

The BRICS Bloc in the Field of Renewable Energy and Its Role in Global Environmental Balance: An Analytical Study Covering the Period 2015-2024.

Le Bloc des BRICS dans le Domaine de l'Énergie Renouvelable et son Rôle dans l'Équilibre Environnemental Mondial : Une Étude Analytique pour la Période 2015-2024

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Abstract: This paper examines the role of the BRICS countries in renewable energy and its importance for global environmental balance. Using a descriptive-analytical approach with data from 2015-2023, the study shows that renewable energy consumption in BRICS plays a key role in reducing carbon emissions and improving environmental quality. BRICS nations contributed nearly half of the global renewable energy during this period.

Keywords: BRICS, Renewable Energy, Environmental Balance,

Jel Classification Codes : Q51, Q53, Q54, Q56

Résumé : Cette étude examine le rôle de l'alliance des BRICS dans le secteur des énergies renouvelables et son importance pour l'équilibre environnemental mondial. En utilisant une approche descriptive-analytique, l'étude analyse des données de la dernière décennie (2015-2023) et révèle que la consommation d'énergie renouvelable des pays BRICS réduit significativement les émissions de dioxyde de carbone, représentant près de la moitié de la part mondiale des énergies renouvelables durant cette période.

Mots clés: BRICS, Énergie Renouvelable, Équilibre Environnemental

Jel Classification Codes: Q51 , Q53, Q54 , Q56

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1. INTRODUCTION

The global energy system is heavily dependent on fossil fuels, and the BRICS countries are among the world's largest energy consumers, with China topping the list, the Russian Federation, India, and Brazil ranking among the top ten global emitters, while South Africa ranks 17th. Consequently, these countries are currently grappling with enormous environmental challenges. Therefore, the focus has shifted to decarbonization initiatives and mitigation of global warming by restructuring the energy networks in these countries, which necessarily includes policies that support the deployment of clean energy sources in order to mitigate the growing risks of global environmental changes and reduce greenhouse gas emissions.

Ensuring secure energy supplies, expanding access to energy, and minimizing environmental consequences are challenging issues for the BRICS countries. Recognizing this. Therefore, they have undertaken numerous collaborative efforts through joint investments, knowledge and technology exchange, and the organization of regular conferences and workshops that bring together representatives from governments, businesses, and research institutions from the BRICS countries to explore ways to enhance cooperation in the field of renewable energy.

Based on this premise, the problem of this study is as follows:

- How has the BRICS bloc's involvement in renewable energy impacted the global environmental balance?

This main question includes the following sub-questions:

- What is each country's contribution to the total renewable energy within the group?
- Is there a positive impact on carbon reduction in the BRICS countries due to the use of renewable energy?
- Has the BRICS bloc's involvement in renewable energy helped combat climate change and improve air quality?

We rely on the following hypotheses to address this study:

- ✓ Brazil, India, and China are, respectively, the most contributing countries to renewable energy in the BRICS.
- ✓ There is a positive impact on carbon reduction in the BRICS countries due to the use of renewable energy.
- ✓ The BRICS countries contribute positively and effectively to the preservation of the global ecological system.

Through this research, we aim to study the contribution of the BRICS countries in reducing the destructive impacts of climate change, which leads to natural disasters such as floods, droughts, or fires. This is because the bloc contributes a high percentage of air pollution (51% in 2021) due to the excessive use of non-environmentally friendly energy. This necessitates the urgent need to correct the course by adopting safe, environmentally friendly energy to try to mitigate the negative impacts of climate change, and this will be achieved by measuring the contribution of the BRICS countries' efforts in renewable energy globally, which reflects their role in the global transition towards clean and sustainable energy.

Studies have shown that renewable energy positively reduces carbon emissions in the BRICS countries in the short and long term, reflecting its significant impact on mitigating environmental damage. The most important of these studies are mentioned.

- Aubin Simon Mandimby (2024) Renewable energy reduces carbon emissions in BRICS countries.

The study employed a quantitative approach, using the ARDL panel methodology to examine the long-term relationship between CO₂ emissions and factors such as renewable energy consumption, industrialization, foreign investment, and economic growth. The analysis involved conducting various tests, including unit root, cointegration, and descriptive statistics. Key findings indicate a significant negative impact of renewable energy consumption on CO₂ emissions, suggesting that an increase in renewable energy usage reduces emissions over time. Additionally, industrialization and GDP growth showed a positive correlation with CO₂ emissions.

- R. Akram, Md. Tariq Majeed, Zeeshan Farid (2020): Asymmetric effects of energy efficiency and renewable energy

on carbon emissions in BRICS economies: Evidence from a nonlinear regressive auto-distributed lag model.

The study analyzed the asymmetric relationship between energy efficiency, renewable energy, and CO₂ emissions in BRICS economies. The analysis involved the application of multiple tests, including the cross-sectional dependence test and unit root test to measure data volatility, the asymmetric co-integration test to identify non-linear relationships, and the panel NARDL model to assess short- and long-term asymmetric associations. The results revealed asymmetric effects for all selected variables, with energy efficiency and renewable energy contributing to the reduction of CO₂ emissions.

In studying the relationship between renewable energy in BRICS countries and environmental balance, we relied on the descriptive-analytical method to analyze the data obtained from reports of international organizations, including the International Re-newable Energy Agency (IRENA), the International Energy Agency (IEA), and the United Nations Environment Programme (UNEP). We also relied on government data, national statistics for each country, and open data platforms (World Bank Open Data, etc.).

2. Definition of Renewable Energy and Its Sources

2.1 Definition of Renewable Energy

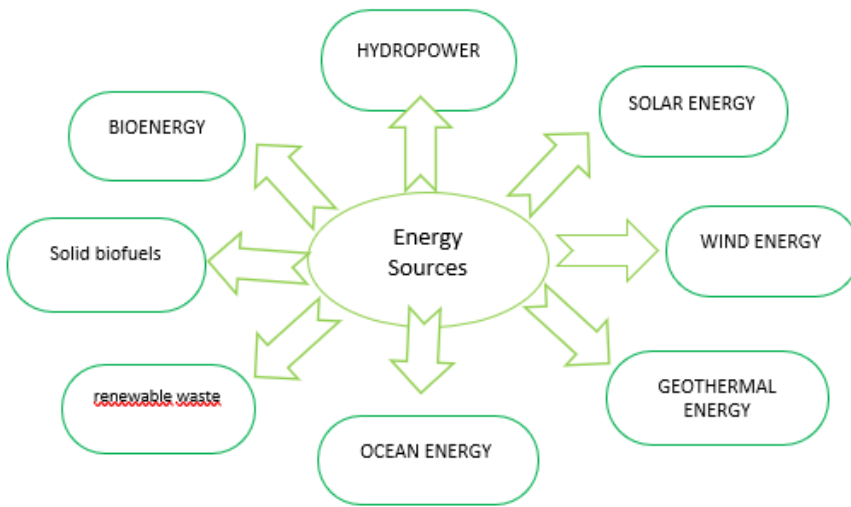
According to the United Nations, renewable energy is defined as:

Renewable energy is derived from inexhaustible, naturally occurring sources. It is considered environmentally friendly, as it does not contribute to rising temperatures or emit harmful gases. The primary sources of renewable energy include solar and wind power.*(United Nations)*

2.2 Sources of Renewable Energy

The main sources of renewable energy can be summarized in the following figure :

Fig N° 1: Represents the main sources of renewable energy



Source : created by the authors

The figure represents the main sources of renewable energy, with wind, solar, and hydropower being the most common and widespread. These sources are particularly notable for their strong capacity to generate electrical and thermal energy, making them the most utilized in various fields and sectors. They are also considered raw natural resources available in most countries.

2. Definition of the BRICS Bloc

The BRICS bloc is an economic alliance consisting of five major developing countries: Brazil, Russia, India, China, and South Africa. On August 24, 2023, during the BRICS summit held in South Africa, five new countries were accepted to join BRICS. These countries are Saudi Arabia, the United Arab Emirates, Egypt, Ethiopia, and Iran. Their membership will be effective from January 1, 2024. This bloc plays a significant role in the energy sector due to its enormous energy needs and diverse energy resources. In the field of energy, BRICS focuses on cooperation to enhance energy security, diversify energy sources, and develop sustainable technologies. *(the diplomat)*

3. The Contribution of Alternative Energy to Environmental Balance in BRICS Countries and Globally

We measure the contribution of alternative energy to environmental balance through the following indicators: the share of renewable energy in the total energy mix in BRICS countries, the reduction of carbon dioxide emissions in BRICS countries, and the contribution of renewable energy in BRICS countries to the global consumption of renewable energy.

3.1 The share of renewable energy in the total energy mix in BRICS countries

The indicator of renewable energy contribution as a percentage of total energy consumed in BRICS countries reflects each country's efforts in implementing agreed measures at both local and regional levels. A higher value of this indicator means that the country is moving towards achieving a higher share of renewable energy in its energy mix, thereby enhancing ecosystem sustainability and reducing reliance on fossil fuels.

After calculating the contribution percentage of each country to the total renewable energy consumed among BRICS countries, we obtained the results shown in the following table:

Table N°1: Represents the percentage of renewable energy in each country as part of the total energy in BRICS countries

%	2015	2016	2017	2018	2019	2020	2021	2022
Brazil	43.7	45.4	45.3	46.9	47.5	50	46.5	-
India	37.4	33.4	33	32.5	32.9	33.5	36.2	34.9
Chine	13.4	12.2	12.6	13.1	13.5	14.4	14.9	15.2
Russian Fed	3.6	3.2	3.4	3.2	3.2	3.2	3.7	3.5
South Africa	9.2	7.6	7.8	7.9	8	8.7	9.8	9.7

Source : created by the authors based on: International Renewable Energy Agency (**IRENA**)

https://www.irena.org//media/Files/IRENA/Agency/Publication/2024/Mar/IRENA_RE_Capacity_Statistics_2024.pdf?rev=a587503ac9a2435c8d13e40081d2ec34

We observe from the table that Brazil enjoys the highest contribution percentage in renewable energy, exceeding 40% throughout the period from

2015 - 2022. This indicates its strict commitment to adopting renewable energy sources, especially with regard to its abundant hydropower resources. The slight decline in 2022 is due to drought and economic challenges affecting hydropower generation.

The data shows that India plays an important role in the contribution of renewable energy in BRICS countries, achieving high contribution rates exceeding one-third. This is due to the heavy reliance on renewable energy sources and its extensive investments, particularly in solar and wind energy as we have seen previously. This helps reduce greenhouse gas emissions and contribute to combating climate change.

Despite being a major energy consumer, China shows a low contribution of renewable energy not exceeding 20% of the total production, which is low compared to Brazil and India. However, it demonstrates a steady and continuous growth trend, indicating a focused strategy to increase reliance on renewable energy.

As for Russia, the table shows a very weak contribution to the total renewable energy in BRICS countries, with stable percentages at around 3%. This indicates a greater reliance on traditional energy sources, South Africa has a limited contribution to renewable energy in the total energy production. However, a gradual increase is observed starting from 2018, indicating a shift towards renewable energy sources.

We conclude that renewable energy consumption remains limited in BRICS countries compared to traditional energy, with the exception of Brazil and India. This is primarily due to weak investments in renewable energy, the impact of unstable environmental and climatic factors, and excessive reliance on traditional sources.

3.2 Reduction of CO2 Emissions in BRICS Countries

We rely on this indicator to assess the carbon emissions by sector in each BRICS country, as well as the emissions avoided in the electricity and heat sector through the adoption of renewable energy, considering it the most energy-intensive sector

3.2.1 CO2 emissions in Brazil AND which have been avoided through renewable energy

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The volume of carbon emissions by economic sector in Brazil, along with a detailed breakdown of carbon sources within the electricity and heat sector, are illustrated in Figure N° 2 and Figure N°3.



Source:

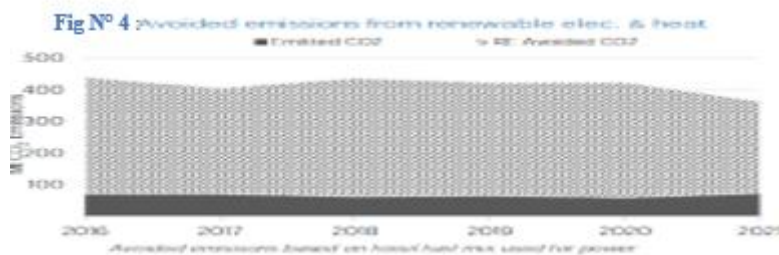
https://www.irena.org//media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Central-America-and-the-Caribbean/Belize_Central-America-and-the-Caribbean_RE_SP.pdf

The figure shows that CO₂ emissions in Brazil during the studied period exhibited fluctuations across various sectors, with a slight downward trend in recent years, particularly in 2020. The transportation sector is the largest contributor to emissions, followed by other industrial sectors. The construction sector recorded the lowest contribution to emissions, with a slight decrease in 2021 (1%) compared to 2016.

The amount of emissions related to electricity and heat generation in Brazil also showed relative stability throughout the period, with gas being the main source of CO₂ emissions in this sector at 44%, followed by coal at 38%, and oil at 18% of the emissions.

The following chart focuses on the amount of carbon in the electricity and heat sector that was avoided due to the use of renewable energy, where the larger the shaded area, the greater the reliance on renewable energy sources.

The following chart shows the amount of CO₂ avoided in the electricity and heat sector by adopting renewable energy:



Source:

https://www.irena.org/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Central-America-and-the-Caribbean/Belize_Central-America-and-the-Caribbean_RE_SP.pdf

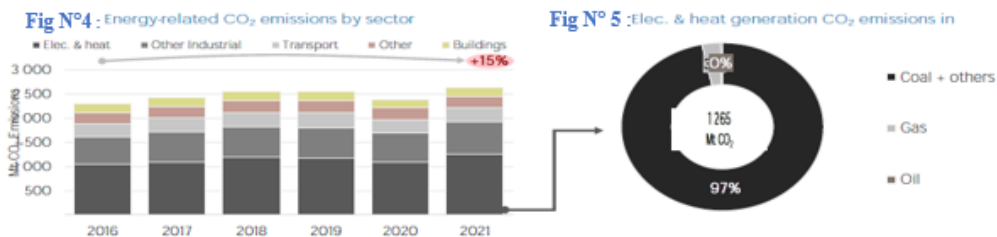
The figure shows that the volume of carbon emissions avoided by using renewable energy (the shaded area) in the electricity and heat generation sector is greater than those resulting from traditional energy sources (the black area). The shaded area represents the carbon emissions that were avoided by adopting renewable energy in this sector. This can be attributed to the widespread use of renewable energy sources for heat and electricity generation, which has led to a reduction in emissions from traditional sources.

We conclude that Brazil is moving in the right direction towards a more sustainable future with increasing reliance on renewable energy sources.

3.2.2 CO2 emissions in India and which have been avoided through renewable energy

The volume of carbon emissions by economic sector in India, along with a detailed breakdown of carbon sources within the electricity and heat sector, are illustrated in Figures N°4 and Figure N°5.

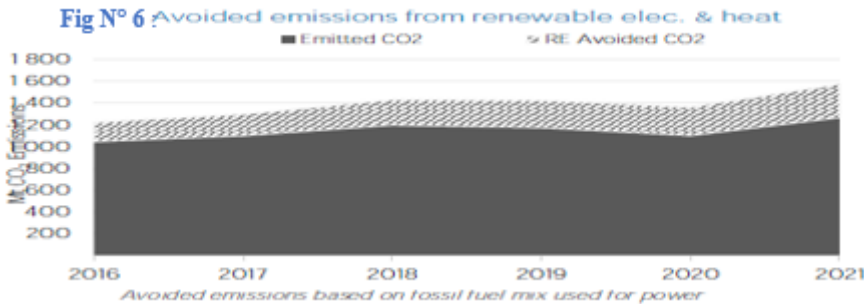
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Source:
https://www.irena.org//media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Asia/India_Asia_RE_SP.pdf

The figure shows the increasing trend of carbon emissions in India since 2016, which is attributed to the steady economic growth in the country. The electricity and heat sector is the largest contributor to carbon emissions, experiencing a significant increase starting from 2017 with a slight decrease in 2020. In this sector, 97% of CO₂ emissions come from coal and other sources, while 3% come from gas, highlighting the heavy reliance on fossil fuels. This presents a significant challenge in achieving emission reduction targets. Following this sector, other industries, and to a lesser extent, the transport and building sectors, also contribute to emissions.

The following chart focuses on the amount of carbon in the electricity and heat sector that was avoided due to the use of renewable energy in India. The larger the shaded area, the greater the reliance on renewable energy sources:



Source:

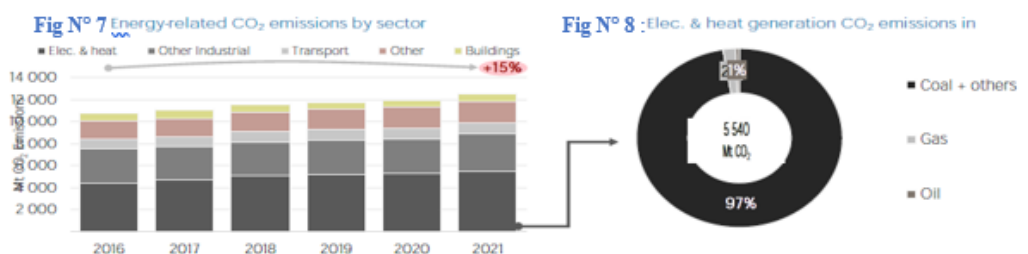
https://www.irena.org//media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Asia/India_Asia_RE_SP.pdf

The figure shows that the black area, representing emissions from conventional energy, is much larger than the shaded area, indicating India's excessive reliance on traditional energy for heat and electricity generation. Coal is one of the cheapest energy sources available in India. The shaded area, which represents the carbon emissions avoided by adopting renewable energy, ranged only between 1000 and 1600 metric tons, with a significant upward trend indicating an expansion in investment in renewable energy in this sector.

These results suggest that fossil fuels dominate the most energy-consuming sector in India, causing an increase in the amount of carbon emissions in the country. However, in recent years, greenhouse gas emissions have decreased but remain low.

3.2.3 CO₂ emissions in China and which have been avoided through renewable energy

The volume of carbon emissions by economic sector in China, along with a detailed breakdown of carbon sources within the electricity and heat sector, are illustrated in Figure N°7 and Figure N°8.



Source:

https://www.irena.org//media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Asia/China_Asia_RE_SP.pdf

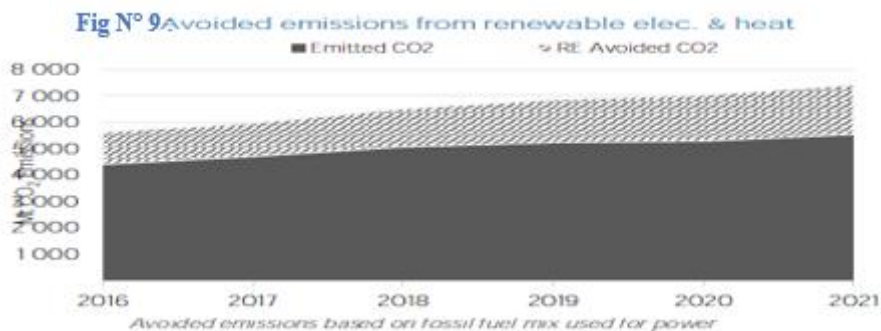
Reading the figure shows that CO₂ emissions have been continuously increasing across all sectors during the period 2016-2021. The largest

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increase in emissions during the same period was recorded in the building sector, with a rise of 15%. The figure indicates that the electricity and heat sector is the highest contributor to emissions, with fossil fuels (97%) being the main source of CO₂ emissions.

These data suggest that China faces significant challenges in reducing greenhouse gas emissions. Despite some progress in energy efficiency and the development of renewable energy sources, China still heavily relies on fossil fuels, contributing to its high emissions. Therefore, it is essential for China to take strong and rigorous measures to reduce greenhouse gas emissions by investing in renewable energy sources, improving energy efficiency, and implementing policies to reduce energy consumption to help mitigate climate change.

The following chart focuses on the amount of carbon in the electricity and heat sector that was avoided due to the use of renewable energy. The larger the shaded area, the greater the reliance on renewable energy sources:



Source:

https://www.irena.org//media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Asia/China_Asia_RE_SP.pdf

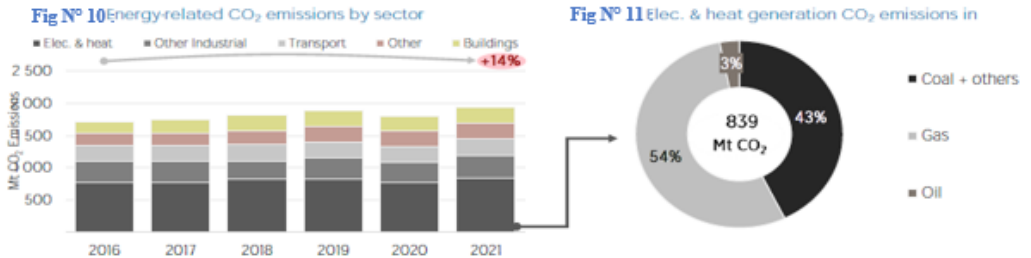
Figure Number 9 illustrates the positive impact of renewable energy on mitigating carbon dioxide emissions in China between 2016 -2021. While data indicates a continuous rise in CO₂ emissions from electricity and heat generation during this period, the rate of increase

has demonstrably slowed. This slowdown can be attributed to the expansion of renewable energy sources, particularly in conjunction with government policies promoting clean air and environmental targets. These policies have further encouraged the use of natural gas in power generation, heating, and transportation. Notably, the volume of CO₂ emissions avoided due to renewable energy, represented by the shaded area in the figure, has increased proportionally with the growth of renewable energy deployment.

These findings suggest that China has made significant strides in developing renewable energy, and that this progress is playing a key role in mitigating greenhouse gas emissions.

3.2.4 CO₂ emissions in Russian and which have been avoided through renewable energy

The volume of carbon emissions by economic sector in Russian, along with a detailed breakdown of carbon sources within the electricity and heat sector, are illustrated in Figure N°10 and Figure N°11:



Source:

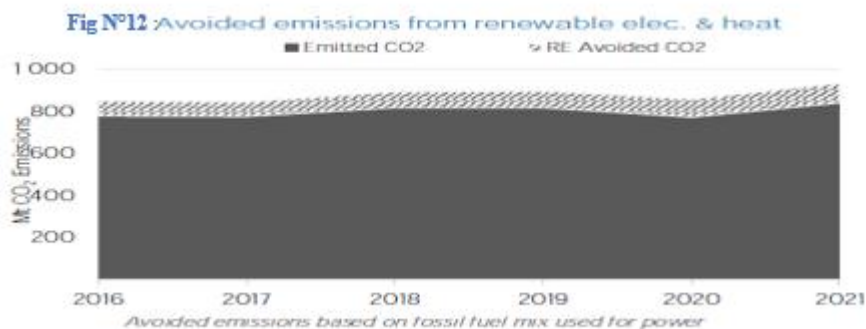
https://www.irena.org//media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Eurasia/Russian-Federation_Eurasia_RE_SP.pdf

The data reveals an increasing trend in carbon dioxide emissions across all sectors in Russia throughout the studied period. The building sector experienced the most pronounced surge, with emissions escalating by 14%. Notably, the electricity and heat generation sector emerges as the largest contributor to carbon emissions, with natural gas accounting for over 54% of CO₂ emissions within this sector, followed by coal at 43%.

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These findings underscore the substantial challenges Russia faces in mitigating its greenhouse gas emissions. Despite some progress in renewable energy development, Russia remains heavily reliant on fossil fuels, driving its high emission levels. Therefore, it is imperative for Russia to implement robust measures to curb greenhouse gas emissions. This includes investing in renewable energy sources and introducing policies to decrease energy consumption. Such actions are crucial to contribute meaningfully to global efforts in mitigating climate change.

Focusing specifically on the electricity and heat sector, Figure n°12 highlights the impact of renewable energy adoption on it:



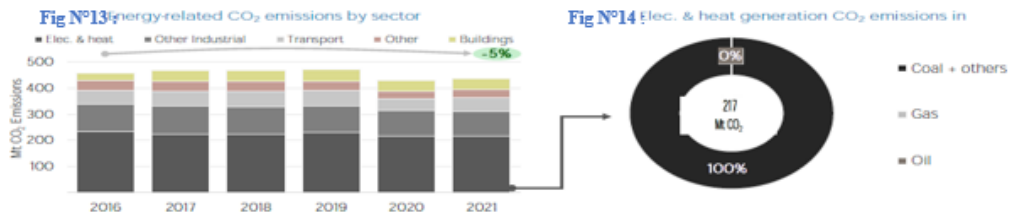
Source:

[https://www.irena.org//media/Files/IRENA/Agency/Statistics/Statistical Pr ofiles/Eurasia/Russian-Federation_Eurasia_RE_SP.pdf](https://www.irena.org//media/Files/IRENA/Agency/Statistics/Statistical_Pr ofiles/Eurasia/Russian-Federation_Eurasia_RE_SP.pdf)

Russia experienced a notable surge in fossil fuel-related CO₂ emissions in 2017 and 2018, followed by a period of relative stabilization in recent years. Conversely, CO₂ emissions avoided through renewable energy have shown a gradual increase, albeit remaining at a modest level since 2016. These trends indicate a continued reliance on fossil fuels for energy production in Russia and suggest that significant progress in renewable energy adoption has yet to be realized.

3.2.5 CO₂ emissions in Suth Africa and which have been avoided through renewable energy

The volume of carbon emissions by economic sector in South Africa, along with a detailed breakdown of carbon sources within the electricity and heat sector, are illustrated in Figure N°13 and Figure N°14:



Source:

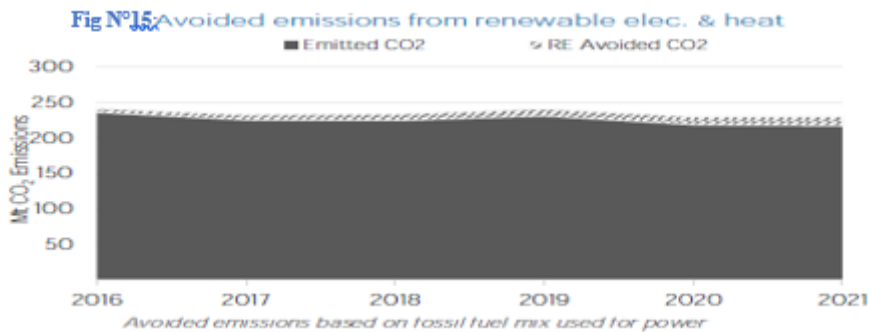
https://www.irena.org//media/Files/IRENA/Agency/Statistics/Statistical_Publications/Africa/South-Africa_Africa_RE_SP.pdf

A significant contributor to South Africa's carbon footprint, carbon dioxide emissions from electricity and heat production reach approximately 200 metric tons of CO₂ annually, as depicted in Figure [Figure number]. This sector relies entirely on oil (representing 100% of production), as illustrated in the pie chart. The industrial sector contributes approximately 100 metric tons of CO₂ annually. While CO₂ emissions from the transportation sector declined from 50 metric tons in 2016 to 30 metric tons in 2021, they still constitute a significant portion of total emissions.

These trends underscore South Africa's continued reliance on fossil fuels, despite the associated environmental risks and their contribution to global climate change. This dependence could hinder efforts to mitigate climate change on a global scale.

Shifting focus to the electricity and heat sector, Figure [Figure number] highlights the amount of carbon emissions avoided in South Africa through the utilization of renewable energy. A larger shaded area within the figure corresponds to a greater reliance on renewable energy sources:

The BRICS Bloc in the Field of Renewable Energy and Its Role in Global Environmental Balance: An Analytical Study Covering the Period 2015-2024.



Source:

https://www.irena.org//media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Africa/South-Africa_Africa_RE_SP.pdf

The graph reveals that avoided CO2 emissions (represented by the shaded area) have remained relatively stagnant at a low level throughout the analyzed period, despite some minor fluctuations. This suggests that while South Africa has made marginal progress in renewable energy adoption, considerable potential for growth in this sector remains untapped.

Sustained efforts to promote and expand the use of renewable energy are essential for South Africa to effectively achieve its climate change mitigation goals

4. The contribution of renewable energy in the BRICS group to the total renewable energy in the world:

Based on data from the International Energy Agency, we calculated the contribution of the BRICS group to global renewable energy. The results are shown in the following table:

Table N°2: Represents the percentage Renewable energy in the BRICS group of the total renewable energy in the world

	2015	2016	2017	2018	2019	2020	2021	2022	2023
%	39.13	40.13	41.61	42.86	42.89	44.15	45.13	46.35	48.86

Source: created by the authors based on:

https://www.irena.org//media/Files/IRENA/Agency/Publication/2024/Mar/IRENA_RE_Capacity_Statistics_2024.pdf?rev=a587503ac9a2435c8d13e40081d2ec34

The table shows an upward trend in the BRICS group's contribution to renewable energy on a global scale, with an increase of about 10 percentage points over nine years, reaching approximately half of the total by 2023. These contributions are particularly supported by China, which has been the largest contributor to renewable energy production among the BRICS countries throughout the period, with a contribution exceeding one-third and reaching 37.56% in 2023. Brazil follows, with contributions not exceeding 10% throughout the period, and India has relatively stable contributions of around 5%. Russia's contribution peaked at 2.79% in 2015 but has shown a continuous decline, reaching 1.67% in 2022, attributed to its reliance on conventional energy sources due to the high cost of renewable energy investments. South Africa has recorded the lowest contribution to the total renewable energy among the BRICS countries, with very low percentages that do not reach 1%, but they have been increasing over the studied period, indicating growing efforts to adopt renewable energy.

The attached table illustrates the percentage contribution of each BRICS country to the total global renewable energy

Table N°3: shows the percentage contribution of each BRICS country to the total global renewable energy

%	2015	2016	2017	2018	2019	2020	2021	2022	2023
Brazil	6.075	6.014	5.87	5.78	5.67	5.33	5.2	5.2	5.01
India	4.23	4.48	4.81	5	5.03	4.77	4.77	4.8	4.54
Chine	25.87	26.82	28.38	29.43	29.57	31.75	32.9	34.04	37.56
Russian Fed	2.79	2.56	2.4	2.29	2.16	2	1.82	1.67	
South Africa	0.018	0.23	0.3	0.33	0.31	0.33	0.32	0.31	0.27

Source: created by the authors based on:

https://www.irena.org//media/Files/IRENA/Agency/Publication/2024/Mar/IRENA_RE_Capacity_Statistics_2024.pdf?rev=a587503ac9a2435c8d13e40081d2ec34

We conclude that the BRICS countries make a significant contribution to the global renewable energy sector, thereby helping to combat climate change and improve air quality. This contribution reflects these countries' commitment to sustainable development and their leading role in technological innovation in the clean energy sector, particularly by China, Brazil, and India. This commitment enhances global environmental balance.

5. CONCLUSION

The BRICS countries' coalition in the field of renewable energy plays an active role in combating climate change and improving air quality. Their significant contribution to the global renewable energy total, reaching up to half, is achieved through the efforts of all member countries as follows:

- China: The largest contributor among the BRICS countries, with a contribution rate of 37.56% in 2023. This underscores China's substantial focus on developing the renewable energy sector and reducing carbon emissions, a crucial step in fighting climate change.

- Brazil: Ranking second, with a contribution not exceeding 10% throughout the period, indicating a strong commitment to developing its natural resources, such as hydropower and wind energy.

- India: Maintains stable contribution rates at around 5%, indicating ongoing efforts in developing renewable energy infrastructure and supporting modern technology in this field.

- Russia: Contributes less than 3%, facing technical and investment challenges in expanding its renewable energy sector.

- South Africa: Recorded the lowest contribution with very low rates not reaching 1%, but is making increasing efforts to adopt renewable energy and improve its sustainability.

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(28/07/2024 18:28)
- International Renewable Energy Agency (**IRENA**)
- https://www.irena.org//media/Files/IRENA/Agency/Publication/2024/Mar/IRENA_RE_Capacity_Statistics_2024.pdf?rev=a587503ac9a2435c8d13e40081d2ec34
- https://www.irena.org//media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Central-America-and-the-Caribbean/Belize_Central-America-and-the-Caribbean_RE_SP.pdf
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