# Integration of Mining and Agribusiness as Catalysts for the Energy Transition in Brazil

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## ABSTRACT

The article analyzes the strategic integration of Brazil's mining and agribusiness sectors as catalysts for energy transition and decarbonization. Based on a literature review, data analysis, and SWOT; the study identifies the country's potential for green hydrogen and biofuel production, which are essential for replacing fossil fuels and reducing reliance on imported fertilizers. Although Brazil benefits from diversified mineral reserves and a clean energy matrix, challenges remain in supply security, requiring public policies to foster investments in sustainable technologies and strengthen domestic supply chains. The integration of these sectors is vital for Brazil to stand out in the global renewable energy landscape and achieve its climate goals.

**Keywords:** Energy Transition; Green Economy; Green Hydrogen; Mining; Agribusiness.

## INTRODUCTION

Brazil's economic growth is directly linked to the performance of strategic sectors such as agribusiness and mining (**Fig. 1**), both of which are sensitive to global market conditions and environmental policies. Despite having a relatively clean energy matrix, the country faces structural challenges in advancing decarbonization, primarily through the energy transition by replacing fossil fuels with renewable sources. One of the main obstacles is the dependence on imported inputs, such as fertilizers, which are essential for agriculture and biofuel production, vital to the decarbonization process. With the production of potassium and phosphate concentrated in a few countries, it is estimated that the volume of fertilizers imported by Brazil will increase by about 20% by 2030,

making it urgent to debate the expansion of mining activities, especially for fertilizer production.

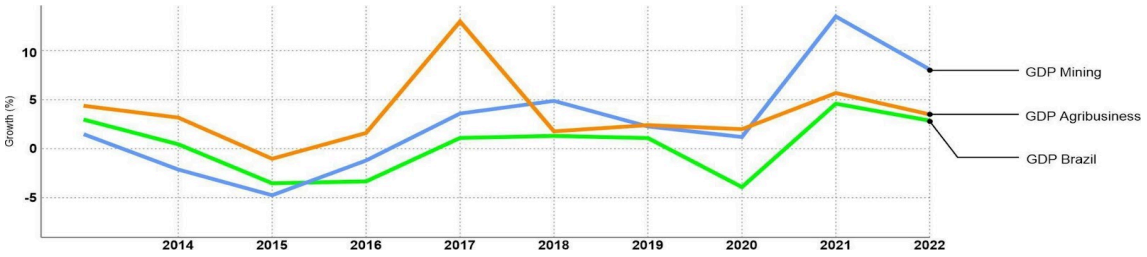


**Figure 1.** GDP of Brazil, Agribusiness and Mining (2014-2022) | Source: Elaborated by the authors

Due to the characteristics of its energy and electrical matrix (**Fig. 2**), Brazil has enormous potential to produce green hydrogen, a renewable alternative obtained from clean energy sources such as solar and wind. For this, the use of specific minerals, including rare earths, nickel, lithium, copper, and manganese, is necessary, which are also critical for developing new energy technologies.

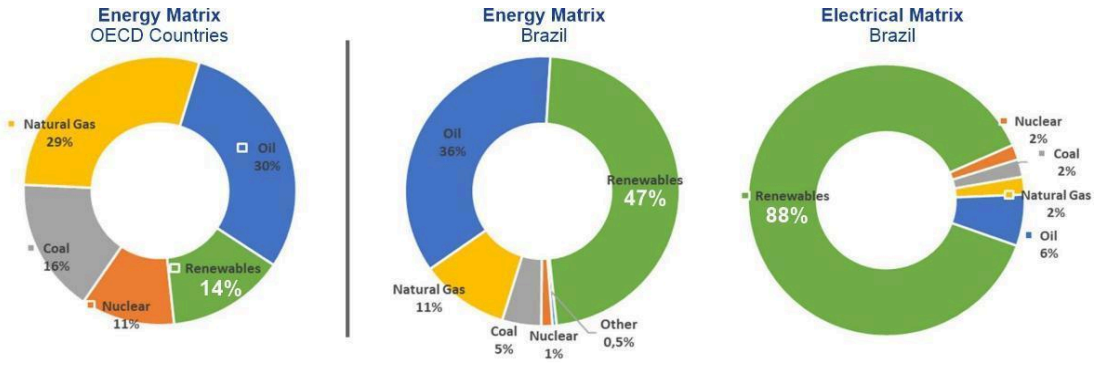


**Figure 2.** Energy Matrix of OECD and Brazil | Electrical Matrix of Brazil (2022) | Source: MME and EPE

Producing green hydrogen will contribute to decarbonization, positively impacting the fertilizer industry by enabling the generation of green ammonia, which, in turn, can be converted into green urea and other nitrogenous compounds. In this context, integrating mining and agribusiness in Brazil represents a strategic opportunity to overcome structural challenges, boost the energy transition, and strengthen sustainable development.

## MATERIALS AND METHODS

This article adopts a multidisciplinary approach to analyze how the integration of the mining and agribusiness sectors can catalyze the energy transition in Brazil. The methodology includes:

. Literature Review: A review of scientific literature and technical reports on the relationships between mining, agribusiness, and energy transition, focusing on studies from the last ten years, addressing data on imported inputs and the impact of green hydrogen and biofuel production.

. Secondary Data Analysis: Data from official sources, such as the Ministry of Agriculture (MAPA), the National Mining Agency (ANM), and the National Fertilizer Distribution Association (ANDA), were used to estimate Brazil's dependence on imported fertilizers and project demand through 2030.

. Sectoral Case Study: Evaluated the potential for green hydrogen production in Brazil using solar and wind energy data provided by the National Electric System Operator (ONS) and the Energy Research Company (EPE), as well as critical minerals such as rare earths, nickel, lithium, copper, and manganese (**Table 1),** based on studies by the Brazilian Mining Institute (IBRAM).

. SWOT Analysis: A Strengths, Weaknesses, Opportunities, and Threats analysis was conducted to identify the advantages and challenges of integrating the mining and agribusiness sectors to promote the energy transition. The analysis considered factors such as public policies, technological investments, and existing infrastructure.

| Minerals | Global Reserves | Global Production | Opportunity for Brazil |
|---|---|---|---|
| Rare Earths | 40% China \| 20% Vietnam \| **19% Brazil** | 69% China | |
| Ni Nickel | 42% Indonesia \| 18% Australia \| **12% Brazil (GO, PA e BA)** | 50% Indonesia \| Brazil 8º place | |
| Li Lithium | 33% Chile \| 22% Australia \| 13% Argentina \| **0,5% Brazil** | 73% Chile and Australia | |
| C Graphite | 28% China \| **26% Brazil** | 77% China | |
| Mn Manganese | 32% South Africa \| 26% Australia \| **Brazil has reserves in PA,MG and CE** | 36% South Africa | |
| Cu Copper | 19% Chile \| 12% Peru \| **2% Brazil** | 35% Chile and Peru \| 44% of refining in China | |

**Table 1.** Requirements and Materials for Key Clean Energy Technologies | Source: USGS, ANM and Systemiq

## RESULTS AND DISCUSSION

The results indicate that the integration of Brazil's mining and agribusiness sectors has great potential to drive the energy transition and decarbonization. The SWOT analysis highlighted strengths such as the diversity of mineral reserves and the robustness of agribusiness, along with opportunities in renewable energy leadership, which should be encouraged given the threats, such as global supply chain disruptions due to geopolitical conflicts. As the sixth largest global investor in low-carbon technologies, with $34.8 billion in 2023, Brazil can attract more investments in the mineral sector, crucial for the transition and to counter the growing dependence on imported fertilizers (**Table 2**), projected to increase by 20% by 2030. This requires policies that promote local mining, ensuring supply and reducing geopolitical vulnerabilities.

| | Nitrogen | Potash | Phosphorus |
|---|---|---|---|
| How it's produced | Synthesized from a source of Hydrogen, steam and N2 atm. | **Mined from marine deposits** | **Mined from fossil deposits** |
| Countries with production greater than 500k tons/year | 38 | 10 | 11 |
| Percentage of Global Production Marketed | 30% | 78% | 46% |
| Largest importers | US, Índia, **Brazil** | **Brazil**, China, USA | Índia, **Brazil** |
| Estimated Greenfield Cost (including infrastructure) | US$ 3.3 - 3.6 Billion 1.3 million tons/year | US$ 5.5 - 7.0 Billion 3.0 million tons/year | US$ 6.0 Billion 2.0 million tons/year |
| Time for a Greenfield (including ramp-up) | Minimum 4 years | Minimum 4 years | Minimum 6 years |

**Table 2.** Global Fertilizer Market Overview | Source: 2023 Fact Book, Nutrien

The case study highlighted Brazil's potential for green hydrogen production, due to its electrical matrix with 88% renewable sources. Green hydrogen, used as fuel and in green ammonia production, can reduce CO2 emissions and boost Brazil's competitiveness in sustainable fertilizer production. To solidify these positions, public policies must incentivize sectoral integration, promote innovation, and strengthen internal supply chains, which are essential for leading the energy transition and positioning Brazil prominently in the global green economy.

## CONCLUSION

Integrating the mining and agribusiness sectors is crucial for Brazil's energy transition and decarbonization. Despite having a relatively clean energy

matrix, Brazil faces significant challenges, including reliance on imported inputs like fertilizers and critical minerals. Expanding the mining of potassium, phosphate, and other critical minerals, combined with the development of green hydrogen and biofuels, presents opportunities to reduce this dependency, strengthen internal supply chains, and attract low-carbon technology investments. Leveraging Brazil's potential for green hydrogen, supported by its clean energy matrix, could position the country as a leader in renewable energy and sustainable fertilizer production. Public policies should encourage this integration to drive sustainable economic growth and meet international climate commitments.

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