

# Hydrogen Policy in Brazil: Emerging Path to Green Re-Industrialization?



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**Abstract** Brazil has set the ambitious goal of becoming the world's most competitive hydrogen producer by 2030, leveraging its vast renewable energy potential. The development of a market for low-carbon hydrogen and ammonia is central to Brazil's green industrial policy and its new strategy for re-industrialization. While the country holds strong prospects for green hydrogen production, it presently lags behind current frontrunners, with most low-carbon hydrogen projects still in early stages. The recently introduced Hydrogen Act and accompanying tax credits are pivotal in shaping a policy framework, fostering low-carbon hydrogen production and usage. In the absence of a national hydrogen strategy, some states, most notably Ceará, have pushed ahead attracting considerable investments for hydrogen production and export in the past years. Internationally, Brazil has begun reasserting its engagement in hydrogen governance, hosting key global forums, and advancing bilateral and multilateral hydrogen cooperation. This chapter elaborates on these trends and provides a comprehensive review of policy objectives and initiatives, stakeholders, pilot projects, and international cooperation efforts related to the endeavor of creating a market for low-carbon hydrogen in Brazil.

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## 1 Introduction

With its high share of renewables in the energy mix, abundant resources for a further expansion of renewable energy capacities, and an increasingly friendly political environment for regional and international cooperation, Brazil is well-positioned to become a future frontrunner in a global clean hydrogen economy. The country has recently signaled strong ambitions to develop a domestic market for hydrogen, adopting a favorable policy framework and attracting pilot projects, particularly in the coastal regions.

Broad support for hydrogen across Brazilian administrations has shielded the country's hydrogen policy from recent fluctuations in its climate and energy politics. From Dilma Rousseff's backing of the Paris Agreement to Jair Bolsonaro's strained ties with the EU over environmental protection, and Lula da Silva's renewed focus on the energy transition, the commitment to developing a hydrogen economy has remained in place. This resolve stems from a convergence of objectives: Hydrogen promises investments, economic and energy security, and climate change mitigation through industrial decarbonization. Developing a domestic market for hydrogen further feeds into the country's ambitions for rebuilding its industrial capacities.

This chapter offers a comprehensive overview of Brazil's hydrogen policy objectives and initiatives, relevant stakeholders, and international cooperation efforts. It thereby sheds light on current hydrogen projects and future ambitions at the federal and state levels. It further explores the interplay of the diverse policy objectives shaping the country's approach to hydrogen governance and elaborates on pivotal policy initiatives that align with these goals.

The chapter is structured as follows: Sect. 2 discusses the current and potential future role of hydrogen in Brazil's economy. Section 3 then delves shortly into the overarching goals driving the country's hydrogen policy. Section 4 outlines strategies and policy initiatives at both the federal and state levels. Section 5 focuses on investment and provides an overview of existing pilot projects and stakeholders. Brazil's efforts for international cooperation in the development of a hydrogen economy are addressed in Sect. 6. The final section of the chapter provides concluding remarks.

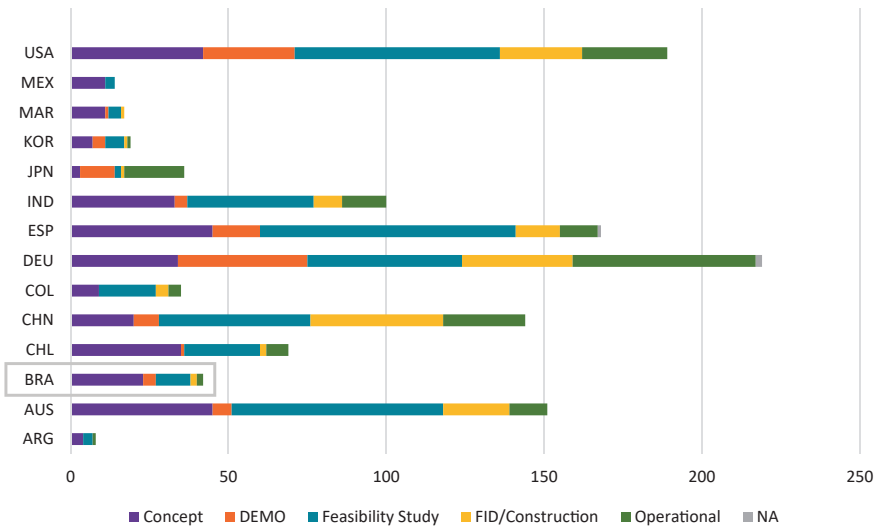
## 2 The Current Role of Hydrogen in the Brazilian Economy and Future Potentials

Hydrogen already plays an important role in Brazil's industry. Latin America, in general, consumes about 5% of the global demand for hydrogen, and approximately 10% of this is consumed in Brazil (IEA, 2021). This makes Brazil one of the four largest consumers of hydrogen in the region. This hydrogen is currently still mostly produced from natural gas via steam methane reforming (SMR) in refineries, particularly those belonging to the country's national oil company Petrobras. As of 2022, 87% of the hydrogen produced in Brazil came from SMR, being mostly used in the

refineries themselves and, occasionally, also for fertilizer production. In refineries, hydrogen is primarily used in the hydrotreating of fuels (MME, 2022).

While the country’s production of hydrogen in refineries is expected to remain stable in the foreseeable future (MME, 2022), new initiatives have been ramped up throughout the country to produce low-carbon hydrogen and its derivatives. As of October 2024, the International Energy Agency (IEA) registered 42 low-emission hydrogen projects in Brazil (IEA, 2024). While this is only a share of what firms in frontrunner countries such as Germany or the United States have initiated, no other country in the region, except Chile, registers as many projects as Brazil (see Fig. 1). Most of them, however, are still at an early stage of development. Almost half of the projects are expected to generate ammonia, underscoring the country’s ambition to become a leader in the production of green fertilizers (see Sect. 3).

According to recent estimations, green hydrogen produced in Brazil could have one of the lowest levelized costs in the world (Bhashyam, 2023). Particularly the regions in the Northeast and South are projected to be one of the most promising locations globally for producing clean hydrogen and its derivatives (Agora Hank et al, 2023; Industry et al, 2024). Brazil’s energy mix already relies strongly on renewable energy (including hydropower and biomass), accounting for 49% of the country’s total energy supply and 89% of its electricity supply (IEA, n.d).



**Fig. 1** Number of low-emission hydrogen projects by development stage in selected countries. *Source* Authors, based on data from IEA (2024)

### 3 Policy Objectives Guiding Brazil's Green Hydrogen Ambitions

Brazil's hydrogen policy is steered toward three overarching objectives: strengthening economic and energy security; achieving decarbonization; and attaining economic growth, competitiveness, and re-industrialization by attracting green investment. Over the past years, these interrelated goals have guided policymaking to varying degrees.

The pursuit of economic and energy security<sup>1</sup> has a long history in the country and is associated with two political strategies employed in the recent past: First, Brazil has made repeated efforts to gain sovereignty over its energy resources and related rents. The most important decisions taken in this context were the creation of Petrobras, the country's national oil company, in 1953 and the establishment of Eletrobras, its national utility company, in 1962. Second, Brazil has invested strongly in a diversification of its energy mix to safeguard the country against supply fluctuations and price shocks, particularly in oil and gas. In reaction to the oil crisis of the 1970s, it passed the *Pro-Álcool Program* with the aim of substituting petroleum-based fuels with ethanol. The program has widely been considered a success (Oliveira, 2002). The country has also promoted hydropower and nuclear energy early on to reduce its heavy reliance on fossil fuels. In 1985, both the Itaipu Hydroelectric Dam and the first Angra Nuclear Power Plant were opened. More recently, the country started the exploration of the pre-salt oil and gas layers starting in 2010.

The promotion of green hydrogen promises to feed these demands for economic and energy security in two ways: First, Brazil's agriculture industry demands large amounts of fertilizer and, so far, strongly depends on imports. As of 2023, the country imported about 80% of its fertilizer, which turned out to be costly when Russia's war in Ukraine caused a global supply crisis (Ysamat, 2023). In reaction, the Bolsonaro administration drafted the *National Fertilizer Plan* in 2022, whose central aim is to reduce import dependencies (Brazil, 2022). The production of green fertilizers—with green ammonia as the main feedstock—could therefore serve to reduce both import dependencies and greenhouse gas (GHG) emissions. Second, hydrogen could contribute to enhancing the stability of Brazil's energy system. It relies strongly on hydropower and other renewable sources, which tend to be subject to output fluctuations. In times of low supply, particularly in the dry season, stored hydrogen could balance these fluctuations (Agora Industry et al, 2024).

Another important objective for Brazil's hydrogen strategy (particularly since 2023) is decarbonization, frequently mentioned in official documents, at both the federal and state level. The country's current president Lula da Silva has, in public statements, repeatedly linked Brazil's green hydrogen ambitions with the government's renewed drive toward environmental protection and decarbonization, signaling intensified interests in the development of sustainable hydrogen compared to the previous administration of Jair Bolsonaro (Brazil, 2023c; 2023a; 2023b). This

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<sup>1</sup> Economic security is for the purpose of this chapter understood as the reduction of exposure to foreign trade (McCaffrey & Poitiers, 2024).

discursive shift might also be beneficial for fostering international cooperation, as a pro-decarbonization government might have more leverage to sell the ambition for developing a national hydrogen economy.

Sectors such as transportation and hard-to-abate industries like steel, petrochemical, and cement are seen as important targets for decarbonization through hydrogen (MME, 2023; Brazil, 2024d). Decarbonized industrial products might be consumed domestically or exported, particularly green fertilizer. The Brazilian government considers hard-to-abate sectors as objects of a long-run decarbonization mission, which could be addressed through the building of experimental hubs within the framework of a national energy transition policy. This could allow for the building of synergies “between energy generation and related infrastructure, seeking to catalyze national efforts for the decarbonization of hard-to-abate sectors” (MME, 2023). It should be noted, however, that green hydrogen is only one decarbonization pathway that the government is pursuing. The production of biofuels, so-called fuels of the future also plays an important role in the government’s decarbonization policy (Brazil, 2024a).

The third objective that is linked to the promotion of hydrogen in Brazil is the quest for re-industrialization, competitiveness, and economic growth. The country’s high potential for low-cost clean hydrogen promises to deliver jobs, growth, and even industrial leadership in a future green hydrogen economy. In this vein, the Brazilian government is strongly invested in international cooperation for the development of an export market for hydrogen and hydrogen-based industrial and chemical products (see Sect. 6). These ambitions for growth and competitiveness are embedded in Brazil’s agenda for “neo-industrialization” spelled out in its New Industry Brazil (NIB) Program (Brazil, 2024a), launched in January 2024. After experiencing decades of deindustrialization, the program’s central goal is to strengthen the country’s competitiveness in new and established industries. Supporting the development of a clean hydrogen economy is expected to serve this objective (Brazil, 2024a, 2024b). Moreover, its support for clean hydrogen is driven by concerns about competitiveness in future decarbonized international markets. Brazil’s industry needs to secure the supply of low-carbon hydrogen to not risk losing access to markets that are increasingly adopting GHG-related import requirements. Several industrial products exported to the EU, the UK, and potentially to other markets will fall under carbon border adjustment mechanisms (CBAMs) planned by these jurisdictions (Perdana et al, 2024).

Thus, Brazil’s approach to hydrogen, which is strongly embedded in its green industrial policy, seeks to balance these three overarching objectives. Although it remains unclear to what degree the mitigation of GHG emissions is prioritized over the others, there seems to be no general conflict between strengthening economic and energy security, achieving decarbonization, and fostering economic growth and international competitiveness in Brazil.

## 4 Governing Hydrogen: Policy at the Federal and State Level

In Brazil, hydrogen production, infrastructure, and usage have been promoted not only by the federal but also by state governments. This section retraces the policy developments related to hydrogen at both levels. While the federal government adopted subsidies and standards for low-carbon hydrogen in 2024, some states have pioneered the promotion of hydrogen even earlier, attracting considerable investments and building pilot projects. After illustrating the evolution of the federal policy landscape, we discuss the ambitions and strategies of state governments.

### 4.1 Governing Hydrogen at the Federal Level

From 2002 onwards, Brazil's federal government has progressively focused on the development of a hydrogen economy through multiple strategic policy documents and initiatives. Table 1 provides an overview of the most important documents and laws. Although no official national hydrogen strategy has been developed so far, the body of existing laws, programs, roadmaps, and official studies provide the basis for assessing Brazil's federal hydrogen policy.

Starting with the *Brazilian Hydrogen and Fuel Cell Systems Program* (PROCAC), which was later renamed the *Science, Technology and Innovation Program for the Hydrogen Economy* (PROH2), efforts have been made to enhance research and development (R&D) in hydrogen and fuel cell technologies (FCT) by fostering public-private partnerships and protecting intellectual property. In 2005, the Ministry of Mines and Energy (MME) together with the Ministry of Science, Technology, and Innovation (MCTI) developed the *Roadmap for the Structuring of the Hydrogen Economy in Brazil*, a comprehensive study to assess the prospects and challenges for creating a hydrogen market in Brazil. In consideration of the country's competitive advantages, it proposed to prioritize various technological pathways, including electrolysis but also ethanol, and natural gas reforming (EPE, 2021). In 2010, another study commissioned by the MCTI followed up with concrete policy recommendations for fostering hydrogen supply, demand, and infrastructure (CGEE, 2010). Although hydrogen was mentioned in the *Science, Technology and Innovation Plans for Electricity and Biofuels* published in 2017 and 2018, the federal government at that time did not seriously engage in creating a favorable policy environment for the development of a hydrogen market. The *National Energy Plan 2050*, launched in 2020 by the MME, addresses hydrogen as a key component for decarbonizing Brazil's economy, but without providing clear guidance on technology and sector prioritization (EPE & MME, 2020). The call for a "rainbow" (p. 26) strategy with no special emphasis on green hydrogen was reasserted by the MME in another report published one year later (EPE, 2021).

**Table 1** Policy documents and federal laws related to hydrogen in Brazil

Policy document/law	Year	Description
Brazilian Hydrogen and Fuel Cell Systems Program (PROCAC/PROH2)	2002	<ul style="list-style-type: none"> <li>Promotes the establishment of research networks and intellectual property protection for R&amp;D in hydrogen and FCT</li> </ul>
Roadmap for the Structuring of the Hydrogen Economy in Brazil	2005	<ul style="list-style-type: none"> <li>Elaborates on potentials and challenges for hydrogen market development in Brazil</li> </ul>
Hydrogen Energy in Brazil—Support for Competitiveness Policies: 2010–2025	2010	<ul style="list-style-type: none"> <li>Outlines strategic guidelines for creating a hydrogen economy (incl. production, infrastructure, and usage)</li> <li>Makes policy recommendations for all segments of a future Brazilian hydrogen economy</li> </ul>
Strategic Agenda for Science, Technology, and Innovation in the Brazilian Electricity Sector	2017	<ul style="list-style-type: none"> <li>Details objectives for hydrogen and FCT research and innovation policy</li> </ul>
Science, Technology, and Innovation Plan for Renewable Energy and Biofuels: 2018–2022	2018	<ul style="list-style-type: none"> <li>Encourages demonstration projects for hydrogen production</li> </ul>
National Energy Plan 2050	2020	<ul style="list-style-type: none"> <li>Acknowledges the potential of hydrogen for the decarbonization of the economy</li> <li>Discusses different technological pathways</li> </ul>
Baseline to support the Brazilian Hydrogen Strategy (Technical Note)	2021	<ul style="list-style-type: none"> <li>Details main opportunities and challenges to the development of hydrogen production and use in Brazil</li> </ul>
National Hydrogen Program: proposal for guidelines	2021	<ul style="list-style-type: none"> <li>Highlights domestic and international hydrogen prospects</li> <li>Establishes objectives and principles for the National Hydrogen Program</li> <li>Maps the governance structure of the National Hydrogen Program</li> </ul>
PNH <sub>2</sub> 's three-year work plan (2023–2025)	2023	<ul style="list-style-type: none"> <li>Defines the main areas for political support</li> <li>Proposes policy strategies and tax incentives (especially for low-carbon hydrogen)</li> <li>Positions Brazil as a key player in the global energy transition</li> </ul>
New Industry Brazil Program	2024	<ul style="list-style-type: none"> <li>Presents a green industrial policy strategy that includes hydrogen promotion as a priority for industrial decarbonization</li> </ul>
Law 14948/24 (Hydrogen Act)	2024	<ul style="list-style-type: none"> <li>Establishes the legal framework for low-carbon hydrogen promotion</li> <li>Defines low-carbon, renewable, and green hydrogen and creates a certification scheme</li> <li>Establishes tax credits for low-carbon hydrogen</li> </ul>
Law 14990/24 (Low Carbon Hydrogen Development Program)	2024	<ul style="list-style-type: none"> <li>Establishes a subsidy program to facilitate the production and usage of hydrogen in heavy industry and transport</li> </ul>

*Sources* Authors' compilation based on CGEE (2010), CGEE (2017), MCTI (2018), MME (2020), GIZ (2021), EPE (2021), MME (2021), Brazil (2024c, 2024d)

Since 2021, hydrogen has become more central to energy and industrial policy in Brazil. In April of that year, the *National Council of Energy Policy* (CNPE) adopted a resolution for the creation of a *National Hydrogen Program* (PNH2). In response to this, the MME led the development of guidelines that specify objectives and principles for the program. Again, the government emphasizes its intention to promote hydrogen in accordance with the country's "national potential of energy resources" (p. 13), not precluding hydrogen production from non-renewable sources (EPE & MME, 2021). The PNH2's three-year working plan for 2023–2025, which was developed under the auspices of Lula's Minister of Mines and Energy, Alexandre Silveira de Oliveira, departs from this approach putting decarbonization and climate change mitigation at the center of hydrogen policy. The plan thus prioritizes low-carbon hydrogen and calls for the development of respective standards and certification schemes. It further tries to harmonize the policy efforts by establishing six main axes for the PNH2: (1) strengthening technological bases, (2) training human resources, (3) conducting energy planning, (4) creating regulatory frameworks and (5) fostering neo-industrialization and competitiveness as well as (6) international cooperation. The plan also presents a progression in terms of ambition, setting the goal of becoming the world's most competitive producer of low-carbon hydrogen worldwide by 2030 (MME, 2023).

The launching of the NIB Program in early 2024 has further clarified Brazil's ambitions for fostering hydrogen production and use. The program establishes a green industrial policy agenda combining the objectives of industrial development and decarbonization. Thereby, it seeks to promote the development of domestic industries targeting "the nationalization of production and equipment dealing with renewable energy generation" in the country (Brazil, 2024a). The promotion of low-carbon hydrogen is one of the policy priorities laid out in the program. In total, around USD 50 billion (BRL 300 billion) of funding from different sources will be made available until 2026 to support the objectives set by the NIB (Brazil, 2024b). Although it is unclear what share will be devoted to hydrogen, the development of "renewable energy capacities, particularly solar, wind and low-carbon hydrogen" is stated as one out of five priorities for financing with regards to decarbonization (Brazil, 2024a, p. 79).

Despite this multitude of studies and strategy documents, impactful policies promoting hydrogen investment at scale remained scarce. This changed with the adoption of the *Hydrogen Act* and the *Low Carbon Hydrogen Development Program* (PHBC) in 2024. Brazil's Hydrogen Act which became law on 6 August 2024 established a new regulatory framework for hydrogen development in the country. The framework is guided by five central principles (Brazil, 2024c):

- Respect for technological neutrality in the definition of incentives
- Competitive inclusion of low-carbon hydrogen in the energy mix for decarbonization
- Predictability in formulating regulations and granting incentives for market expansion
- Rational use of the existing infrastructure dedicated to energy supply

- Encouraging research and development for the use of low-carbon hydrogen.

Particularly the first is reflected in the way renewable and low-carbon hydrogen are standardized by the Hydrogen Act. Renewable hydrogen is defined as hydrogen “obtained from renewable sources, including hydrogen produced from biomass, ethanol, and other biofuels, as well as electrolytic hydrogen, produced by electrolysis of water, using renewable energies, such as solar, wind, hydraulic, biomass, ethanol, biogas, biomethane, landfill gas, geothermal and others to be defined by the government” (Brazil, 2024c). This standard interprets “renewable” broadly and leaves open the possibility for further extensions by the government. Low-carbon hydrogen is defined by the maximum amount of permissible lifecycle emissions. Initially, the bill foresaw low-carbon hydrogen to account for no more than 4 kg of CO<sub>2</sub>-equivalent per kilogram of hydrogen produced (4 kgCO<sub>2</sub>eq/kgH<sub>2</sub>). In July 2024, however, the Brazilian Senate decided to raise the threshold to 7 kgCO<sub>2</sub>eq/kgH<sub>2</sub>, which was later adopted in the Hydrogen Act. This is currently the highest permissible emission level for low-carbon hydrogen apart from the unofficial standard suggested by the China Hydrogen Alliance (see Gong & Quitzow in this volume).<sup>2</sup> The controversial decision might have been motivated by the goal of making hydrogen produced from ethanol eligible for subsidy programs (Collins, 2024a).

The law also creates the country’s own certification scheme, the *Brazilian System of Hydrogen Certification* (SBCH2), in which membership will be voluntary. Moreover, it includes subsidy programs: The *Special Incentive Regime for Low-Carbon Emission Hydrogen Production* (Rehidro) foresees tax breaks for companies using products made in Brazil in their hydrogen supply chain. The program is an extension of the *Special Regime of Incentives for Infrastructure Development* passed in 2007, allowing tax exemptions when acquiring or renting equipment for infrastructure development. The budget of the program is equally unclear. To benefit from the regime, firms need to comply with specific requirements, particularly a minimum share of domestic goods and services to be utilized, as well as a minimum investment in RD&I. Finally, there shall be a cap on the maximum share of hydrogen that can be exported after making use of this incentive. If passed, companies wishing to request the benefit will have five years to adapt to the requirements.

The PHBC, adopted shortly after the Hydrogen Act, will subsidize the promotion of low-carbon hydrogen in hard-to-abate sectors (including fertilizer, steel, cement, chemical, and petrochemical industries) and heavy transport. Most importantly, the PHBC grants a “tax credit on the sale of low-carbon hydrogen and its derivatives produced in the national territory” (Brazil, 2024d). Between 2028 and 2032, tax credits are expected to amount to over USD 3.3 billion (BRL 18 billion), which will be granted to producers and buyers of low-carbon hydrogen.

The funding shall generally be provided via budget allocations, donations from domestic or international bodies (either public or private), loans from domestic and

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<sup>2</sup> For comparison, the EU’s threshold is much lower, defining low-carbon hydrogen as hydrogen produced with lifecycle emissions not exceeding 3.38 kgCO<sub>2</sub>e/kgH<sub>2</sub> (EU, 2023). Unlike the EU criteria for clean hydrogen, Brazil’s Hydrogen Act foresees no additionality criteria.

international financial institutions, as well as the share of surplus profits of official financial development agencies from the previous financial year. Companies interested in producing low-carbon hydrogen take part in a competition with rules proposed by the PNH2 management committee. If the bid is successful, PHBC subsidies will be granted for ten years.

Another boost for the country's competitiveness could come from the recent approval of its Investment Plan for the *Renewable Energy Integration Program* to be funded by the Climate Investment Fund, one of the largest multilateral climate funds. The plan is expected to unlock additional resources amounting to USD 1.09 billion for industrial decarbonization and the creation of low-carbon hydrogen hubs (Collins, 2024b). A first call for project proposals was issued in October 2024 (MME, 2024).

These policy advances all take place in the context of broader discussions on the re-industrialization of the Brazilian economy. The current Lula administration has consistently linked this idea to the ambition of building a green economy, which might be interpreted as a response not only to civil society pressures for more sustainability but also to the desire for a new narrative for future development projects with both domestic and international appeal. In early 2023, the Ministry of Development, Industry, Trade and Services (MDIC) announced the creation of a new Secretariat for Green Economy, Decarbonization, and Bio-Industry, working alongside the Ministry of Environment (MMA), promoting the administration's green industrial policy agenda (Brazil, 2023d).

The government's focus on low-carbon over green hydrogen, defined in the Hydrogen Act as "produced by electrolysis of water, using renewable energy sources" (Brazil, 2024c), reflects its emphasis on aligning the country's hydrogen ambitions with the potentials of its energy mix. Brazil seeks to declare hydrogen from ethanol as sustainable, capitalizing on its large ethanol industry. Furthermore, the country has large natural gas reserves, which could be beneficial for producing blue hydrogen (Agora Industry et al, 2024). Interestingly, the preferred terminology also varies in official documents according to the actors concerned: subnational stakeholders aiming to produce and export hydrogen sourced through wind and solar often refer to "green hydrogen" in their programs, bills, and decrees.

The small but growing number of laws incentivizing particularly hydrogen production points to the acceleration of the policy discussion in Brazil between 2023 and 2024. Federal-level hydrogen policymaking has gained momentum, making the country's stance clearer for stakeholders and society. These plans and policies will be welcomed by partners and investors as they provide incentives and increase legal certainty for current and future hydrogen projects in the country. Generally, they signal that hydrogen has constituted a priority in Brazil's climate, energy, and industrial policy.

## 4.2 *Governing Hydrogen at the State Level*

While Brazil's main legislative framework for hydrogen governance is now established at the federal level, hydrogen policies have also been developed at the subnational level and ambition varies significantly from state to state. Ceará, for instance, is a trailblazer for green hydrogen development. The uneven distribution of state-level policies across the nation reflects different points of departure regarding energy mix, geographical location, pre-existing cooperation agreements, and political ambition. In the absence of a national hydrogen strategy, many states have, particularly since 2021, adopted hydrogen policies and programs to promote its production, transport, and usage. Table 2 in section 5 below provides an overview of hydrogen-related policy initiatives at the state level.

States from the Northeast have so far been the most ambitious in developing policies, focusing mostly on hydrogen export. They enjoy favorable conditions due to their existing renewable energy capacities and relative proximity to Europe. Being the most industrialized and logistically developed in the country, states in the South and Southeast have generally been less ambitious in adopting export-oriented hydrogen policies. The incentives for hydrogen exports are less pronounced, justifying why many of the projects in these regions have a stronger focus on domestic (or non-specified) markets. Rio de Janeiro is an exception, having developed a pilot project for hydrogen production and export at the Port of Açu. São Paulo state, the country's most industrialized and largest subnational economy, accounting for approximately 30% of the country's GDP (Exame, 2023), has not yet developed ambitious hydrogen policies. Western regions have also not shown the same ambition as the Northeast for crafting hydrogen markets. Overall, the state policy frameworks of northeastern states are the most extensive, relying on financial instruments such as tax breaks or low-interest loans to promote research and equipment acquisition, as well as hydrogen usage in transport and agriculture.

## 5 **Investing in Green Hydrogen: Stakeholders, Partnerships, and Pilot Projects**

This policy environment is giving rise to a still limited but growing low-carbon hydrogen market in Brazil. Firms have started to invest in hydrogen production and infrastructure, either on their own or in cooperation with other private or public entities. Important private stakeholders are, in the first place, those companies already engaged in the production and usage of hydrogen. As the Brazilian market is strongly dominated by Petrobras, hydrogen-producing firms are limited in number. Besides Petrobras, which is currently responsible for over 90% of hydrogen output in the country, other market participants are Messer, Air Liquide, Air Products, and Linde.<sup>3</sup>

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<sup>3</sup> Linde was acquired by Messer in 2019. It is represented by White Martins in Brazil (GIZ, 2021).

Petrobras' role as Brazil's main hydrogen producer, now and possibly also in the future, cannot be overstated. The national oil company combines a strong tradition in energy and is considered a strategic asset for both investors and society at large and, although there are many controversies surrounding the state's role in its management, it has a reputation of being a frontrunner in new and risky energy enterprises. Petrobras also controls much of the country's long-distance pipeline network, which could theoretically be adjusted to accommodate hydrogen transport. Finally, the company has already gained much experience in sourcing hydrogen for fertilizer production, which could promptly synergize with the country's announced plans to revive the fertilizer industry. Although the Brazilian state is Petrobras' main shareholder<sup>4</sup> (Petrobras, 2023) the company is a publicly traded corporation and thus relies strongly on private investments. For Petrobras, the involvement in the production of low-carbon hydrogen and ammonia could provide a pathway for diversifying its portfolio, which is still heavily dependent on fossil fuels.

However, other private and public companies have also started to invest in hydrogen (see EPE, n.d for an overview). The fact that most of these firms are not based in Brazil legitimizes the government's current ambition to create favorable conditions for domestic companies along the hydrogen value chains (see Sect. 4.1). The geographical distribution of pilot projects largely reflects the different levels of ambition in state-level policymaking. Firms have often cooperated with local and state governments to realize hydrogen production or infrastructure projects. Most of the existing local initiatives are still in the stage of development, focusing on production, research, and in some cases international cooperation for export. In the following, we discuss some of the most important pilot projects and partnership agreements that have been pursued to realize the production and use of hydrogen in and beyond Brazil.

The first green hydrogen plant was launched in December 2021 in Itumbiara (Goiás state), where experiments were carried out to study the production and storage of hydrogen, as well as its re-conversion into electricity and its feeding into the country's power grid. The hydrogen has been generated from both a solar and a hydropower plant (Gontijo, 2023). In November 2023, EDP (with its Pecém project) and Eletrobras Furnas (in Itumbiara) received the first renewable hydrogen certificates in Brazil, following EU guidelines, being issued by the National Electricity Trade Chamber (CCEE, 2023; H2LAC, 2023).

In the state of Pernambuco, the Brazilian subsidiary of China's state-owned energy firm CTG collaborated with the state government to launch the *Green Hydrogen TechHub* at the Port of Suape, the most important in the country's Northeast. The aim is to foster research and development focusing on the production, transport, and storage of green hydrogen (Suape, 2022). This collaboration also involves the National Service for Industrial Training (SENAI), which has signed a Memorandum of Understanding (MoU) with CTG and the Government of Pernambuco in 2022.

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<sup>4</sup> As of end of 2023, the Federal Government holds 50.26% of Petrobras' common shares (Petrobras, 2023).

In Rio de Janeiro state, multiple hydrogen projects are planned at the Port of Açu, which has an important oil and gas service infrastructure and, similar to other Brazilian ports, has shown interest in having a large offshore wind farm built in its area (Neder, 2022). If successful, this would allow large-scale hydrogen production facilities, be it for local consumption or exports. A first MoU was signed in May 2022 between the port's operator and Shell. It is expected that the pilot plant will become operational in 2025. The proposal envisions an electrolysis plant as well as a renewable ammonia plant and explicitly aims to integrate local firms along the supply chain, not having to rely only on exports (Porto do Açu, 2022). The Norwegian company Fuella is further planning to build a green ammonia plant at the port's site (Porto do Açu, 2024). Most recently, HIF Global signed a land reservation contract with the Port of Açu to realize a large e-methanol project that is expected to produce about 800,000 tons per year (HIF Global, 2024). Unlike the ports of Pecém and Suape, the Port of Açu is privately owned and is thus perhaps the most relevant case of an international private-private port partnership for the development of low-carbon hydrogen in the country.

In 2023, the state of Rio Grande do Sul signed an MoU with the Port of Rotterdam aiming at fostering the production of onshore and offshore renewable energy and green hydrogen in the vicinities of the Rio Grande Port. The signing took place during the World Hydrogen Summit in 2023 (Rio Grande do Sul, 2023b). Additionally, Neoenergia, controlled by the Spanish Iberdrola Group, signed an MoU with the Rio Grande do Sul state for the development of wind power projects and green hydrogen production (Neoenergia, 2022).

The state of Piauí announced two important projects for green hydrogen production in December 2023 (Brazil, 2023e). The recently inaugurated Piauí Port is planned to host green hydrogen facilities in the Export Processing Zone (EPZ) of Parnaíba. It is estimated that USD 35.7 billion (BRL 200 billion) will be invested in the project through public-private partnerships. The state of Piauí has developed strategic partnerships for the construction of one of the world's largest projects for green hydrogen and green ammonia production, which could make hydrogen one of the main products for the Parnaíba EPZ. It is expected that both plants (planned to be operational in 2035) will generate 20 GW of power. The companies *Green Energy Park* from Croatia, and *Solatio* from Spain, are the main private investors (Freire, 2023). Once operational, with construction set to begin in 2024, exports are to be directed to Europe, Asia, and the Middle East. Piauí state has partnered with the EU and is expected to receive around USD 10.7 billion (BRL 60 billion) of investments in green hydrogen production as part of Brazil's PNH2.

Apart from port-centered infrastructure, the Federal University of Santa Catarina (UFSC) opened its *Solar Energy and Green Hydrogen Research Laboratory* in August 2023, which includes a pilot plant producing nitrogen fertilizer from green hydrogen. The project resulted from Brazilian-German cooperation, receiving financial and technical support from the German government (UFSC, 2023). Germany also supports the development of a hydrogen research center at the Federal University of Itajubá. The facility includes an electrolyzer and a refueling station for facilitating

research on the application of hydrogen in the transport sector (CH2V, n.d). The research center focuses on the application of hydrogen in the transport sector.

In the state of Paraná, the *Itaipu Technological Park* (PTI), located in the border city of Foz do Iguaçu, has advanced research in renewable hydrogen production over the past 12 years. The research center is operated by *Itaipu Binacional*, which also manages the Itaipu Hydroelectric Power Plant, the country's largest. PTI uses its own green hydrogen pilot plant to research the potential for producing and applying hydrogen in the transport and chemicals sector. In May 2023, the state government announced a USD 89.1 million (BRL 500 million) investment in green energy, which could incorporate green hydrogen. The know-how that has been developed at PTI, as well as the strategic location at a trinational border (Argentina, Brazil, and Paraguay) could contribute to the development of a regional hydrogen economy.

Finally, the largest project aimed at producing green hydrogen and ammonia is located in the state of Ceará. In 2021, the state government partnered with the Port of Pecém, the Federation of Industries of the State of Ceará, and the Federal University of Ceará to create a "Green Hydrogen Hub". As of late 2023, over 30 MoUs had been signed between the state government and other actors with the aim of producing and exporting green hydrogen and ammonia. The *Pecém Complex*, located in the city of São Gonçalo do Amarante, is a joint venture between the Ceará government and the Port of Rotterdam, officially launched in October 2018 (Ceará, 2018). As time progressed, the port's operations have developed projects with already existing renewable energy facilities in the state, stressing the potential for expansion in the area. Given the existing partnership with Rotterdam, Europe's largest port, the production and export of green hydrogen through Pecém was envisioned and kickstarted in 2021 and is an important flagship project of the state government.

As of late 2023, Ceará had 100 wind power farms (generating 2.5 GW), as well as 72 that had been commissioned (with a 2.8 GW capacity). Other 26 offshore projects (with an expected 64.9 GW capacity) were expecting environmental licensing from the Brazilian Institute of Environment and Renewable Natural Resources in early 2024. As for solar, 1.5 GW of installed capacity was spread among 35 initiatives across the state, whereas 419 solar plants were under construction with an estimated 16.7 GW capacity (Ceará, 2024). The existing and potential capacity for renewable energy production is an important asset for the development of a green hydrogen economy in the state.

As of January 2024, the current and expected investments in the Pecém Green Hydrogen Hub amounted to USD 30 billion, including signed pre-contracts amounting to USD 8 billion (Ceará, 2024). These numbers are likely to grow if international partners, such as several European countries, uphold their plans to upscale green hydrogen use. In December 2022, the Portuguese company EDP, one of Ceará's main partners for green hydrogen production, announced the creation of its first green hydrogen molecule produced in Brazil. This took place in Pecém's thermal power station in an existing pilot project for green hydrogen production. In January 2023, efforts were further intensified announcing the creation of a green power plant (EDP, 2023).

The focus of Ceará state on green hydrogen production and its relatively broad public–private partnerships in the field is a result of a longer-standing strategy by the state toward capitalizing global green hydrogen demand by making use of its existing renewable energy capacities, as well as its export facilities. These elements (large existing and expanding solar and wind projects, existing relations with foreign actors in international trade activities, as well as geographical proximity to Europe relative to other Brazilian regions) have contributed to a unique hydrogen profile. The adoption of the *State Policy for Green and Sustainable Hydrogen and its Products* (see Table 2) and the establishment of a green hydrogen council further facilitate these ambitions (Ceará, 2023).

The state of Ceará hence stands out as a pioneering subnational force in the green hydrogen economy. Through comprehensive planning and public–private collaboration, the state has attracted significant attention, pushing ahead with the production and exportation of green hydrogen. The strategic establishment of the Green Hydrogen Hub, bolstered by partnerships with entities like the Port of Rotterdam, has positioned Ceará as one of the leaders in renewable energy in Brazil. The state’s plans to strengthen its green hydrogen infrastructure, reinforced by substantial investment and partnerships, highlight a promising model for leveraging local resources for the energy transition. However, as other states ramp up their investment in green hydrogen production through different pilot projects, they might also become potential frontrunners, depending in particular on their specific energy environment and trade capabilities.

## 6 International Hydrogen Cooperation

Since the return of Lula as president, Brazil has been heavily invested in demonstrating its renewed engagement in international cooperation, particularly with regard to environmental and climate politics. Under its presidency, it hosted the G20 Summit in 2024 under the slogan “Building a Just World and a Sustainable Planet” and will host the United Nations Climate Change Conference (COP) in 2025. Concerning green hydrogen in particular, the PNH2’s Three-Year Plan considers the support for “cooperation at the regional and global level” as one out of six central elements for the promotion of hydrogen (MME, 2023). Generally, the federal government and subnational actors in Brazil have engaged in international cooperation at three levels: First, Brazil has been actively involved in multilateral hydrogen forums. It has, second, engaged in club cooperation across the region and within the BRICS. Third, Brazil has advanced several bilateral initiatives related to green hydrogen production and trade.

At a global level, Brazil has been involved in the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) as one of its founding members. Its participation in the IPHE was the result of US-Brazil diplomatic talks in 2003 when Washington invited the country (at the time, under Lula da Silva’s first administration) to be a member. This took place along with another invitation by the United States for

**Table 2** State-level policy initiatives and programs for hydrogen in Brazil

State/federal district	Law
Alagoas	<ul style="list-style-type: none"> <li>• Law 9360/2024 promotes the production, processing, and use of green hydrogen, aiming to modernize, diversify, and decarbonize the local industry</li> <li>• The law supports scientific and technological research and encourages the establishment of green hydrogen firms</li> </ul>
Amazonas	<ul style="list-style-type: none"> <li>• Law 6376/2023 declares climate emergencies and environmental racism a matter of state interest and cites RD&amp;I, production, and usage of green hydrogen as a state priority</li> <li>• Bill 12/2024 outlines a framework for producing green hydrogen in the state, defining it as hydrogen produced via water electrolysis with zero carbon emissions</li> <li>• The bill encourages inter-institutional cooperation among government, research, and private sectors while promoting R&amp;D through research centers and pilot plants</li> </ul>
Bahia	<ul style="list-style-type: none"> <li>• Decree 21200/2022 establishes the <i>State Plan for the Green Hydrogen Economy</i>, aiming to curb GHG emissions, attract investments, and foster scientific advancement in green hydrogen production and use</li> <li>• Further aims are forming partnerships, aligning policy with global initiatives, incentivizing projects, and establishing a business-friendly environment to develop and modernize the local green hydrogen industry</li> <li>• The decree encourages diverse economic sector engagement, particularly in industry, urban mobility, and transportation</li> </ul>
Ceará	<ul style="list-style-type: none"> <li>• Law 18459/2023 establishes the <i>State Policy for Green and Sustainable H<sub>2</sub></i>, focusing on the diversification of the energy mix and GHG emission reduction</li> <li>• It governs the exploration, production, transportation, and storage of green hydrogen, emphasizing national interest, public utility, and sustainability as priorities</li> <li>• Objectives include increasing the state's green hydrogen share, fostering related research, and stimulating investment in the green hydrogen sector</li> <li>• The state government created the <i>State Council for the Governance and the Development of Green and Sustainable Hydrogen and its Products</i> to guide and develop the field</li> </ul>
Espírito Santo	<ul style="list-style-type: none"> <li>• <i>Program for Renewable Energy Generation within the Sustainable Chain</i> (2023) has the aim of fostering the production, storage, and use of sustainable hydrogen</li> <li>• It revolves around regional development policies, regulation, incentives, financing, and socio-economic benefits</li> </ul>
Federal District	<ul style="list-style-type: none"> <li>• Law 7.404/2024 establishes the <i>Federal District's Green Hydrogen Policy</i> to reduce carbon emissions and expand the Federal District's energy mix</li> <li>• It outlines several goals, such as reducing GHG emissions, supporting technological development, attracting investment, and promoting infrastructure for green hydrogen</li> <li>• It encourages tax credits and partnerships to enhance hydrogen and calls for the decarbonization of transport</li> <li>• The program is funded by specific budget allocations and includes a system for monitoring and evaluation</li> </ul>

(continued)

**Table 2** (continued)

State/federal district	Law
Goiás	<ul style="list-style-type: none"> <li>• Law 21767/2023 establishes the <i>State Policy for Green Hydrogen</i>, tackling the promotion of green hydrogen, encompassing research, production, regulation, financing, investment, use, and collaborative partnerships</li> </ul>
Maranhão	<ul style="list-style-type: none"> <li>• The state government established the state policy for fostering green hydrogen production and use both for hydrogen and fertilizer production in 2023</li> <li>• Included in the new <i>Policy of Ecological Taxation</i>, it promotes incentives for acquiring hydrogen-related equipment and facilities, focusing on partnerships (also in RD&amp;I)</li> </ul>
Mato Grosso	<ul style="list-style-type: none"> <li>• Bill 1032/2021 proposes a public policy for green hydrogen in the state, aiming to enhance its contribution to the energy mix, particularly for agriculture</li> <li>• It stresses climate change mitigation and fostering the state's green hydrogen supply chain through incentives, legal frameworks, and infrastructural investment</li> <li>• Bill (1521/2024) seeks to establish the <i>State Policy for Renewable and Low-Carbon Hydrogen</i>, outlining a plan to develop a hydrogen economy</li> <li>• It encourages investment in research, production, and consumption of renewable and low-carbon hydrogen</li> <li>• It supports transitioning to a low-carbon economy by replacing fossil fuels and developing hydrogen infrastructure, including hubs</li> <li>• It promotes collaboration among various sectors and proposes incentives for hydrogen-related investments</li> </ul>
Minas Gerais	<ul style="list-style-type: none"> <li>• The state government and the Federation of Industries of Minas Gerais launched the program <i>Minas do Hidrogênio</i> in 2021</li> <li>• It focuses on solar energy use for electrolysis-based hydrogen production, as well as biomethane and ethanol as sources</li> <li>• The stated goal of the project is to have the local industry use the hydrogen produced</li> <li>• State law 24940/2024 established the framework for the development and utilization of low-carbon and green hydrogen in the state</li> <li>• It aims to integrate hydrogen into the energy mix, reduce GHG emissions, and combat climate change</li> <li>• It promotes technological advancements, investments in infrastructure, and the development of a hydrogen value chain, focusing on applications in energy and agriculture</li> <li>• It provides fiscal instruments to encourage the production and acquisition of hydrogen-related equipment</li> <li>• It includes support for innovation and technological enterprises linked to hydrogen</li> </ul>
Paraíba	<ul style="list-style-type: none"> <li>• Law 12345/2022 established the state's public policy for green hydrogen aiming at GHG reduction, the diversification of the state's energy mix, fertilizer production, and the decarbonization of the transport sector</li> <li>• It regulates the development of hydrogen supply chains aiming to attract investment</li> </ul>

(continued)

**Table 2** (continued)

State/federal district	Law
Paraná	<ul style="list-style-type: none"> <li>• Law 21454/2023 aimed at increasing the share of renewable hydrogen in the state's energy mix, stimulating renewable hydrogen use in energy and fertilizer production, reducing GHG emissions, fostering a renewable hydrogen production chain, and attracting investment</li> </ul>
Pernambuco	<ul style="list-style-type: none"> <li>• The <i>Green Hydrogen Policy</i>, established by state Law 17976/2022, aims to elevate the role of hydrogen within the energy mix, boost its diverse applications (including agriculture), reduce greenhouse gases, support the supply chain, improve economic, social, and environmental outcomes, promote technological advances, attract infrastructure investments, and enhance sector-specific professional development and training</li> </ul>
Piauí	<ul style="list-style-type: none"> <li>• The state's hydrogen-based energy policy aims to reduce emissions and boost energy production by integrating hydrogen into the state's energy mix</li> <li>• It encourages the use of hydrogen in various sectors like agriculture and supports the development of a local hydrogen industry</li> <li>• It seeks to attract investments in hydrogen infrastructure and develop training programs for the workforce</li> </ul>
Rio de Janeiro	<ul style="list-style-type: none"> <li>• Bill 1460/2023 seeks to establish the state's green hydrogen policy aiming to integrate green hydrogen into its energy mix, incentivize its use across sectors (including agriculture), enhance its supply chain, and attract investments while prioritizing greenhouse gas reduction and climate change mitigation</li> <li>• It stresses the need to pursue economic, social, and environmental sustainability, diversify the energy mix, and promote technological innovation and workforce development within the hydrogen sector</li> </ul>
Rio Grande do Norte	<ul style="list-style-type: none"> <li>• Bill 499/2023 established the state's <i>Legal Framework for Green Hydrogen and the Green Industry</i>, aiming to bolster investment by establishing a regime of tax benefits</li> <li>• It empowers state and local authorities to enact tax incentives, providing legal clarity to enhance sector growth</li> </ul>
Rio Grande do Sul	<ul style="list-style-type: none"> <li>• State decree 57173/2023 creates the <i>H2V-RS Program</i>, targeting the development of the local green hydrogen production chain for domestic use and export</li> <li>• It supports a low-carbon transition aligned with the UN's Sustainable Development Goals and aims to diversify the state's energy mix with an emphasis on renewables</li> <li>• It seeks to increase job creation, foster technological innovation, and uphold ESG principles to add value to regional products and services while encouraging sectoral dialogue and cooperation</li> </ul>
Santa Catarina	<ul style="list-style-type: none"> <li>• Bill 423/2021 aims to promote hydrogen with a focus on green fertilizer production and GHG emissions reduction</li> <li>• It strengthens the hydrogen value chain and aligns its use with environmental and social principles</li> <li>• It incentivizes infrastructure investment, sectoral workforce training, and technological advancements, supporting efficient and sustainable hydrogen applications</li> </ul>
São Paulo	<ul style="list-style-type: none"> <li>• Bills 308/2023 and 1510/2023 promote the use of hydrogen cars through tax reductions</li> </ul>

(continued)

**Table 2** (continued)

State/federal district	Law
Sergipe	• Bill 426/2023 promotes the use of hydrogen cars through tax reduction
Tocantins	• Bill 109/2023 establishes the <i>State Policy for Attention to Climate Emergencies and the Fight Against Environmental Racism</i> which proposes the creation of programs and the development of technologies for green hydrogen, as well as its use and production

Sources Authors' compilation based on Alagoas (2024), Amazonas (2023, 2024), Bahia (2022), Casarin (2021), Ceará (2023), Chiappini (2021), Espírito Santo (2023), Federal District (2024), Maranhão (2023), Mato Grosso (2021, 2024), Minas Gerais (2024), Paraíba (2022), Paraná (2023), Pernambuco (2022), Piauí (2024), Rio de Janeiro (2023), Rio Grande do Norte (2023), Rio Grande do Sul (2023a), Santa Catarina (2023), São Paulo (2023, 2024), Sergipe (2023), Tocantins (2023)

Brazil to be part of the Carbon Sequestration Leadership Forum (CSLF). Within the IPHE, Brazil took part in discussions related to research, testing, and the commercial use of hydrogen and fuel cells, as well as the elaboration of codes and common standards (Benevides, 2011).

Brazil has further taken part in Mission Innovation, the Hydrogen Initiative, the Clean Energy Marine Hubs, and the International Hydrogen Trade Forum, which all fall under the scope of the Clean Energy Ministerial, a multilateral forum formed to promote cooperation on matters related to the energy transition (MME, 2023). In 2024, Brazil hosted the organization's Ministerial Meeting to demonstrate its renewed commitment to the global energy transition (Clean Energy Ministerial, 2024).

A particular pressing issue for Brazil's future green hydrogen economy is standardization. The Brazilian National Standards Organization, which works closely with the federal and subnational governments, is a member of ISO TC-197, seeking standardization in the field of systems and devices for the production, storage, transport, measuring, and use of hydrogen (ISO, nd). However, Brazil's strong reliance on biomass and its decentralized energy market could complicate the certification of green hydrogen in accordance with strict standards such as those applied in the EU (Agora Industry et al, 2024). Therefore, recent government documents, particularly the PNH2's Three-Year Plan, have stressed the importance of harmonizing standards and quality infrastructure to remove potential investment barriers (MME, 2023). A globally accepted definition for renewable hydrogen could facilitate Brazil's hydrogen export ambitions if the level of permitted lifecycle emissions was higher than the level currently set by individual actors representing important export markets such as the EU.

Brazil is also engaged in hydrogen cooperation within the region. The PNH2's Three-Year Plan states "the aim of positioning Latin America within the global hydrogen arena" (MME, 2023), expressing its support for integrated regional economic development in the sector. This aligns with the ideological shift of Lula's administration, which is generally more prone to regional integration than his predecessor. The creation of a regional hydrogen economy represents an opportunity for Brazil and South America to become global players in energy through regional

integration. Without collaborative consultation, however, there is a risk of contestation and unhealthy competition, as highlighted by the dispute surrounding the EU-Mercosur free trade agreement awaiting ratification (CFR, 2023).

Despite verbal endorsements, Brazil has so far taken an ambiguous stance toward regional cooperation. The country has actively participated in actions organized by the *Collaborative Platform for Green Hydrogen Development in Latin America and the Caribbean* (H2LAC) launched by the GIZ, the World Bank, the United Nations Economic Commission for Latin America and the Caribbean (CEPAL), and the EU's *Euroclima + Program* in 2020 (H2LAC, nd). Furthermore, the ABIHV joined the *LAC Green Hydrogen Action Alliance*, a platform for collaboration between private and public actors constituted at COP 26. However, when the Inter-American Development Bank (IDB) and the Latin American Energy Organization launched CertHiLAC at COP 28, an initiative to develop a common certification system for clean hydrogen in the region, Brazil did not sign the declaration (IDB, 2023). Its own certification scheme relies on very lenient sustainability criteria for defining clean hydrogen (see Sect. 4.1), which could have been called into question by joining CertHiLAC.

Hydrogen has also become an increasingly relevant topic for Brazil within the BRICS. The organization has repeatedly discussed and mentioned clean hydrogen in official documents. In a declaration adopted at the 15th BRICS Summit, member countries declare “hydrogen produced on the basis of zero and low emission technologies and processes” as a crucial element “for a just transition towards more flexible, resilient and sustainable energy systems” (BRICS, 2023).

The strongest emphasis of Brazil's international hydrogen politics has so far been on bilateral cooperation. As the future export of green hydrogen and its derivatives represents an important pillar of Brazil's hydrogen strategy, the federal government is particularly interested in securing trade partnerships and funding for production and transport infrastructure. In June 2023, it secured over USD 2 billion of funding from the European Union, which will be channeled through the EU's Global Gateway initiative to hydrogen production projects in Brazil (Parkes, 2023). In December 2023, Lula's government joined forces with the UK in founding the *Brazil-UK Hydrogen Hub*, which is supposed to serve as a bilateral platform for cooperation and the facilitation of access to finance in the development of a global hydrogen market (UK Department of Energy Security & Net Zero, 2023). Germany has also signaled an interest in cooperating for green hydrogen trade. In 2020, the *Brazil-Germany Alliance for Green Hydrogen* was created by the Chambers of Commerce and Industry of São Paulo and Rio de Janeiro (Hydrogen Europe, 2022).

Many of these initiatives are part of Lula's recent efforts to revive bilateral and multilateral relations in the context of climate and energy policy and to redefine Brazil as an environmental promoter. This new phase presents Brazil with a chance to regain its role as a key player in the global sustainability dialogue and at the same time capitalize on its high potential for building a green hydrogen economy. Brazil might continue to build on these efforts if it aligns this momentum with subnational actors' goals, consistent federal policy, and constructive international collaboration. Thus, by working with a wide range of partners to cooperate for production, export,

and standards, hydrogen may increasingly find itself at the core of Brazil's energy transition.

## 7 Conclusion

Brazil has set itself the ambitious objective of becoming the “most competitive global producer of hydrogen” by 2030 (MME, 2023). Developing a low-carbon hydrogen economy promises growth and re-industrialization, economic and energy security, and industrial decarbonization across the country. Although the success of this endeavor is highly uncertain, the country generally enjoys favorable conditions for green hydrogen production, due to its large renewable energy sector, making it one of the most lucrative places for investment and future hydrogen trade. Still, becoming the world's leading producer of green hydrogen will be an enormous political challenge.

So far, Brazil lags behind global players, such as Germany, Japan, or Spain, and regional players, such as Chile, in terms of clean hydrogen projects. Although several projects have been initiated, most of them are still in the planning stage. For now, existing hydrogen production plants first and foremost produce grey hydrogen, which is primarily used in refineries. The political landscape, however, is rapidly changing. Developing a low-carbon hydrogen economy has evolved as a key policy priority, at least since the new Lula administration, and is strongly embedded in Brazil's recent turn to industrial policy. The Hydrogen Act establishes a new regulatory framework for hydrogen and creates a low-carbon hydrogen standard as well as financial incentives for hydrogen production. The tax credits provided by the PHBC will further boost the production and usage of hydrogen in the country.

Most hydrogen production pilot projects are realized at the state level. Some also aim at the production of green ammonia, underscoring the government's ambition to reduce its export dependency on fertilizer. These projects are typically governed by public-private partnerships and, in many cases, involve ports, signaling export ambitions.

On the international stage, President Lula has recently re-established Brazil's central role, particularly in the context of environmental and climate governance. The country has hosted the G20 Summit and the Mission Innovation and Clean Energy Ministerial Meeting in 2024 and will host the COP in 2025. International hydrogen cooperation has been advanced multilaterally, seeking to play an influential role in shaping international standards, but also across the region and within the BRICS. The primary mode of cooperation, however, has been the conclusion of bilateral agreements on hydrogen trade.

The advanced focus of the Brazilian government on low-carbon hydrogen in both its domestic and foreign politics can be understood as the consequence of three developments: First, a widespread awareness among policymakers and experts has developed for the potential of Brazil's extensive renewable energy capacities and resources,

providing favorable conditions for low-carbon hydrogen production. Second, developing new competitive future-fit industries has evolved as a central quest for the country's recent turn to industrial policy. Third, the promise to contribute to a future global hydrogen economy serves to affirm the government's recent attempts to rebuild the country's image as a relevant global actor in environmental governance and beyond.

Although economic powerhouses like China, the United States, and the EU may be seen as the main actors aiming at leadership in the hydrogen sector, other countries, particularly those in the Global South, might also play an essential role in shaping a yet-to-be-formed global hydrogen economy. Internationally, Brazil's hydrogen ambitions have so far not been featured prominently in policy discourses. Yet, the country is developing an extensive policy framework supporting green hydrogen domestically and is increasingly engaged in bilateral and multilateral hydrogen cooperation. Thus, Brazil's role in the future might be much more central than it currently is.

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