

Green Protectionism: Local Content Policies for Renewables in Brazil and China.

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Abstract. The global transition toward low-carbon energy systems has increasingly intertwined climate policy with national industrial development strategies. Governments are not only seeking to reduce greenhouse gas emissions but also to capture economic value from emerging clean technologies. Within this context, many countries have adopted forms of green industrial policy, including regulatory instruments designed to stimulate domestic manufacturing and technological capability. Among these instruments, Local Content Requirements (LCR) have become a widely used mechanism in the renewable energy sector. This study examines the role of LCR policies in the renewable energy strategies of Brazil and China, two large emerging economies that have pursued ambitious expansions of wind and solar energy while attempting to strengthen their domestic industrial bases. The objective of the article is to compare how these countries implemented local content policies and to evaluate their impact on industrial development and technological competitiveness. The research adopts a qualitative comparative approach based on academic literature, institutional reports, and policy documents from organizations such as the World Bank, IRENA, and national agencies. The analysis focuses primarily on the wind and solar industries, examining the policy instruments used to enforce LCRs, the institutional coordination behind renewable energy policies, and the resulting development of domestic supply chains. Findings indicate that while both nations successfully expanded renewable capacity, China transitioned into a global technological leader through integrated planning and forced technology transfer, while Brazil's industrial progress was heavily tied to specific financing conditions through the Brazilian Development Bank (BNDES), which stimulated the creation of a domestic wind energy supply chain but generated more limited international competitiveness. The study concludes that the effectiveness of green protectionist instruments depends largely on state capacity, policy coordination, and market scale, highlighting the importance of strategic planning in transforming renewable energy expansion into sustainable industrial development.

Keywords. Green industrial policy, local content requirements, renewable energy, Brazil, China.

1. Introduction

The accelerating global energy transition has transformed climate policy into a central pillar of national industrial strategies. Governments increasingly recognize that decarbonization policies are not only environmental instruments but also powerful drivers of industrial transformation and technological leadership. As a result, many states have adopted strategic policy frameworks that combine environmental objectives with industrial development goals. This phenomenon has been described in the literature as green industrial policy, a framework that seeks to simultaneously promote sustainable development and domestic economic

growth (1).

Within this context, the intersection of environmental goals and economic sovereignty has given rise to a new era of green protectionism, characterized by the use of regulatory tools designed to ensure that investments in renewable energy generate domestic employment, technological capabilities, and industrial diversification. One of the most widely used mechanisms within this policy framework is the adoption of Local Content Requirements (LCR), which obligate project developers to source a specific share of inputs from domestic suppliers.

Emerging economies have been particularly active in employing these instruments. Countries such as Brazil and China view the energy transition not only as a climate imperative but also as an opportunity to restructure their productive bases and strengthen their position within global value chains. Brazil's renewable energy policy, for instance, has historically been linked to industrial development strategies and state-supported financing mechanisms (2).

China has implemented one of the most ambitious renewable energy industrialization programs in the world. Through long-term planning and large-scale public investment, the country rapidly developed domestic capabilities in wind and solar technologies, eventually becoming the dominant global supplier in several renewable energy markets (3).

The research problem guiding this study concerns how Local Content Requirements were operationalized in two of the world's largest renewable energy markets and what impact these policies had on the development of domestic industries. While LCRs are often criticized for potentially increasing project costs and distorting markets, policymakers in emerging economies frequently defend them as necessary tools for technological catch-up and industrial learning.

This article compares the implementation of LCR policies in Brazil and China in order to understand their role in shaping renewable energy industrial development. By examining policy instruments, institutional frameworks, and industrial outcomes, the study contributes to the broader debate regarding the effectiveness of green industrial policies in developing economies.

2. Research methods

This study employs a qualitative comparative research design focused on analyzing public policy instruments used by Brazil and China in the renewable energy sector, as it is useful to examine how different institutional environments shape similar policy tools, such as Local Content Requirements.

The methodological approach relies primarily on secondary data sources, including peer-reviewed academic literature, reports from international organizations, and official publications from national institutions. These sources include reports from organizations such as the World Bank, the International Renewable Energy Agency (IRENA), and the United Nations Industrial Development Organization (UNIDO), as well as Brazilian institutional sources such as the Institute for Applied Economic Research (IPEA) and the Brazilian Development Bank (BNDES).

The analysis focuses on the policy instruments used to implement LCRs, institutional coordination between industrial and energy policy, development of domestic supply chains and the impact on

international competitiveness

The research focuses on two sectors in particular: wind and solar energy, which have experienced the fastest global expansion in renewable electricity generation during the past two decades. Examining these industries allows for a detailed assessment of how LCR policies influence industrial capability development.

3. Green industrial policy and LCRs

Green industrial policy refers to government interventions designed to promote structural economic transformation while simultaneously addressing environmental objectives, particularly the transition to low-carbon and sustainable production systems (4). Unlike traditional environmental regulation, which primarily focuses on emission reductions, green industrial policy actively seeks to shape economic structure and promote the development of strategic industries.

From an economic perspective, such policies are often justified by the presence of market failures, including technological spillovers, coordination problems, and learning externalities. In emerging sectors such as renewable energy, private firms may be reluctant to invest due to high upfront costs and uncertain returns. Government intervention can therefore play a critical role in supporting industrial development and technological innovation (1).

Within this policy framework, Local Content Requirements represent a regulatory mechanism aimed at ensuring that renewable energy investments generate broader economic benefits. LCR policies mandate that a minimum share of equipment, services, or labor used in energy projects must originate from domestic suppliers. These requirements can stimulate domestic manufacturing, encourage foreign companies to establish local production facilities, and support job creation.

According to international policy studies, LCR policies are often implemented alongside other instruments such as subsidies, tax incentives, and renewable energy auctions (5). By guaranteeing a domestic market for local producers, governments may facilitate industrial learning and capability development.

Supporters argue that LCRs are essential for enabling developing economies to participate more actively in global clean technology value chains. Empirical research suggests that these policies can help domestic firms build technological expertise and gradually increase export competitiveness (6).

However, LCR policies are also controversial. Some critics argue that such requirements may increase the cost of renewable energy projects and potentially conflict with international trade rules. Policy analysts have emphasized that poorly designed local content policies can generate inefficiencies if they remain in place for too long or fail to promote

technological upgrading (7).

Despite these criticisms, many countries have adopted some form of local content policy in their renewable energy strategies. Brazil and China represent two particularly important cases due to the scale of their energy markets and the central role of state institutions in guiding industrial development.

4. Local content policies in renewable energy

4.1 Brazil

Brazil's renewable energy expansion has been closely linked to state-led financing mechanisms and industrial policy coordination, particularly through the Brazilian Development Bank (BNDES). Rather than imposing universal regulatory requirements on renewable energy developers, Brazil implemented local content policies primarily through financing conditions attached to subsidized credit programs (8,9).

Access to BNDES financing has historically required compliance with specific local content or "nationalization" thresholds, which determine the proportion of equipment and services that must originate from domestic suppliers (9). In the wind sector, projects financed through BNDES were required to meet local content levels of approximately 40–60%, depending on the technological configuration of turbines and project characteristics (9). Manufacturers seeking accreditation under the bank's financing programs also had to demonstrate compliance with detailed production criteria, such as domestic manufacturing of turbine towers, nacelles, or blades.

These requirements were implemented primarily through the FINAME program, a subsidiary credit line of BNDES dedicated to financing industrial machinery and equipment. Developers that failed to meet the local content requirements could still construct renewable energy projects but would be unable to access subsidized financing, which significantly reduced their competitiveness in Brazil's auction-based electricity market (9).

The combination of energy auctions and local content financing requirements contributed to the rapid expansion of wind power in Brazil during the 2010s. Government procurement auctions created stable demand for renewable electricity while BNDES financing requirements encouraged developers to purchase equipment from domestic suppliers (4,10). As a result, several international turbine manufacturers established local production facilities in Brazil in order to qualify for BNDES financing programs and participate competitively in energy auctions (4).

This policy framework contributed to the development of a regional industrial cluster associated with wind energy production, particularly

in Brazil's Northeast region. Studies of renewable energy integration indicate that the expansion of wind capacity generated significant regional economic activity and helped diversify local industrial structures (10).

However, the effectiveness of local content policies has varied across renewable energy technologies. While Brazil successfully developed a domestic wind turbine manufacturing industry, the solar photovoltaic sector has been less successful in attracting domestic manufacturing investment. One explanation is the strong international price competitiveness of imported photovoltaic panels, particularly those produced in China (2).

Although BNDES introduced a Progressive Nationalization Plan for photovoltaic equipment that aimed to gradually increase domestic manufacturing of solar modules and system components, the domestic solar industry has remained limited compared with the wind sector (3). Analysts suggest that high global competition and the technological complexity of photovoltaic supply chains have limited the ability of Brazilian local content policies to generate large-scale domestic manufacturing in this segment (2).

4.2 China

China's renewable energy strategy represents one of the most comprehensive examples of state-led green industrial policy in the global energy transition. Beginning in the early 2000s, the Chinese government implemented a combination of industrial planning, regulatory requirements, financial incentives, and technology development policies aimed at rapidly expanding domestic renewable energy capacity (3).

In the early stages of wind power development, China adopted explicit local content requirements mandating that a large share of wind turbine components be produced domestically. These requirements were introduced in 2003 and required developers to source at least 70% of turbine components from domestic manufacturers (3,13). The policy aimed to stimulate technology transfer from foreign firms and accelerate the development of local manufacturing capabilities.

Foreign wind turbine manufacturers seeking access to the Chinese market were often required to establish joint ventures with domestic firms, facilitating the transfer of technical knowledge and manufacturing expertise to Chinese companies (3). This strategy allowed domestic producers to gradually develop technological capabilities in turbine design, component manufacturing, and project development.

In addition to local content requirements, China implemented a broader industrial strategy that included direct subsidies, public investment in research and development, and large-scale renewable energy deployment programs (11). The

Chinese government also relied on state-owned enterprises and policy banks to finance renewable energy infrastructure projects and support domestic manufacturers.

China's large domestic energy market played a crucial role in this process. By rapidly expanding renewable electricity generation, the government created strong internal demand that allowed domestic firms to achieve economies of scale and reduce production costs (3). As a result, Chinese manufacturers gradually became competitive in international markets.

After domestic technological capabilities matured, China began to relax formal local content requirements. However, by that time domestic firms had already developed strong industrial capabilities and established dominant positions in global renewable energy supply chains (3).

Today, Chinese companies account for a substantial share of global production in both solar photovoltaic modules and wind turbine manufacturing. Their expansion has been supported not only by domestic policy frameworks but also by international investment strategies that include renewable energy projects in emerging markets such as Brazil (12).

5. Comparative analysis

The comparison between Brazil and China reveals that both countries used LCRs as instruments of green industrial policy, but their policy designs and industrial outcomes differed significantly.

One key difference concerns the institutional mechanisms used to implement local content policies. In Brazil, LCR policies were primarily enforced through conditional access to subsidized financing provided by BNDES. Developers that complied with local content thresholds could obtain long-term loans at preferential interest rates, while projects that relied on imported equipment faced higher financing costs (?). China, by contrast, implemented direct regulatory local content requirements during the early stages of wind industry development. These policies were complemented by broader industrial planning frameworks and state-directed investments in renewable energy manufacturing (3).

Another difference lies in the strategic objectives of the policies. Brazil's renewable energy policies primarily aimed to promote domestic industrial activity associated with the expansion of the internal electricity market. The focus was therefore on developing a national supply chain capable of supporting domestic energy deployment (4,10). China, however, pursued a more ambitious strategy that sought not only to expand domestic renewable energy capacity but also to establish global technological leadership in renewable energy manufacturing. Through coordinated industrial planning and large-scale market creation, China positioned its firms to compete internationally in

wind turbine and photovoltaic production (3,11).

Differences in state capacity and market scale also influenced policy outcomes. China's centralized planning institutions allowed for strong coordination between energy policy, industrial policy, and technological development strategies (11). Brazil's policy framework, while supportive of renewable energy deployment, has relied more heavily on financial instruments rather than comprehensive industrial planning.

Empirical studies comparing renewable energy policy frameworks in Brazil and China suggest that China's integrated approach contributed to the emergence of globally competitive firms, while Brazil's policies primarily stimulated regional industrial development within the domestic market (13).

6. Conclusions

This study examined the role of Local Content Requirements (LCR) as instruments of green industrial policy in Brazil and China. The analysis shows that both countries used these policies to ensure that renewable energy expansion generated broader domestic economic benefits, including industrial development and technological learning.

In Brazil, local content policies were implemented primarily through financing conditions attached to development bank loans, which encouraged developers to source equipment from domestic manufacturers in order to access subsidized credit (9). This approach contributed to the development of a domestic wind energy supply chain and stimulated regional industrial activity, particularly in the Northeast of the country (10).

However, Brazil's experience also illustrates some limitations of local content policies. The reliance on financing mechanisms means that industrial outcomes are closely tied to the availability of public credit. Moreover, domestic manufacturing development has been uneven across renewable energy technologies, with the solar photovoltaic sector remaining highly dependent on imported equipment (2,3).

China's experience demonstrates a different trajectory. By combining local content requirements with long-term industrial planning, large-scale domestic demand, and state-supported technological development, China successfully transformed its renewable energy sector into a globally competitive manufacturing industry (3,11).

These findings suggest that the effectiveness of green protectionist policies depends on several structural factors, including state capacity, market size, and the degree of coordination between industrial and energy policies (1,6). Local content requirements can play an important role in facilitating industrial learning and technology transfer during the early stages of sectoral development.

However, the long-term success of these policies appears to depend on whether countries can transition from domestic market protection toward innovation-driven competitiveness in global markets. Future research should therefore examine how emerging sectors such as green hydrogen, energy storage, and advanced grid technologies, may shape the next phase of green industrial policy in emerging economies.

7. References

- [1] Rodrik D. Green industrial policy. *Oxford Review of Economic Policy*. 2014;30(3):469-491.
- [2] Gomes L, et al. The policy dimension of energy transition: The Brazilian case in promoting renewable energies (2000–2022). *Energy Policy*. 2023;175:113480.
- [3] Muhammed G, Tekbiyik-Ersoy N. Development of renewable energy in China, USA, and Brazil: A comparative study on renewable energy policies. *Sustainability*. 2020;12(21):9136.
- [4] Meckling J, Nahm J. Green industrial policy and the global transformation of climate politics. *Global Environmental Politics*. 2021;21(4):1–19.
- [5] UNEP DTU Partnership. Local content requirements in auction schemes for renewable energy. Copenhagen: UNEP DTU Partnership; 2021.
- [6] Calzada J, et al. The impact of local content requirements on the development of export competitiveness in solar and wind technologies. *Renewable and Sustainable Energy Reviews*. 2022;168:112913.
- [7] United Nations Industrial Development Organization (UNIDO). The role of local content policies in manufacturing and mining. Vienna: UNIDO.
- [8] Elizondo Azuela G, et al. Performance of renewable energy auctions: Experience in Brazil, China and India. Washington (DC): World Bank; 2014.
- [9] International Renewable Energy Agency (IRENA). Renewable Energy Policy Brief: Brazil. Abu Dhabi: IRENA; 2015.
- [10] Diniz TB, Caiado Couto L. Achieving a high share of non-hydro renewable integration in Brazil through wind power: Regional growth and employment effects. *Renewable and Sustainable Energy Reviews*. 2024;192:114367.
- [11] Instituto de Pesquisa Econômica Aplicada (IPEA). Green energy development and cooperation among emerging economies: China-Brazil cooperation as an example. Brasília: IPEA; 2022.
- [12] Nascimento AM, Liu L, Alves JRCS, Oriá P. Chinese investment in the Northeast region of Brazil: an analysis about the renewable energy sector. *REGE Revista de Gestão*. 2021;28(4):376-389.
- [13] Paixão MAS, Miranda SHG. Um comparativo entre a política de energia renovável no Brasil e na China. *Pesquisa & Debate*. 2018;29(2).