Empirical Analysis of BRICS Countries Pathway Toward Low-Carbon Environment

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Abstract

Background: The rising sea level, the lasting variations on the surface ocean current, vulnerable ecosystems, hydrological cycle, extreme weather conditions, and the like are subjects emanating from the rising emission in the atmosphere. Global climate change has emerged as humanity's greatest challenge, affecting both the earth's natural security and the long-term growth of human society. Yet, the reckless pursuit of economic gains put social and ecological environmental safety at a severe demerit. This practice has brought grave consequences to humanity in environmental pollution, climate change, health hazards depletion, etc. Protecting the environment and fostering long-term growth while reducing carbon emissions has become a global concern. The BRICS countries (Brazil, Russia, India, China, and South Africa) are participating in the fight against climate change through LCE promotion. In this study, we use content analysis to discuss some of the policies, plans, programs outlined by the various governments in the BRICS that can help them reach to help them accomplish LCE.

Results: The study discussion indicates that Brazil has adopted the (National Energy Plans 2030 and 2050), Russia (Energy strategy 2035 for Russia), India actions and plans also include (Apex Committee for Implementation of Paris Agreement of India, China (Pollution Control, Energy Conservation, and Carbon Reduction and South Africa (Economic Reconstruction and Recovery Plan). The result from the study also indicates that currently Brazil, Russia, India, China, and South Africa are rated "Insufficient," "Critically Insufficient," "Compactible" "incompatible," and "Highly Insufficient" respectively in their commitment to Nationally Determined Contributions (NDC) to the Paris Agreement.

Conclusion: The paper recommends that BRICS countries reach LCE through; expansion in low-carbon investments and financing, focus on taxation extends beyond energy, investment in low-carbon cities, adapting to a circular economy and low-carbon technology, a revisitation of the electricity markets, and the promotion of climate-friendly international trade among the BRICS countries.

Background

The deployment of a low-carbon environment (LCE) has become contentious among government, scientists, policymakers, and the general public because of the obstacles associated with climate change (CC) and global warming. The primary purpose of LCE is to reduce global greenhouse gas (GHG) emissions and mitigate CC (1). According to a recent report by the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), global temperatures, GHG emissions, and other factors are rising exponentially to stages that will have devastating impacts on society (2). United Nations report on climate indicated rising sea levels, permanent changes in ocean currents, the hydrological cycle, vulnerable ecosystems, and more extreme weather events are among the many environmental issues rising emissions pose (3). A slew of environmental problems increased to prominence in the 21st century. Governments worldwide are looking for policies, rules, and ways to reduce the negative impact of socio-economic activity on the environment (4).

To protect the environment and foster long-term growth, reducing carbon emissions has become a global concern. During the 1997 Kyoto Protocol, the United Nations Framework on Climate Change (UNFCCC) declared that countries who signed the Protocol must reduce their GHG emissions by an average of 5% below their 1990 baseline between 2008 and 2012 (5). As a result of the UNFCCC Protocol, governments worldwide have implemented regulations to achieve this objective. Although the BRICS countries (Brazil, Russia, India, China, and South Africa) signed the UNFCCC Kyoto Protocol to reduce emissions, there are still concerns about environmental issues in light of these countries' recent economic boom (6). A current agreement on CC is the Paris Agreement target of countries achieving below 2°C warmings. The Paris Agreement and the 2030 Agenda for Sustainable Development put out a blueprint for LCE, CC resilient, and sustainable future for all countries to implement as soon as possible (7).

Over the last 60 years, the BRICS economies have been consistently strong in terms of economic development. It is estimated that the BRICS economies will account for 50% of the globe's economy by 2025 (8, 9). CC would be the fundamental challenge that the BRICS nations and the rest of the world would face in 2020 (2). In terms of cultural background, language, and economic structure, the BRICS countries differ. These countries, however, have one thing in common: their economic development has exceeded that of the world's major industrialized nations. The BRICS countries continued to outperform the rest of the globe even after the global financial crisis began in 2007. While emerging economies decrease by 6% in 2009 (for instance, Japan and Germany), Brazil remained stable, India expanded 5.9%, and China gained 8.1 %; the group's worst performer was Russia, which shrank by 7% (6).

The BRICS countries' contribution to global economic growth and development should not be underestimated. The financial assistance of these countries stems from the role entrepreneurs and companies play in industries such as construction, manufacturing, mining, and others. The gross domestic product (GDP) per capita of the BRICS countries is shown in Fig. 1. The figure indicates that BRICS country's GDP per capita has increased from \$21240 in 1960 to more than \$ 20 trillion in 2020 (9). Specifically, in 2018 the nominal growth of GDP in the BRICS countries accounted for 23% of global output (9).

Concerns had been expressed about the BRICS countries' social and environmental resilience. For the BRICS countries, bridging the economic and ecological gap and minimizing CC is critical to international sustainable development (11, 12). The deterioration of the environment makes us aware of the consequent excessive CO₂ emissions, which contribute considerably to the GHG effect on global economic development (12). The BRICS nations had considerably impacted recent international economic growth and the environment and natural resources in recent decades (13). Figure 2 indicates the per capita CO₂ emission trends of the BRICS countries from 1960 to 2019. The figure shows increased emission CO₂ due to the rise in the economic development of the BRICS countries.

Economists examined the socio-economic performance of various countries through the lens of social and environmental welfare, considering the social and ecological consequences of economic expansion (14). Recently most countries have shifted their attention to environmental protection and simultaneously developing their economies (15). The interests of corporate entities, enterprises, and lawmakers have evolved to encourage and develop new sustainable economic models that can be labeled "green" (16). Entrepreneurs have been urged to engage in green entrepreneurship, which benefits both the economy and

the environment. Green entrepreneurship, which combines environmental, social, and economic goals, has been identified as a viable strategy for establishing a sustainable society (17, 18).

Global climate change has emerged as humanity's greatest challenge, affecting both the earth's natural security and the long-term growth of human society. As a result, lowering GHG emissions and slowing the climate change trend have become a significant concern worldwide. Therefore, it is critical to developing LCE to address long-term economic and environmental issues (19). The sustainability of the biological ecosystem is threatened by rising overall CO₂ emissions, which also substantially impact human society. CO₂ emissions linked to climate change have long been labeled a "super wicked problem," severely affecting human well-being (9). Firms in developing economies are reluctant to initiate significant green initiatives due to weak rules and regulation that fails to protect against unethical behavior and a lack of well-developed communication channels for championing the enormous benefits of green initiatives (20, 21).

The concept of LCE and renewable energy is vital for all international communities due to the world's current dual difficulties (climate crisis and economic development demand). The international community encompasses entrepreneurs and other key stakeholders who can help ensure a safe environment for human survival (9). Alister D, Chloé F (22) noted that with suggestions to link stimulus packages to battle the coronavirus to a cleaner economy, all governments are under pressure to proclaim more ambitious climate actions in the Paris climate agreement's first five-year milestone. As seen in Fig. 3, the BRICS countries are well-represented among the world's major carbon emitters, with all five countries ranking among the top fifteen. Almost two-fifths of world carbon emissions are attributed to the BRICS. As a result, environmental sustainability concerns have been raised in the context of the BRICS countries (11).

Global warming, climatic disasters, and climate transition risks can cause economies in developed and developing countries, resulting in increased financial instability, return volatility, and stranded growth rates (24). Climate disasters are becoming more common, endangering the lives and livelihoods of millions of people worldwide. Climate risks can force countries into a lower-growth path marked by more financial volatility, budgetary limitations, and poverty traps, in addition to causing a rapid economic and social catastrophe (25). This is especially true for more vulnerable developing countries, many of which have been disproportionately affected by COVID-19's economic consequences (25).

Recently, the BRICS leaders reaffirmed their decision to take decisive action in dealing with climate change during the most recent BRICS summits in Xiamen 2017 and Johannesburg 2018, respectively, through the Xiamen Declaration and the Johannesburg Declaration. Under the preposition "BRICS: Stronger Partnership for a Brighter Future," the leaders in Xiamen pledged to strengthen BRICS cooperation on climate change and expand green financing, as well as to take actions to advance result-oriented cooperation in areas such as air and water pollution prevention, waste management, and biodiversity conservation (26)

This calls for research on the way forward to enhance LCE, especially in the BRICS countries where economic growth is rising. Given the enormity of addressing the world's terrible effects of climate change, this study is essential and significant. The contribution of this study is that it discusses multi-level policy, plans adopted by the BRICS countries to achieve LEC. Also, to achieve success in the reductions in the global LCE and prevent the catastrophic impact of climate change in the BRICS countries, governments in these countries, through the effort of various actors, put out policies that can lead to this target. There is a need for government decarbonization policy and equitable transition to be coordinated at the international, national, and local levels. Furthermore, policy recommendations are included in this study to help generate fresh ideas for future low-carbon development and guide future practices in tackling CC in the BRICS countries.

This study discusses international, federal, and local climate policy set out by various governments in the BRICS countries in achieving LCE through a multi-level perspective. Thus, the discussion will cover; policy framework towards climate change reduction, low carbon energy trends and policies, and energy efficiency trends and policies. In addition, the research examines the Climate Action Tractor's (CAT) six important categories for assessing each country's commitment to the Paris Agreement and UNFCCC protocols.

Concept of Low-Carbon Economy (LCE)

The concept of an LCE was initially introduced in the United Kingdom's White Paper in 2003. LCE aims to increase economic production by reducing CO₂ and GHG emissions (27). The primary source of climate change is a rise in GHG emissions from human activity, particularly CO₂ emissions. As a result, establishing LCE has become the universal consensus in fighting against global warming. According to a recent estimate by the Carbon Trust, global low-carbon exports will be worth more than \$1 trillion by 2020 (28). LCE can be defined as an economic model which aims at minimal consumption of Carbon Energy (coal, oil, etc.) and output of GHG, specifically CO₂ (29). The World Low Carbon and Eco-economy Conference and Technical Exposition reported that LCE aims to use high technology, high energy efficiency, high economic benefit, low energy consumption, low pollution, and low emission by stakeholders (29).

LCE is defined as "a way of thinking, behaving, and operating that minimizes carbon pollution while allowing for resource sustainability, economic development, and higher quality of life" (28). Therefore, environmentally sustainable technologies are critical for tackling CC and easing the transition to an LCE (30). The goal of an LCE is to improve people's quality of life by increasing resource utilization efficiency and lowering environmental emissions. Economic, commercial, and technical shifts will accelerate the need for global LCE. Governments, businesses, and consumers must all work together to adopt LCE (31–33).

Methods

The methodology of this paper is based on data gathered from Climate Action Tractor (CAT) database. CAT methodical approaches six critical areas in assessing every country's commitment to Nationally Determined Contributions (NDC) to the Paris Agreement and UNFCCC protocols. Table 1 explains these six criteria of CAT assessment. To provide policy makers, civil society, and the media with an up-to-date assessment of countries' individual reduction targets

and a global overview of their combined effects, the Climate Action Tracker (CAT) project was launched in 2009. All of this is being done in order to make these pledges more transparent and to encourage those governments that haven't made them yet to do so. In addition, CAT assesses whether countries are on track to meet their commitments with current implemented policies (34).

Table 1
Criteria for Nationally Determined Contributions to Paris Agreement

Nationally Determined Contributions to Paris Agreement	Meaning
Critically Insufficient	NDCs with this rating falls well of a country's "fair share" range and are not at all consistent with holding warming below 2°C let alone the Paris Agreement stronger 1.5°C
Highly Insufficient	NDCs with this rating fall outside of a country's "fair share" range and not consistent with holding warming below 2°C let alone the Paris Agreement stronger 1.5°C
Insufficient	NDCs with this rating are in the least stringent part of a country's "fair share" range and not consistent with holding warming below 2°C let alone the Paris Agreement stronger 1.5° C
Compatible	NDCs with this rating are consistent with the 2009 Copenhagen 2°C goal and therefore fall within a country's "fair share" range but are not entirely consistent with the Paris Agreement.
1.5° C Paris Agreement Compatible	This rating indicates that a government's NDCs in the most stringent part of a country's "fair share" range: it is consistent with the Paris Agreement stronger 1.5° C limit
Role Model	This rating indicates that a government's NDC is more ambitious than what is considered a "fair share" contribution: it is consistent with the Paris Agreement stronger 1.5° C limit
Source: Climate Action Tracker (35)	

Results

Brazil

Brazil's emissions are expected to be 4% to 5% lower than their prior forecast from December 2019 (39). Emissions from energy (including transportation) and industrial activities are expected to rise considerably due to COVID-19 and the decline in Brazil's economy. However, unless emissions reduce during the early 2020s, Brazil will fall short of its 2030 NDC target. Deforestation emissions are continuing to rise, indicating that Brazil will not fulfill its NDC commitments. CAT considers Brazil's present Paris Agreement aim "insufficient" since it does not go far enough to keep warming below 2°C, let alone 1.5°C, as depicted in Figure 4.

Russia

Russia's current 2030 emissions target (25-30% lower than 1990 levels) was deemed "Critically Insufficient" by the (35). Russia's classification would be raised from "Highly Insufficient" to "Highly Sufficient," with a reduction of 33% below 1990 levels. Russia's NDC update should be much more ambitious if it plays a fair role in limiting global warming to 1.5°C, as shown in Figure 5.

India

India boosts its NDC target, plans to build new coal-fired power plants, and instead develops a strategy to phase out coal for electricity generation by 2040 (57). In that case, it might become a global climate leader with a "1.5 C compatible" grade, as shown in Figure 6. The GDP intensity target could be replaced with an absolute target to promote transparency and clarity (57). Three of the most recent policies outlined by India to reach LEC are discussed below:

China

China's emission forecasts have been lowered due to the current COVID-19 epidemic. If current policies are followed, GHG emissions in 2030 will range from 12.9-14.7 Gt CO₂e/year. As a result of these efforts, China is expected to meet its 2020 promise and 2030 NDC targets (68). Due to revised GDP projections in the ongoing global pandemic, the carbon intensity target (emissions/GDP) has also been lowered by -3 to -8 percent to 14.4-16.9 Gt CO₂e/ in 2030. China's NDC and national policies are "incompatible" with keeping global warming below 2°C, much less 1.5°C, unless other countries make significantly more significant cuts and similarly higher efforts, as indicates in Figure 7 (68).

South Africa

South Africa's NDC goal is rated as "Highly Insufficient" based on the upper end of the NDC target range, as shown in Figure 8. In light of this, South Africa's 2030 goal, which was resubmitted to the UNFCCC as part of the Paris Agreement's 2020 ambition-increasing cycle, should be reconsidered (34).

Discussion

Multi-Level Policy for Low Carbon Emission in the BRICS Countries

This paper will take an overview of the strategy adopted by the BRICS countries to reduce carbon emissions. The BRICS summits and environment ministers' meetings have supported the UN's CC initiatives, particularly the G20 and UN summits' rising action on sustainable development, CC, and biodiversity. The UN has received similar support from the majority of BRICS summit commitments. Improving collaboration and continuing the exchange of knowledge reduce the adverse effect of CC on food security and agriculture is one of the aims of BRICS countries (2). The study delved into three recent policies adopted by each government in the BRICS countries to solve CC issues, GHG, carbon emission, and general environmental problems. This section will provide insight into the aims and objectives of some of these projects and policies and how they can lead to LCE in the BRICS countries.

Brazil s pathway to a low carbon economy

Brazil is among the five significant emergings "BRICS" countries, and it has the world's sixth-highest GHG emissions (36). In the run-up to the Paris climate change summit, Brazil boosted the ambition of its climate initiatives through various programs and activities (36). Green finance tools, such as green bonds and green loans, can channel vast private capital towards climate and environment-friendly investments. Investors commit to climate-related projects by boosting the use of renewable energy, improving energy efficiency, and adapting to CC. In Brazil, private capital is exceptionally significant, especially given the country's vulnerable fiscal status. The key to Brazil's LCE and environmentally sustainable economy is a compelling blend of private and public engagement (37). Brazil's Ministry of Agriculture, Livestock, and Supply (MAPA) announced the ABC+ Sectoral Plan for Climate Change Adaptation and Low Carbon Emission in Agriculture Seeking Sustainable Development (2020-2030) on Apr 20, 2021. The plan aims to strengthen Brazilian agriculture by establishing sustainable, resilient, and productive systems. MAPA serves as a tool for promoting sustainable agriculture by implementing adaptation and mitigation techniques for GHG emissions. In the third quarter of 2021, a document will be released that will outline the plan's actions and quantitative goals of Brazil towards LCE (38). Three of the most recent policies outlined by Brazil to reach LEC are discussed below:

National Energy Plans 2030 and 2050

The Ministry of Mines and Energy (MME) and the Brazilian Energy Research Company launched the 2050 National Energy Plan (PNE 2050). The MME coordinates the program, supporting construction, appliances, and manufacturing efforts. Other more recent measures emphasizing energy efficiency include the MME and (PNE 2030), which estimates that by 2030, Brazil will have cut its energy use by 10%. The MME is currently working on the PNE 2050 National Energy Plan, which will likely be completed shortly (40). Analysis and estimates of economic development, energy demand, and output potential will be used to inform energy policy for the next 30 years (40). The Governmental Energy Research Company emphasizes investing in modern renewable energies such as wind and solar; the plan estimates a relative increase in energy supply from thermal power plants fueled by natural gas and coal (41).

Plan to Control Illegal Deforestation and Recovery of Native Vegetation (PPCDAm and PPCerrado)

The Executive Committee for the Control of Illegal Deforestation and the Recovery of Native Vegetation is established by this Decree, comprising 12 articles. It sets the committee's composition, tasks, and responsibilities above, proposing planning, articulating, and integrating strategies to prevent and control illegal deforestation and native vegetation recovery (42). Forest legislation was identified by the (PPCDAm and PPCerrado) as a system of laws that govern the exploitation and utilization of forest resources. The plan aimed at protecting regions or resources in Brazil date back to the colonial period, with the primary goal of ensuring control over the management of certain features such as flora, water, and soil (43)

Providing for the establishment of the Amazon Fund

The Amazon Fund is a ground-breaking project for Reducing Emissions from Deforestation and Forest Degradation (REDD+) finance. The fund was established to gather non-reimbursable investments into deforestation prevention, monitoring, combat, conservation, and sustainable environment in Brazil (44). The Brazilian National REDD+ Strategy (ENREDD+) was approved at the end of 2015, with the overall goal of preventing illegal deforestation, promoting forest ecosystem conservation and restoration, and fostering a low-carbon, sustainable forest economy while providing environmental, social, and economic benefits (44). Some of the Brazilian government's policies, strategies, and action plans in achieving low-carbon emission are presented in Table 2.

Table 2: Some policies and action plans of Brazil on carbon emission control

Source: Author compilation

Russia pathway to a low carbon economy

Russia saw its emissions nosedive after the Soviet Union's smokestack industries fell in 1991(45). The country is still less than half of what it was in 1990, reducing CO2 emissions compared to the UN's benchmark. Russia started to fight CC as early as the 1980s. By the late 1980s, climatologists had reached a consensus on human contributions to current global warming, resulting in the 1992 ratification of the UNFCCC. The Soviet Union was a leading climate voice in this regard (45). Russia has been actively involved in international climate negotiations for more than two decades through the United Nations, the G8 and G20, and the BRICS bloc, including the UNFCCC and the Paris Agreement's commitment to avoid "dangerous interference with the climatic system" and achieve net-zero carbon emissions by 2050 (46). Russia's Energy Strategy 2035, which was established in June 2020, aims to increase the country's fossil fuel industries, concentrating on natural gas production and exports. Russia's fuel and energy complex (FEC) will become the country's economic backbone during the next decade, while the worldwide surging renewable energy sector is the solution to CC. (45).

Russia's current 2030 emissions target (25-30% lower than 1990 levels) was deemed "Critically Insufficient" by the (35). Russia's classification would be raised from "Highly Insufficient" to "Highly Sufficient," with a reduction of 33% below 1990 levels. Russia's NDC update should be much more ambitious if it plays a fair role in limiting global warming to 1.5°C, as shown in Figure 5. Three of the most recent policies outlined by Russia to reach LEC are discussed below:

Energy strategy 2035 for Russia

Policies, Strategies, and Action Plans	Year
Brazil became the signatory nation of the "United Nations Framework Convention on Climate Change" (UNFCCC)	1992
Brazil signed the "Kyoto Protocol."	1997
National Energy Efficiency Plan	2011
Mining Sector Plan for mitigation and adaptation to climate change - Plan for low carbon mining	2013
Agricultural Sector Plan for mitigation and adaptation to climate change and the consolidation of a low carbon economy in agriculture (Plan ABC)	2013
Transport Sector Plan for mitigation and adaptation to Climate Change	2013
National Adaptation Plan to Climate Change Vol I and II	2016
Decree No. 8.972 creating the National Policy for the Recovery of Native Vegetation	2017
Decree no 9.17 administrative infractions and penalties to the environment	2017
Ten-Year Energy Expansion Plan (PDE 2029)	2018
Decree No. 9308 establishing the annual compulsory targets for greenhouse gas emission reduction related to fuel trade referred to in Law No. 13.576	2018
Inter-ministerial Committee on Climate Change.	2019
Decree no. 10.387 to provide incentives for financing infrastructure projects with environmental and social benefits.	2020
Providing for the establishment of the Amazon Fund	2020
Plan to Control Illegal Deforestation and Recovery of Native Vegetation (PPCDAm and PPCerrado)	2020
National Energy Plans 2030 and 2050 (PNE)	2020

The Russian government approved a new Energy Strategy till 2035 in June 2020. The strategy said that one of Russia's primary objectives is to become a global leader in hydrogen production and export. It also set concrete export goals of 0.2 million tons by 2024 and 2 million tons by 2030. Energy (47). To meet these goals, the government plans to undertake the following measures (48):

- i. investments in hydrogen and hydrogen-based energy mix production, transportation, and consumption;
- ii. growth in natural gas-based hydrogen generation, including the use of renewable and nuclear energy;
- iii. development of Russian low-carbon technologies for producing hydrogen from methane pyrolysis, electrolysis, and other methods, including by the localization of foreign technologies;
- iv. internal market demand for hydrogen fuel cells in transportation, as well as the use of hydrogen and hydrogen-based energy mixes as energy storage and a conversion tool to increase the efficiency of centralized power supply systems;

Approving the hydrogen roadmap 2021-2024 for Russia

As governments and corporations worldwide (including many oil and gas giants) focus more intensely on energy transition, the commercialization of hydrogen technology might play a vital role in the global clean energy agenda. Russia recently released its hydrogen roadmap. The plan, which covers the years 2021–2024, is intended to be a first step for the Russian government, industry, and institutions to better understand the potential of hydrogen and encourage the deployment of hydrogen pilot projects (49,50).

In addition to several organizational and regulatory steps, the hydrogen roadmap calls for the development of high-priority pilot hydrogen projects that include, among other things, pilot equipment for carbon-free hydrogen production is being developed, manufactured, and used. Gas turbine development, manufacture, and testing for methane-hydrogen fuel; prototyping a hydrogen-powered train transit system; construction of low-carbon hydrogen generation pilot sites at hydrocarbon processing plants or natural gas generating plants; Hydrogen production based on nuclear power (48).

National Action Plan for the First Phase of Adaptation to Climate Change of Russia

Russia issued a comprehensive strategy to adapt its economy and society to climate change on Jan 4, 2020. The Russian government has published the National Action Plan for the First Phase of Climate Change Adaptation for Up to 2022. The statement lays out the steps that federal and regional governments

will take to "lower the population's, economies, and natural environment's susceptibility to climate change impacts." Furthermore, it identifies several potential opportunities that may arise due to climate change (51). This national plan lays out the economic and social measures that will be implemented by federal and regional executive bodies to reduce the vulnerability of the Russian population, economy, and natural resources to CC's effects, as well as seize the opportunities that such changes present. This authorized national plan is the first step in adapting the economy and population to CC. It includes structural, organizational, and methodological strategies to help states build CC adaptation solutions (52). Some of the Russian government's policies, procedures, and action plans in achieving low-carbon emission are presented in Table 3.

Table 3: Some policies and action plans of Russia on carbon emission control

Policies, Strategies, and Action Plans	Year	Source: Author compilation
Russia became the signatory nation of the "United Nations Framework Convention on Climate Change" (UNFCCC)	1992	India pathway to a low carbon economy
Russia signed the "Kyoto Protocol."	1997	
Program for Energy-Efficient Economy with an outlook to 2010	2001	
Rules of Using Thermal Performance of Buildings	2009	India's energy future has implications for both global and national development goals. India's existing and projected emissions are significant enough to impact international mitigation efforts (53). India's multi-level energy and climate
On the Measures of Implementing Article 6 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change	2009	
Legislation on the limitations of associated gas flaring	2009	
Decree No. 449 on the Mechanism for the Promotion of Renewable Energy on the Wholesale Electricity and Market	2013	
Greenhouse Gas Emission Reduction (Presidential Decree 752)	2013	
State Program on Energy Efficiency and Energy Development (approved by Government Decree No 321)	2014	
National Action Plan for the First Phase of Adaptation to Climate Change	2020	
Energy Strategy 2035 approved by Government Decree	2020	
Government Directive No. 2634-r approving the hydrogen roadmap 2021-2024	2020	

governance framework include the national level, federal states, and cities, each with its own set of obligations, challenges, and opportunities. It might be claimed that since India's economic liberalization in 1991, its states have grown in importance and become critical stakeholders in the country's multi-level energy and climate governance frameworks (54). After 2007, climate policy became a distinct policy field in India. This is evidenced by the announcement of India's first National Action Plan for Climate Change in 2008 and the founding of the Nation Council on Climate Change, which the Prime Minister chairs. A Parliamentary Forum on Global Warming and Climate Change has also been established to urge parliamentarians to work with climate change experts. (55). Under the Paris Agreement, India has committed to having a national grid with 40% non-fossil fuel-built electric capacity by 2030. The country had already installed 24% (87GW) of renewable energy capacity as of March 2020 (56). Three of the most recent policies outlined by India to reach LEC are discussed below:

Apex Committee for Implementation of Paris Agreement of India

India's Ministry of Environment, Forests, and Climate Change (MoEFCC) has formed a high-level inter-ministerial Apex Committee for the Implementation of the Paris Agreement, confirming the country's commitment to "walk the walk" on CC (58). AIPA intends to provide a coordinated response to CC concerns to keep India on pace to meet its Paris Agreement obligations, especially its Nationally Determined Contributions (NDC). AIPA would also act as a National Authority to regulate carbon markets in India per Article 6 of the Paris Agreement. AIPA will also issue guidelines on carbon pricing, market mechanisms, and other similar instruments that affect CC and NDCs. It will assess the business sector's and multilateral agencies' contributions to CC and provide recommendations on better aligning their climate actions with national priorities. (58).

Three of the most recent policies outlined by Russia to reach LEC are discussed below:

The Indian NDCs have three quantitative goals (58):

- By 2030, the intensity of gross domestic product emissions will be reduced by 33-35% compared to 2005 levels.
- By 2030, non-fossil fuel-based electricity will account for 40% of total electricity generation.
- Using afforestation programs to create a carbon sink of 2.5-3 billion tonnes of CO₂.

Prime Minister's Farmer Energy Security and Upliftment Campaign (PM-KUSUM scheme)

The Ministry of New and Renewable Energy created this program to assist farmers with financial incentives to migrate from fossil fuel-powered pumps to new solar-powered machinery. The primary goal of this program is to make farmers economically self-sufficient. Farmers will be allowed to set up solar plants on their farm's idle land either by themselves or in partnership with an investor under the initiative, allowing them to earn a regular income (59). The electricity generated will be acquired at or below the Electricity Regulatory Commission's set rates. Plants with capacities ranging from 500 KW to 2 MW are proposed as part of the program. Farmers with less land who want to reduce their reliance on agriculture would be the main benefactors of the scheme. The solar plant will continue to provide them with a steady stream of money (59).

National Action Plan on Climate Change (NAPCC)

The NAPCC addresses the urgent and critical concerns of the country through a directional shift in the development pathway, including the enhancement of the current and planned activities outlined in the technical document (60). The NAPCC also presents several steps to simultaneously advance India's development and CC-related objectives adaptation and mitigation. The NAPCC lists eight national climate change missions. (1) National Solar Mission (2) National Energy Efficiency Mission (3) National Mission on Sustainable Habitat (4) National Water Mission (5) National Mission for Sustaining the Himalayan ecosystem (6) National Mission for a Green India (7) National Mission for Sustainable Agriculture (8) National Mission on Strategic Knowledge for Climate Change (60,61). Some of the policies, strategies, and action plans by the Indian government in achieving low-carbon emissions are presented in Table 4.

Table 4: Some policies and action plans of India on carbon emission control

Policies, Strategies, and Action Plans	Year	Source: Author compilation
India became the signatory nation of the "United Nations Framework Convention on Climate Change" (UNFCCC)	1992	China pathway to a low carbon economy China surpassed the United States as the world's leading GHG producer in 2007, accounting for roughly 28–30% of total worldwide emissions (62). China's remarkable emissions could be attributed to its vast socio-economic size of about 1.4 billion people, the second-largest economy, largest product exporter, most significant energy consumption, and largest energy importer. China has made remarkable economic progress over the last three decades, with a fast growth rate and increases in annual GDP (63,64). China's export is predominantly focused on value-added intermediate goods and processing trade (63) argues that rapid economic expansion leads to very high energy consumption and carbon emissions per GDP. (65) observed that China is projected to face sustained demands for CO ₂ reductions in the mid-and long-term due to the country's current economic situation. China must find long-term solutions to attain
India signed the "Kyoto Protocol."	1997	
National Electricity Policy	2005	
Integrated Energy Policy	2006	
National Action Plan on Climate Change	2008	
National Afforestation Program - Revised Operational Guidelines	2009	
National Policy on Biofuels	2009	
National Mission for Electric Mobility Plan 2020	2012	
National Agroforestry Policy 2014	2014	
National Urban Transport Policy	2014	
National Auto Fuel Policy and Auto Fuel Vision and Policy 2025	2014	
National Electricity Plan (Generation)	2016	
Tariff Policy 2006	2016	
Prime Minister's Farmer Energy Security and Upliftment Campaign (PM-KUSUM scheme)	2019	
Union Budget 2019-2020	2019	
Notification SO 4259(E) creating the Apex Committee for Implementation of Paris Agreement	2020	

LCE while maintaining an appropriate rate of economic growth. China's government announced in 2005 that by 2020, emissions of CO₂ per unit of GDP would be reduced by 40% to 45% (63). There have been plans to make the country carbon-neutral by 2060 and a revised objective of peaking emissions by 2030 (66). Carbon emissions are projected to rise shortly because China's economy has steadily grown despite the COVID-19 pandemic. As a result, China will need to accelerate domestic low-carbon innovation to meet its 2030 goal of peaking carbon emissions and reaching carbon neutrality by 2060 (67).

In the 11th Five-Year Plan (FYP), the emphasis on energy efficiency was maintained. At the commencement of the 12th FYP, this resulted in a significant re-alignment, including low-carbon, green, sustainable development, and market-based policies (62). The Chinese government has put forward various strategic plans to achieve LCE. These policies focus on energy saving, green infrastructure, renewable energy, and low-carbon cities. In 2007, the concept of "eco-civilization was proposed to achieve LCE in China (63). Three of the most recent policies outlined by China to reach LEC are discussed below:

Pollution Control, Energy Conservation, and Carbon Reduction

The National Development and Reform Commission drafted this legislation. It intends to improve internal investment management, reinforce and standardize the central budget for pollution control, energy conservation, and CO₂, and mobilize "social capital" to engage in pollution control, energy conservation, and CO₂ reduction. It is intended to take the place of the "Interim Measures for the Special Management of Investment in Ecological Civilization Construction within the Central Budget (69).

The initiative was designed to support the government's Air Pollution Control Action Plan and the 13th FYP for Energy Efficiency and Clean Energy (2016-2020), emphasizing lowering air pollution at its source through better energy efficiency and the expansion of clean energy. As part of the effort, green funding was mainstreamed in financial institutions, assisting the government in meeting its objectives. Huaxia Bank, a commercial bank, received assistance from the industry to provide financing to enterprises seeking to reduce air pollution and carbon emissions by improving energy efficiency, investing in clean energy, and strengthening air pollution controls. (70).

The 14th Five-Year Plan

The work report described the road to carbon neutrality by 2060 and peaking emissions by 2030, with China increasing up efforts to decarbonize its economy. By 2021, the government has set a goal of reducing energy intensity by roughly 3%. Authorities intend to lower energy intensity by 13.5 % during the following five years and carbon intensity by 18%. According to this report, an "action plan" for achieving peak carbon emissions will be established by the end of the decade (71). The 14th Five-Year Plan lays out China's development goal and roadmap for 2021-2025 and concrete environmental and efficiency targets. The strategy reaffirms the previously stated aim of carbon neutrality by 2060 and sets a target for emissions to peak in 2030 (72,73).

New Energy Vehicle Industry Development Plan and 2020 New Energy Vehicle Promotion Subsidy Plan

The New Energy Vehicle Industry Development Plan seeks to help the country produce electric and fuel cell automobiles. The 2020 New Energy Vehicle (NEV) Promotion Subsidy Plan establishes governmental support for the electrification of vehicles in the areas of public transportation, urban public transit, road passenger transportation, rental (including online car-hailing), environmental sanitation, urban logistics and distribution, postal express, civil aviation, airport, and party transportation for the years 2020 to 2022 (74). China's Plan 2021–2035 aims to put the country in a position to meet future demand for autonomous, connected, electrified, and shared mobility. Its three main objectives are to

- (1) establish a globally competitive auto industry with advanced NEV technologies and a positive brand reputation;
- (2) transition to an energy-efficient and low-carbon society with a convenient charging service network and battery electric vehicles as the mainstream in sales; and
- (3) improve national energy security and air quality, mitigate climate change, and stimulate economic growth (74). Some of the Chinese government's policies, strategies, and action plans in achieving low-carbon emissions are presented in Table 5.

Table 5: Some policies and action plans of China on carbon emission control

Source: Author compilation

South Africa pathway to a low carbon economy

In light of the growing need for CO₂ emissions and realize the potential benefits of a green-based society, the South African government has established plans to reduce carbon emissions by 34% and 42% by 2020 and 2025, respectively (75). Climate change has a significant influence on South Africa, remarkably increasing temperatures and water variability. The rate of the warming recorded in the western and northeast have been 2° per century or more, more than twice the worldwide temperature increases (76). By 2030, the National Development Plan (NDP) of South Africa intends to eradicate poverty, protect the environment, and promote economic development (77). South Africa is a signatory to the Paris Climate Change Agreement and has ratified it. South Africa's emissions are predicted to peak, plateau, and then drop beginning in 2025. The energy industry is responsible for about 80% of the country's total GHG emissions, with power generation and liquid fuel production accounting for half of that (78). There is already investing in renewable energy, energy efficiency, and public transportation to cut emissions in South Africa (78). The National Development Plan (NDP) 2030 for South Africa is a long-term strategy for the country. It identifies an ideal state where inequality and unemployment are decreased and poverty eradicates, allowing all South Africans to live well. Three of the most recent policies outlined by South Africa to reach LEC are discussed below:

Economic Reconstruction and Recovery Plan

South Africa's economic reconstruction and recovery plan, which aims to foster equitable and inclusive growth, was launched in October 2020. Many proposed measures could help South Africa adapt to a changing CC and reduce CO₂ emissions while bringing long-term social and economic benefits (79). On Mar 24, 2021, the government enacted a revised draft Nationally Determined Contribution (NDC), the basis of South Africa's CC response. Under the UNFCCC and the Paris Agreement, South Africa has agreed to contribute to the global CC effort (79). Green recovery initiatives and more aggressive climate action can complement each other to cut GHG emissions, build resilience, and boost economic growth. Countries can think about how these recovery actions will help them improve their NDCs and meet the longer-term goals of the Paris Agreement, which is especially essential as the COP26 in Glasgow approaches (80).

National Climate Change Adaptation Strategy (NCCAS)

Policies, Strategies, and Action Plans	Year
China became the signatory nation of the "United Nations Framework Convention on Climate Change" (UNFCCC)	1992
China signed the "Kyoto Protocol."	1997
The "National Chinese Plan to Respond to Climate Change" was released to control carbon emission by 2010, effectively	2007
A comprehensive Work Plan for Energy Saving and Emission Reduction was initiated by the Chinese National Development and Reform Commission (NDRC)	2007
The NDRC's first series on "Low carbon Pilot Cities" experimented with eight cities and five provinces.	2010
China's 12th Five-Year Plan declares the goal of reducing carbon emission intensity by 17% from the 2010 baseline	2011
The first series of 'energy-saving and emission-reduction demonstration cities,' which included eight cities, launched.	2011
The second series of 'Low-Carbon Pilot Cities' extended to 29 cities.	2012
The second series of 'energy-saving and emission-reduction demonstration cities' included 10 cities	2013
National Plan For Tackling Climate Change 2014-2020	2014
The newly revised Environmental Protection Law commenced	2015
The national carbon emission trading market was officially initiated	2017
China implemented the first green tax law, namely, the Environmental Protection Tax Law	2019
New Energy Vehicle Industry Development Plan and 2020 New Energy Vehicle Promotion Subsidy Plan	2020
14th Five-Year Plan	2021
Notice 655/2021 on Pollution Control, Energy Conservation, and Carbon Reduction	2021

South Africa's National Climate Change Adaptation Strategy (NCCAS) puts forth a coherent vision for CC adaptation and resilience and critical sectors for achieving that vision (81). As stipulated in the Paris Agreement, the NCCAS serves as South Africa's National Adaptation Plan and indicates its commitment to its international obligations under the UNFCCC. The NCCAS will serve as the foundation for meeting South Africa's adaptation responsibilities under the Nationally Determined Contributions (81).

Integrated Resource Plan (IRP)

The IRP is a capacity plan for energy that attempts to estimate the country's electricity demand, how it will be supplied, and how much it will cost. On May 6, 2011, South Africa's then-Department of Energy (DoE) released the Integrated Resource Plan, which forecasted the country's estimated energy demand for the next 20 years, from 2010 to 2030. The Department of Energy envisioned the IRP as a "living plan" that would be revised regularly (82). According to the IRP, the Department of the Environment should modify the IRP at least every two years. However, this was never done, resulting in an insufficient energy mix to satisfy the constantly shifting demands. However, this was never done, resulting in an energy mix that did not sufficiently help South Africa's continually changing supply and demand circumstances, nor did it reflect worldwide technological advances in energy-generating efficiency and responsibility (82). The 2010–2030 IRP assessed the preferred generation technology needed to fulfill predicted demand growth until 2030. Affordable power, reduced GHG emissions, decreased water use, diverse electrical generation sources, localization, and regional development were all included. Some of the South African government's policies, strategies, and action plans in achieving low-carbon emissions are presented in Table 6.

Table 6: Some policies and action plans of South Africa on carbon emission control

Source: Author compilation

Policy Recommendation for BRICS countries Transition to LCE

This section discusses several strategies and recommendations for BRICS countries' pathway to LCE. (Figure 9). These strategies can also be applied at various scales towards CO2 emissions reduction in the BRICS countries.

1. Expand low-carbon investments and financing in the BRICS countries

Policies, Strategies, and Action Plans	Year	A unique opportunity exists
South Africa became the signatory nation of the "United Nations Framework Convention on Climate Change" (UNFCCC)	1992	to ensure that new infrastructure investments
South Africa signed the "Kyoto Protocol."	1997	serve the climate agenda while also encouraging
Disaster Management Act (No. 57)	2003	economic development, and it is urgent and
Integrated Coastal Management Act (No. 24 of 2008)	2008	unprecedented. For the BRICS regions, the
Integrated Coastal Management Act (No. 24 of 2008)	2010	additional short-term costs of switching to a low-
National Climate Change Response Policy White Paper (NCCRP)	2011	carbon energy system would be barely a fraction
National Climate Change and Health Adaptation Plan 2014-2019	2014	of the overall infrastructure financing required (83). If
Sectoral Cold Spell Management Plan	2015	BRICS governments reevaluate their support for
National Greenhouse Gas Emissions Reporting Regulations	2017	investments in greenhouse-gas-intensive activities and
National Development Plan 2030	2017	mainstream climate objectives into public
Carbon Tax Act 15	2019	procurement and official development assistance,
National Energy Efficiency Strategy	2019	public finance and investment can also
Integrated Resource Plan	2019	catalyze the low-carbon transition. Public finance is
National Climate Change Adaptation Strategy (NCCAS)	2020	simply one of several tools that may facilitate the
Economic Reconstruction and Recovery Plan	2020	transition, such as developing infrastructure,

and retraining. An essential part of creating a transition strategy is identifying potential investors and entrepreneurs in the region who may be willing to make the most effective use of public financing (84).

2. Focus on taxation extends beyond energy

The most commonly researched environmental tax mechanisms are taxes on particular activities or consumption that generate highly damaging emissions, effluents, or residues, such as energy taxes and the carbon tax (85). While subsidies and tax expenditures favoring the development and use of fossil fuels impede low-carbon innovation, the current low oil prices also present a chance for reforms. Also, the government in the BRICS regions can provide tax incentives and subsidies to organizations or entrepreneurs who go into green business. (86) noted that an economy-wide carbon tax and governments committing to global action to reduce CO₂ emissions are other ways to reduce cross-sectoral leakage in the economy.

3. Investment in Low-Carbon Cities

As a notion of urban development, low-carbon consumption and production in cities can help create more cost-effective and environmentally-friendly urban energy and ecological systems. Reduced greenhouse gas emissions and minimal energy use are required in low-carbon cities (87). Cities play a significant role in global greenhouse gas emissions, particularly urban regions, which account for 67–76% of worldwide CO₂ emissions and energy consumption (88). Cities have evolved into fundamental units for executing emissions-reduction measures. Reduced greenhouse gas emissions and low energy usage are required in low-carbon cities in addition to a focus on economic development. To establish a win-win situation between urbanization and environmental protection, traditional energy technologies should be changed and innovated to limit the consumption of high-carbon energy and the production of urban greenhouse gases (87). Therefore, the study recommends that various governments in the BRICS should invest more in low-carbon cities, leading them to LCE. (1) added that, after 2009, many cities released their low-carbon economic development implementation plans for low-carbon city construction. Low-carbon pilots, sponge cities, low-carbon community pilots, and national low-carbon city (town) pilots are primarily responsible for achieving low-carbon cities.

4. Adapting to Circular Economy and Low-carbon Technology

The circular economy is a business model that highlights the ecosystem's regenerative capacity by reducing non-renewable resource consumption, extending the usable life of commodities, and reusing all materials that enter the economic cycle to reduce waste and pollution (85). Low-carbon technology will become more widely used as solutions become more mature on the market. The transition to clean and secure electricity will lay the groundwork for end-use electrification, a top priority (89). Low-carbon technology is one of the specialized techniques for reducing carbon dioxide emissions in buildings. Low-carbon

technology emits the least amount of GHGs into the environment, specifically CO₂ (90). Evaporative cooling, passive ventilation and cooling, solar photovoltaic, dehumidification, and energy recovery systems are examples of renewable and sustainable energy technologies (90).

5. The BRICS countries should revisit electricity markets

To achieve effective decarbonization of energy systems, electricity must be used. On the other hand, deregulated electricity markets do not provide the long-term price signal for investment in high-capital-cost, low-carbon technology. Newmarket arrangements, such as long-term supply agreements, as well as a robust and steady CO₂ price signal, will be needed to ensure competitive and timely investment in low-carbon solutions. To stimulate investment in low-carbon technologies, jurisdictions with regulated systems should consider providing more competition (83).

6. Promote climate-friendly international trade among BRICS countries

Although the international trade regime does not restrict states from implementing aggressive climate measures, some international trade barriers can undercut climate goals. Import restrictions, for example, continue to penalize trade in some technologies required for the low-carbon transition. Many countries that are promoting greener growth by favoring domestic manufacturers of low-carbon technologies must exercise caution. Where these regulations impede international trade, they may have a negative impact on total investment and the adoption of sustainable technologies (83). BRICS countries' pathway to LCE can be successful through the promotion of climate-friendly trade among themselves.

Conclusion

The discussion above has shown that various governments in the BRICS countries have put measures to control CC and its consequence on people. All these policies are aimed at LCE, which is quite recommending. However, the critical issue that needs to be addressed is the implementation of such policies. This will require strict measures to monitor the practical evaluation of the plans and procedures in the BRICS countries to achieve the target of LCE. The study discussed Brazil's policies, which include (National Energy Plans 2030 and 2050, Plan to Control Illegal Deforestation and Recovery of Native Vegetation, and to provide for the establishment of the Amazon Fund). Russia has also adopted (Energy strategy 2035 for Russia, Approving the hydrogen roadmap 2021–2024 for Russia, and National Action Plan for the First Phase of Adaptation to Climate Change of Russia). India's actions and plans also include (Apex Committee for Implementation of the Paris Agreement of India, the Prime Minister's Farmer Energy Security and Upliftment Campaign, and the National Action Plan on Climate Change). China also has implemented these strategies (Pollution Control, Energy Conservation, and Carbon Reduction, The 14th Five-Year Plan, and New Energy Vehicle Industry Development Plan). South Africa also has taken these initiatives (Economic Reconstruction and Recovery Plan, National Climate Change Adaptation Strategy, and Integrated Resource Plan). The study advocates that BRICS countries can reach LCE though; expansion in low-carbon investments and financing, focus on taxation extends beyond energy, investment in low-carbon cities, adapting to a circular economy and low-carbon technology, a revisitation of the electricity markets, and the promotion of climate-friendly international trade among the BRICS countries.

Abbreviations

LCE: Low-Carbon Environment; Climate Change (CC); GHG: Global Greenhouse Gas; IPCC: Intergovernmental Panel on Climate Change; IPBES; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services; UNFCCC: United Nations Framework on Climate Change; BRICS: Brazil, Russia, India, China, and South Africa); MAPA: Brazil's Ministry of Agriculture, Livestock, and Supply; NDC: Nationally Determined Contributions; CO₂: Carbon dioxide; MME: Ministry of Mines and Energy; PNE: National Energy Plan; CAT: Climate Action Tracker

Declarations

Availability of data and materials

The raw material that the analysis is based on is available on the <https://climateactiontracker.org/> database.

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Figures

Figure 1
 BRICS countries' per capita GDP trends from 1960 to 2020 Source: World Bank Data (10)

Figure 2
 CO₂ emissions per capita in the BRICS countries from 1960 to 2019 Source: World Bank Data (10)

Territorial (MtCO₂)

Rank	Country	MtCO ₂
1	China	10175
2	United States of	5285
3	India	2616
4	Russian	1678
5	Japan	1107
6	Iran	780
7	Germany	702
8	Indonesia	618
9	South	611
10	Saudi	582
11	Canada	577
12	South	479
13	Brazil	466
14	Mexico	439
15	Australia	411

Figure 3

Top Fifteen Metric tons of carbon dioxide equivalent (MtCO₂e) in 2019 Source: Global Carbon Atlas (23)

Figure 4

Brazil Nationally Determined Contributions to Paris Agreement Source: Climate Action Tracker (39)

Figure 5

Russia Nationally Determined Contributions to Paris Agreement Source: Climate Action Tracker (35)

Figure 6

India Nationally Determined Contributions to Paris Agreement Source: Climate Action Tracker (57)

Figure 7

China Nationally Determined Contributions to Paris Agreement Source: (68)

Figure 8

South Africa Nationally Determined Contributions to Paris Agreement Source: Climate Action Tracker (34)

Figure 9

BRICS pathway to Low Carbon-environment