports. Furthermore, Australia is an EU ally. However, two other factors drastically curtail the role Australia might play for EU hydrogen imports. First is the extensive distance between Australian and European ports. Transport would require a large amount of hydrogen (derivative) freighters that would be slow to produce and would drive up prices. Second, the EU faces fierce competition for hydrogen—both from Australia's own domestic demand and from hydrogen importers Japan and Korea.

Latin America may well become another major production and exportation hub in the global hydrogen trade; however, it will first require a clear political vision, collaboration, and long-term engagement of all relevant national and international stakeholders.[38] Most Latin American countries, especially those in the Southern Cone, have prospered off of commodity export revenue, though less so through hydrogen production or energy exports. **Chile** noticeably aims at becoming a global energy export hub, seeking to reach 25 GW of installed electrolyser capacity by 2030; its untapped potential for renewables encompasses several hundred GW, yet insufficient (export) infrastructure and inexperience in the sector feed high costs and could potentially delay Pepe. The total investments required to develop Chilean ports, infrastructure, and first production plants is expected to exceed €18 billion by 2040.[39] While long-distance transport will likely cease to be a problem in the long-term,

[35] A longstanding dispute between Algeria and Morocco has repeatedly affected energy trade and spilled over to Tunisia and the EU. Previous diplomatic escalations have shown that the situation requires constant and careful diplomatic effort. See also Dworkin (2022), Escribano & Urbasos (2023), Ghilès (2021), Malesani (2022).

[36] See Zholdayakova et al. (2023).

[37] Central Asia could also use pipeline networks via Turkey. However, this mammoth project requires the collaboration of numerous nations and, if existing pipelines are to be repurposed, a drop in gas demand along the corridor. These developments are implausible within the next decade.

[38] See IEA (2021).

[39] GIZ (2021).

the scarcity of suitable freighters will remain an issue in the medium-term. Importantly, the EU will face fierce competition for Chilean hydrogen from other consumers such as Japan. In theory, Chile's geography allows it to serve both regions (East Asia from its northern coast and Germany/the EU from its southern one), but the country is unlikely to develop both routes simultaneously.[40] Furthermore, decreasing value-chain costs in Chile require addressing line congestions and bottlenecks, stability issues, utility system costs, curtailment, energy cost structures, and land and water permits/availability. In this context, Chile—similar to other prospective Latin American producers—has significant long-term potential as a hydrogen exporter (perhaps in the 2040s), but its short-term viability in meeting Europe's needs is questionable. All this despite the fact that Chile is a crucial partner for the EU that fulfils a value-based approach to trade.

Brazil represents a special case among Latin American producers. It meets the criteria of a first mover. Low production costs, favourable geographical and climatic conditions, and widespread use of renewable energies are Brazil's strengths in the field, particularly if decisive action and careful consideration is taken. Noticeably, Brazil has valuable experience in commodity trade, fossil fuel exports, and petrochemicals (even though the sector is in decline).[41] The latter includes a vital (conventional) hydrogen industry, with domestic industry being the main consumer. Brazil's north-eastern ports are among the closest to Europe and have the potential to host hydrogen production hubs.[42] Optimistically, Brazilian green hydrogen could be available for Europe as early as 2025. While Brazil is a reliable partner and its current government seems committed to producing and exporting green hydrogen for the long haul, its priorities might change with time and geopolitical shifts—especially, given that Brazil's leadership and its preferences have been volatile over the past years and might further change along with geopolitical convergence among the BRICS. Moreover, additional technological development and cooperation in research and renewable energy will be necessary.

Plans to focus on **developing countries that lack political stability, infrastructure (in both production and exportation), and/or significant experience in energy exports** are incompatible with the above-mentioned goals. Focussing on countries that lack infrastructure, finance, resources, and know-how will delay hydrogen exports by more than a decade. Still, there are multiple benefits to importing from these prospective producers in the long-term, which is why a slowly evolving partnership that uses technology transfer and infrastructure investments to build up to their exportation of hydrogen in the (late) 2030s is a potent tool for long-term diversification and sustainable development. However, these countries should not be considered as sources of hydrogen in the short- or medium-term.

[40] Hydrogen Council (2022).
[41] APLA (2017).
[42] Deutsch-Brasilianische Industrie und Handelskammer (2022).

Multilateral frameworks

So far, this paper has analysed the goals of importing hydrogen, how to prioritise them, and which countries stand out as potential partners. A natural follow-up would be to evaluate the potential forms of partnership. While strict bilateral trade is the starting point, multilateral frameworks for hydrogen trade are increasingly discussed. While a hydrogen spot market is undoubtedly a distant reality, different setups can emulate some of its features.

Often dubbed the "Hydrogen Alliance" or "Global Hydrogen Accord", one framework is a multilateral agreement between EU importers and major exporters. It typically aims at securing a rapid, reliable, efficient, and international hydrogen market by emulating a multilateral market structure, effectively circumventing the market power effects and dependencies that can result from bilateral structures.

This proposal is geopolitically, economically, and technologically beneficial. In a multilateral framework, diversification is easier, which mitigates geopolitical tensions. Pooling exporters and importers in a common market increases both transparency and the likelihood that non-differentiable supply and demand can be matched. Furthermore, it can be expected that prices will be more balanced (for both consumers and producers across different projects) and more hydrogen would be produced than in a strictly bilateral setup.[43] Depending on the degree of technological cooperation within the framework, both specialisation and innovation spill-overs are likely and would accelerate technological progress.

However, there are numerous variables of this approach that need to be determined. What would be the degree of institutionalisation (e.g. an agreement or a supranational organisation), the mechanisms for enabling trade (specific auction systems), the dimensions covered by the framework (e.g. purely trade-focussed or a holistic setup including infrastructure, technology cooperation, standards, investments, education, and market development), and the countries involved?

Degree of institutionalisation

The ability to catalyse the global hydrogen transition would clearly be aided by a broader and more institutionalised framework. More specifically, the most effective way forward would be to develop a supranational organisation with holistic and binding fields of collaboration. However, given the variety of national goals and (regulatory) preferences of coun-

[43] First, the increased coordination decreases market frictions and transaction costs (which appear e.g. in the form of negotiation efforts), which widens the funds that can actually be put to work in production. Second, the enhanced match-making process in the framework increases the chance that both supply and the demand side can establish projects.

tries, the barriers to such an organisation are also significant. The odds that such a supranational body could be quickly and successfully formed are, therefore, low. Conversely, an intra-governmental agreement with a coordinating body might serve as a feasible first step to kick-start a gradual harmonisation of national political goals and regulatory preferences. Such a setup would be less effective than a supranational constellation and it might turn the Alliance into a mere discussion platform. Yet, it does offer more flexibility and, if embraced by all Alliance members, it could facilitate cooperation and coordination on a wide array of topics from technology transfer to consistent harmonisation of product and contract certification, regulation, and standardisation as well as on value and supply chain alignment. A cooperative body could also foster the creation of flexible mini-alliances (minilateralism) focussing on specific, ad hoc topics such as technology transfer or contract structure.

Mechanisms to organise trade

The absence of a broad hydrogen market (and the reliance on bilateral trade instead) prevents the construction of price indices that comprehensively reflect supply and demand patterns.[44] Hence, as of today, green hydrogen producers and project developers need to search for and identify buyers on a case-by-case basis, and product requirements (e.g. the maximum carbon intensity of production and its means of verification) need to be defined in individual, bilateral negotiations. The resulting transaction costs and uncertainty are an immense obstacle for the hydrogen transition.

It is likely that, even inside the Alliance, bilateral contracts (with individually fixed volume and price conditions) will remain necessary at an early stage. A gradual multilateralisation of trade inside the Alliance is feasible in the medium-term, however. One possible way to do this would be to offer Alliance members access to a support mechanism with fixed green premium subsidies, as has been proposed by the European Commission in the draft proposal for the creation of a hydrogen bank.[45] This could serve as an intermediate instrument to match supply and demand in this transition phase using a selective auction scheme. Over time, the system could gradually transition into a market intermediary for double-sided auctions as opposed to signed agreements between producers and off-takers.[46] This mechanism would enable both large-scale production and cost reductions that result from economies of scale and competition; the latter, in turn, would be a latent enabler of multilateral trade inside the Alliance.

The eventual setup of an auction mechanism for multilateral trade inside the Alliance depends on its institutionalisation.[47] A supranational agreement would easily allow for the internationalisation of the Hydrogen Bank ("Hydrogen Alliance Bank"); joint governance mechanisms and a supranational intermediate that centralises the auction platform would be essential merits of the Alliance. This could be extended into a common technology and innovation fund that supports clean hydrogen projects among the Alliance's exporting countries, and it could pave the way to providing privileged access to further aspects of the

[44] S&P Global Commodity insight is currently the only available price index for hydrogen, but it relies on estimations of the production cost—not trading prices—of hydrogen. It features hydrogen produced from steam methane reforming (SMR), including Carbon Capture and Storage (CCS) in certain regions, and—if available—zero-carbon hydrogen from proton exchange membrane (PEM) and alkaline electrolysis (S&P Global, 2022).
[45] European Commission (2023b).
[46] The auctioneer could sign agreements with both producer and off-taker, similar to the H2Global model.
[47] In its early stages, the Alliance will mostly develop on a government-to-government level. However, private actors will be in charge of signing the contracts, so their representatives should be brought onboard early.

EU's common market. The scheme would closely resemble the design of the proposed EU hydrogen bank, albeit with more incentives and agency for exporters. A less institutionalised scheme, on the other hand, would need to rely on Europe establishing and managing an international expansion to the hydrogen bank. While this would allow the EU to unilaterally set the regulatory framework, exporters' lack of agency in this context would gravely diminish their incentive to join the Alliance—especially for those exporters that are not (exclusively) dependent[48] on possibly supplying the EU. Most likely, in such a case, the Alliance would not organise but instead only gather several bilateral contracts, and it would fail to achieve significant progress towards the multilateralisation of the hydrogen trade, ultimately calling the necessity of the Alliance into question.

Dimensions to be covered

The Alliance could exclusively focus on fostering trade between its members, or it could address several dimensions of the hydrogen economy: whether know-how, technology cooperation, funding mechanisms (public/private blending) in upstream (electrolysers), midstream (infrastructure), and downstream (green steel production), or standards, investments, education, and market development.

If the Alliance were to adopt a broader focus, it would certainly be beneficial to the global hydrogen economy, as increased cooperation helps advance technology and lower prices. However, this could also unintentionally prove to be a central roadblock: The effort needed to bridge the preferences of prospective member countries increases with the number of fields of collaboration. If a supranational institution materialises—which is generally preferable—countries will want extensive time to negotiate, potentially derailing the Alliance. Therefore, a stronger degree of institutionalisation should go in hand with a lower number of dimensions to be covered. After all, the Alliance can always choose to address new dimensions later.

Countries involved

The process of selecting potential members of the Alliance should align with the prioritisation framework laid earlier in this paper. The members of the Alliance should enable the hydrogen transition and assist the EU and its member states in achieving their climate goals. Nonetheless, given its enduring and significant nature, the Alliance must adopt a broader perspective (and, thus, a list of member countries). The Alliance needs to place Europe strategically within a new long-term global framework and consider hydrogen as a long-term technology path. Geopolitical implications (and possibly even value-based aspects) may therefore be more relevant than in the case of bilateral setups.

Many different constellations of countries would be possible and they are also dependant on various (diplomatic) factors that are not fully considered in this study. However, this paper proposes a two-tiered Alliance—with varying degrees of institutionalisation—as a

[48] Any approach that seems to predominantly target countries with little or no bargaining power vis-à-vis unilateral EU standards risks repercussions—even if done without bad intentions. Prospective exporters are increasingly voicing concerns about the rising discriminatory behaviour of European actors that mirrors historical colonialism. This discourse can and will feed into the dangerous narrative of an "imperialist" EU that certain hostile actors wish to construct.

compromise between the imperative of ramping up the market in the short-term (accelerator) and expanding the market in the long-term (incubator). Potential members of these two tiers can be found below,[49] each fulfilling the recommendations presented earlier in this paper.

The first tier of partners should comprise exporters that are able and willing to enter large-scale hydrogen trade with EU countries before 2030—in short, first movers. This group of countries is the core of the Alliance and should include a practical but broad list of fast producers. A higher degree of institutionalisation might be easier to achieve within this group when compared to the second tier. Specifically, this group could constitute a Hydrogen Alliance Bank to centralise the auction scheme mechanism and facilitate rapid investments in hydrogen projects. This Bank could facilitate the harmonisation of technological and regulatory/certification standards and provide privileged access to the European hydrogen market and a technology and innovation fund. **First tier countries include Brazil, Canada, Norway, and Oman.**

The second tier of partners comprises countries that lack the experience, infrastructure, resources, and/or political stability to enter the first tier. These countries will not be able to deliver hydrogen before 2030 without tackling significant barriers (including conflict), but they do have the potential and political will to participate in hydrogen trade with Europe. Helping these countries transition into hydrogen exporters will help them to develop new capacities and lay the foundation for gradually increase hydrogen imports to meet demand growth over the coming decades. Within this second tier of partners, bilateral cooperation on a broader array of topics including technology (transfer) and regulatory exchange as well as political dialogue and engagement via diplomatic instruments like H2Diplo could help stabilise these countries and accelerate their participation in hydrogen value chains. Additionally, these countries could be granted access to dedicated and privileged (financial) support schemes (e.g. blended finance) to develop green hydrogen transport infrastructure through multinational banks like the European Bank for Reconstruction and Development or through national co-financing mechanisms. **Second tier countries include Algeria, Chile, Egypt, Kazakhstan, Kenya, Morocco, Namibia, Senegal, Tunisia, Ukraine, and Uruguay.**

Adopting this two-tiered approach streamlines the efforts of various German and European hydrogen initiatives, such as H2Diplo and H2Global, fostering a more integrated and task-differentiated collaboration based on the relevance of each country. The framework also represents and includes multiple world regions; indeed, excluding particular regions would set a dangerous precedent and could be understood as a hostile act, thus accelerating fragmentation of the global order.

[49] We emphasise that these lists are tentative and only reflect the most exemplary members of the group. They are certainly open to additions.

Conclusions and further observations

The path to a hydrogen-powered future is complex and demands more than just technological innovation. Imports are to be a central component of the European hydrogen economy, but there are a multitude of (sometimes conflicting) objectives that policymakers need to consider—and little clarity on which of these objectives should supersede the other.

In this paper, we analysed five prominent (groups of) goals that dominate the discussion, i.e. a successful and swift ramp-up of imports; affordability; consistency with fundamental EU principles; global sustainable development; and strategic autonomy, geopolitical risk, and diplomatic leverage. The analysis reveals that the need for a rapid and successful market ramp-up is paramount, highlighting the importance of first movers—i.e. countries with notable capacities and experience relevant to hydrogen development. Focussing on developing countries with little to no capacity to develop hydrogen exports is at odds with the hydrogen transition and, ultimately, European and German climate targets. Their lack of experience in energy exports would inadvertently slow down the hydrogen economy, underscoring the need for a nuanced approach to incorporating these countries. Establishing a diverse pool of exporters is important, but the inclusion of instable exporters will require continuous diplomatic, developmental, and perhaps even military support, thus adding to overall costs. A multilateral framework for the hydrogen trade is indeed a valuable catalyst of the hydrogen transition, but, depending on the political momentum and willingness to compromise, policymakers must decide between the difficult-but-rewarding supranational framework and the easy-but-ineffectual broad intergovernmental club.

The analysis's findings also highlight misconceptions that are inherent to the current debate. While some of the outlined objectives indeed align with one another, such co-benefits often rely on external factors; generally, significant trade-offs will be required. The tendency to neglect these trade-offs and instead act on the assumption that clean technologies only lead to win-wins is a dangerous fallacy—there is no way to have it all, and difficult considerations will need to be made. Eventually, an agenda that misrepresents the intrinsic trade-offs in sustainable transitions and seeks to use energy policy as a vessel to channel goals from other policy fields can lead to the failure of both energy and climate policies.

Along these same lines, geostrategic aims, value-based trade, and resilience-building along value chains do not always coincide. Our analysis has shown that they can, but not usually. Just because a country is aligned with EU values does not mean that it is stable or able to be part of a resilient value chain and vice versa. In this vein, Germany and the EU's wider geopolitical objectives may require them to team up with partners who do not fully share the EU's vision. These trade-offs require sober analysis and consideration, and they should not be made with an oversimplified "one rule fits all" approach.

There are numerous considerations to be made for (strategic) hydrogen imports beyond the ideas presented in this paper. Notably, this analysis focussed almost entirely on the European perspective. However, this does not mean that Germany and the EU have their pick of the litter when it comes to choosing partners. While exporters are indeed keen to sell in the world's largest common market, Europe is definitely not the only target market for most exporters; other regions are also seeing more demand for hydrogen. Moreover, bottlenecks along the value chain will further constrain the global hydrogen supply for decades to come. First, the transition to a sellers' market means that exporters' preferences are bound to become more relevant.[50] This may require European actors to not only compromise when it comes to regulation but also, more importantly, to be open towards negotiating business models with exporters that represent a fair(er) distribution of risk. Second, a sellers' market means that the states that draw out negotiations and keep exporters waiting are playing with fire—first movers may well lose interest and/or consider other importers. Moreover, even for first movers, hydrogen projects will take four to six years, on average, to complete. By this logic, projects need to begin no later than 2024 if they are to help achieve the EU's 2030 targets. Binding action is thus imperative to reach the targets.

Aside from collaboration with trade partners externally, a successful import strategy will require increased collaboration within the EU itself. EU countries—particularly neighbours that will require each other for hydrogen flows—need to be organised well beyond their jurisdictions. More joint ventures and common platforms between energy ministries of member states could be useful, but also the Hydrogen Alliance is an effective tool. Its formation would not only work to harmonise the hydrogen economy with exporters but also among European importers. There is a need for increased collaboration among potential member states of the Alliance, and this constellation could contribute to a coordinated approach to overcoming disputes in favour of a common vision that lends itself to assertiveness and decisiveness.

While this paper focusses on the importation of hydrogen(-based) energy, its analyses can also be applied to other questions connected to the hydrogen economy. For example, how can import partners contribute to spatially diversified decarbonisation efforts, e.g. through maritime trade routes or air traffic hubs? Are strategic partnerships for green steel or cement a complement or substitute to the hydrogen trade? Ultimately, hydrogen imports offer German and European policymakers the chance to rethink and reshape the geography of international energy trade—a promising challenge indeed.

[50] This will be further explored in our upcoming SWP Research Paper on the geopolitics of hydrogen.

References

Ansari, D. (2022a). The hydrogen ambitions of the Gulf States: Achieving economic diversification while maintaining power. *SWP Comment 2022/C 44*

Ansari, D. (2022b). Letting Agrabah go: why we must de-orientalise our approach to the Arab Gulf states. The Loop. https://theloop.ecpr.eu/letting-agrabah-go-why-we-must-de-orientalise-our-approach-to-the-arab-gulf-states/

Ansari, D. (2023). Omani Hydrogen for Germany and the EU: Not just a matter of energy policy. *SWP Comment 2023/C 18*

Ansari, D., Grinschgl, J., & Pepe, J. M. (2022a). Electrolysers for the hydrogen revolution: Challenges, dependencies, and solutions. *SWP Comment 2022/C 57.*

Ansari, D., Schönenberg, R., Abud, M., Becerra, L., Brahim, W., Castiblanco, J., ... & Wyborn, C. (2022b). Communicating climate change and biodiversity loss with local populations: Exploring communicative utopias in eight transdisciplinary case studies. *UCL Open: Environment Preprint*.

APLA (2017). Brazil: Petrochemicals and Chemicals. *Global Business Report.* https://www.gbreports.com/wp-content/uploads/2017/11/Brazil-Chemicals-2017-Web-Version.pdf

Bianco, C. (2021). Power play: Europe's climate diplomacy in the Gulf. *ECFR Policy Brief. Retrieved January*, *16*, 2022.

Braun , J. F., Frischmuth, F., Gerhardt, N., Pfennig, M., Schmitz, R., & Wietschel, M. (2023). Fraunhofer CINES Report. Clean hydrogen deployment in the Europe-MENA region. https://www.cines.fraunhofer.de/content/dam/zv/cines/dokumente/Fraunhofer_CINES_Clean_Hydrogen_Deployment.pdf

Bundesregierung (2021). German Sustainable Development Strategy. Available online: https://www.bundesregierung.de/resource/blob/974430/1940716/4bdf89ceea3b1e4367918384b8839%E2%80%8Ea37/2021-07-26-gsds-en-data.pdf?download=1%E2%80%8E

Collier, P., & Rohner, D. (2008). Democracy, development, and conflict. Journal of the European Economic Association, 6(2-3), 531-540.

Deloitte (2022). Unfolding the Hydrogen system map: The formula to establish the Hydrogen ecosystem. *Report.* https://www2.deloitte.com/content/dam/Deloitte/xe/Documents/energy-resources/me_unfolding-the-hydrogen-system-map.pdf

Deutsch-Brasilianische Industrie und Handelskammer (2022). Aufbau von Green Hydrogen Hubs in strategischen Häfen Brasiliens: Zielmarktanalyse 2022 mit Profilen der Marktakteure. *Report*. https://www.german-energy-solutions.de/GES/Redaktion/DE/Publikationen/Marktanalysen/2022/zma-brasilien-h2.pdf?__blob=publicationFile&v=3

Drieghe, L., & Potjomkina, D. (2019). EU's value-based approach in trade policy:(free) trade for all?. *Global Affairs*, *5*(1), 63-72.

Dworkin, A. (2022). North African standoff: How the Western Sahara conflict is fuelling new tensions between Morocco and Algeria. *ECFR Policy brief.*

Escribano, G., & Urbasos, I. (2023). Spain's Hydrogen Ambition: Between reindustrialisation and export-led energy integration with the EU. *RIFS Discussion Paper.*

European Commission (2022a). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the committee of the Regions. REPowerEU Plan. https://eur-lex.europa.eu/resource.html?uri=cellar:fc930f14-d7ae-11ec-a95f-01aa75ed71a1.0001.02/DOC_1&format=PDF

European Commission (2022b). Joint Communication to the European Parliament and the Council: A strategic partnership with the Gulf. https://www.eeas.europa.eu/sites/default/files/documents/Joint%20Communication%20to%20the%20European%20Parliament%20and%20the%20Council%20-%20A%20Strategic%20Partnership%20with%20the%20Gulf.pdf

European Commission (2023a). A Green Deal Industrial Plan for the Net-Zero Age. https://commission.europa.eu/system/files/2023-02/COM_2023_62_2_EN_ACT_A%20Green%20Deal%20Industrial%20Plan%20for%20the%20Net-Zero%20Age.pdf

European Commission (2023b). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the European Hydrogen Bank. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0156

European Union. (2012). Consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union – Consolidated version of the Treaty on European Union – Protocols – Declarations annexed to the Final Act of the Intergovernmental Conference which adopted the Treaty of Lisbon, signed on 13 December 2007 – Tables of equivalences. Official Journal C 326, 26 October

Gates, S., Hegre, H., Jones, M. P., & Strand, H. (2006). Institutional inconsistency and political instability: Polity duration, 1800–2000. *American Journal of Political Science*, *50*(4), 893-908.

Ghilès, F. (2021). Escalating rivalry between Algeria and Morocco closes the Maghreb-Europe pipeline. *CIDOB Notes.* https://www.cidob.org/es/publicaciones/serie_de_publicacion/notes_internacionals_cidob/260/escalating_rivalry_between_algeria_and_morocco_closes_the_maghreb_europe_pipeline

GIZ (2021). Conditions and Opportunities of Green Hydrogen Trade from Chile to Germany and Japan. *Report.* https://www.energypartnership.cl/fileadmin/user_upload/chile/media_elements/Studies/Abstract_Hydrogen_Export_from_Chile_to_GER_EP_CHL_2_2021.pdf

Grinschgl, J., Pepe, J. M., & Westphal, K. (2021). A new hydrogen world: Geotechnological, economic, and political implications for Europe. *SWP Comment (No. 58/2021).*

Hydrogen Council (2022). Global Hydrogen Flows: Hydrogen trade as a key enabler for efficient decarbonization. Presentation. https://hydrogencouncil.com/wp-content/uploads/2022/10/Global-Hydrogen-Flows.pdf

IEA (2021). Hydrogen in Latin America: From near-term opportunities to large-scale deployment. *IEA Report.* https://iea.blob.core.windows.net/assets/65d4d887-c04d-4a1b-8d4c-2bec908a1737/IEA_HydrogeninLatinAmerica_Fullreport.pdf

Latulippe, N., & Klenk, N. (2020). Making room and moving over: knowledge co-production, Indigenous knowledge sovereignty and the politics of global environmental change decision-making. *Current Opinion in Environmental Sustainability*, *42*, 7-14.

Leonard, A., Ahsan, A., Charbonnier, F., & Hirmer, S. (2022). Renewable Energy in Morocco: Assessing risks to avoid a resource curse. *Available at SSRN 4025835*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4025835

Mahony, M., & Hulme, M. (2018). Epistemic geographies of climate change: Science, space and politics. *Progress in Human Geography*, *42*(3), 395-424.

Malesani, P. (2022). Italian Foreign Policy and the Western Sahara: Balancing Relations with Morocco and Algeria. *IAI Commentaries.*

Mense, N.S. (2023). Green Hydrogen and the Pathway toward a Decarbonised Energy Economy. *A Frost & Sullivan Insight Prepared Exclusively for the World Future Energy Summit 2023.*

Nunez, A., & Quitzow, R. (2023). Germany's Hydrogen Strategy: Securing Industrial Leadership in a Carbon-Neutral Economy. *RIFS Discussion Paper.*

Pepe, Jacopo Maria (2022a). Neue deutsche Energiepolitik. Das Gas-magazine, 1/2022

Pepe, Jacopo Maria (2022b), Geopolitics and Energy Security in Europe: How Do We Move Forward?, *FESJust Climate: Brussels, Belgium*

Pfennig, M., Bonin, M. V., & Gerhardt, N. (2021). Ptx-Atlas: Weltweite Potenziale für Die Erzeugung von Grünem Wasserstoff und Klimaneutralen Synthetischen Kraft—Und Brennstoffen. *Fraunhofer IEEE Institute für Energiewirtschaft und Energietechnik: Kassel, Germany*.

Ploeg, F. V. D. (2011). Natural resources: curse or blessing?. *Journal of Economic literature*, *49*(2), 366-420.

Rabe, W., Kostka, G., & Stegen, K. S. (2017). China's supply of critical raw materials: Risks for Europe's solar and wind industries? *Energy Policy*, *101*, 692-699.

Roll, S. (2022). Loans for the president: External debt and power consolidation in Egypt. *SWP Research Paper (No. 12/2022).*

Ruseckas, L. (2022). Europe and the Eastern Mediterranean: The potential for hydrogen partnership. *SWP Comment (No. 50/2022)*

S&P Global (2022), S&P Global Commodity Insight:
Platts Hydrogen Assessments. https://www.spglobal.com/commodityinsights/en/our-methodology/price-assessments/energy-transition/hydrogen-price-assessments

Staiß, F., Adolf, J., Ausfelder, F., Erdmann, C., Fischedick, M., Hebling, C., ... & Wurbs, S. (2022). *Optionen für den Import grünen Wasserstoffs nach Deutschland bis zum Jahr 2030: Transportwege-Länderbewertungen-Realisierungserfordernisse*. acatech-Deutsche Akademie der Technikwissenschaften.

Terrapon-Pfaff, J., Prantner, M., Ersoy, S. R. (2022). Risikobewertung und Risikokostenanalyse der MENA-Region. MENA-Fuels: Teilbericht 8 des Wuppertal Instituts an das Bundesministerium für Wirtschaft und Klimaschutz (BMWK). *Report.* Wuppertal, Stuttgart, Köln, Saarbrücken

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*, 101667.

Zholdayakova, S., Abuov, Y., & Zhakupov, D. (2022). Toward a Hydrogen Economy in Kazakhstan. *ADBI Working Paper (No. 1344)*

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