Green Industrial Development in Brazil: Opportunities in the National and International Markets for Renewable Hydrogen and Derivatives

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Overview

The process of global energy transition is driven by the urgency to decarbonize economic activities emitting Greenhouse Gas (GHG) emissions. International recognition of the severity of the negative impacts of climate change has broadened consensus on the need for economic growth based on sustainable development. Additionally, transitioning to renewable sources allows for increased energy supply security in countries highly dependent on importing fossil energy resources and vulnerable to geopolitical conflicts and price volatility.

According to a study by Arbache and Esteves (2023), the powershoring process could serve as a lever for green industrialization in Latin American countries. This stems from the fact that powershoring is focused on three important vectors in the decision-making of companies originating from foreign investments: (i) the combination of resilience with economic efficiency; (ii) the combination of environmental compliance with economic development; and (iii) the creation of alternatives for energy transition and security for companies, as well as different sectors and global value chains, reducing demand pressure on the electrical systems of their countries of origin. In summary, powershoring revolves around the central idea that climate change and geopolitical factors have opened a window of opportunity for countries with comparative advantages in renewable energy production to attract energy-intensive industries committed to decarbonization.

In Brazil, the process of green industrialization is relevant for achieving decarbonization goals, advancing the supply of high-value-added green products in the global market, and expanding investments, employment, and income. Brazil possesses competitive techno-economic advantages to produce renewable hydrogen, with potential applications in various greenhouse gas-emitting sectors, including transport and industry. Those two sectors account for approximately 52.6% and 16.4% of total emissions in the energy matrix, respectively. Additionally, Brazil demonstrates potential for the construction of what are called hydrogen hubs. These hubs are geographical centers that encompass different links of the value chain, including production, transportation, storage, and final use, and can serve two types of demand: (i) domestic market demand, either within the hub or in industries located in other sites; and (ii) for export (Castro *et al*., 2023).

Building upon the theoretical framework of green industrialization and powershoring in the Global South, this study aims to map and analyze the best opportunities in the national and international markets for renewable hydrogen and its derivatives (such as ammonia and methanol) in Brazil.

Methods

The research question guiding the research methodology is as follows: "What are the opportunities in the national and international markets for renewable hydrogen and its derivatives (such as ammonia and methanol) in Brazil?". Exploratory qualitative and quantitative research has been employed to comprehend and analyze the current market and identify actions and perspectives for the ramp up of the hydrogen economy in Brazil. Therefore, through a mixed-methods approach, this study combines: i) mapping and analysis of Brazilian trade balance data for hydrogen and derivatives; ii) analysis and review of studies from international and national entities specialized in the field, such as: International Energy Agency (IEA), International Renewable Energy Agency (IRENA), Hydrogen Council, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Group for the Study of the Electric Sector UFRJ (GESEL), Energy Research Company (EPE), Ministry of Mines and Energy (MME), Institute of Applied Economic Research (IPEA) and Brazilian Institute of Geography and Statistics (IBGE).

Results

Currently, hydrogen production in Brazil utilizes processes with high CO2 emissions through natural gas reforming, known as grey hydrogen. Most of hydrogen production plants are in coastal regions near the gas pipeline network. Refineries, industrial gas companies, and the chlor-alkali industry are the economic agents responsible for hydrogen production (GIZ, 2021). The domestic market produces an average of 492.4 thousand tons of hydrogen per year, between 2015 and 2021, with approximately 78% consumed by refineries themselves. Supply and trade of hydrogen occur through four main industrial gas companies: Linde, Air Products, Air Liquide, and Messer. International trade of hydrogen is insignificant, with low volumes of imports and exports.

Within the ammonia and methanol market, the domestic market has produced an average of 240 thousand tons of ammonia and 29 thousand tons of methanol in the last 3 years. Both products are used for the synthesis of other chemicals, such as nitrogenous fertilizers

and biodiesel, respectively. In 2022, ammonia imports totaled 445 thousand tons (US$ 494 million), and methanol imports totaled 1.34 million tons (US$ 563 million). It is noted that the values of domestic methanol production are nearly insignificant compared to import data. Ammonia exports amounted to 98.8 thousand tons (US$ 27 million), while methanol exports totaled 1.36 thousand tons (US$ 0.83 million). Thus, in comparison with domestic production, ammonia exports represent 41%, and methanol exports represent 5%.

The importation of both products represents, in terms of foreign currency outflow, over US$ 1 billion per year, impacting the Brazilian trade balance. Thus, there is a strong potential for replacing ammonia and methanol imports through local production, which presents an opportunity for the development of the renewable hydrogen industry. After 2019, the use of hydrogen to produce fertilizers ended. Methanol production in Brazil, decades ago, had a small production capacity through the facilities of the companies Copenor (BA), Prosint (RJ) and Petrobras (PR), which were responsible for 1/3 of domestic consumption. However, since 2016 methanol production has become insignificant, with the majority being imported.

The main applications that can drive the domestic hydrogen market in Brazil are: i) hydrogen for steelmaking and metallurgy, leveraging Brazil's competitiveness in iron ore and renewable hydrogen to export metallics or low-carbon steel; ii) green ammonia for fertilizers and chemicals; iii) refinery, with the direct replacement of grey hydrogen; iv) hydrogen and derivatives as fuel for heavy and long-distance transportation; v) methanol as a raw material for industry; vi) power generation; and vii) blending in the natural gas pipeline network.

However, the main challenge in expanding renewable hydrogen demand is the high production cost, characteristic of nascent industries, which remains significantly higher compared to substitute energy inputs, namely natural gas and grey hydrogen produced from fossil sources. Without compensatory solutions for this "green premium" cost difference, difficulties arise in ensuring project demand, financial capacity, and investment pace in the country. Moreover, international cooperation and alliances with public and private sector entities can facilitate knowledge sharing, capacity building for emerging markets, creating innovation opportunities, and political dialogue.

Facilitating international trade of hydrogen and derivatives also involves relevant international standards, as well as purchase or sale auctions or long-term contracts between different countries. Countries such as Germany, the Netherlands, Japan, and South Korea stand out as examples of importers of renewable hydrogen (Hydrogen Council, 2022). In this context, financing mechanisms have emerged to develop the international hydrogen market and its carriers, such as H2Global for ammonia, methanol, and SAF, for export projects from non-European countries to supply Europe, especially Germany and the Netherlands. Launched in March 2023, the European Hydrogen Bank includes, on one hand, support for European supply – the domestic pillar – and, on the other hand, imports from third countries – the international pillar. Thus, international cooperation has played a significant role in the development of renewable hydrogen projects in Brazil. It is noteworthy that Brazil has engaged in important international forums related to the topic, such as joining the Hydrogen Initiative, Clean Energy Marine Hubs, and the International Hydrogen Trade Forum (IHTF), all under the framework of the Clean Energy Ministerial (CEM). Additionally, Brazil has been establishing bilateral cooperations on the topic of hydrogen with different countries, including Germany, the United States, and the United Kingdom.

Conclusions

Public policies and international cooperation aimed at maximizing value creation, cost reduction, partnership establishment, and reducing demand and financial risks for private entities are necessary to enable renewable hydrogen market and a green industrialization in Brazil. It is worth noting that increased efforts and investments in developing industrial capacities are crucial to seizing emerging opportunities in green technology development.

The consolidation of new business models in this process can ensure the preservation and competitiveness of national commodities and industrialized products in the global context, especially given recent international developments, notably the European Union's Carbon Border Adjustment Mechanism (CBAM) for taxing carbon-intensive imports. Furthermore, it can drive the expansion of foreign and domestic investments across the entire hydrogen production chain, from renewable energy plant implementation to transportation and final use infrastructure, positively impacting job creation and income generation.

Partnerships in domestic market projects will be fundamental for reducing commercial risks and enhancing the financial capacity of projects. This will be achieved by ensuring demand for hydrogen and its derivatives, which in turn facilitates the entry of various sources of financing (CASTRO; LEAL, 2023). Finally, the GESEL team thanks the EDP Group for its technical and financial support, through the Pecém H2V Research & Development (R&D) Project with resources from the R&D Program of the National Electric Energy Agency.

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