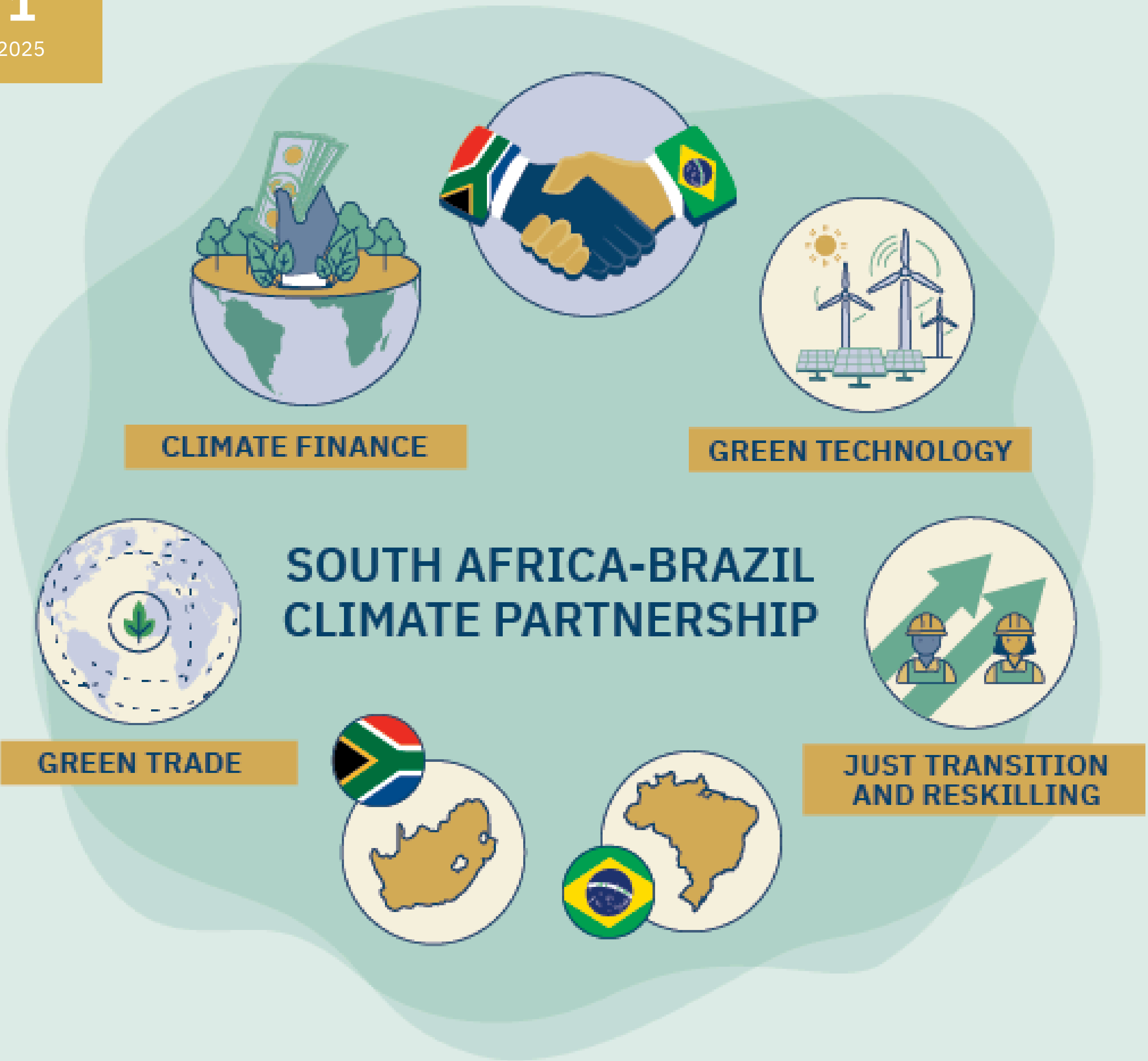
Working Paper
1
2025



Technology for Green Growth and Industrialisation

NERISSA MUTHAYAN

higher education & training
Department: Higher Education and Training
REPUBLIC OF SOUTH AFRICA
SAIIA 90 YEARS EST.1934
SABTT South African BRICS Think Tank
NATIONAL INSTITUTE FOR THE HUMANITIES AND SOCIAL SCIENCES

About this project

In partnership with the South African BRICS Think Tank and the National Institute for the Humanities and Social Sciences, the South African Institute of International Affairs (SAIIA) has initiated a research project entitled "BRICS Shaping Economic Cooperation for Green Growth, Development and the Just Transition: Partnership between Brazil and South Africa".

The objective of the project is to contribute towards shaping a Global South economic cooperation agenda that supports green growth, development and a just transition in targeted countries and in global economic governance forums. This will be achieved through research, policy dialogues, network development and capacity-building activities centred on Brazil's and South Africa's approaches to the just transition.

A study of Brazil and South Africa can provide important shared learnings regarding the interconnectedness of climate change responses with other instruments relating to trade, technology, social protection and financing. Such learnings are relevant for how BRICS members and other developing countries shape their own transitions to a new economic and social paradigm, as well as how they engage and help shape transforming the global climate and economic governance architecture.

The project focuses on four key themes:

- strengthening the multilateral trade system for green growth and development;
- climate finance for green growth and development;
- reskilling of affected communities in the fossil fuel-intensive sector; and
- technology for green growth and industrialisation.

Among the project outputs will be the following:

- a Brazil–South Africa climate and just transition dialogue platform to contribute towards a community of practice focused on the green growth, economic cooperation and development concerns of the Global South;
- a series of working papers on each of the project themes;
- an edited volume; and
- a foresight workshop exploring the trajectory for the development of a Global South-friendly climate governance architecture through enhanced BRICS economic cooperation.

The project will support the appointment of a South African research fellow, who will complete the fellowship at SAIIA and the project's Brazilian partner institute, the Institute of Applied Economic Research (Instituto de Pesquisa Econômica Aplicada [IPEA]).

Introduction

Green technology, also known as sustainable or clean technology, refers to innovations that reduce environmental harm through efficient and ecologically responsible processes, products and services. These technologies help lower greenhouse gas emissions, conserve natural resources and limit ecological degradation. While the term includes a range of applications, from carbon capture and battery storage to electric mobility and green hydrogen, this paper focuses on solar photovoltaic (PV) and onshore wind energy. These two technologies dominate current global deployment trends and feature prominently in decarbonisation strategies.

Solar and wind power play central roles in reducing dependence on fossil fuels. In the International Energy Agency's Net Zero Emissions by 2050 Scenario, they are projected to generate nearly 70% of the world's electricity by mid-century. Solar energy is widely available; solar PV cells convert sunlight directly into electricity. Wind arises from solar-induced atmospheric pressure differences and its energy can be captured through turbines. These technologies underpin the reconfiguration of national energy systems.

Although falling costs have encouraged adoption, market forces alone have not driven the expansion of renewable energy. Research shows that industrial policy has enabled scaling in countries such as China, Germany and India.[1] In developing economies, renewable transitions raise complex distributional challenges. These include economic risks to coal-dependent regions and concerns that renewables do not deliver equivalent local benefits when technologies are imported and job creation is limited.

In Brazil and South Africa, public criticism often centres on insufficient knowledge transfer, limited local manufacturing and weak skills development.[2] In these contexts, expanding solar or wind energy may displace coal-based employment, especially in South Africa, but generate few local jobs unless policies foster domestic production and supporting ecosystems.[3]

Nobel Economic Sciences laureate Daron Acemoglu and his co-authors argue that governments must guide innovation toward cleaner technologies through targeted policy interventions such as a combination of taxes on dirty technologies and subsidies towards clean technologies. Market mechanisms alone will not displace entrenched high-emission systems.[4] Scholar Dani Rodrik similarly contends that the renewed global interest in industrial policy must align with inclusive and low-carbon development objectives, particularly in lower-income economies.[5] These perspectives underscore the importance of policy design in shaping equitable energy transitions.

This paper examines how industrial policy can help Brazil and South Africa capture greater developmental benefits from solar and wind energy deployment. It considers how each country navigates global trade constraints, particularly under World Trade Organization (WTO) rules, and engages with multilateral technology governance platforms such as the UN Framework

[1] Mariana Mazzucato and Gregor Semieniuk, "Public Financing of Innovation: New Questions," *Oxford Review of Economic Policy* 33, no. 1 (2017): 24.
[2] Krish Chetty et al., "Fostering a Just Energy Transition: Lessons from South Africa's Renewable Energy Independent Power Producer Procurement Programme," *South African Journal of International Affairs* 30, no. 2 (2023): 225.
[3] HR Bohlmann, JA Bohlmann, and M Chitiga-Mabugu, "Just Energy Transition of South Africa in a Post-COVID Era," *Sustainability* 15, no. 14 (2023): 10854.
[4] Daron Acemoglu et al., "Transition to Clean Technology," *Journal of Political Economy* 124, no. 1 (2016): 52.
[5] Dani Rodrik, "Green Industrial Policy," *Oxford Review of Economic Policy* 30, no. 3 (2014): 469.

Convention on Climate Change's (UNFCCC) Technology Mechanism. It also assesses whether current strategies foster domestic capacity and contribute to a just transition.

The paper proceeds in four parts. The first section introduces the concept of green technology with a specific focus on wind and PV energy, setting the stage for a comparative analysis of how these technologies have unfolded in two key emerging economies: Brazil and South Africa. The second section explores the role of industrial policy in enabling (or impeding) the domestic development of renewable energy technologies, with specific attention to the structure, incentives and limitations of wind and solar policy frameworks in each country. The third section identifies key lessons and comparative insights drawn from both cases, particularly regarding the interplay of industrial development, equity concerns and technological capability. The final section concludes by reflecting on what a coherent and just green industrial policy might require, especially within the constraints of international trade regulations and the imperatives of socio-economic inclusion.

Industrial policy and renewable energy: A theoretical primer

The global energy transition presents both an environmental imperative and an industrial opportunity. As wind and PV technologies become increasingly central to decarbonisation strategies, developing countries need to ensure that their participation in this transition yields long-term developmental benefits. In particular, the pursuit of a 'green industrial policy' – the strategic deployment of state capabilities to stimulate low-carbon industries – has become a defining challenge for countries such as Brazil and South Africa.

Industrial policy has historically shaped technological progress and structural transformation, and its recent revival reflects the recognition that market forces alone are often insufficient to drive innovation, especially in strategically important sectors such as renewable energy.[6] Both demand-side instruments (eg, renewable energy auctions, feed-in tariffs, public procurement) and supply-side measures (eg, subsidies for local manufacturing, R&D incentives and technology transfer mandates) are required to stimulate green technological upgrading.[7] However, for late-industrialising countries, the design of such policies must contend with complex global dynamics, including concentrated supply chains (often dominated by China), intellectual property constraints and geopolitical competition.[8] Consequently, many developing countries assert that the already-industrialised world should provide adequate support for green transitions domestically that do not undermine development agendas or ambitions. An integral component of this is appropriate technology transfer – not only in the final product but also in the knowledge, skills and industrial processes associated with building such products.

Technology transfer is defined as 'a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental

[6] Philippe Aghion et al., "Carbon Taxes, Path Dependency, and Directed Technical Change: Evidence from the Auto Industry," *Journal of Political Economy* 124, no. 1 (2016): 1.
[7] Tilman Altenburg and Dani Rodrik, "Green Industrial Policy: Concept, Policies, Country Experiences" (Geneva: UN Environment, 2017), 10.
[8] Carlota Perez, "Green Growth and the Global South: A Development Strategy for the 21st Century," *Global Policy* 1, no. 1 (2013): 1.

organizations (NGOs) and research/education institutions'.[9] While international climate frameworks such as the UNFCCC formally commit developed countries to promote technology transfer, in practice the flow of advanced renewable energy technologies to the Global South remains highly uneven.[10] The UNFCCC's Technology Mechanism – comprising the Technology Executive Committee and the Climate Technology Centre and Network – aims to support policy coherence and implementation capacity, but its impact has been constrained by limited funding and voluntary engagement by private sector actors.[11]

Intellectual property rights (IPRs) are frequently cited as key obstacles to equitable green technology dissemination. While not all renewable energy technologies are IPR intensive, high-value segments such as battery storage, smart grid integration and next-generation solar panels remain heavily protected.[12] Yet focusing on IPRs alone obscures other important barriers to local technological upgrading, such as limited absorptive capacity, underdeveloped innovation ecosystems and weak coordination between industrial and energy policy domains.[13]

Brazil and South Africa have both utilised industrial policy levers to promote domestic participation in wind and solar markets, albeit with mixed outcomes. Notably, both countries diverged from their traditional model of state-led electricity generation, dominated by Eletrobras in Brazil and Eskom in South Africa, by introducing independent power producers (IPPs) as part of their renewable energy procurement strategies.[14] In doing so, they sought to combine private investment with public planning, often attaching localisation requirements or development obligations to long-term power purchase agreements. However, such efforts have had to contend with structural challenges, including currency volatility, limited domestic manufacturing capacity, political blockages and grid infrastructure bottlenecks.[15]

The political economy of green industrial policy in Brazil and South Africa differs significantly from early adopters in Europe and North America. Unlike established renewable energy leaders, which often control major portions of global supply chains, these middle-income countries are latecomers operating under tighter fiscal constraints and greater social pressure to create jobs and alleviate inequality.[16] For them, industrial policy is not only a tool for energy transition but also a means to rectify longstanding developmental deficits.

Brazil's industrial policy for wind and solar energy

Brazil's renewable energy strategy has been characterised predominantly by state intervention to shape technological capabilities and market structure, particularly through a combination of public financing, localisation requirements and auction-based procurement. Historically

---

[9] UNFCCC, "Technology Transfer Framework."
[10] David Ockwell and Rob Byrne, *Sustainable Energy for All: Innovation, Technology and Pro-Poor Green Transformations* (Routledge, 2017), 50.
[11] UNFCCC, "The Technology Mechanism under the Convention."
[12] Kelly Sims Gallagher, *The Global Diffusion of Clean Energy Technologies: Lessons from China* (MIT Press, 2014), 100.
[13] Rasmus Lema and Rainer Quitzow, "Green windows of opportunity: latecomer development in the age of transformation toward sustainability," *Industrial and Corporate Change* 30, no. 1 (2021): 110.
[14] Anton Eberhard and Raine Naude, "The South African Renewable Energy Independent Power Producer Procurement Programme: A Review and Lessons Learned," *Journal of Energy in Southern Africa* 28, no. 4 (2017): 11.
[15] Haneen Bakhtary et al., *Clean Energy Transitions in Emerging Economies: The Role of Finance, Technology and Policy* (IEA-IRENA-DFI Working Group, 2021), 5.
[16] Stéphane Hallegatte et al., *Shock Waves: Managing the Impacts of Climate Change on Poverty* (World Bank, 2016), 50, Shock Waves: Managing the Impacts of Climate Change on Poverty.

dominant in hydropower and biofuels, Brazil shifted towards wind and PV in the early 2000s, driven by the imperative to diversify its energy mix and stimulate industrial upgrading.

A foundational instrument was the Programme of Incentives for Alternative Electricity Sources (Programa de Incentivo a Fontes Alternativas de Energia Elétrica [PROINFA]),[17] established in 2002 under the Cardoso administration and later expanded by President Lula da Silva. PROINFA was designed to foster the development of wind, biomass and small hydroelectric sources. The programme's first phase relied on long-term power purchase agreements with state utility Eletrobras and established feed-in tariffs for 3 300MW of renewable capacity. In its second phase, however, the government replaced fixed tariffs with competitive auctions, reflecting concerns about cost and efficiency.[18]

Although PROINFA catalysed initial investment in wind energy, implementation was delayed by bureaucratic hurdles, including complex licensing procedures and grid interconnection challenges. Importantly, the programme required domestic content in equipment, thereby pushing transnational turbine firms to localise production to qualify for financing from the Brazilian National Development Bank (BNDES). BNDES offered subsidised loans that were conditional on minimum local content thresholds, serving as a powerful industrial policy lever.[19]

The introduction of reverse electricity auctions in 2009 marked a pivotal shift in Brazil's renewable energy governance.[20] These auctions, governed by the National Electric Energy Agency (ANEEL), introduced demand certainty and price competition. The state awarded contracts to IPPs that bid the lowest price per MWh within capped price ceilings. These auctions led to a dramatic drop in wind tariffs and created a surge in installed capacity, positioning Brazil as one of the top 10 wind markets globally.[21]

The state's active role continued through industrial policy linkages. BNDES maintained its requirement for local content in exchange for preferential credit. This spurred the establishment of local manufacturing facilities by foreign turbine producers such as Vestas and GE, resulting in a growing domestic supply chain. However, the 2015–2016 economic crisis severely curtailed investment and led to a temporary halt in new wind power contracting.[22]

By 2022, Brazil's installed wind capacity surpassed 22GW, and the sector had matured with improved integration into the national grid. Still, intermittent output and network variability posed

[17] Ricardo Marques Dutra and Alexandre Salem Szklo, "Incentive policies for promoting wind power production in Brazil: Scenarios for the Alternative Energy Sources Incentive Program (PROINFA) under the New Brazilian electric power sector regulation," *Renewable Energy* 33, no. 1 (2008): 5.
[18] M. T. Tolmasquim et al., "Electricity market design and renewable energy auctions: The case of Brazil," *Energy Policy* 158 (2021): 112558.
[19] B. Bayer, "Experience with auctions for wind power in Brazil," *Renewable and Sustainable Energy Reviews* 81 (2018): 2644.
[20] In Brazil's renewable energy procurement system, a reverse auction refers to a bidding process in which electricity producers compete to offer the lowest price per megawatt-hour. The federal government, through regulated auctions conducted by the Electric Energy Trading Chamber and overseen by ANEEL, awards long-term power purchase agreements to the lowest qualifying bidders. This mechanism has played a central role in scaling up wind and solar power while reducing costs and ensuring transparency. See Tolmasquim et al., "Electricity market design and renewable energy auctions," 112558.
[21] M. Fraundorfer and F. Rabitz, "The Brazilian renewable energy policy framework: instrument design and coherence," *Climate Policy* 20, no. 5 (2020): 652.
[22] A. Ferreira et al., "Economic overview of the use and production of photovoltaic solar energy in Brazil," *Renewable and Sustainable Energy Reviews* 81 (2018): 181.

ongoing challenges, prompting calls for smarter grid management and hybridisation with other renewables.[23]

Solar power in Brazil followed a delayed trajectory. Despite the country's favourable solar irradiance, averaging over 3 000 sunlight hours annually, government policy prioritised wind over solar in earlier phases. High component costs and an absence of local production capacity also inhibited early adoption. The turning point came with ANEEL's Normative Resolution 482 in 2012, which introduced Brazil's net metering system. This regulatory change allowed distributed generators to feed surplus power back into the grid and receive credit, thereby incentivising household and small business investment in PV systems.

In 2014 Brazil held its first solar-specific electricity auction, awarding contracts for nearly 900MW of PV capacity. As with wind, state-backed auctions guaranteed demand at fixed prices, which reduced investor risk and encouraged scaling. Public banks, led by BNDES, offered further financial incentives. However, unlike wind, localisation requirements and limited industrial capacity constrained domestic solar manufacturing, leading to continued reliance on imported modules.[24] This limited capacity stemmed from several factors. Externally, Brazil faced strong price competition from dominant global solar module producers, particularly in Asia, which benefited from economies of scale and subsidised supply chains. Internally, high capital costs, underdeveloped local supply chains for polysilicon and wafers, and inconsistent policy incentives created a challenging environment for scaling domestic solar manufacturing.

As of 2023, solar has emerged as Brazil's second-largest source of electricity generation after hydro. Total installed capacity reached 23.9GW, with distributed generation accounting for a growing share. Declining costs improved regulatory clarity, and technological advancements have made solar PV the country's most cost-competitive energy source. Still, challenges persist in expanding grid infrastructure, integrating decentralised generation and ensuring equitable access for low-income populations.[25]

Brazil's experience underscores the effectiveness of combining market-based mechanisms such as auctions with targeted industrial policy tools such as local content rules and concessional finance. Yet, the contrasting trajectories of wind and solar also reflect path dependency, state prioritisation and differences in technology maturity and market structure. Hochstetler aptly characterises this as a form of state activism under constraints, where the Brazilian government pursued green energy development with limited fiscal space and institutional capacity while still managing to shape firm behaviour and sectoral dynamics through policy innovation.[26]

South Africa's wind and solar energy policies

South Africa's energy landscape remains heavily coal-dependent, accounting for approximately 80% of electricity generation. The power sector is dominated by the vertically integrated state-owned utility Eskom, which historically generated, transmitted and distributed over 90% of South Africa's electricity. This concentration of power has had significant implications for the country's

[23] D. Werner and L. L. B. Lazaro, "The policy dimension of energy transition: The Brazilian case in promoting renewable energies (2000–2022)," *Energy Policy* 175 (2023): 113480.

[24] L. Böckler and M. G. Pereira, "Consumer (Co-)ownership in renewables in Brazil," in *Energy Transition: Financing Consumer Co-Ownership in Renewables* (Springer International Publishing, 2019), 535, Consumer (Co-)ownership in renewables in Brazil.

[25] D. D. dos S. Carstens and S. K. da Cunha, "Challenges and opportunities for the growth of solar photovoltaic energy in Brazil," *Energy Policy* 125 (2019): 396.

[26] Hochstetler, *Political Economies of Energy Transition*, op. cit., 129–130.

energy transition, particularly in relation to the deployment of renewable energy technologies such as wind and PV.

The Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), launched in 2011, represents one of the most successful utility-scale renewable energy programmes in Africa. By using a competitive bidding model, the REIPPPP attracted over ZAR[27] 200 billion (approximately $ 11 billion) in private investment during its initial rounds and enabled the procurement of over 6 200MW of renewable energy, primarily from wind and PV sources. The programme distinguished itself by incorporating socio-economic development criteria such as job creation, local ownership and skills development in previously marginalised communities. It also mandated local content requirements and community trust ownership schemes to support a broader developmental agenda.

However, the REIPPPP has encountered substantial setbacks since 2015, primarily due to institutional resistance from Eskom, which refused to sign new power purchase agreements for several years, citing financial constraints and grid concerns. This obstructionism appeared predominantly political, reflecting broader dynamics of rent-seeking, resistance to liberalisation and protection of coal-related interests. Scholar Anton Eberhard demonstrates how political fragmentation, bureaucratic inertia and vested interests within Eskom and government structures slowed the momentum of the programme just as international interest was peaking.[28] This aligns with Acemoglu and Robinson's framework of 'economic backwardness in political perspective', in which inefficient institutions are preserved to protect political rents, often at the expense of productivity-enhancing reforms.[29]

Further complicating the transition has been Eskom's significant and growing debt burden, alongside the technical and financial failures of its flagship coal plants, Medupi and Kusile, both of which experienced severe delays, design defects and cost overruns. Originally meant to bolster supply security, these plants instead deepened fiscal strain and increased reliance on bailouts, exacerbating South Africa's energy crisis.[30] This culminated in record levels of electricity blackouts ('load shedding') in 2023, with over 330 days affected, severely undermining economic output.[31]

While renewable energy projects have proliferated, grid integration remains a formidable challenge. The national transmission infrastructure, largely unchanged since the coal-dominated era, is poorly aligned with the spatial distribution of new wind and solar installations, especially in the Northern and Eastern Cape provinces. Eskom has confirmed that major grid expansions and reinforcements are required to unlock over 30GW of renewables currently constrained by limited grid access.[32]

Policy efforts to address these issues include the Draft Integrated Resource Plan (IRP 2023), which outlines future electricity generation mixes. However, the IRP has been widely criticised for lacking ambition on renewables and continuing to allocate capacity to gas and coal, despite South

---

27 Currency code for the South African rand.
28 Anton Eberhard, "South Africa's Renewable Energy Transition: Lessons for Other African Countries" (UCT GSB, 2022), 10.
29 Daron Acemoglu and James A. Robinson, "Economic Backwardness in Political Perspective," *American Political Science Review* 100, no. 1 (2006): 115.
30 Chris Yelland, "Understanding the Cost of Electricity from Medupi , Kusile and IPPs," *Daily Maverick*, July 22, 2016.
31 Chris Loewald, "Reflections on Load-Shedding and Potential GDP," 2023.
32 Stuart Theobald, "Eskom's Renewable Energy Shocker," *Business Day*, January 9, 2023; Department of Public Enterprises, *The Eskom Transmission Development Plan (TDP) 2023–2033* (Pretoria: Government of South Africa, 2024), The Eskom Transmission Development Plan (TDP) 2023–2033, 5.

Africa's climate commitments.[33] Similarly, while South Africa's updated Nationally Determined Contribution (NDC) in 2021 improved upon earlier targets, it remains insufficient to align with a 1.5°C pathway. It has also been criticised by civil society for being inadequately supported by domestic implementation measures.[34]

The government's South African Renewable Energy Masterplan (SAREM), approved in March 2025, offers a new blueprint for localisation and green industrialisation. It sets out a vision to increase domestic manufacturing of key components, expand employment opportunities and enhance value-chain competitiveness in renewables and battery storage. However, implementation will require large-scale investment in skills development, technology transfer and transmission infrastructure: areas in which South Africa currently lags behind its competitors.[35]

South Africa's Just Energy Transition Investment Plan, under the $9.3 billion Just Energy Transition Partnership, provides critical concessional finance to support coal decommissioning, green hydrogen development and grid expansion. Yet, questions remain about institutional capacity, labour market readiness and the alignment of financial flows with just transition principles. Without addressing underlying political and infrastructural barriers, South Africa risks perpetuating the very inequalities that the energy transition seeks to redress.[36]

The Hydrogen Society Roadmap (2022) positions green hydrogen as a frontier opportunity for South Africa, leveraging its renewable resources and mineral endowments. However, grid constraints, high capital costs and skills shortages threaten its scalability and inclusiveness. Likewise, distributed generation, enabled through deregulation (including the lifting of the 100MW licensing cap), is gaining momentum among commercial users, yet household-level adoption remains constrained by affordability and spatial inequalities.

In sum, South Africa's renewable energy strategy exemplifies the tension between ambitious policy intent and institutional fragmentation. While the REIPPPP has successfully introduced competitive procurement into the electricity market, the structural dominance of coal, coupled with Eskom's fragility and political economy constraints, continues to limit a fully just and accelerated transition. Addressing these challenges requires not only policy consistency and investment in grid infrastructure but also deliberate efforts to integrate affected communities, promote local manufacturing and deliver long-term developmental benefits.

Lessons from Brazil and South Africa

Brazil and South Africa's experiences with wind and solar energy transitions reveal how institutional design, political coalitions and industrial strategy shape divergent pathways to decarbonisation. While both countries adopted auction-based procurement mechanisms and sought to embed localisation strategies, their outcomes diverge due to differences in policy coherence, grid infrastructure and vested interests within each political economy.

---

[33] Richard Worthington, "IRP 2023 is a Mantashe energy consensus manifesto passing as a plan," *Business Day*, January 22, 2024, accessed August 4, 2025.
[34] Climate Action Tracker, "South Africa: Country Profile" (2024).
[35] South African Renewable Energy Masterplan (SAREM), (Pretoria: Government of South Africa, 2025), South African Renewable Energy Masterplan (SAREM), 5.
[36] Presidential Climate Commission, *Just Energy Transition Investment Plan: Progress and Governance Report* (Pretoria: PCC, 2024), Just Energy Transition Investment Plan: Progress and Governance Report, 20.

In Brazil, the early introduction of PROINFA in 2002 marked a coordinated state effort to stimulate domestic wind and biomass industries. The subsequent adoption of reverse auctions, backed by concessional financing from BNDES, fostered a competitive environment for renewable developers while promoting domestic industrial participation.[37] Crucially, Brazil's localisation requirements, combined with concessional financing, enabled the growth of domestic turbine manufacturers and stimulated significant industrial spillovers, particularly in wind power.[38] This success reflects the strength of institutional alignment between energy, industrial and financial policies. However, these achievements have not been fully replicated in the solar PV sector, which remains more import-dependent. External factors such as global supply chain dominance by China and internal constraints such as high capital costs and late regulatory adaptation contributed to this asymmetry.

By contrast, South Africa's REIPPPP was designed to attract private investment, encourage socio-economic development and diversify the energy mix away from coal. The programme succeeded in procuring over 6GW of renewable capacity by 2022 and was lauded for its transparency and competitive pricing. However, its trajectory was repeatedly hindered by Eskom's refusal to sign power purchase agreements, political delays during the state capture era and persistent institutional resistance to renewables. Unlike Brazil, South Africa lacked the vertically integrated industrial strategy that could link renewable energy procurement with domestic manufacturing at scale.

This divergence highlights a key lesson: industrial policy coherence matters. Drawing on Rodrik's recent work, green industrial policy should be rooted in clear objectives, institutional experimentation and the ability to coordinate across ministries and sectors.[39] Brazil's experience illustrates this potential, whereas South Africa's fragmented governance and entrenched coal interests diluted the developmental impact of its renewable energy rollout.

Both countries have also faced challenges in integrating renewable energy into legacy grid infrastructures. In South Africa, outdated and under-invested transmission lines, particularly in provinces best suited for wind and solar, have become a major bottleneck. The SAREM and IRP 2023 identify this constraint, yet implementation remains sluggish and underfunded. South Africa's updated NDC also lacks sufficient ambition to meet net-zero by 2050 targets without a radical overhaul of energy infrastructure.[40] In Brazil, saturation of grid capacity in high-resource regions, especially the Northeast, has similarly constrained further wind and solar deployment.[41]

Finally, both countries offer important insights into the political economy of transition. In South Africa, the coal sector remains a dominant employer and political constituency, supported by powerful unions, complicating efforts to decommission plants and invest in renewables. In Brazil, coal is marginal to the national energy mix, but vested interests in the industrial agribusiness sector remain the principal obstacle to a deeper ecological transition, as they drive deforestation and inhibit a broader just transition trajectory.[42] In both contexts, the state has struggled to mobilise

---

[37] Kathryn Hochstetler, *Political Economies of Energy Transition: Wind and Solar Power in Brazil and South Africa* (Cambridge University Press, 2020), 50, Political Economies of Energy Transition: Wind and Solar Power in Brazil and South Africa.
[38] Bayer, "Experience with auctions," 2648.
[39] See Tilman Altenburg and Christian Assmann, eds., "Green Industrial Policy: Concept, Policies, Country Experiences" (Geneva/Bonn: UN Environment/German Development Institute, 2017), 1.
[40] Climate Action Tracker, "South Africa Country Assessment," May 20, 2025.
[41]Bloomberg, "Brazil's Green-Energy Industry is Falling Victim to its Own Success," June 25, 2025.
[42] Hochstetler, *Political Economies of Energy Transition*, 15.

and maintain a coherent just transition coalition, especially where short-term distributional impacts of decarbonisation are concentrated geographically and socially.

To move forward, both countries must consolidate long-term, inclusive green industrial strategies. These should link procurement frameworks to localisation targets, improve skills ecosystems, expand grid infrastructure and ensure rent-sharing mechanisms are equitable. The green transition is not merely a technological problem; it is a state capacity and governance challenge. Without credible commitments to long-term coordination and equity, decarbonisation may either stall or deepen inequality. A just transition, therefore, requires not only cleaner power but also stronger democratic and developmental institutions.

BRICS, BASIC, the G20 and green technology acquisition

The BASIC coalition, comprising Brazil, South Africa, India and China, emerged as a negotiating bloc within the UNFCCC process to assert the developmental interests of large emerging economies in global climate governance. Closely aligned with the broader BRICS formation (which also includes Russia), both groupings have consistently advocated for equity in international climate negotiations, particularly through their commitment to the principle of 'common but differentiated responsibilities and respective capabilities'. In the climate governance architecture, BRICS has sought to maintain policy space for national development goals while selectively engaging in climate action and green technology acquisition.[43]

However, the bloc's recent expansion to include Iran, Egypt, Ethiopia, the United Arab Emirates (UAE) and Indonesia potentially dilutes its prior unified commitment to decarbonisation. The newer members lack a cohesive climate mitigation agenda and some, such as Iran and the UAE, are heavily dependent on hydrocarbons, which complicates consensus-based commitments within the group. This divergence may explain why BRICS, while rhetorically supportive of climate cooperation, has so far failed to advance ambitious cross-border technology partnerships in renewables or hydrogen on a meaningful scale.

Despite these structural weaknesses, there have been promising developments. For instance, the New Development Bank has funded solar and wind projects in South Africa and Brazil. In the South African case, a ZAR 2.6 billion (approximately $ 150 million) loan supported IPP procurement under the REIPPPP, with green hydrogen potential also under exploration.[44] South Africa's positioning as the only African country in both BRICS and G20 makes its role strategic. Yet, the national IRP 2019, which still favours coal-heavy baseload capacity, is insufficiently aligned with the country's NDC obligations and the Renewable Energy Master Plan's ambitions, even by mid-2025.[45]

Moreover, the G20's Energy Transitions Working Group has developed voluntary guiding principles to accelerate hydrogen deployment, emphasising fair trade, certification standards and

[43] Chetty et al., "Fostering a Just Energy Transition," 160.
[44] M. Müller, "Between Global Geopolitics and National Interests: BRICS Cooperation in the Mineral Sector," *South African Journal of International Affairs* 32, no. 2 (2025): 173.
[45] M. C. Udeagha and E. Muchapondwa, "Green Finance, Fintech, and Environmental Sustainability: Fresh Policy Insights from the BRICS Nations," *International Journal of Sustainable Development & World Ecology* 30, no. 3 (2023): 201.

investment frameworks.[46] BRICS members, especially India and China, have shown increasing interest in these efforts, but coordination with South Africa remains fragmented. A lack of unified certification systems, infrastructure bottlenecks and overlapping policy objectives still hinder the emergence of a harmonised hydrogen economy among BRICS countries.[47]

A special edition of the *South African Journal of International Affairs* on the just energy transition and green mineral geopolitics further underscores the tension between industrial policy sovereignty and the demands of the energy transition. Müller and her co-authors, for instance, argue that the shift to green technologies in the BRICS context is as much about geopolitical repositioning as it is about sustainability.[48] Industrial policy is often wielded defensively to preserve domestic extractive advantage (eg, critical minerals for batteries) rather than to support integrated green tech ecosystems. This mirrors Rodrik's view that successful industrial policy requires embedded autonomy: the state must be both insulated from capture by entrenched interests and attuned to dynamic industrial possibilities. South Africa's current transition management falls short on both counts. Its state-led frameworks are vulnerable to incumbent lobbying from the coal sector and proactive planning for a green industrial base remains weak, despite the rhetoric around green hydrogen corridors and local beneficiation.[49]

By contrast, Brazil's climate transition has not been hindered by coal interests to the same extent; coal is a marginal energy source in the country. Instead, industrial agriculture and deforestation pose the most acute threats to Brazil's ecological integrity and emissions reduction efforts. Yet it has emerged as a major innovator in biofuels and green finance and holds considerable potential for leadership in the BRICS hydrogen economy, provided its forest protection policies align with low-carbon goals.

Going forward, a more coherent framework for green technology transfer within BRICS – one that aligns G20 hydrogen protocols with BRICS development financing and technology co-production – could offer significant gains. However, this will depend on resolving tensions between geopolitical pluralism and climate ambition, especially within South Africa's domestic policy architecture.

Conclusion

The comparative analysis of Brazil and South Africa's experiences with wind and solar PV industrial development underscores both the potential and the fragility of green industrial transitions in middle-income countries. Each has demonstrated the ability to design policy instruments that attract investment, stimulate domestic manufacturing and build initial renewable energy capacity. Yet both have also encountered structural and political limitations that hinder the full realisation of their green industrial ambitions.

---

46 A. M. Jaffe et al., "Green innovation of state-owned oil and gas enterprises in BRICS countries: a review of performance," *Climate Policy* 23, no. 9 (2022): 1167.
47 Q. Wang, X. Wang, and R. Li, "Geopolitical Risks and Energy Transition: The Impact of Environmental Regulation and Green Innovation," *Humanities and Social Sciences Communications* 11 (2024): Article 145.
48 Melanie Müller, Meike Schulze, and Svenja Schöneich, "The Energy Transition and Green Mineral Value Chains: Challenges and Opportunities for Africa and Latin America," *South African Journal of International Affairs* 30, no. 2 (2023): 169.
49 A. Boretti, J. I. Agbinya, and K. Okedu, "Why Africa Must Assert Sovereignty Over Its Hydrogen Future," *International Journal of Hydrogen Energy*, in press.

In Brazil, early coherence between industrial and energy policy, especially in the wind sector, resulted in a domestically anchored supply chain, catalysed by demand guarantees, state-backed finance and localisation rules. Yet solar PV diffusion lagged, revealing the constraints of limited domestic capacity, regulatory lags and a shallow innovation ecosystem. In South Africa, the REIPPPP initially provided a global benchmark for competitive renewable procurement, but political inertia, Eskom resistance and grid constraints eroded momentum, exposing the fragility of transitional coalitions and the path dependency associated with carbon-heavy incumbents.

Across both cases, lessons emerge: success hinges not only on the design of industrial policy tools but also on their insulation from elite capture, their compatibility with trade and investment rules and their ability to link global decarbonisation goals with local development gains. Furthermore, skills mismatches and underdeveloped technological ecosystems remain barriers to inclusive benefit, echoing Rodrik's argument that 21st-century industrial policy must be both green and equitable. As the international climate governance architecture (BRICS, BASIC, G20, WTO) evolves, Brazil and South Africa have a critical opportunity to shape rules that enable innovation, facilitate fair technology transfer and protect developmental space.

The road to a just energy transition will not be paved solely by wind turbines or solar panels; it must also include domestic industrial strategies that democratise benefit, strengthen public institutions and recognise the political economy realities of reform. This calls for politically durable, evidence-based and participatory approaches to industrial policy – attuned to the global climate imperative but rooted in local transformation.

Policy recommendations

Align industrial and energy planning

Integrate renewable energy procurement with clear, long-term industrial policy signals. South Africa's REIPPPP and Brazil's auction models should be better coordinated with localisation and skills strategies to generate lasting economic spillovers.

Invest in grid infrastructure and storage

Both countries must prioritise investment in transmission infrastructure to accommodate decentralised renewables and prevent curtailment. Smart grids, flexible dispatch protocols and public investment in storage (especially in Brazil's Northeast Region and South Africa's Northern Cape) are essential.

Scale domestic innovation ecosystems

Move beyond technology importation toward adaptive R&D. Public investment in energy research institutions, partnerships with universities and directed funding for domestic start-ups can deepen endogenous innovation capabilities.

Strengthen labour market and skills pipelines

Develop targeted green skills roadmaps in collaboration with unions and technical training institutions. Reskilling programmes must be proactive, especially in coal-intensive regions such as South Africa's Mpumalanga province or Brazil's southern Santa Catarina state.

Reform state-owned utilities

In South Africa, unbundling and financial reform of Eskom must be accompanied by transparent governance and stakeholder accountability. Brazil should clarify Eletrobras's role in supporting distributed generation and grid integration.

Leverage multilateral platforms

Brazil and South Africa should use their position in BRICS, BASIC and the G20 to push for binding commitments on technology transfer, support for green industrial finance and reform of WTO rules to allow green developmentalism.

Mandate just transition in law

Enshrine the principles of a just transition into national legislation to ensure worker protection, community participation and fiscal support in coal phase-out areas. This should include social safety nets and revenue earmarking from carbon pricing where applicable.

Enhance monitoring and evaluation

Both countries should establish independent bodies to track the socio-economic and environmental outcomes of their renewable energy industrial policies, ensuring that evidence, not ideology, drives policy adaptation.

Author

Nerissa Muthayan

Nerissa Muthayan was a Research Fellow in the Climate and Natural Resources Programme at the South African Institute of International Affairs.

Acknowledgement

This work is based on the research supported by the National Institute for the Humanities and Social Sciences.

About SAIIA

SAIIA is an independent, non-government think tank whose key strategic objectives are to make effective input into public policy, and to encourage wider and more informed debate on international affairs, with particular emphasis on African issues and concerns.

Cover image: SAIIA

Please note that all currencies are in US$ unless otherwise indicated.

Jan Smuts House, East Campus, University of the Witwatersrand
PO Box 31596, Braamfontein 2017, Johannesburg, South Africa
Tel +27 (0)11 339 2021 • Fax +27 (0)11 339 2154
saiia.org.za • info@saiia.org.za

SOUTH AFRICAN INSTITUTE OF INTERNATIONAL AFFAIRS