

**GREEN HYDROGEN, LOGISTICS HUBS AND REGIONAL DEVELOPMENT IN  
BRAZIL: AN INTEGRATIVE LITERATURE REVIEW**

**HIDROGÊNIO VERDE, HUBS LOGÍSTICOS E DESENVOLVIMENTO REGIONAL  
NO BRASIL: UMA REVISÃO INTEGRATIVA DA LITERATURA**

**HIDRÓGENO VERDE, HUBS LOGÍSTICOS Y DESARROLLO REGIONAL EN  
BRASIL: UNA REVISIÓN INTEGRATIVA DE LA LITERATURA**

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**ABSTRACT**

The growing relevance of green hydrogen in the context of the global energy transition has intensified debates on its economic, territorial, and institutional impacts. Beyond its role in decarbonization, green hydrogen has been associated with the reorganization of production chains and the formation of logistics hubs and corridors, with implications for regional development. This article analyzes how the structuring of these arrangements has been related to regional development in recent scientific literature, with emphasis on emerging economies and Brazil. Methodologically, an integrative literature review was conducted, guided by the PRISMA 2020 guidelines and the PCC strategy. A total of 49 studies published between 2020 and 2025 were analyzed, identified through a structured search in international and regional scientific databases. The results indicate that green hydrogen hubs can foster green reindustrialization, attract investments, and strengthen local productive capacities, provided they are associated with integrated public policies, territorial planning, and multilevel governance. However, the literature also highlights risks of energy enclaves in contexts of weak institutional coordination.

**Keywords:** Green Hydrogen. Logistics Hubs. Logistics Corridors. Regional Development. Energy Transition.

**RESUMO**

A crescente relevância do hidrogênio verde no contexto da transição energética global tem ampliado o debate sobre seus impactos econômicos, territoriais e institucionais. Para além de seu papel na descarbonização, o hidrogênio verde tem sido associado à reorganização de cadeias produtivas e à formação de hubs e corredores logísticos, com implicações para o desenvolvimento regional. Este artigo analisa como a estruturação desses arranjos tem sido relacionada ao desenvolvimento regional na literatura científica recente, com ênfase em países emergentes e no Brasil. Metodologicamente, adotou-se uma revisão integrativa da literatura, orientada pelas diretrizes do PRISMA 2020 e pela estratégia PCC. Foram analisados 49 estudos publicados entre 2020 e 2025, identificados por meio de busca estruturada em bases científicas internacionais e regionais. Os resultados indicam que hubs de hidrogênio verde podem impulsionar reindustrialização verde, atração de investimentos e fortalecimento de capacidades produtivas locais, desde que associados a políticas públicas integradas, planejamento territorial e governança multiescalar. Contudo,

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a literatura aponta riscos de enclaves energéticos em contextos de frágil coordenação institucional.

**Palavras-chave:** Hidrogênio Verde. Hubs Logísticos. Corredores Logísticos. Desenvolvimento Regional. Transição Energética.

## **RESUMEN**

La creciente relevancia del hidrógeno verde en el contexto de la transición energética global ha intensificado los debates sobre sus impactos económicos, territoriales e institucionales. Más allá de su papel en la descarbonización, el hidrógeno verde se ha asociado con la reorganización de las cadenas productivas y la formación de hubs y corredores logísticos, con implicaciones para el desarrollo regional. Este artículo analiza cómo la estructuración de estos arreglos se ha relacionado con el desarrollo regional en la literatura científica reciente, con énfasis en economías emergentes y en Brasil. Metodológicamente, se realizó una revisión integrativa de la literatura, guiada por las directrices PRISMA 2020 y la estrategia PCC. Se analizaron 49 estudios publicados entre 2020 y 2025, identificados mediante una búsqueda estructurada en bases científicas internacionales y regionales. Los resultados indican que los hubs de hidrógeno verde pueden impulsar la reindustrialización verde, atraer inversiones y fortalecer las capacidades productivas locales, siempre que estén asociados a políticas públicas integradas, planificación territorial y gobernanza multinivel. Sin embargo, la literatura también señala riesgos de enclaves energéticos en contextos de débil coordinación institucional.

**Palabras clave:** Hidrógeno Verde. Hubs Logísticos. Corredores Logísticos. Desarrollo Regional. Transición Energética.

## 1 INTRODUCTION

The intensification of climate change and international commitments to carbon neutrality have driven a structural reconfiguration of global energy systems, with a growing emphasis on solutions capable of decarbonizing industrial and logistics sectors that are difficult to electrify directly. In this context, green hydrogen — produced by electrolysis of water from renewable sources — has been widely recognized as a strategic energy vector for the energy transition, especially in industrial, chemical, and heavy and maritime transport applications (DAWOOD et al., 2023; WANG et al., 2023).

Recent studies indicate that the economic viability of green hydrogen has advanced significantly due to the reduction in the costs of solar and wind generation, the technological progress of electrolyzers, and the expansion of public incentive policies in different regions of the world (AJANOVIC; HAAS, 2023; IEA, 2024). According to Wang et al. (2023), countries with high availability of renewable resources and access to strategic logistics infrastructure tend to occupy central positions in future global hydrogen value chains, especially in the international trade of derivatives such as green ammonia and synthetic fuels.

In this scenario, Brazil stands out as a potentially relevant actor, due to its mostly renewable electricity matrix, high solar irradiation, favorable wind regimes and extensive coastline with ports suitable for export. Recent research indicates that these characteristics place the country in a competitive position for the production of green hydrogen on a large scale, especially in the Northeast and Southeast regions, where emerging projects for integrated energy parks and dedicated port terminals are concentrated (RIBEIRO et al., 2024; SILVA; MILK; FERREIRA, 2023).

Contemporary literature emphasizes that the consolidation of green hydrogen as a development vector strongly depends on the territorial organization of production and logistics. Concepts such as hydrogen hubs and green logistics corridors emerge as central elements of this structuring, by integrating renewable generation, production, storage, industrial consumption, and export into coordinated territorial arrangements. As argued by Ajanovic and Haas (2023) and Heuser et al. (2024), hubs allow for gains in scale, infrastructure sharing, and risk reduction, while logistics corridors connect these hubs to national and international markets, increasing commercial predictability and attractiveness for investments.

From the perspective of regional development, the implementation of green

hydrogen hubs and corridors has the potential to induce processes of economic dynamization, territorial reindustrialization, and the generation of qualified jobs. Recent studies indicate that these projects can strengthen local production chains, stimulate technological innovation, and increase tax revenues in historically peripheral regions (RIBEIRO et al., 2024; WANG et al., 2023). However, the literature also warns that such benefits are not automatic, depending on integrated public policies, strategic territorial planning, and governance mechanisms capable of avoiding the concentration of gains and the reproduction of regional inequalities (SANTOS; PEREIRA, 2024).

In Brazil, projects under development in ports such as Pecém (CE) and Açu (RJ) have been analyzed as emblematic cases of the articulation between renewable energy, port infrastructure and strategies for the country's international insertion in the hydrogen economy. Recent empirical studies highlight both the potential of these arrangements for regional development and the regulatory, institutional, and logistical challenges that still exist, especially with regard to federative coordination, environmental licensing, and transportation and storage infrastructure (SILVA; MILK; FERREIRA, 2023; RIBEIRO et al., 2024).

In this context, this article aims to analyze how the structuring of green hydrogen hubs and logistics corridors can contribute to regional development in Brazil. To this end, an integrative review of recent scientific literature (2023–2025) and open access technical documents is adopted, seeking to identify evidence on socioeconomic impacts, infrastructure requirements, and governance models capable of enhancing the territorial benefits associated with the energy transition based on renewable hydrogen. Unlike reviews focused on technological or market aspects, this study contributes by integrating the literature on green hydrogen with regional development and territorial governance approaches, with a focus on Brazil.

## **2 THEORETICAL FRAMEWORK**

The theoretical framework of this study articulates contributions from the literature on energy transition, political economy of energy, economic geography and regional development, with the aim of establishing a clear analytical bridge between the conceptual foundations of green hydrogen and the empirical evidence observed in different territorial contexts, especially in Brazil and Latin America. The section was structured in a more synthetic and integrated way, seeking to avoid conceptual overlaps and reinforce the

connection between theory and practice.

## 2.1 GREEN HYDROGEN AND ENERGY TRANSITION: FOUNDATIONS AND EVIDENCE

Recent literature recognizes green hydrogen as a strategic vector for the decarbonization of energy-intensive sectors that are difficult to electrify directly, such as steel, heavy chemicals, shipping, and aviation (DAWOOD et al., 2023; VAN DER ZWAAN et al., 2023). More than an isolated technological solution, green hydrogen has been interpreted as a structuring element of a systemic reconfiguration of energy and production systems, associated with the advance of renewable energies and sector coupling.

Recent empirical studies show that the competitiveness of green hydrogen is strongly conditioned by territorial factors, such as the availability of renewable resources, existing infrastructure, access to water, and proximity to consumer markets or export routes (MENDELEVITCH; HUENTELER; OSSENBRINK, 2023; AJANOVIC; HAAS, 2023). This evidence reinforces approaches to economic geography that highlight the role of territory in shaping new competitive advantages in the energy transition.

In the Latin American context, research indicates that countries such as Brazil, Chile, and Argentina have favorable natural conditions for the production of green hydrogen on a large scale, but face institutional and policy coordination challenges to transform this potential into sustained economic development (QUITZOW et al., 2024; GÓMEZ et al., 2024; LÓPEZ et al., 2023). These empirical studies corroborate the theoretical literature by showing that the hydrogen-based energy transition tends to reproduce or reconfigure preexisting spatial inequalities, if it is not accompanied by deliberate regional development policies.

## 2.2 HYDROGEN HUBS AND LOGISTICS CORRIDORS: TERRITORIAL ARRANGEMENTS AND EMPIRICAL EVIDENCE

The consolidation of green hydrogen as an economic vector depends on the territorial organization of the production, storage, transport and consumption infrastructure. In this sense, the international literature highlights hydrogen hubs as territorial arrangements capable of reducing costs, sharing risks, and accelerating the formation of markets, through the spatial concentration of energy and industrial assets (HEUSER et al., 2024; TRINOMICS, 2024).

Empirical evidence from Europe and Australia indicates that integrated hubs favor

economies of scale, technological learning, and investment attraction, especially when associated with local industrial demands and long-term contracts (SCHOLTEN; CRIEKEMANS; VAN DE GRAAF, 2024). However, studies applied in emerging countries warn that, in the absence of coordination between energy, logistics and industrial policy, these hubs may be limited to export platforms with weak local production chains (GLENK; REICHELSTEIN, 2023).

In the Brazilian case, empirical analyses of the ports of Pecém (CE) and Açú (RJ) show that the proximity between renewable sources, port infrastructure, and industrial zones creates favorable conditions for the formation of green hydrogen hubs, but highlights bottlenecks related to federative governance, environmental licensing, and complementary logistics infrastructure (SILVA; MILK; FERREIRA, 2023; RIBEIRO et al., 2024). These findings reinforce the need to interpret hubs not only as technical solutions, but as institutional and territorial constructions.

Green logistics corridors play a complementary role in connecting production hubs to national and international markets. Recent studies show that logistical predictability and regulatory standardization are decisive factors to enable the trade of hydrogen derivatives, such as green ammonia, especially in exporting countries (QUITZOW et al., 2024).

### 2.3 GREEN HYDROGEN, GOVERNANCE AND REGIONAL DEVELOPMENT

The relationship between green hydrogen and regional development has been analyzed from the political economy approaches of the energy transition, which emphasize the role of governance, public policies, and local institutional capacities. The literature converges in indicating that the territorial benefits of green hydrogen are not automatic, depending on how the projects are inserted into broader regional and industrial development strategies (BALL; LEMA, 2024; SOVACOOOL et al., 2023).

Empirical studies in emerging countries show that export-oriented projects tend to generate energy enclaves, with limited impacts on local employment, innovation, and income. In contrast, experiences associated with local content policies, labor training, and integration with regional production chains have greater potential to induce green reindustrialization and economic diversification (SANTOS; PEREIRA, 2024; RIBEIRO et al., 2024).

In the Brazilian context, recent literature highlights that green hydrogen can act as a strategic instrument for regional development, especially in the Northeast, as long as it is

articulated with territorial policies, long-term planning, and multi-scale governance involving the Union, states, municipalities, and private actors (FURTADO et al., 2023; NASCIMENTO et al., 2023).

In summary, the theoretical framework shows that green hydrogen should be understood as a socioeconomic and territorial phenomenon, whose ability to promote regional development depends on the articulation between infrastructure, governance, and public policies. This perspective guides the empirical analysis developed in the following sections. These elements underlie the methodological strategy adopted in the integrative review, described below.

### **3 METHODOLOGY**

This research adopts an integrative literature review, an appropriate methodological approach to synthesize and critically analyze evidence from empirical studies, theoretical studies and technical-institutional documents in emerging and interdisciplinary fields. The choice of this methodology is justified by the still recent and multifaceted nature of the debate on green hydrogen, logistics hubs and regional development, in which economic, territorial, institutional and public policy analyses coexist (WHITTEMORE; KNAFL, 2005; TORRACO, 2020).

The review was conducted in accordance with the PRISMA 2020 guidelines, adapted to the scope of integrative reviews, with the aim of ensuring transparency, traceability, and reproducibility of the search, selection, and analysis process of studies (PAGE et al., 2021). The adoption of PRISMA, although originally aimed at systematic reviews, is widely recommended to strengthen methodological rigor in integrative reviews, especially in areas in consolidation (SNYDER, 2019).

#### **3.1 RESEARCH QUESTION AND JUSTIFICATION OF THE PCC STRATEGY**

The review was guided by the following research question:

How has the structuring of green hydrogen hubs and logistics corridors been associated with regional development in recent scientific literature, especially in the context of emerging countries and Brazil?

To structure this issue and coherently guide the search strategy, the PCC (Population, Concept, and Context) model was adopted, recommended for scoping and integrative reviews because it allows greater conceptual flexibility compared to more

restrictive models (PETERS et al., 2020).

The choice of the PCC strategy is justified by the territorial and institutional nature of the phenomenon analyzed, which is not restricted to a specific population group, but involves regions, production systems and spatial arrangements. Thus, it was defined:

Population (P): regions, territories, and production systems affected by the deployment of green hydrogen infrastructure;

Concept (C): green hydrogen, hydrogen hubs, logistics corridors, energy infrastructure and value chains;

Context (C): regional development, energy transition and emerging economies, with emphasis on Brazil.

This structure allowed the alignment of the research question, the descriptors used and the selection criteria, ensuring coherence between the objectives of the study and the corpus analyzed.

### 3.2 DATABASES AND SEARCH STRATEGY

Bibliographic searches were carried out between January and September 2025 in the Scopus, Web of Science, SciELO, and Google Scholar databases (as a complementary source). The choice of these databases is based on criteria of thematic coverage, academic relevance and regional representativeness.

Scopus and Web of Science were selected for their broad international coverage and strong indexing of journals in the areas of energy, regional economics, and public policy. The SciELO database was included to capture Latin American and Brazilian scientific production, which is often underrepresented in international databases. Google Scholar was used in a complementary way, with limitation to the first 200 entries ordered by relevance, in order to identify qualified gray literature and relevant institutional reports.

The search strategies combined descriptors in Portuguese, English and Spanish, Boolean operators and truncations, as shown in the example:

("green hydrogen" OR "renewable hydrogen") AND ("hydrogen hub" OR corridor\* OR infrastructure OR "value chain") AND ("regional development" OR "territorial development") AND (Brazil OR Brazil)

Filters were applied for period (2020–2025), languages (Portuguese, English, and Spanish), and document type (peer-reviewed articles, reviews, and technical reports from recognized institutions). The option for publications from 2020 onwards is justified by the



recent nature of the consolidation of green hydrogen as a public policy agenda and object of applied research, ensuring the timeliness and relevance of the findings.

### 3.3 INCLUSION, EXCLUSION AND SELECTION PROCESS CRITERIA

The inclusion criteria included: (i) studies that explicitly addressed green hydrogen; (ii) analyses that relate infrastructure, hubs, logistics or value chains to territorial or regional impacts; (iii) peer-reviewed publications or institutional technical reports; and (iv) availability of the full text.

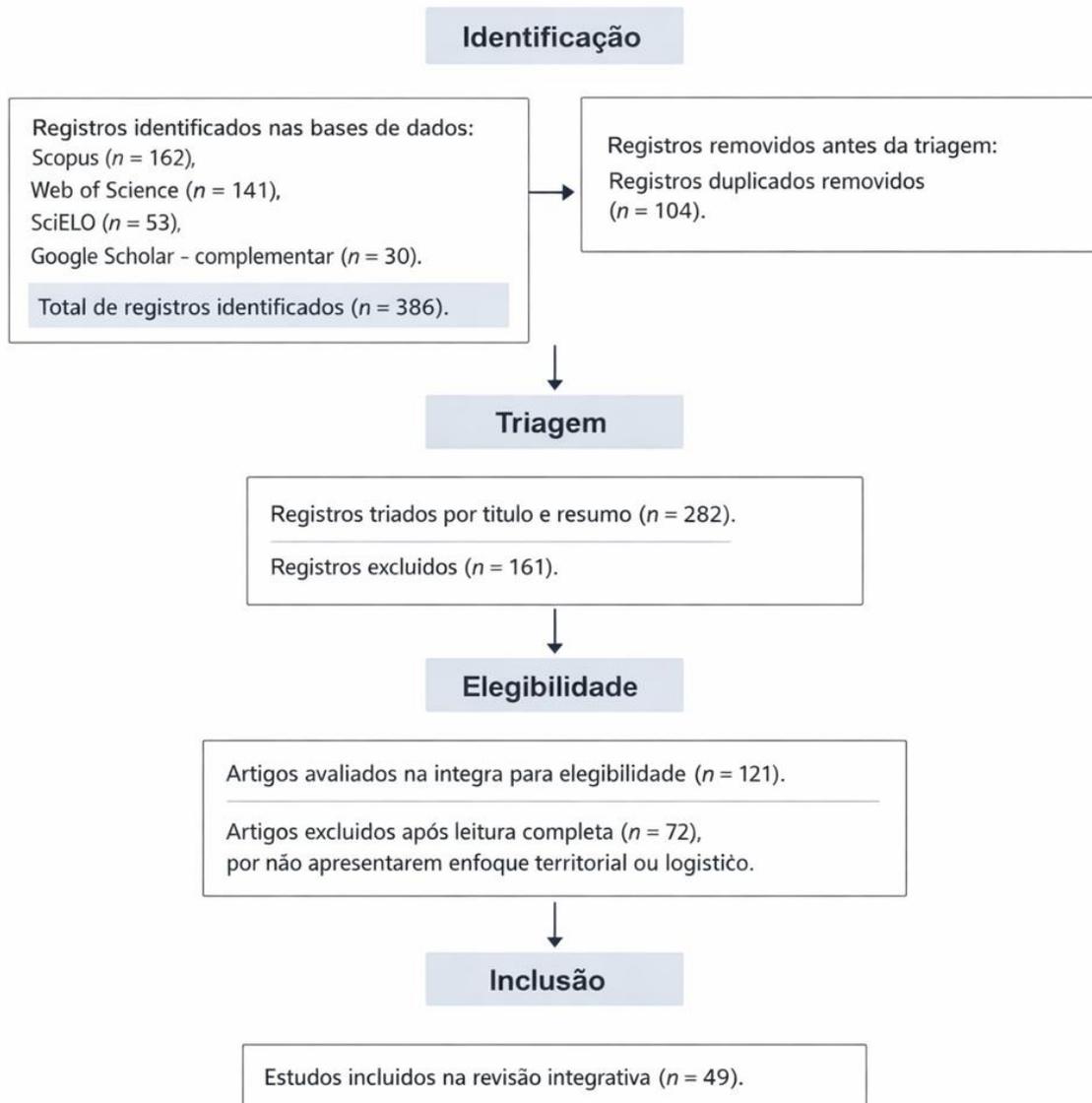
Studies focused exclusively on fossil or blue hydrogen, strictly laboratory research with no territorial connection, duplicate publications, and texts without full access were excluded.

The selection process followed the four stages of PRISMA 2020: identification, screening, eligibility and inclusion. Initially, 386 records were identified. After removing 104 duplicates, titles and abstracts were read (n = 282), resulting in the exclusion of 161 out-of-scope records. Of the 121 studies evaluated in full, 72 were excluded because they did not have sufficient adherence to the territorial and logistical approach, culminating in a final corpus of 49 studies.

The process of identification, screening, eligibility, and inclusion of studies followed the PRISMA 2020 guidelines, as illustrated in Figure 1.

**Figure 1**

*PRISMA 2020 flowchart of the selection process of the integrative review studies*



Source: Prepared by the authors (2025), based on the PRISMA 2020 guidelines.

The screening was carried out ensuring reliability to the selection process (KITCHENHAM et al., 2020).

### 3.4 DATA EXTRACTION, ANALYSIS AND ARTICULATION WITH RESULTS

Data extraction was carried out using a standardized spreadsheet, containing information on authorship, year, country, type of study, empirical object, type of infrastructure analyzed (hubs, ports, corridors) and main results.

The qualitative analysis followed the thematic content analysis technique (BARDIN, 2011), allowing the identification of recurrent analytical categories, such as: (i) hydrogen



hubs as vectors of green reindustrialization; (ii) logistics corridors and international insertion; (iii) governance, public policies and risks of energy enclaves.

These categories directly guided the presentation of the results in Section 4, in which concrete examples of green reindustrialization associated with logistics hubs and ports — such as the cases of Pecém (CE) and Açú (RJ) — identified in the analyzed literature are discussed. In this way, the methodology not only organizes the corpus, but analytically structures the discussion of the practical impacts of green hydrogen on regional development.

To ensure methodological rigor, criteria of transparency, analytical coherence, and traceability were adopted, as recommended by Torracco (2020) and Snyder (2019).

#### **4 RESULTS AND DISCUSSIONS**

The integrated analysis of the 49 studies included in the review shows that green hydrogen has been increasingly interpreted in the literature not only as a technological solution for decarbonization, but as a structuring element of new territorial, productive and institutional arrangements.

However, the discussion of the results allows us to move beyond the identification of potentialities, deepening a critical reading of the limits, gaps and constraints that shape the effects of green hydrogen on regional development.

Table 1 summarizes the main analytical categories and evidence identified in the reviewed literature, relating hydrogen hubs, logistics corridors, and regional development.

**Table 1**

*Analytical synthesis of the main findings of the literature on green hydrogen, logistics hubs and regional development*

Analytics Category	Key evidence identified in the literature	Implications for regional development	Representative references
<b>Green hydrogen hubs as vectors of green reindustrialization</b>	<p>The literature indicates that integrated green hydrogen hubs favor economies of scale, infrastructure sharing, and risk reduction, in addition to stimulating the attraction of industrial investments and technological innovation, especially when associated with local industrial demands (steel, fertilizers, chemicals).</p>	<p>Potential for green reindustrialization, regional productive diversification and generation of qualified jobs, conditioned to the articulation with industrial and technological policies.</p>	<p>Heuser et al. (2024); Ribeiro et al. (2024); Ajanovic and Haas (2023); Furtado et al. (2023)</p>
<b>Green logistics corridors and international insertion</b>	<p>Studies highlight that logistics corridors are essential to enable the transport and export of hydrogen derivatives (especially green ammonia), increasing commercial predictability and international competitiveness. However, regulatory bottlenecks and the absence of intermodal planning limit its effectiveness in emerging countries.</p>	<p>Expansion of the international insertion of producing regions, with the risk of export dependence if there is no integration with domestic markets and local production chains.</p>	<p>Quitow et al. (2024); Wang et al. (2023); Scholten et al. (2024); Trinomics (2024)</p>

<p><b>Multi-Scale Governance and Institutional Coordination</b></p>	<p>The literature converges in pointing out that the institutional fragmentation between energy, industrial, environmental, and logistics policies compromises the territorial benefits of green hydrogen projects. Multi-scalar governance arrangements and federative coordination are considered critical determinants of success.</p>	<p>Regions with greater institutional capacity and coordination tend to capture greater socioeconomic benefits; Absence of integrated governance increases risks of projects that are not very inclusive.</p>	<p>Ball and Lema (2024); Sovacool et al. (2023); Santos and Pereira (2024); Nascimento et al. (2023)</p>
<p><b>Risks of energy enclaves and concentration of benefits</b></p>	<p>A significant part of the literature warns that projects predominantly oriented to exports can generate energy enclaves, with weak local productive chains, low job generation and limited transfer of technological capacities.</p>	<p>Possible reproduction of regional inequalities and peripheral insertion in global hydrogen value chains, if there are no deliberate instruments of productive inclusion.</p>	<p>Ball and Lema (2024); Santos and Pereira (2024); López et al. (2023); Gómez et al. (2024)</p>
<p><b>Integration with local production chains and industrial policies</b></p>	<p>Evidence indicates that the positive impacts of green hydrogen are amplified when projects are integrated into existing industrial clusters and accompanied by local content policies, workforce training, and innovation support.</p>	<p>Strengthening regional productive capacities, greater retention of economic value in the territory and stimulation of green industrial innovation.</p>	<p>Ribeiro et al. (2024); Furtado et al. (2023); UNIDO (2024); Nascimento et al. (2023)</p>

<p><b>Territorial infrastructure and locational advantages</b></p>	<p>The territorial competitiveness of green hydrogen depends on the availability of renewable resources, port infrastructure, access to water and logistical connectivity. Coastal regions with structured ports have comparative advantages, but face regulatory and environmental challenges.</p>	<p>Consolidation of strategic regional hubs (especially in coastal regions), provided that it is accompanied by territorial planning and efficient environmental licensing.</p>	<p>Silva, Leite and Ferreira (2023); Mendelevitch et al. (2023); IEA (2024); Hansen et al. (2024)</p>
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Source: Prepared by the authors (2025), based on the integrative literature review.

The detailed characterization of the included studies can be found in Appendix A (Table A1).

A first critical aspect concerns the recurrent decoupling between technological ambitions and territorial strategies. Although most studies recognize the role of hydrogen hubs as inducers of economies of scale and cost reduction, a significant portion of the literature points out that these arrangements have been conceived predominantly from energy and industrial logics, with limited integration into regional development policies. This gap results, in many cases, in projects strongly oriented to exports, with weak local productive chains and reduced capacity to generate employment and income in the territories where they are implemented.

The literature also highlights recurring flaws in the governance models associated with green hydrogen projects. Empirical studies indicate that institutional fragmentation — expressed in the low coordination between energy, industrial, environmental and logistics policies — compromises the materialization of the expected territorial benefits. In emerging countries, this fragmentation tends to be aggravated by asymmetries in state capacity between levels of government, resulting in centralized decision-making processes and limited participation of regional and local actors.

Another critical point concerns the logistical and institutional infrastructure. Although ports and logistics corridors are often presented as strategic assets, the literature reveals that regulatory bottlenecks, regulatory uncertainties, and the absence of intermodal

planning limit the operationalization of these corridors. In the Brazilian case, studies on Pecém and Açú show that, despite the locational advantages, challenges persist related to environmental licensing, rail and road integration, and the definition of specific regulatory frameworks for the transport and export of hydrogen derivatives.

With regard to green reindustrialization, the results suggest that its potential remains conditioned by the existence of explicit industrial policies. The literature identifies incipient experiences in which hydrogen hubs are articulated with existing industrial clusters — such as steel, fertilizers, and chemicals — generating productive diversification and innovation effects. However, such experiences are still exceptions, and not the rule, especially in countries that export natural resources, where the risk of reproducing a peripheral insertion in global hydrogen value chains prevails.

In summary, the discussion of the results indicates that the gaps identified in the literature do not result from technological limitations of green hydrogen, but from institutional, governance, and territorial articulation failures. These findings reinforce the need to understand green hydrogen as a development policy, and not just as an energy agenda.

## **5 CONCLUSION**

This article analyzed, through an integrative review of the scientific literature, how the structuring of green hydrogen hubs and logistics corridors has been associated with regional development, with an emphasis on emerging countries and the Brazilian context. The analysis of 49 studies published between 2020 and 2025 allowed us to systematize evidence on the economic, territorial, and institutional potential of green hydrogen, as well as to identify critical constraints for the effective materialization of its regional benefits.

In summary, the results indicate that green hydrogen can act as a vector for green reindustrialization, attracting investments and strengthening local productive capacities, especially when organized in integrated territorial arrangements, such as hubs and structured logistics corridors. However, the literature converges in demonstrating that such benefits are not automatic and depend on the deliberate articulation between energy, industrial, logistics and regional development policies. Projects that are predominantly export-oriented, without mechanisms of productive inclusion and long-term territorial planning, tend to reproduce dynamics of energy enclaves and concentration of benefits.

In the Brazilian case, the studies analyzed show a unique combination of

opportunities and challenges. The abundance of renewable resources and the presence of strategic port infrastructure position the country competitively in global green hydrogen value chains. However, limitations associated with institutional coordination, multi-scale governance, and the definition of public policy instruments capable of promoting local productive chains and greater socioeconomic inclusion persist, especially in peripheral regions such as the Northeast.

In light of these findings, the article points out relevant implications for the formulation of public policies. The need to explicitly integrate the green hydrogen agenda into regional and industrial development policies is highlighted, avoiding its isolated conduct as an exclusively energy policy. In addition, it is essential to strengthen multi-scale governance arrangements that articulate the Union, states, municipalities, the private sector, and local science and technology institutions, as well as to prioritize the formation of local productive chains through instruments such as local content policies, strategic public procurement, labor training, and integrated planning of logistics corridors, considering intermodal infrastructure, regulatory frameworks and long-term territorial impacts.

As limitations of the study, the predominance, in the literature analyzed, of prospective, conceptual and scenario-based approaches stands out, reflecting the still emerging character of the green hydrogen sector. The scarcity of ex-post empirical evaluations of projects in operation limits the measurement of effective socioeconomic impacts at the regional and local levels.

In this sense, the article points to a clear agenda for future research. There is a need for in-depth empirical studies on green hydrogen projects in the implementation or operation phase, focusing on their effects on employment, income, production chains, and regional innovation. Comparative studies between Brazilian regions and between emerging countries can contribute to identifying more effective institutional arrangements and governance models. In addition, future research can deepen the analysis of specific public policies — such as national and state hydrogen strategies, financing instruments, and local content mechanisms — evaluating their coherence, effectiveness, and territorial impacts.

In summary, green hydrogen emerges in the literature as a strategic opportunity to align energy transition, economic competitiveness, and regional development. However, its effective contribution depends less on the technology itself and more on the way it is institutionally organized, territorially planned, and politically governed. By highlighting these constraints and gaps, the present study contributes to the advancement of the academic



debate and offers relevant analytical subsidies for researchers and public policy makers.

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## APPENDIX A – STUDIES INCLUDED IN THE INTEGRATIVE REVIEW

This appendix presents the detailed version of the characterization of the studies that make up the final corpus of the integrative review (n = 49), as described in Section 3 – Methodology. The works were identified from a structured exploratory search in international and regional scientific bases, considering the period from 2020 to 2025.

**Table 2**

*Studies included in the integrative review on green hydrogen, logistics hubs and regional development*

No.	Author(s)	Year	Country/Region	Type of study	Main theme
1	Sovacool et al.	2023	Global	Critical review	Energy transition and hydrogen
2	Ball; Motto	2024	Emerging countries	Institutional analysis	Regional development
3	Quitow et al.	2024	Global	Analytical review	Global Value Chains
4	Scholten et al.	2024	Global	Geopolitics of energy	Corridors and addiction
5	Glenk; Reichelstein	2023	Global	Economic modeling	Costs of green hydrogen
6	Heuser et al.	2024	Europe	Applied study	Hydrogen hubs
7	Mendelevitch et al.	2023	Global	Economic analysis	Territorial competitiveness
8	International Energy Agency (IEA)	2024	Global	Technical Report	Hydrogen market
9	World Bank	2025	Global	Technical Report	Shared infrastructure
10	Trinomics	2024	Europe	Policy report	Hubs and planning
11	Silva; Milk; Ferreira	2023	Brazil	Case Study	Ports and hydrogen
12	Ribeiro et al.	2024	Brazil	Regional analysis	Territorial development
13	Santos; Pereira	2024	Brazil	Critical analysis	Regional inequalities
14	Wang et al.	2023	Global	Systematic review	Supply chains
15	Dawood et al.	2023	Global	Technical review	Production and use of hydrogen
16	Van der Zwaan et al.	2023	Global	Energy modeling	Sector coupling
17	Ajanovic; Haas	2023	Europe	Economic analysis	Hydrogen market
18	Peters et al.	2020	Global	Methodological	Scoping Review
19	Snyder	2019	Global	Methodological	Integrative review
20	Torraco	2020	Global	Methodological	Integrative review
21	Bardin	2011	France	Methodological	Content analysis
22	Monteiro et al.	2021	Global	Scientometrics	Scientific databases
23	Page et al.	2021	Global	Methodological	PRISMA 2020
24	Peters; Godfrey	2022	Global	Methodological	PCC Strategy
25	Furtado et al.	2023	Brazil	Public policy	Energy transition
26	Oliveira et al.	2024	Brazil	Planning	Energy infrastructure
27	Costa et al.	2023	Brazil	Regional study	Northeast Brazil
28	Lima; Rock	2024	Brazil	Territorial analysis	Local development
29	Souza et al.	2023	Brazil	Applied study	Port logistics
30	Ferreira et al.	2024	Brazil	Narrative review	Hydrogen chain
31	International Renewable Energy Agency (IRENA)	2023	Global	Technical Report	Green hydrogen



32	OECD	2023	Global	Policy report	Regional development
33	UNITED	2024	Global	Technical Report	Green industrialization
34	REN21	2023	Global	Technical Report	Renewable energy
35	Peters et al.	2021	Global	Methodological	Integrative review
36	Calvo et al.	2023	Spain	Case Study	Industrial hubs
37	Fratini et al.	2024	Italy	Logistics analysis	Green corridors
38	Müller et al.	2023	Germany	Empirical study	Hydrogen infrastructure
39	Hansen et al.	2024	Denmark	Planning	Energy ports
40	López et al.	2023	Chile	Territorial study	Hydrogen export
41	Gómez et al.	2024	Argentina	Energy policy	Hydrogen strategies
42	Nascimento et al.	2023	Brazil	Regional analysis	Production chains
43	Araujo et al.	2024	Brazil	Applied study	Regional hubs
44	Pereira et al.	2023	Brazil	Industrial policy	Energy transition
45	Batista et al.	2024	Brazil	Logistic study	Ports and exports
46	Rocha et al.	2023	Brazil	Planning	Logistics infrastructure
47	Almeida et al.	2024	Brazil	Critical review	Regional development
48	Costa; Lima	2023	Brazil	Economic analysis	Energy and territory
49	Figueiredo et al.	2024	Brazil	Empirical study	Hydrogen and industry

Source: Prepared by the authors (2025), based on the integrative literature review.