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A Grand Strategy for Europe's Clean Industrial Future

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Executive Summary

Europe needs a pragmatic clean industrial strategy and external action to match. In an era of fuel shocks, supply chain chokepoints, and brute transactionalism, business-as-usual frameworks built on climate altruism or free-trader assumptions are no longer sufficient. A realist approach to industrial and foreign policy need not come at the expense of low-carbon ambitions or durable cooperation with partners, but it does require a coherent, focused agenda to stimulate exports where feasible, secure the most vulnerable supply chains, and bolster European clean technology at home and abroad. This paper draws on a year of internal analysis and workshops with European policy planners, diplomats, and European Commission officials. It assesses Europe's industrial base across clean tech and industrial supply chains, evaluates past diplomatic efforts by the European Union (EU) and its member states on climate and clean tech, and prescribes policy ideas that balance development and decarbonization with the imperatives of security and competitiveness.

Key Findings

- Europe's clean industrial base is at a juncture. It is highly uneven, with clear export-ready strengths like grid tech, wind, and geothermal turbines; secure supplies in inverters, heat pumps, nuclear fuels, some metal recycling, and potentially rare earth refining. But it has severe vulnerabilities in mined rare earths, nickel, cobalt, graphite, magnets, battery materials, solar, and green iron. Progress on clean steel and fuels is likely but entails economic obstacles.

- Not all industrial strengths are created equal. Europe needs a prioritization framework to remediate its weaknesses and bolster its strengths (see figure 4). For example, grid tech is an essential strength that Europe should double-down on; magnets and batteries are a top-tier security goal for indigenization; while critical raw material (CRM) extraction, processing, as well as some metal production require some friendshoring (or nearshoring) out of necessity or economic reality.

- The EU and its member states have built important diplomatic muscle through 300 green pacts across sixty countries. These efforts have been too broad but, when focused, they have specifically targeted CRMs, an important starting point that could help ease supply concerns. However, diplomacy might have been overly focused on hydrogen.

- EU support for clean energy abroad has rightfully backed grid projects, but it has prioritized solar over wind, hydro over geothermal, and overextended to hydrogen. Foreign green ammonia projects are a potential success while CRM projects urgently need support to scale—especially for graphite and rare earths.

Recommendations

- Fortify the EU's domestic industrial base with local content, impactful subsidies, and strategic sector prioritization. This requires recalibrating price thresholds in the Industrial Accelerator Act (IAA) to reflect EU-China cost differentials, ensuring that future EU funds for clean tech are both ample and flexible to support production (as well as grants and low-interest rate loans), and prioritizing supply chains with resilience implications like batteries and magnets or competitiveness opportunity like grid tech and wind.

- Access to local content must be strategic and tightened by flipping the IAA's logic. Instead of extending EU-origin eligibility to all free-trade-agreement partners, it should be granted selectively as a bargaining chip to third countries under the same joint-venture conditions as the single market. Companies domiciled in dominant market-share countries (such as China) should be treated as production from those countries.

- Re-position the Global Gateway to bolster European-made industrial clean tech products, driven primarily by a so-called global grid initiative that stimulates European grid tech exports and manufacturing abroad. Wind projects should be prioritized over solar, geothermal brought to parity with hydro given its new growth outlook, and hydrogen pragmatically focused on near-term, proven applications like fertilizer. Optimal win-win projects might include building EU-made wind farms and grids to power CRM or green industrial projects in third countries.

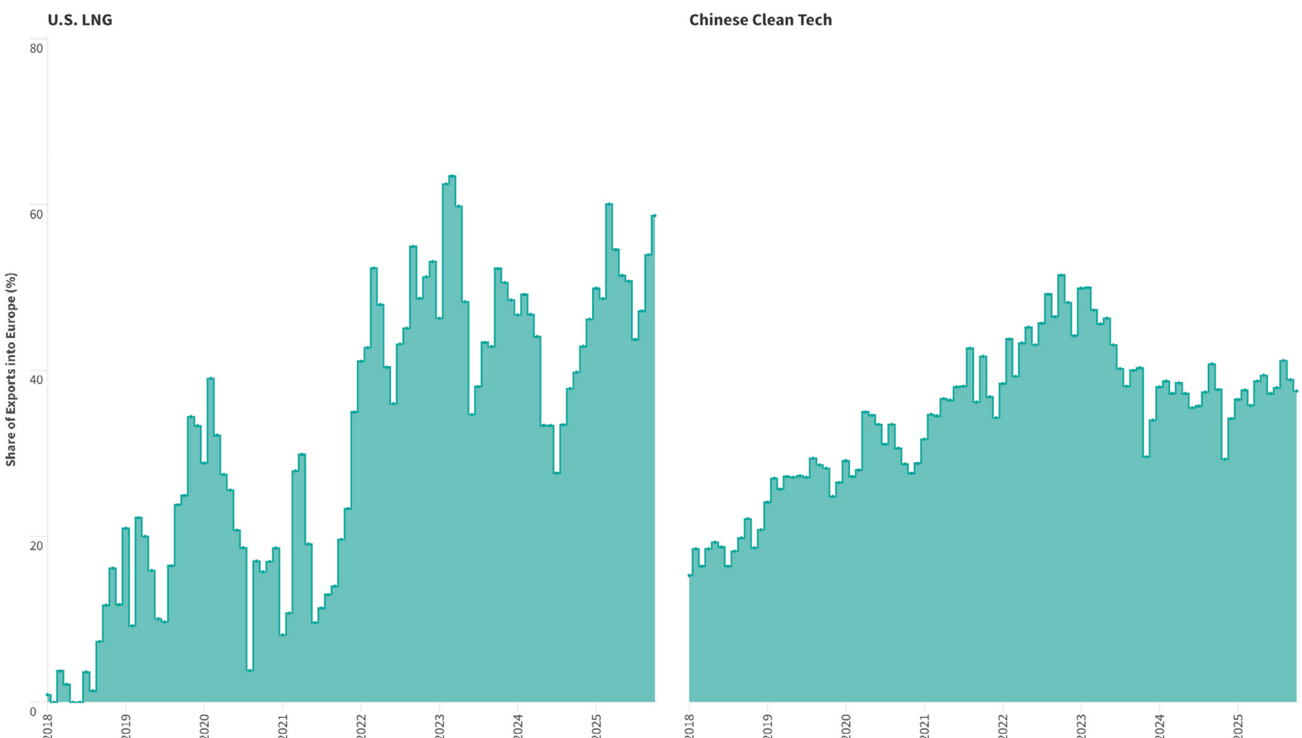
- Existing pacts should be transformed into targeted industrial action by narrowing down priority technology verticals as offensive export plays (grids in South Africa), supply chain incubation (solar inputs in India), inward industrial investments (magnets with Japan), and science diplomacy on breakthroughs for competitiveness and resilience (sodium-ion batteries with South Korea).

From the Green Deal to Law of the Jungle

Europe's energy and foreign policies are not yet suited to today's harsh geopolitical environment. Since the 2019 European Green Deal, the European Union (EU) has cut emissions by reducing fossil fuel consumption. But it has created new dependencies by swapping them for energy technologies and imported fuels.[1] The rise of China—and now the United States—as competing state-capitalist poles has challenged the EU's free market–based energy and industrial models.[2] Europe now sits between two energy hegemons, consuming over half of U.S. liquefied natural gas (LNG) exports and Chinese clean technology exports (see figure 1). These dependencies pose distinct risks: LNG exposure is immediate and vulnerable to shocks, while clean tech dependence is long term and carries risks of industrial coercion and cyber vulnerabilities.[3] The remedies to both, however, point in the same direction: electrify as much of the European economy as possible using clean energy produced from secure and, where necessary, domestic inputs.[4]

Figure 1. Europe Is Caught Between Energy Hegemons

Europe now accounts for about half of U.S. LNG and Chinese clean tech exports.



Source: Authors' analysis based on data from the U.S. Energy Information Administration and Ember.

Note: Chinese clean tech includes solar photovoltaics (PV), wind, batteries, electric vehicles (EV), heating/cooling, and grid technologies.

Europe will need a clear vision of its own clean industrial ambitions, including an attractive external offering to counter the U.S.-Chinese power competition. China is now an established actor in the Global South, deploying finance at scale, while the United States has adopted a transactional approach to secure resources.[5] In the past, Europe has projected its values of sustainable stewardship on third countries and, in the context of energy policy, primarily focused on assisting in the reduction of carbon emissions.[6] While this should remain an aim of its Global South engagement, the EU might take a new approach that better serves and aligns with its own priorities: insulating itself from hydrocarbon shocks and carving niches in value-add alternatives for clean tech production. What Europe can and should offer third countries are focused, concrete opportunities to access its remaining electrification equipment (especially the power grid), develop mutually beneficial supply chains, and collaborate on innovation for low-carbon breakthroughs with competitiveness and security dividends. Doing so will ensure that Europe's low-carbon industry remains fruitful—an essential development for a durable, long-term energy transition.

Europe's Clean Industrial Production Outlook

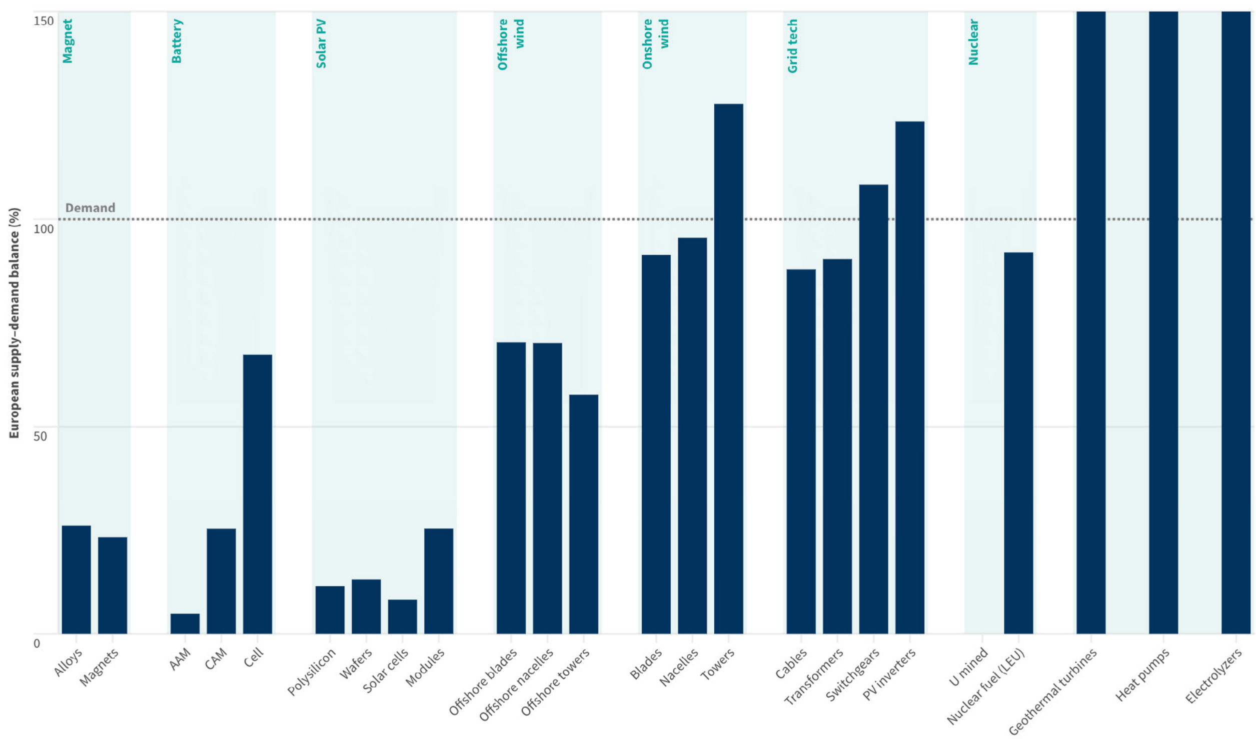
Europe's outlook includes notable vulnerabilities and legacy strengths. To gauge this, domestic manufacturing capacity potential for 2030 is harmonized against projected demand in what should be viewed as a best-case scenario where new projects with established start dates are actualized, those without closure dates remain online, and demand remains within the bounds of consensus growth (see figure 2). The UK, Norway, and Switzerland are included alongside the twenty-seven member states of the EU. In this scenario, Europe can domestically produce about 25 percent of permanent magnet materials—essential to electric vehicles (EVs) and offshore wind turbines—and 65 percent of battery cells, but far fewer cathodes and just 5 percent of the anodes it requires. Solar photovoltaic (PV) production remains limited at about 10 percent of core inputs, while offshore wind is slightly undersupplied from domestic production, and onshore wind remains a strong industrial base capable of meeting demand with potential exports. Similarly, grid tech—solar inverters, transformers, switchgears, and cables—will remain well supplied with the continued potential for some exports. Nuclear fuels are likely to come close to self-sufficiency, while geothermal turbine production will yield a comically large supply-demand ratio of 1,485 percent because Europe is the world's leading supplier with inconsequential demand. Lastly, if heat pump and electrolyzer factories are developed at pace, they risk oversupply due to weak or unclear domestic demand.

Critical raw materials (CRMs) and industrial products also yield varying strengths (like recycled copper and aluminum) and weaknesses (like graphite and rare earths) (see figure 3). Mined and especially processed lithium represents a potential opportunity with significant projects in the pipeline that could deliver domestic production, including via recycling.

Figure 2. Europe's Clean Tech Manufacturing Outlook Is Mixed

By 2030, magnet, battery, and solar PV remain exposed, while wind, grid, nuclear, heat pump, electrolyzer, and geothermal are strong.

2030



Source: Analysis based on findings from Milo McBride and Daniel Helmeci, "Europe's Clean Industrial Outlook," Carnegie Endowment for International Peace, forthcoming. Data sourced from the Net Zero Industrial Policy Lab, Global Clean Investment Monitor, EIT InnoEnergy, S&P Global, Benchmark Mineral Intelligence, United Nations COMTRADE, Eurostat, the Fraunhofer Institute, SolarPower Europe, Wind Europe, Rystad Energy, the EU Joint Research Centre, European Hydrogen Observatory, Reform EU, Argus Media, Euratom, ORC World Map, and industry reports.

Note: Europe's 2030 supply forecasts sum projects that are operational, under construction, and announced—including those without Final Investment Decision (FID) but with start dates before 2030 to help illustrate a best-case scenario. Supply reflects the manufacturing nameplate capacity—not production—which implies a lower level of output than indicated. For the following sectors, both the 2025 and 2030 percentage exceeds 150 percent: geothermal (1485.69 percent in 2030 and 2513.15 percent in 2025), electrolyzer (609.64 percent in 2030 and 2070.23 percent in 2025), heatpump (206.45 percent in 2030 and 240.90 percent in 2025). For the following wind components, the 2025 percentage also exceeds 150 percent: offshore nacelles (197.67 percent), offshore towers (162.79 percent), offshore blades (162.79 percent), and onshore towers (179.13 percent).

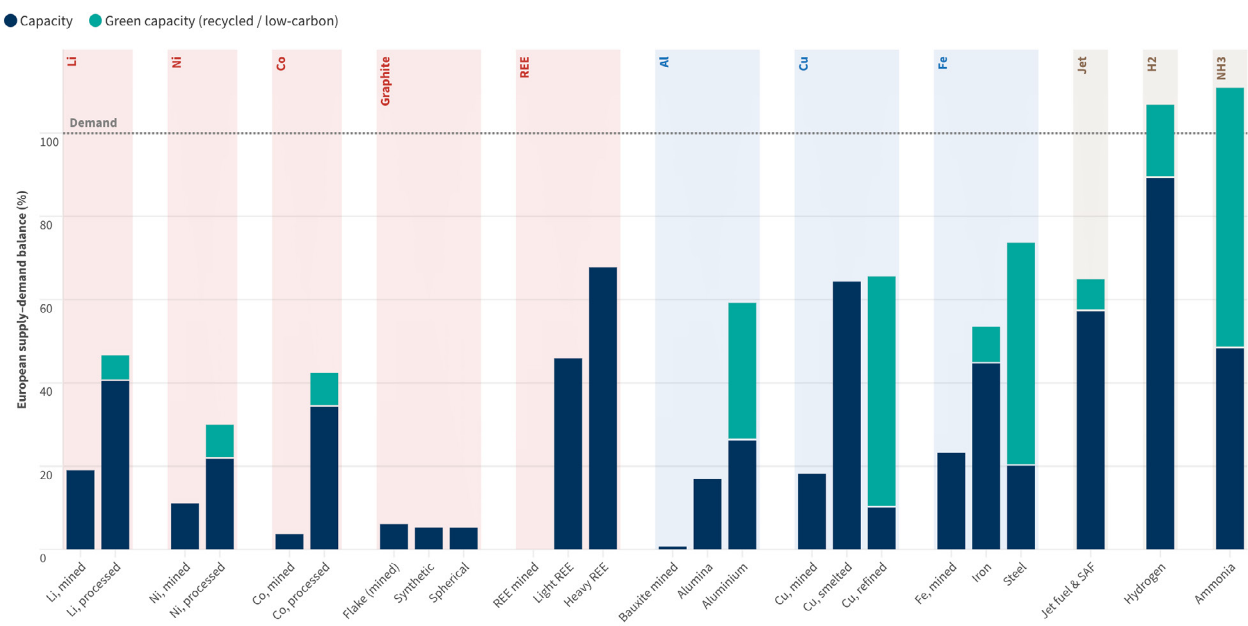
However, mined nickel and cobalt remain in very small supply at about 5 to 10 percent of demand with little growth opportunities. Graphite—including flake, synthetic, and processed materials—is a severe vulnerability with few potential projects producing, at best, 5 percent of projected demand. Most concerningly, Europe has zero rare earth mines that can be activated by 2030. That said, a surprising scale of rare earth processing could be developed—even for heavy rare earths—if adequate rare earth mineral inputs can be sourced. Copper and aluminum are bright spots: While only copper is mined in notable but modest quantities, Europe's recycling capacity for both is immense. It can, in theory, produce nearly 50 percent and 30 percent of aluminum and copper supply, respectively. However, Europe's scrap is susceptible to export leakage and does not guarantee production.[7]

Heavy industry presents a unique challenge. Decarbonization of this sector is inflationary and energy intensive—an unfortunate reality as European industry faces a second China shock and an additional energy crisis.[8] If all clean steel projects start on time, most of Europe's steel production will come from low-carbon electric arc furnaces (EAFs) and not coal-based blast furnaces. But this switch will create two obstacles: The first is that Europe will be significantly undersupplied in green iron ore (about an 80 percent deficit). The second is that EAF steel cannot fully substitute the quality of blast furnace steel, especially in strategic applications because of its lower purity.[9] Notable progress is possible on green ammonia, which is essential to fertilizer production, including potential imports of clean ammonia. However, most domestic hydrogen production will remain fossil-based and exposed to gas imports. Europe can reach its goal of 6 percent sustainable aviation fuel (SAF) production, but it remains exposed to kerosene imports and might struggle to build SAF production because while much of the pipeline today is cheaper, biofuel-based solutions, this will eventually require far costlier synthetic fuels.[10]

Figure 3. Europe's Critical Raw Materials and Heavy Industry Outlook

Mined graphite and rare earths pose severe risks, while decarbonizing ammonia and steel makes modest progress.

2030



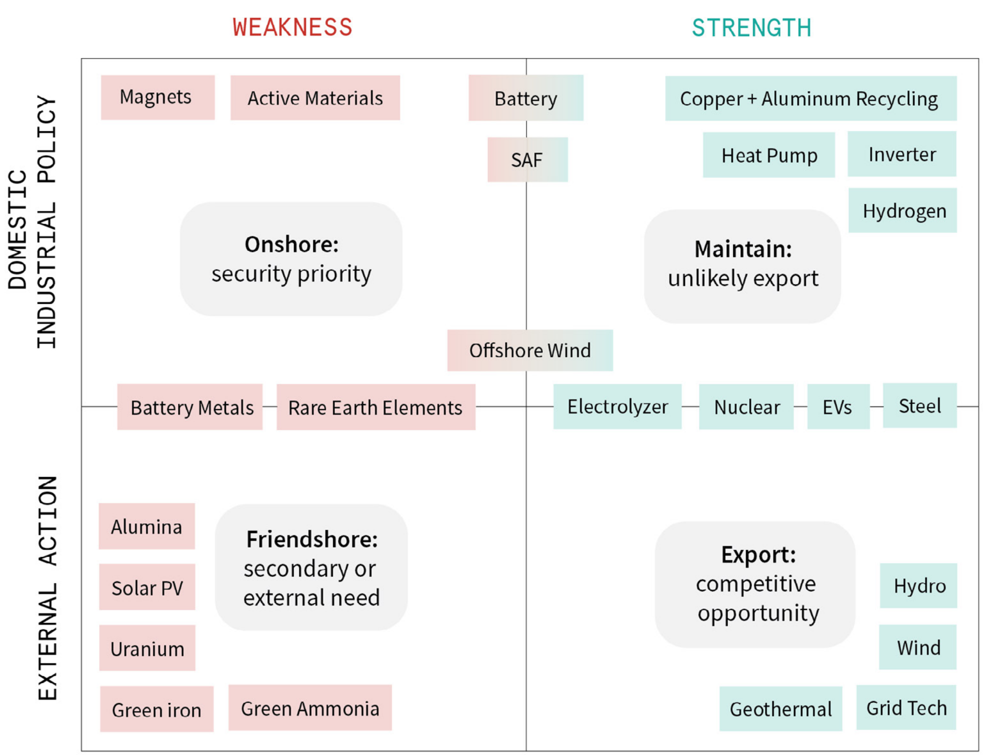
Source: Analysis based on findings from Milo McBride and Daniel Helmeci "Europe's Clean Industrial Outlook," Carnegie Endowment, Forthcoming. Data sourced from EUROFER, EuroMetaux, DNV, UK House of Commons Library, Global Clean Investment Monitor, European Aluminum, European Hydrogen Observatory, European Union Aviation Safety Agency, Fast Markets, US Energy Information Administration, BP, Argus Media, Eurostat, Fuels Europe, and the Net Zero Industrial Policy Lab via S&P Global.

Note: Europe's 2030 supply forecasts sum projects that are operational, under construction, and announced—including those without FID but with start dates before 2030 to help illustrate a best-case scenario. Supply reflects the manufacturing nameplate capacity—not production—which implies a lower level of output than indicated, except for kerosene, where production was used due to relatively lower refinery utilization rates.

Not all strengths and weaknesses are created equally, however. Some strong sectors pose opportunities for export, while some weakness will require onshoring due to economic security risks (see figure 4). The matrix listed below can help policymakers conceptualize these sectors. Grid tech, geothermal turbines, and wind turbines present clear opportunities for both domestic use and export or foreign operation plays. We emphasize that these technologies—especially grid hardware—are strengths that Europe should double down on. Conversely, rare earth magnets and lithium-ion batteries will, at least to some extent, require onshoring due to their dual-use applications.[11] Similarly, jet fuel and power electronics carry security risks, pointing to domestic production.[12] CRMs, on the other hand, will require both onshoring and friendshoring (bringing production to trusted partner countries) because of limitations to mining in Europe. Other sectors that pose unlikely export opportunities—like heat pumps and hydrogen—can be left to maintain, while electrolyzers, steel, and electric vehicles all have some export potential but face fierce competition against Chinese products.[13] Some components (like green iron ore) or hardware (like solar panels) do not pose immediate security risks and might be friendshored or traded freely.[14]

Figure 4. Europe's Policy Action by Clean Industrial Sector

A successful Clean Industrial Deal will require both domestic and foreign dimensions—tailored to specific technologies and materials.



Source: Authors' analysis based on data observed in Figure 2 and Figure 3. For methodology, see Bentley Allan et al., "How the U.S. Can Stop Losing the Race for Clean Energy," Carnegie Endowment for International Peace, February 2025, and for additional framing on the matrix see Benjamin Bartle et al., "Secure, Competitive, Global: The Playbook for United States Energy Statecraft in a New Technological Era," RMI, 2025.

Securing the Domestic Industrial Base

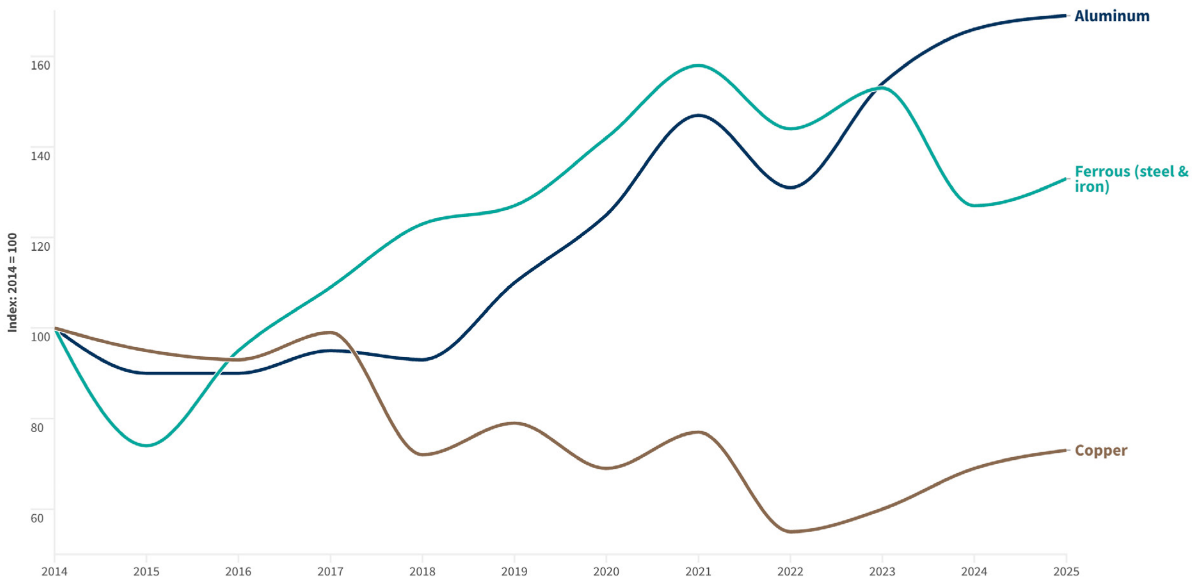
The EU needs a policy ecosystem that incubates and protects domestic industry where necessary. As demonstrated in the previous section, Europe has a strong pipeline of projects, but many will struggle to scale up and reach market without targeted support. The recently tabled Industrial Accelerator Act (IAA) introduces some important tools—its local content provisions are an especially useful starting point—but the current requirements are insufficient to deliver genuine impact, and the broad geographical scope of EU-origin eligibility creates a significant circumvention risk.[15] The IAA's local content requirements include an escape a loophole: if EU products are more costly than a certain price range to foreign products, the requirements don't apply. These weak and undifferentiated rules send poor investment signals and, more worryingly, may lead to the IAA's nonapplication across sectors because Chinese firms can dump into the single market to depress prices below this threshold.[16] Solutions to this challenge might include increasing the price threshold across the board or designing sector-specific thresholds that preemptively reflect current and future EU-China cost gaps.

Going forward, the EU will need focused and effective state-aid measures. First, Europe's clean tech sector would benefit from moving from project-level, lump-sum allocations to bankable, output-based support.[17] These so-called ramp-up incentives—which might provide time-limited subsidies in early development—can help mines, processing plants, and downstream factories weather initial losses amid cheap Chinese imports.[18] Such incentives should be timebound and coordinated by the EU to prevent rent-seeking and intra-EU subsidy races.[19] Looking ahead, the next Multiannual Financial Framework and the proposed European Competitiveness Fund will need to scale up and surgically spend resources—including grants, guarantees, and low-interest loans—on strategic clean technologies.[20] This funding should focus on closing the gap for private investment. It should prioritize technologies where a strong industrial base is essential for the bloc's security—namely magnets and batteries—and where Europe can scale competitive industries, like grid tech, turbines, and wind through existing incumbents.

Europe should continue to embrace targeted yet nuanced trade and cyber-related protectionism. Chinese overcapacity is accelerating and could cut further into European production, while Beijing has already weaponized critical chokepoints.[21] First, Europe might explore a sequenced trade policy starting with sector-specific safeguards and quotas on some Chinese goods where Europe has an industrial base like wind or metals. This more-calibrated move may limit the potential for retaliation. Second, Europe needs to secure its scrap metals and prevent leakage so that they can be recycled domestically. Exports of some strategic secondary materials have grown sharply in recent years (see figure 5), representing a significant loss of potentially recyclable inputs for European industry. Ensuring that valuable scrap metal and e-waste stay in the single market might require the enforcement of existing EU regulations, but Europe also might explore more aggressive measures like export restrictions and subsidies to scale-up recycling capacity in new areas beyond copper and aluminum (or even fund scrap stockpiles).[22] Lastly, as Europe electrifies, it needs to do

Figure 5. EU Exports of Metal Waste and Scrap

Both aluminum (+69 percent) and ferrous exports (+33) have risen significantly in the last decade.



Source: Authors' analysis based on Eurostat.

so with cyber hygiene. European-made power electronics offer a durable long-term solution, and Europe's domestic base is mature.[23] The recent ban on EU funding for Chinese inverters is a meaningful first step but, going forward, more stringent measures might be phased in, like those outlined in the EU's proposed cybersecurity framework, to sufficiently remediate these risks.[24]

Simultaneously, the EU has begun to spur efforts to internationalize green industrial policy, as evidenced by specific projects under the Global Gateway, the promise of preferential purchasing by the forthcoming CRM Centre, and the first-of-its-kind Clean Trade and Investment Partnership (CTIP) agreement with South Africa.[25] However, critical questions remain about whether Europe has the tools necessary to invest in strategic projects abroad. As the United States has begun investing government equity into projects and offering price floors, the EU should actively pursue how it might replicate such powerful forms of foreign project finance that help provide investor confidence, regardless of mineral market volatility.[26] Its partnership with the Japan Organization for Metals and Energy Security (JOGMEC) is a welcome first step toward developing similar tools and transferring such knowledge, but this will take time.[27] Finally, the European Investment Bank's (EIB's) new global strategy goes in the right direction by committing to increase capital efficiency, leveraging EU companies, and proposing to support European export credit agencies. How this will translate into benefits for EU clean tech competitiveness, however, remains to be seen.[28]

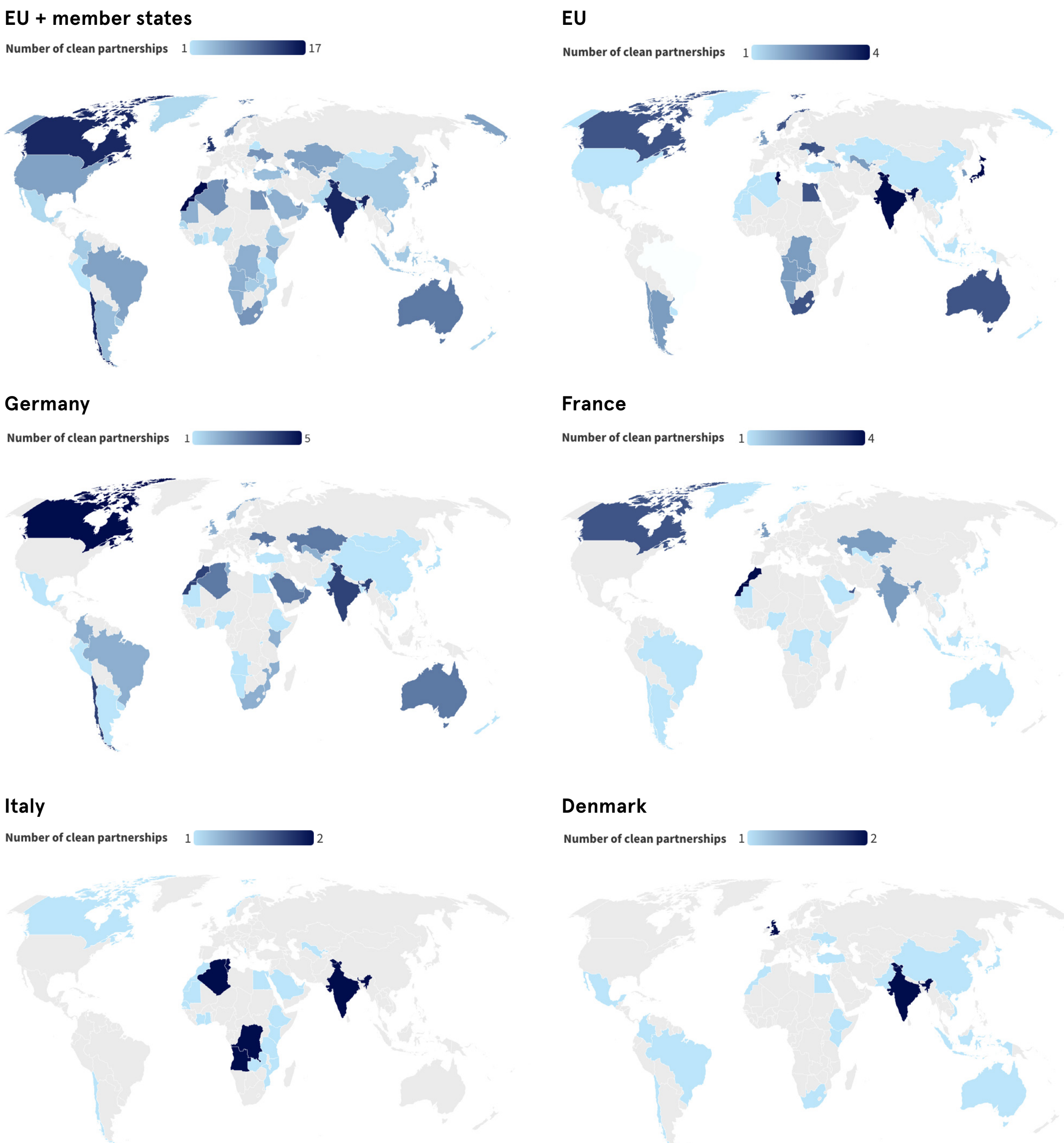
Europe's Green Diplomacy and Its Implications for Clean Tech

Over the past decades, the European External Action Service (EEAS) and member state missions have built out partnerships and pacts that center around climate and clean energy.[29] However, the ethos of such partnerships is both generally broad in scope and, when focused, more tailored to joint goals of capacity building—not market shaping.[30] Going forward, Europe will need to embrace a more utilitarian and business-oriented external posture, prioritizing projects that serve both partners' development priorities and the EU's industrial or resilience goals (ideally both). Fortunately, much of the initial diplomatic architecture has already been built through myriad memorandums of understanding (MOUs), green pacts, and broader bilateral and minilateral agreements (including member state cooperation through Team Europe Initiatives). Europe should take stock of these feats and transform past diplomatic success into future industrial action.

Europe's clean tech external action spans over sixty countries and nearly 300 pacts. Publicly available data shows EU and member state engagements ranging from broad clean energy partnerships (for example, Energy Partnerships and Just Energy Transition Partnerships) to sector-specific agreements on minerals, renewables, hydrogen, and nuclear. These engagements are particularly concentrated in Morocco, India, Canada, and the UK (see figure 6). Other highly engaged partners include Australia, Tunisia, South Africa, Japan, Norway, and Egypt, as well as several Eurasian countries including Kazakhstan and Uzbekistan. These markets are strong candidates for deeper cooperation given existing diplomatic inroads. The analysis also reflects bilateral initiatives by key member states. Germany's footprint is by far the largest, rivaling the EU's at about eighty agreements. France, Italy, and Denmark have each entered into roughly thirty agreements. Germany is heavily focused on hydrogen (largely though its Federal Foreign Office's H2-diplo program), while Denmark has emphasized renewables and France has prioritized nuclear and minerals.

Figure 6. Mapping the EU's Clean Energy External Action

Key partner countries include Morocco, Canada, Chile, India, and the UK, with notable engagement from Germany as an individual state.



Source: Authors' analysis of documents and press releases published by the European Commission, the German Federal Ministry for Economic Affairs and Energy, the French Ministry of Economy, Finance and Industrial, Energy and Digital Sovereignty, the Italian Ministry of Foreign Affairs and International Cooperation, and the Danish Energy Agency.

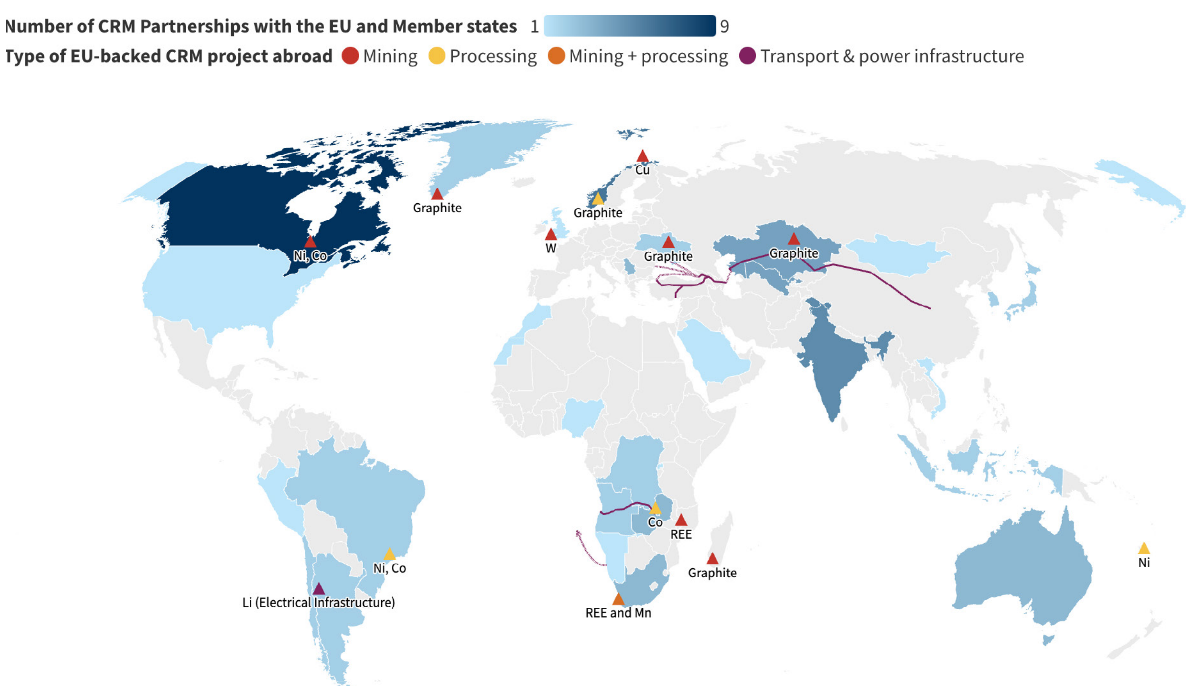
Note: This map is illustrative; boundaries, names, and designations used do not represent or imply any opinion on the part of Carnegie or the authors.

In past years, Europe's external action for clean tech supply chains has overwhelmingly focused, for better or worse, on CRMs and hydrogen. On the bright side, diplomatic overtures for raw materials are a necessary bet—Europe's domestic mining outlook is bearish, recycling is ultra long-term, and the hegemons in Beijing and Washington are scrambling for CRM access.[31] So far, the EU and member states have sealed sixty-five CRM-related pacts with about thirty countries—notably Canada (including Quebec), Norway, India, Australia, Uzbekistan, and Chile (see figure 7). The EU currently has backed twelve CRM projects at very preliminary stages of development in some of these countries. Other highly engaged nations that do not have specifically government-backed projects—like India, Australia, and Chile—present new opportunity. Most interesting is the development of enabling infrastructure to activate CRM flows, like the Trans-Caspian International Transport Route from Southeast Asia and China, the Lobito Corridor in Central Africa, or port-side export terminals in Namibia.

These CRM infrastructure projects would, in varying degrees, help secure Europe's supplies and should be prioritized (see figure 8). It is essential that the EU and especially its member states with active foreign development finance institutions act quickly on supporting

Figure 7. Mapping the EU's External CRM Action

Key CRM partners include Canada, Norway, and, Kazakhstan some include mines and enabling infrastructure.



Source: Authors' analysis based on data observed in Figure 6 (partnerships), European Commission CRMA strategic projects outside of the EU, and CRM-related infrastructures projects under the Global Gateway.

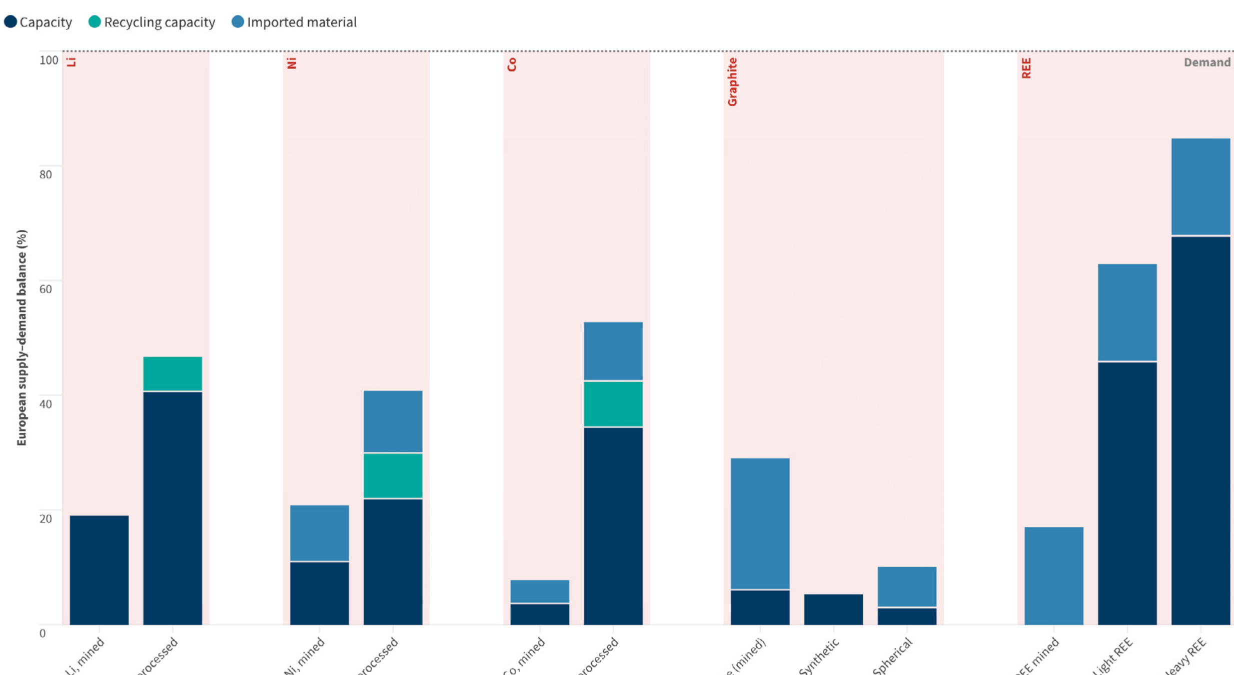
Note: This map is illustrative; boundaries, names, and designations used do not represent or imply any opinion on the part of Carnegie or the authors.

these projects to market. When including potential friendshored CRMs in analysis of projected 2030 supply-demand, the security of supply outlook for graphite and rare earths notably increases. Although none of these foreign projects are likely to come online by this time and they remain significantly behind domestic mines and processing facilities, this benchmarking helps gauge the scale of their impact. Most important is South Africa's rare earth extraction and processing facility, which could fulfill about one-fifth of European demand (including for heavy rare earths). Graphite plays in Madagascar, Kazakhstan, and Greenland could contribute 19 percent of demand (another project in Ukraine remains frozen until Russia's aggression ends). Nickel production in Brazil and Canada—as well as cobalt production in the latter—are important diversification bases to build from, but their contribution will be marginal.

Compared to CRMs, the EU and its member states have nearly twice as many hydrogen pacts with even more countries. This is an inefficient use of diplomatic capital given the relative nicheness of clean hydrogen applications.[32] Although many of these pacts have not

Figure 8. Potential Contribution of Europe's Friendshored Minerals by 2030

The EU's twelve foreign strategic projects are needed for its CRM supply challenge, particularly graphite and rare earths.



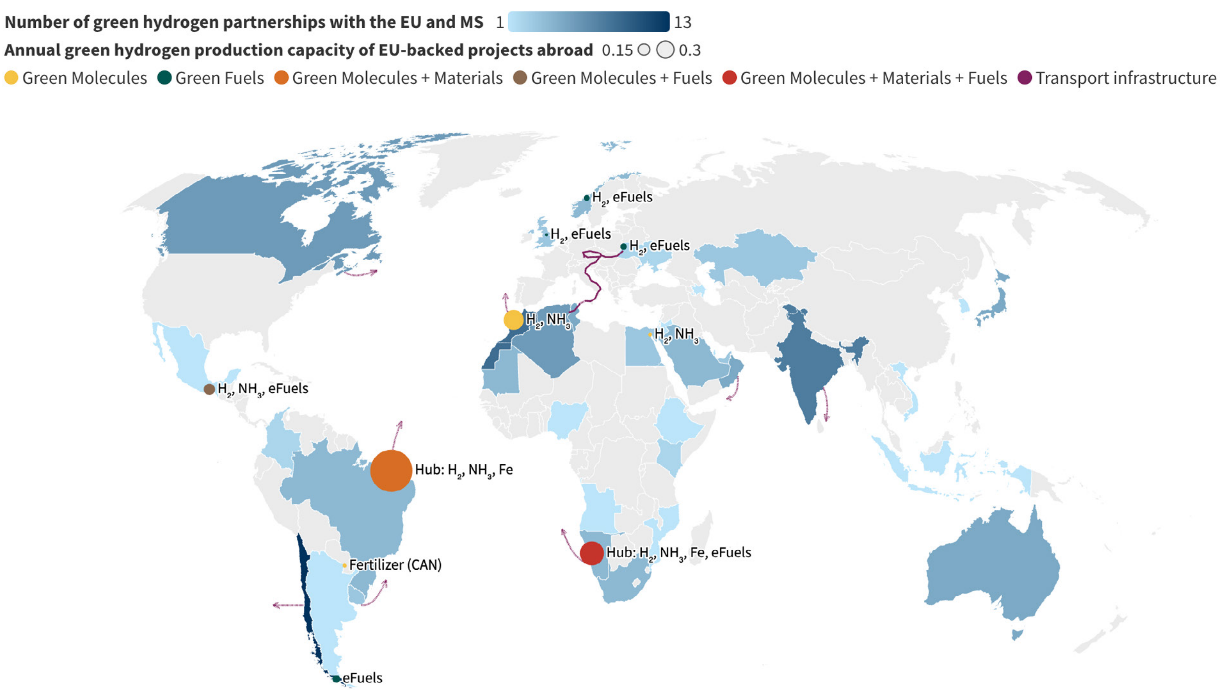
Source: Authors' analysis based on data from the Net Zero Industrial Policy Lab via S&P Global, DNV, Benchmark Mineral Intelligence, EIT InnoEnergy, and the European Commission list of CRMA strategic projects.

Note: Europe and trade partners' 2030 supply forecasts sum projects that are operational, under construction, and announced—including those without FID but with start dates before 2030 to help illustrate a best-case scenario. Foreign projects are highly unlikely to start by 2030: the summary should be viewed as a stand-in and approximation of their impact. The analysis only includes EU-backed projects and is thus inexhaustive. Other supply chains are under development by private firms. Supply reflects the manufacturing nameplate capacity—not production—which implies a lower level of output than indicated.

yielded tangible projects, some important industrial successes are emerging, including green ammonia and iron in Brazil and Namibia (see figure 9). Other markets with numerous European hydrogen pacts—such as India, Oman, and Saudi Arabia—are developing clean ammonia corridor projects that are gaining momentum organically, although the EU has not yet matched their efforts with funding.[33] In several cases, European corporates (and ports) have acted as first movers, providing offtake agreements or project finance to signal commitment to buying and building hydrogen projects.[34] Still, despite these advances, the clean hydrogen market faces headwinds from high costs.[35] The EU and its member states should be more selective going forward: Not every country needs hydrogen, and some analysis suggests Europe's push for electrolytic buildout across Africa risks absorbing scarce clean electrons in energy-poor regions.[36] Where green molecules do make sense, European hardware is essential—and could help absorb potential oversupply if a domestic electrolyzer glut materializes.

Figure 9. Mapping the EU's External Action for Clean Hydrogen

While green hydrogen engagements are spread across geographies, there are notable developments in Brazil, Namibia, and North Africa.



Source: Authors' analysis based on data observed in Figure 6 (partnerships), European Commission Clean Hydrogen Partnership's projects outside of the EU and green hydrogen projects under the Global Gateway; visualization of corridors based on maps from Global Energy Monitor.

Note: Projects with an announced hydrogen production capacity of less than 1000 tons per year are not shown here. Annual hydrogen production capacity uses publicly-announced figures where available. Where only green derivative output (molecules, fuels, or materials) was announced, authors converted it to hydrogen equivalent to keep all projects on a comparable basis. This map is illustrative; boundaries, names, and designations used do not represent or imply any opinion on the part of Carnegie or the authors.

Boosting European Clean Tech Opportunities

Going forward, Europe will need to update its priorities and tools to shape partner goals to its best interests.[37] This section breaks down an external action framework into four specific parts: an external strategy for exports and supporting European factories abroad where the EU has technical leadership; bilateral priorities for supply chain cooperation; third-country access to the single market; and science diplomacy as a tool for developing collaborative innovation efforts. These are not exhaustive pillars of a realist—yet decarbonized—external industrial agenda, but they are achievable and can be realized in tandem with the bloc's commitment to global development.

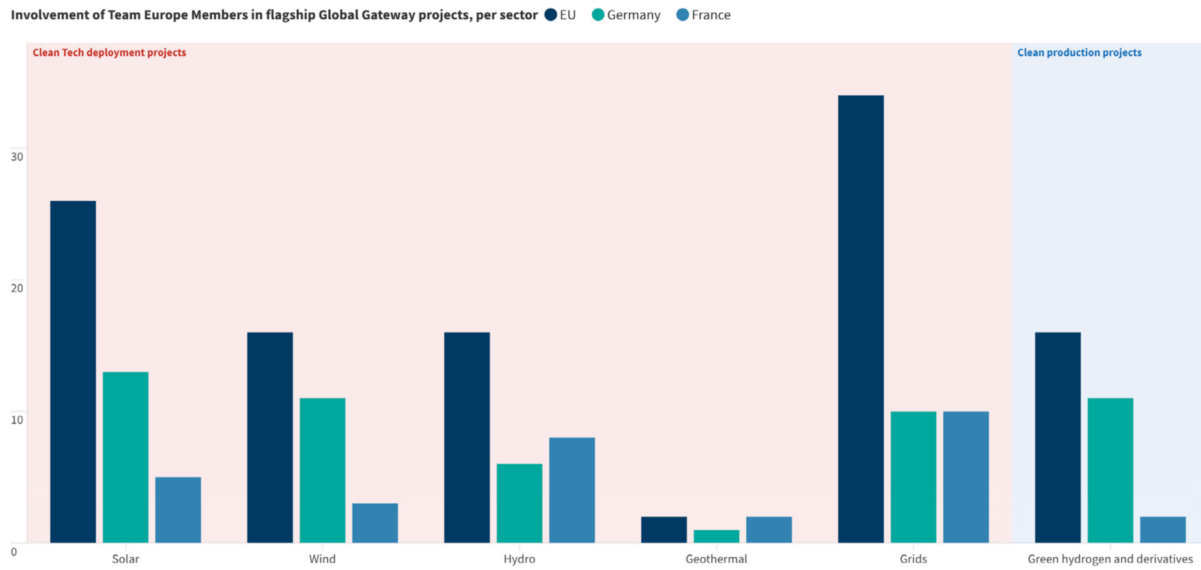
The EU and its member states should consider tailoring foreign projects to bolster European products. This would include those promoted under the Global Gateway to specify that they are developed by European-based firms and procure European-made hardware, whether through exports or manufacturing hubs in the region. This might entail focusing the Global Gateway, the upcoming Global Europe instrument, and Team Europe Initiatives on projects that procure European grid technologies and electrolyzers, as well as wind, hydro, and geothermal turbines. Projects also using European steel for construction would be welcome. Doing so will limit the scope and scale of what is feasible, but it is an important demand-pull to ensure that European external action and development finance operates in the best interest of industry amid an ever-growing flood of Chinese exports and competition across all energy tech sectors.

So far, Europe's clean energy project development in the Global Gateway has prioritized solar over wind, negates geothermal projects, and has a sizeable grid base to build from (see figure 10). Twenty-six significant projects include solar PV, while just sixteen projects include wind power. Some include both. While hydro and wind power projects remain at parity with each other, geothermal projects are almost negligible—just one in Kenya and one in Ethiopia. While there are more than thirty-three grid-related projects, just eighteen are grid specific. The others are co-located with large solar or wind farms. Many of these projects include the modernization and expansion of large regional or national transmission lines, including with the high-voltage direct current system that has been mastered by EU industry. This is the case in, for example, West and Central Africa as well as interconnections through the Mediterranean. The number of hydrogen projects—largely backed by Germany, which has emphasized this vertical—is similar to wind and hydro.

A global grid initiative—through which Europe accelerates electricity infrastructure abroad—would be a powerful central political offering. It would advance the bloc's development commitments, project Europe's model as an electro-state, and support core clean tech strength. Here, the Global Gateway offers a strong foundation to expand upon including supporting the development of European-owned grid tech factories in

Figure 10. The Global Gateway's Main Clean Energy Sectors

More projects have focused on deployment—especially grid and solar—than on clean tech production.



Source: Authors' analysis of European Commission Global Gateway documents and press releases.

Note: Global Gateway projects considered are the flagship projects endorsed by the Council of the European Union for 2026.

countries facing or nearing high, long-term growth in power demand. Conversely, Europe's concentration on solar PV, while practical given the low cost and ease of construction, risks directly benefitting Chinese rather than European industry.[38] The global solar trade is essentially cornered by China, whose firms can increasingly self-finance or rely on private development funds. (One exception might be maintaining support for microgrids in least-developed nations, where solar PV is an essential lifeline to electricity.)[39] The EU should reprioritize its utility-scale solar project resources to wind, where its edge is slipping, and to defend European industry, especially in Mercosur countries (Argentina, Brazil, Paraguay, Uruguay, and Bolivia) and potentially India, against Chinese competition.

While the EU and its member states should continue financing hydro, they should shift some of their attention to geothermal. Its growth market is potentially larger, and Europe retains an industrial niche worth defending.[40] That will require internationalizing innovative financing tools to de-risk drilling, perhaps similar to models already used by Germany's state-owned development bank (KfW) and reinsurance sector.[41] The EU should also build on France's recent pact with Kenya to expand geothermal developments into Zambia and other neighboring countries like Tanzania.[42] Lastly, Europe should remain active—but realist—in green hydrogen, focusing on viable projects and high-value derivatives, especially ammonia-based fertilizers, which can strengthen food security in an era of price shocks and record El Niño weather.[43] Other projects might specify green methanol or iron to help jurisdictions with existing industrial demand decarbonize.

Reforming the EIB's tendering process and developing greater levels of European diplomacy for its business interests might help fully activate this external agenda. EIB procurement procedures are open to all bidders, awarded to the most economically advantageous tender, and largely aligned with member state development banks.[44] However, given the significant and increasing cost advantage, there is a high risk that contracts will be awarded to Chinese clean tech hardware—even in strengths like wind or grid tech.[45] Reforming the bank's procurement rules can help ensure that European public funds do not finance competing companies. Concurrently, the EIB has committed to supporting Europe's private sector, notably by financing international bids through guarantees as well as exploring support for export credit agencies.[46] These are important tools that can also aid European industries abroad and, coupled with tendering procedures that include an option for European preference, would help bolster Europe's exports.

Clean Tech and Related Input Manufacturing Abroad

One optimal strategy might be to find projects where European energy hardware can be deployed to enable local economic development and produce strategic inputs for European industrial needs—a win-win situation. Today, CRM-rich developing countries rightly seek midstream industry, but refining minerals into battery-grade chemicals is energy and water intensive, can cause environmental issues, and offers little price advantage over processed concentrate, which might mostly remain the priority to Europe (especially in third countries with weak governance standards).[47] Even so, mining and beneficiation will still require electricity and Europe should target power infrastructure in its partnership offers. For example, the EIB and the French Development Agency have backed a project in San Juan, Argentina, to build out the regional grid near the site of a French mining company's lithium production.[48] If this project was built with European hardware, it would check all the necessary boxes: bringing power to the region, supporting diversified CRMs, and buying European goods in the process.

The EU can also fund niches of clean tech manufacturing, as it has been doing with hydrogen facilities, in countries optimal for de-risking. The administration of U.S. president Joe Biden began financing Indian solar factories as a way to de-risk from China—but also to empower India's green industrial base.[49] As part of the global grid initiative idea, Europe might also support its grid hardware companies to develop manufacturing hubs in third countries near high electricity growth. This would both offer jobs abroad and increase the market share of European firms, which will need to expand their capacity amid surging power demand and booked-out orders.[50] Similarly, much attention has been given to so-called powershoring, wherein green iron might be produced in countries like Brazil or Namibia to feed European steel production.[51] In an era of more precarious global trade, policymakers might consider nearshoring some of these more strategic products in countries like Turkey or Morocco to ensure that a force majeure event would not risk these supplies.[52]

In the medium term, Europe might find itself with additional solutions that it can offer third countries. Its foreign policy must be ready to adapt. One critical area might be the decarbonization of industrial heat. European firms are leading on myriad solutions like thermal energy storage, high-capacity heat pumps, waste heat use, and direct-use geothermal.[53] Given today's fuel precarity, this vertical may emerge as a new offering that Europe can share with partners, especially fellow fossil-fuel importers interested in electrifying and insulating their industries. Similarly, Europe's offshore wind sector might be an area to support once it recovers from the chaos of the United States' shifting policies. Future markets could include Brazil, Japan, South Korea, and potentially Australia.[54]

A Menu of Specific Technologies and Supply Chains

Europe needs a focused, tailored approach to bolstering key niches of interest with partner countries. Future diplomatic engagement, including bilateral discussions between leadership, should be ultra clear and selective about key pillars of focus. Instead of an MOU for CRMs, the dialogue might specify, for example, graphite. The more specific it is, the clearer the expectations will be on both sides. For example, French President Emanuel Macron went to Mongolia in 2023 to advocate for a uranium mine; two years later, the two sides reached an investment agreement.[55] A broader template for this was outlined in the novel CTIP agreement with South Africa.[56] CTIPs seek to streamline intra-ministerial pacts under one roof and offer a menu of clean energy sectors for governments and industry to jointly develop.[57] That said, discussions with policymakers revealed that cumbersome intra-EU dynamics are a challenge to the promise of timely movement. Written six months since the first CTIP was announced with no sign of follow-up, the European Commission should focus on seeing the South Africa agreement through before expanding the pact to other nations.

Based on analysis of Europe's supply chain and country pacts, there are clear potential updates to existing partnerships that would identify critical opportunities for export promotion, supply chain incubation, and strategic investment inflows (see figure 11). India, for example, is a priority given the free-trade agreement (FTA) negotiations and existing pacts with Europe, its de-risking value vis-à-vis China, and its outsized role in global emissions.[58] The EU and its member states should use this moment to strengthen European wind industry by mandating that the remaining original equipment manufacturers power EU-backed clean industrial projects. Those projects also offer a platform to promote Europe's emerging industrial electrification solutions.[59] On supply chains, Europe could support India's solar manufacturing base, which is on track to become second to China but is hampered by missing inputs like ingots and wafers currently dominated by Chinese firms. Bolstering this would help diversify supply of the world's fastest-growing energy source.[60] Finally, while India has begun developing green ammonia corridors into Europe, this momentum could be leveraged for green iron projects that simultaneously decarbonize India's steel sector and secure European access to low-carbon inputs.[61]

Figure 11. A Menu of Potential Clean Industrial Engagement Ideas

Europe can narrow its existing clean energy pacts into a more targeted approach.

Trade partnership status Trade agreement Adoption/ratification ongoing

Country	Clean Energy Pacts	Exports Promotion *Made by the EU*	Outbound FDI Promotion *Scaling EU, in partner country*	Friendshored Production *Made by the partner*	Inbound FDI Promotion *Made by the partner, in the EU*
Morocco		Power grid	Onshore & offshore wind	eSAF, green ammonia	
India		Onshore wind	Clean heat technologies	Solar PV ingot & wafer, green iron	
Canada		Hydro turbines, onshore wind		Battery active materials, rare earths	Nuclear power
Australia			Onshore & offshore wind	Rare earths, cobalt, green aluminum	
Japan			Floating offshore wind		Permanent magnets, synthetic graphite, & anode
South Africa		Power grid		Rare earths	
Kazakhstan		Power grid		Graphite, rare earths	
Brazil			Onshore & offshore wind	Graphite & anode, rare earths, green iron	
South Korea			Floating offshore wind		Battery active materials, specialized steel
Kenya		Geothermal, power grid		Green ammonia	

Other countries call for different types of agreements. Japan and South Korea are energy- and mineral-poor but host some of the only corporate capacity outside China that can produce sintered permanent magnets and battery active materials.[62] Given the extreme vulnerabilities in both supply chains, encouraging these countries to support their firms to manufacture within Europe is a sound bet. Similarly, nuclear-friendly member states might join forces on opportunities, especially with Canada, to partner on more CANDU reactors in Europe (which do not require more enrichment and thus simplify Europe's fuel security).[63] Brazil and Canada already host EU-backed nickel-cobalt projects, but this scope should expand to rare earths and graphite alongside downstream processing—both countries have large hydro-based renewable capacity and there is high need to diversify anode material and purify heavy rare earths outside of Europe due to nuclear residuals.[64] Finally, an EU-level partnership with Kenya to promote geothermal power across East and Southern Africa would be an enormous win-win—provided it can support European-made turbines.[65]

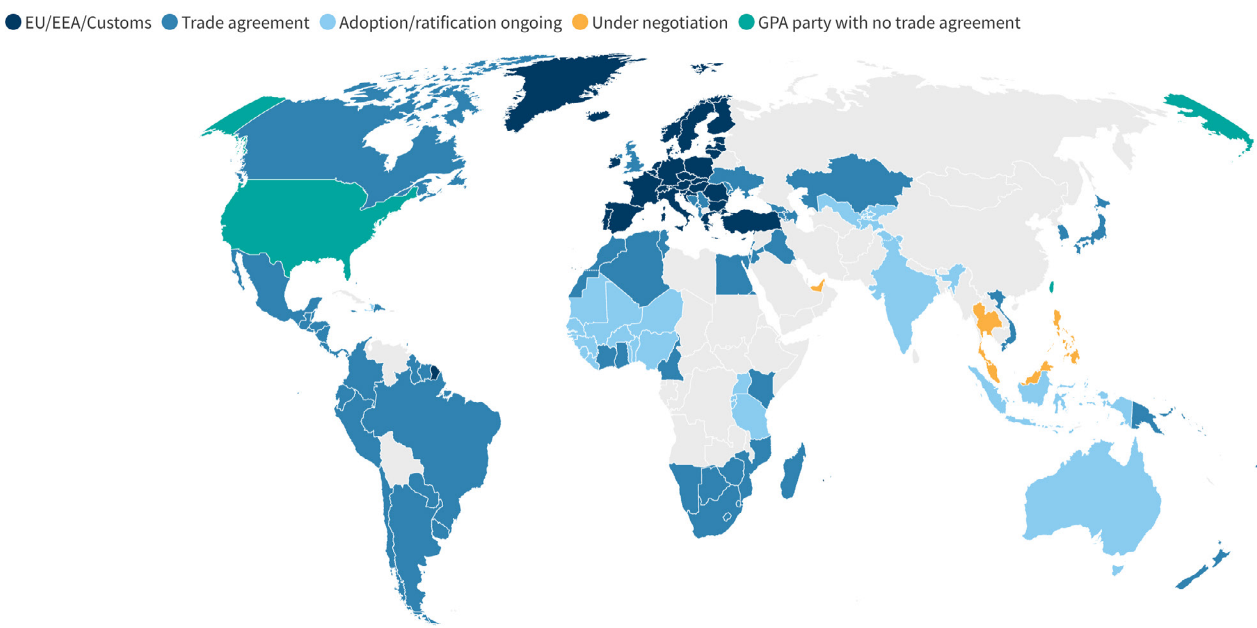
This menu is not exhaustive. Some countries may have unique, one-off opportunities. For example, Europe should pursue a geothermal partnership with the United States, where a new drilling revolution is unlocking geothermal as a global power source, with high potential for diffusion in Europe. (Even before that can happen, U.S. geothermal growth will require European turbines.)[66] Countries such as Chile, Egypt, Norway, the UK, and Vietnam have already been the focus of notable clean energy pacts and might be explored in a similar fashion. Upstream, this analysis omits some inputs like electrolyzer membranes, heat pump compressors, grain-oriented electrical steel for transformers, gear boxes for wind turbines, and battery cell separators. These are essential but underappreciated chokepoints that merit further de-risking analysis. Research from the Clean Technology Partnerships Initiative offers a deeper dive into potential projects and cost structures.[67]

Opening the European Market to Partners

Partnerships aimed at sending minerals, materials, or hardware to the EU might benefit from preferential access to European state aid. Project finance alone may not be enough; projects require offtake and, likely, stricter measures to persuade buyers to lock into potentially more expensive supplies. The IAA, which is under negotiation, could be useful if applied bluntly. As drafted, the act grants EU-origin eligibility to third countries with free trade or customs agreements and, for public procurement, to parties to the World Trade Organization Agreement on Government Procurement (see figure 12).[68] But with more than eighty active trade agreements, this policy could be exploited by Chinese producers that build in qualifying countries to access the single market without transferring technology to European firms, a core and important IAA goal. The likelihood of this risk is high as the United States experienced similar re-routing maneuvers in Morocco under the Inflation Reduction Act, but it should not deter from market access being used as a diplomatic offering and potent de-risking tool.[69]

Figure 12. The Extensive Footprint of the IAA's "EU-Origin" Provisions

EU-Origin designation could span ninety-eight countries by the time the IAA enters into force, making the policy far too broad to be effective.



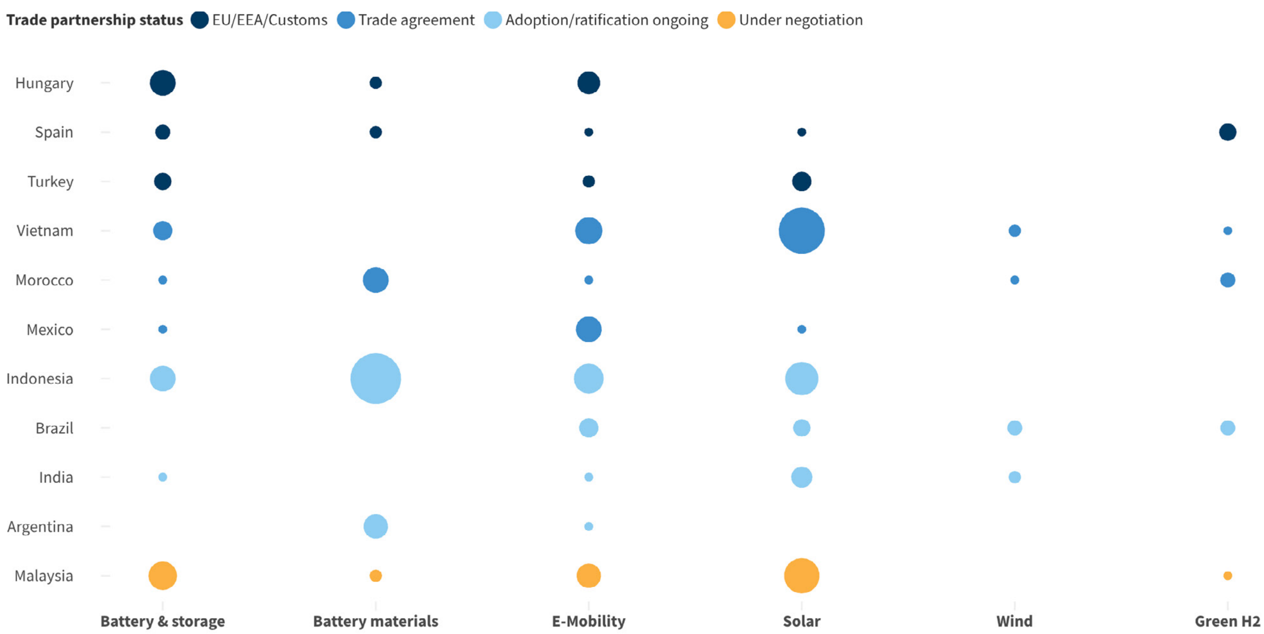
Source: Authors' analysis based on data from the European Commission.

Note: The commission's proposal grants itself the right to exclude trade partners in case of non-reciprocity, supply security concerns, or any other justifiable exception. By the time the IAA enters into force, ninety-eight countries will be deemed eligible for union origin designation. This total aggregates all countries whose trade agreements with the EU are in force or provisionally applied, together with those still being adopted, ratified, or negotiated. It excludes the fourteen West African countries, the four East African Community countries, and Haiti (CARIFORUM), whose agreements have been negotiated but are not applied—even provisionally—for lack of signature and/or ratification. It additionally includes parties with which the EU has no active FTA but which are party to the WTO Government Procurement Agreement (GPA): the United States, Hong Kong, and Taiwan. This map is illustrative; boundaries, names, and designations used do not represent or imply any opinion on the part of Carnegie or the authors.

For the IAA to work—and for Europe to avoid exploitation—Brussels will need to set strict rules in the act's final form and in future delegated acts specifying which third countries qualify for preferential treatment. Under the current proposal, the European Commission can continuously reassess eligible third countries for EU-origin status based on reciprocity and economic security, a powerful lever. It allows the EU to ensure that partner countries genuinely contribute to European value chains rather than serve as transshipment points for Chinese goods. Many countries are at high risk of becoming hotspots for FTA friction due to the preexisting presence of Chinese clean tech manufacturing (see figure 13). To close that loophole, the IAA could require projects in third countries to meet ownership criteria like those applied in the single market, including majority ownership by a European firm. It could also treat companies domiciled in dominant market-share countries—namely China—as equivalent to those countries for the purposes of eligibility. Essentially, this would mean nationality of ownership, not only manufacturing location, would be the determinant.

Figure 13. Countries at Risk of Becoming Chinese Export Rerouting Hubs

Chinese companies are building clean tech manufacturing sites in countries eligible for EU-Origin designation.



Source: Authors' analysis based on data from Figure 12 (the IAA's "Union origin" provisions) and "China's Great Leap Outward," the Net Zero Industrial Policy Lab.

Note: The E-Mobility category includes new energy vehicles (NEVs), NEV parts, electric buses and motorcycles, and charging station manufacturing projects.

Preferential public support access could be handled on a case-by-case basis, with eligibility for specific sectors negotiated individually and potentially tied to an investment arrangement to stimulate trade flows. Instead of including all FTA countries by default and only excluding them for lack of reciprocity or supply security risk, the IAA could flip the logic: exclude all non-EU/European Economic Area countries by default, and then grant EU-origin status selectively on either a project- or country-level—for instance, to those that genuinely grant similar market access to EU companies—with the overarching goal of contributing to the EU's resilience goals. This offering might be wielded as a bargaining chip and provide impetus for corporates to develop these projects.

Innovation and Science Diplomacy in the Age of Green Realism

Europe needs a similarly realist policy on clean energy innovation. The goal should be breakthrough innovations with high opportunity to scale in Europe through related incumbent industries or unlocking technologies with long-term security dividends. Emerging verticals like floating offshore wind, solid-state transformers, and compressed CO_2 geothermal turbines can be absorbed by European corporates in the wind, grid, and geothermal space, thus preserving their competitive stature.[70] Europe might also focus on systems that can abate present and future vulnerabilities, like electric motors that do not require rare earth magnets or breakthroughs in new energy sources that could reduce reliance on foreign fossil fuels (like geologic hydrogen or, perhaps someday, nuclear fusion).[71] Alongside these long-term breakthroughs, process innovations should be bracketed under the same goals of bolstering competitiveness—by lowering manufacturing or material costs—or enhancing resilience.

Science diplomacy offers an effective tool for long-term industrial interests. Europe is a global innovation leader, with Horizon Europe serving as a flagship incubator for advanced technologies—including through partnerships with non-EU countries.[72] Beyond that, EU member states also maintain their own technology and innovation attachés abroad to help coordinate joint initiatives. Yet discussions with policymakers revealed that these attachés are fragmented and uncoordinated—a gap that a Team Europe–style approach could remedy by pooling resources and aligning efforts on key opportunities. A critical question for European policymakers regarding joint innovation—and scaling up patents more broadly—is how to best protect European innovations and ensure that they can be scaled in the single market.[73] Nonetheless, Europe can approach science diplomacy through two pragmatic lenses:

- The first is through competitive edge, where researchers collaborate with leading labs abroad to increase European know-how in specific sectors essential to long-term security.

- The second is external incubation, where Europe deploys and wields its own expertise to help a third country incubate their know-how in a low-carbon sector that can be developed to suit Europe's interests, likely its diversification goals.

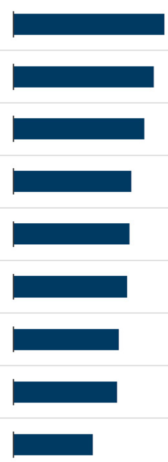
Europe should focus its science diplomacy on countries producing the highest output of clean tech research and on breakthroughs with resilience dividends (see figure 14). South Korea hosts the most important battery producers outside China, and coordinating with its researchers could help Europe develop key emerging technologies—sodium-ion batteries, in particular, are now commercializing in China and require few, if any, CRMs.[74] Australia, with its renewables base and legacy mining sector, is well positioned as a clean metals producer; deeper collaboration could help consolidate its role as a reliable supplier.[75] Norway's importance to European energy, its proximity to the EU, and its abundant renewable resources make it a natural candidate to incubate synthetic fuel innovation.[76] The UK leads Europe in nuclear fusion, with multiple projects advancing—EU labs have strong incentives to engage closely in case this long–sought after energy source emerges.[77] Finally, Japanese research labs are deeply focused on geologic hydrogen—extracting clean, low-cost molecules directly from the earth—which is an area where collaboration could help European researchers unlock their own resources.[78]

Figure 14. A Menu of Science Diplomacy Ideas

Suggestions for innovation, scientific, or research partnerships to explore with like-minded countries.

Horizon Europe association status Full Partial Under negotiation

Country	Innovation Partnership Ideas	Energy Knowledge Index
South Korea	Advanced battery (sodium-ion, lithium metal)	
Australia	Mineral production (alumina smelting, clean iron)	
Norway	Synthetic fuels (eSAF, power-to-liquid)	
United Kingdom	Fusion (superconducting magnets)	
Japan	Geologic hydrogen (exploration, extraction)	
Switzerland	Grid (solid state transformers, superconductors)	
New Zealand	Geothermal (supercritical resources)	
Canada	Mineral prospecting (advanced CRM discovery)	
India	Solar PV (advanced Si processes + perovskite tech)	



Source: Authors' analysis based on data from the European Commission and the Council on Foreign Relations.

Note: ''Horizon Europe association status" indicates whether the country is currently or will soon become fully or partially associated to the EU's main research program. The UK is fully associated to Horizon Europe as of January 1, 2024, with the exception of the European Innovation Council Fund. On June 9, 2026, the EU and Australia formally concluded treaty negotiations for Australia to become associated to Horizon Europe in 2027.

Europe holds a strong position in grid hardware manufacturing, but new developments are on the horizon—superconductors and solid-state transformers among them. EU-Swiss science diplomacy presents an opportune arrangement to explore these types of systems, given Swiss university and lab excellence and the two actors' shared industrial strength in this space.[79] New Zealand, meanwhile, is committed to unlocking supercritical geothermal—essentially geothermal power's equivalent to the fusion breakthrough—which could make this energy source cheaper than fossil thermal plants.[80] Supporting New Zealand's efforts would benefit Europe's own security and decarbonization goals in the very long term by unlocking a new clean power source.[81] Canadian researchers, for their part, hold a strong edge in mineral prospecting, a skill that could help Europe identify new deposits of strategic minerals.[82] Finally, as argued previously, Europe should deploy its leading research labs to support India in scaling solar PV technologies—ingot and wafer production in particular—as well as emerging technologies like perovskite cells.[83]

Building European Power

The coming years will bring new challenges amid deepening global fractures. Europe's role is essential. While unfashionable today, its long-term bets on climate and decarbonization will remain critical for decades to come. Europe thus must retain key value-added, low-carbon industries and work with partner countries to keep those ambitions alive. The EU and its member states have the talent, technology, and market to pull this off—what they need now is coordination, consensus, and focus. The goals identified throughout this paper offer some direction: a strategy to pursue, technologies to back, and key partners to engage. Success may no longer resemble what was envisioned years ago, like Europe developing a battery champion or reclaiming its stature as a leading solar manufacturer. Those were appealing but unrealistic goals. What Europe can do going forward is defend its current strengths while nurturing necessary supply chains and joint innovation with trusted partners. Its success could serve as a template for others seeking to wean themselves off imported fossil fuels—an inspiring prospect in an increasingly precarious world.

Policy Recommendations

Domestic industrial base:

- Europe needs to strengthen its domestic industrial base before it can effectively internationalize, and time is of the essence. This requires strengthening the IAA's provisions—price criteria should be sector-specific and recalibrated to reflect the EU-China cost gap, ensuring local content rules take effect.

- Future state aid should shift toward output-based, coordinated ramp-up subsidies. To complement the IAA, aid must cover operating expenses—not just capital expenditures—during facility ramp-up, when losses are heaviest. This is especially critical for batteries, material processing, and minerals.

Market access and trade defense:

- The IAA must set stringent rules on third-country eligibility. Projects in third countries should meet the same requirements as those within the EU—like European majority equity—and companies domiciled in dominant market-share countries like China should be treated as equivalent to those countries, making ownership nationality the key determinant.

- By flipping the IAA's default logic, market access can be conditional on further agreement. Rather than including all FTA partners in local content and public support provisions, the EU might use this as a potential bargaining chip and offering on a case-by-case basis.

Export promotion and development finance:

- Reorient the Global Gateway around technologies Europe leads and where opportunity is robust. This means bolstering wind over solar in Mercosur countries and India, geothermal over hydro in East Africa, and pragmatic hydrogen derivatives with high impact. A global grid initiative should be the headline vehicle, building on Europe's momentum in foreign transmission projects.

- Realizing this agenda will require adjusting procurement rules with resilience criteria, bolstering business-oriented diplomatic efforts, and designing win-win style projects—in which, for example, the EU backs a mine or iron factory by building out the adjacent grid with European technology and wind turbines.

Bilateral partnerships and innovation cooperation:

- The EU should transform its 300 existing clean energy–related pacts to focus on specific technology verticals that suit its best interests. These can exist as offensive industrial promotion (wind in Brazil), supply chain incubation (solar PV in India), or inward industrial ventures (magnets with Japan).

- A focused innovation policy should prioritize sectors that solidify Europe's strength like grid- and advanced security–related tech, with resilience dividends like mineral-free batteries. European countries should pursue science diplomacy in these sectors with top clean tech innovators to either absorb know-how or incubate it in countries that are optimal for de-risking.

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