international policy centre for inclusive growth
research brief
74
May 2021 ISSN 2358-1379

The International Policy Centre for Inclusive Growth is jointly supported by the United Nations Development Programme and the Government of Brazil.

Potential for cooperation in the dissemination of renewable energy and natural gas among BRICS countries[1]

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1 Introduction

The global energy system is structured around fossil fuels, leading to high emissions of carbon dioxide (CO_2). Initiatives for decarbonisation and global warming mitigation have focused on restructuring countries' energy grids and necessarily include policies that support the dissemination of cleaner energy sources. These transformations vary greatly in nature and pace, given that the challenges imposed by energy transition and the strategies adopted by each country are distinct, according to their economic and institutional differences and energy mix. Each experience has specific goals, and the energy policy tools are diverse.

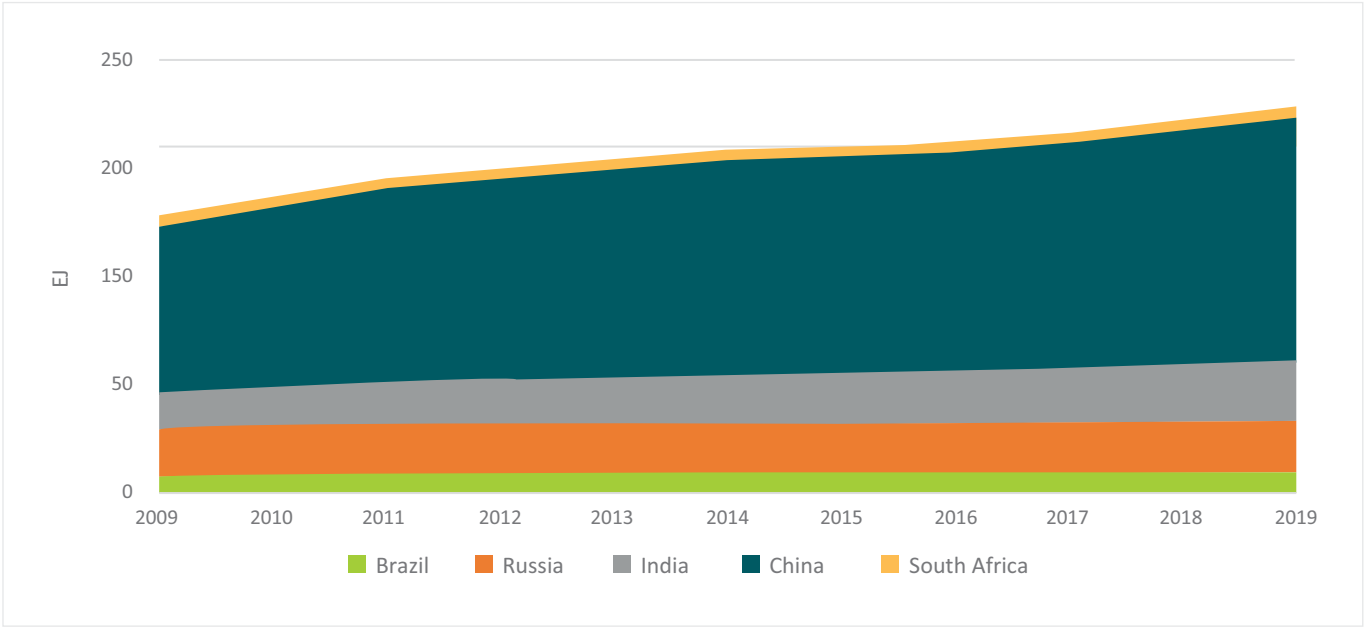
Brazil, Russia, India, China and South Africa (BRICS) have markedly different energy systems, socioeconomic structures and institutional frameworks, suggesting distinct energy transition trends for each country. Nonetheless, the group shares common goals around sustainable development, seeking opportunities for cooperation and complementarities in the energy field. This Policy Research Brief presents the main policies for the dissemination of renewable energy sources and natural gas in BRICS countries and analyses initiatives and opportunities for energy cooperation.

2 Dissemination of renewable energy sources and natural gas in BRICS countries

BRICS countries are major energy consumers, having demanded 223 Exajoules (EJ) in primary energy in 2019 (equivalent to 5.3 billion tonnes of oil), or 38 per cent of the world total. Their energy consumption has increased by 3.3 per cent per year over the last decade, far above the global average of 1.9 per cent. China represents 64 per cent of the block's consumption, followed by India (15 per cent) and Russia (13 per cent).

FIGURE 1

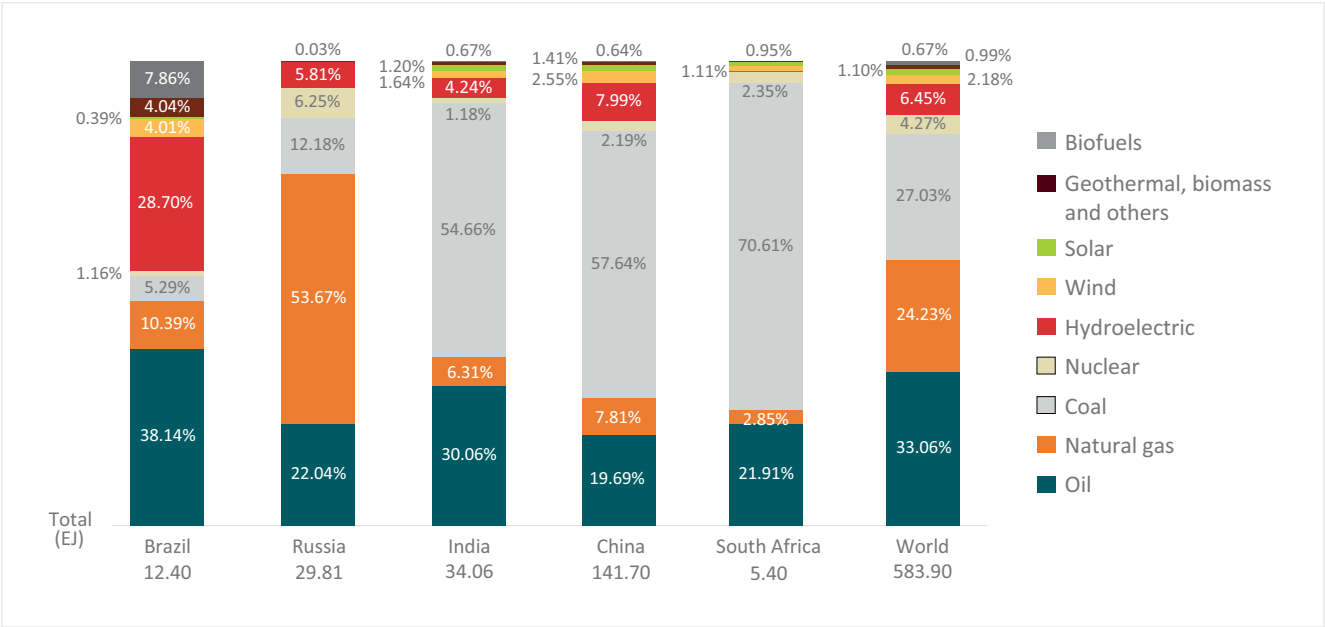
Evolution of primary energy consumption in BRICS countries, 2009-2019



Source: Authors' elaboration based on data from BP (2020).

FIGURE 2

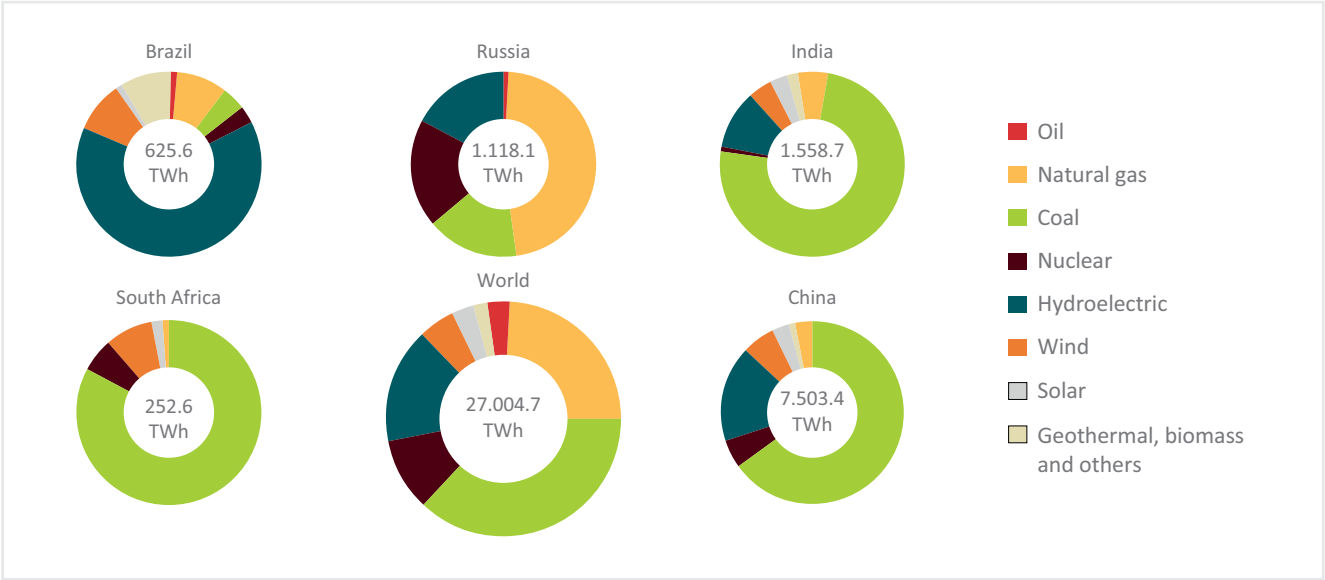
Final primary energy consumption in BRICS countries (2019)



Source: Authors' elaboration based on data from BP (2020).

FIGURE 3

Energy matrices in BRICS countries (2019)



Source: Authors' elaboration based on data from BP (2020).

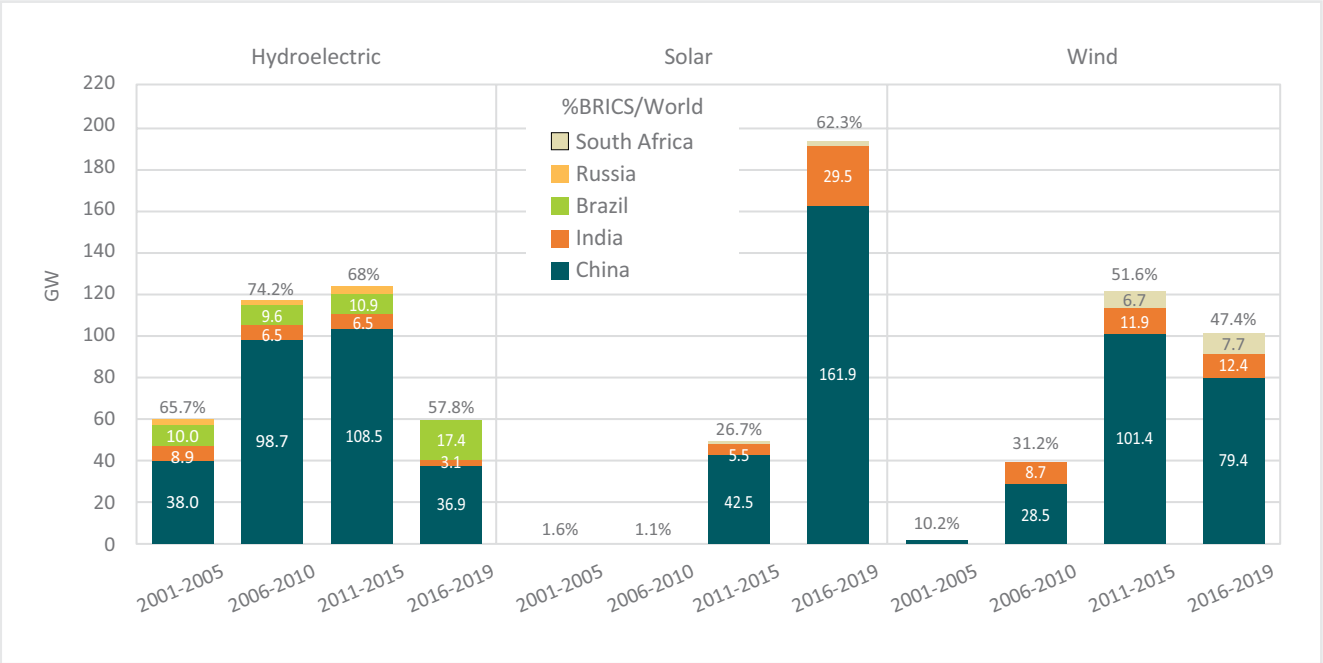
Primary energy consumption in BRICS countries is heavily focused on fossil resources. Fossil fuels are the main energy source in all countries, with coal being prevalent in China, India and South Africa, while natural gas is prevalent in Russia. Brazil has a more diverse fossil consumption, spread between oil and oil by-products, gas and coal, which add up to 55 per cent of the total. The diversity and abundance of energy sources, as well as the high participation of renewables in the electrical grid and in the transportation sector, make the Brazilian case quite distinct (Figure 2).

Electrical systems in BRICS countries are equally focused on fossil fuels, except for Brazil, due to its heavy use of hydroelectricity, in addition to sugar cane by-products and wind power (Figure 3). In this scenario, natural gas plays an important role in BRICS decarbonisation policies, as it replaces more pollutant energy sources and provides reliability and flexibility to electrical systems given the penetration of renewables.

The decarbonisation of the power sector through the electrification of end-uses is one of the main strategies employed in the energy transition of BRICS countries. They are increasingly important for the world's capacity to generate renewable fuels, especially China, India and Brazil, some of the main users of these technologies (Figure 4).

FIGURE 4

Evolution of installed renewable energy capacity in BRICS countries



Source: Authors' elaboration based on IRENA (2020).

3 South Africa

South Africa is the second largest economy in Africa and the world's 7th largest coal producer. Its energy matrix is highly dependent on coal, which answers for 70 per cent of the country's primary energy demands, followed by oil. Other energy sources have little participation in the country's energy balance. South Africa faces the most significant challenges of all BRICS countries in its transition towards sustainable energy, from a standpoint of availability of economic and institutional resources. The country combines the objectives of energy transition with those of economic development and eradication of poverty, based on its great potential for renewables—one of the world's best solar energy resources, as well as high potential for hydroelectric and wind energy in coastal regions—and the universalisation of access to electricity. This strategy, usually known as 'fair energy transition', seeks to benefit the decentralisation of energy generation, reinforce energy security and ensure the access of remote communities to clean energy sources. To that end, South Africa seeks to avoid contracting new coal-fired thermoelectric plants and decommission 11 gigawatts (GW) by 2030. Until then, it plans to increase its capacity for wind (14.1 GW), solar (7.1 GW) and natural gas power generation (3 GW) (South Africa 2019a).[4]

4 Brazil

Brazil is uniquely positioned among BRICS countries, as it has one of the world's cleanest energy matrices and a great potential for renewable sources at competitive costs. The country has a significant hydroelectric installed capacity, with large reservoirs and a nationally interconnected electrical system, which can facilitate the integration of wind, solar and biomass energy. Brazil also has a mature biofuel industry, with several alternatives to oil by-products, especially in the transportation sector. With the discovery of pre-salt oil, Brazil has become an expansion frontier for oil and associated gas production. It is estimated that the country's domestic gas supply will reach 138 MM3/d by 2029 (EPE 2020).

Given this abundance of resources, Brazil's challenges lie in promoting the expansion of the energy supply to sustain economic growth, increase the availability of energy per person[5] and maintain a high proportion of renewable sources in the power grid, given the limitations on the expansion of hydroelectric power.

One of the main tools in the dissemination of renewable energy sources in the electricity sector are auctions to contract new capacity. Wind and solar energy were initially propelled through specific source auctions[6] and gradually became more competitive in open energy auctions. Winning bids can benefit from specific financing programmes for renewable sources. Financing is especially advantageous for projects with high domestic content. The Brazilian Development Bank (*Banco Nacional de Desenvolvimento Econômico e Social*—BNDES) has a credit line available for individual projects and participates in the Innovative Energy Plan (*Plano Inova Energia*), which supports Brazilian businesses in the development and technological harnessing of wind and solar production chains, as well as smart grids.

In the biofuel sector, the federal government uses regulatory instruments and economic incentives for investment, such as financing lines, mandating addition of biofuel to petrol and diesel, tax differentiation, the National Biofuel Policy (*Política Nacional de Biocombustíveis*—RenovaBio)[7] and development programmes for specific biofuels. The New Gas Market Programme (*Novo Mercado de Gás*—NMG) has been conducting normative reforms to incentivise the participation of private agents and increase the offer of domestic and imported gas at competitive prices, allowing for expanded thermoelectrical and industrial fuel use.

5 China

China is the world's largest consumer of primary energy and is responsible for 30 per cent of the global CO_2 emissions—twice those of the US and three times those of the EU. Coal composes the base of China's energy system, despite a drop in its relative participation from 70 to 58 per cent over the last decade. The coal installed capacity is 1,000 GW, almost half of the global capacity, although around 400 GW remain at low or no operation.

Conversely, China has been strengthening its commitment to reducing carbon emissions and developing large-scale programmes to increase renewable energy sources and natural gas production. The country has been rapidly expanding its energy generation from renewable sources, having reached 790 GW in late 2019.[8] China's wind power capacity (240 GW) and solar capacity (204) represent over a third of the world's installed base, and the country has been expanding its investments in offshore wind power, with 11 GW currently under construction. Biomass and bio combustibles have a low participation in the Chinese matrix, but the country has implemented reforestation and urban waste recycling programmes. Since 2020 it has also instituted a 10 per cent ethanol mix to petrol.

In addition, China has subsidy policies for renewable energy sources, having spent USD13 billion in the sector in 2020, and is one of the world's largest issuers of green bonds (Thompson 2020). The country develops cutting edge technologies that support the dissemination of clean energy sources and energy efficiency, such as high-efficiency, intelligent energy systems and batteries, carbon capture and storage, electrical vehicles and the use of hydrogen in the transportation sector, as well as alternative routes for the production of zero carbon hydrogen. China also dominates the global supply chain of photovoltaic solar panels and ultra-fast charging battery cells (Sino-German Energy Transition Project 2020).

Natural gas still has a low participation in the Chinese energy matrix, and the country suffers from constant shortages. The government is seeking to increase the supply of natural gas through incentives to the production of unconventional gas; the expansion of infrastructure for storage and regasification of liquified natural gas as well as domestic and international transport pipelines; and liberal reforms in the gas industry. Local governments, in turn, have enacted clean air policies and environmental goals that support the use of gas in power generation, heating and transportation, as an alternative to coal and petrol (IEA 2019).

6 India

India is the world's third largest energy consumer and CO_2 emitter, but it has the lowest per capita energy consumption of all the BRICS countries. As in South Africa and China, India's energy system is based on coal, the cheapest and most abundant source of fuel in the country. According to IEA (2020), India will drive 25 per cent of the increased global demand for energy over the next two decades and, therefore, its energy transition is critical in the global fight against climate change and the country's own energy security, which suffers from recurring blackouts and has the universalisation of access to energy as one of its goals.

India aims to expand its renewable capacity in 227 GW by 2022 (114 GW from solar energy and 67 GW from wind energy), and in 450 GW by 2030 (US EIA 2020). Solving electrification problems in isolated communities and efficiency gains in agriculture are some of the country's main priorities to meet these goals. The expansion of solar energy is part of the National Solar Mission (*Pandit Jawaharlal Nehru*), which aims to establish India as a global leader in this field (India 2018).

There are various incentives for renewable energy sources in the country, such as state feed-in tariffs, certificates and purchase obligations for renewable energy, and incentives via subsidies, taxes and auctions. The government offers tax benefits to solar panels, reducing installation costs.

The country aims to increase its natural gas consumption, which is currently low, as part of the national plan to reduce air pollution, especially in urban areas. The government offers incentives to private and state companies to produce natural gas, especially unconventional and deepwater gas, and plans to expand the infrastructure of gas pipelines, regasification terminals and distribution stations for compressed natural and biogas.

7 Russia

Russia is the world's second largest exporter of natural gas and the third largest exporter of crude oil and coal. It ranks fourth in primary energy consumption, electricity consumption and CO2 emissions. Russia's energy matrix is dominated by fossil fuels—natural gas (53 per cent), coal (12 per cent) and oil (22 per cent). Carbon-free energy sources are represented mainly by hydroelectricity (5 per cent) and nuclear (6 per cent) plants. Solar and wind power, biomass and other renewable sources are insignificant and add up to less than 1 per cent of the country's energy matrix (BP 2019).

Russia's strategy is to develop the so-called 'fuel and energy complex', aiming to increase the use of domestic resources to boost economic growth, including the production of oil and gas reserves that are difficult to extract in the far East, the modernisation and expansion of its nuclear sector, and fostering energy efficiency and the use of renewable sources. Hydrocarbon exploration industries have a high participation in the country's economy (25 per cent of gross domestic product—GDP, 39 per cent of the federal budget and 65 per cent of export revenues) and support existing political power networks and long-term investments in fossil fuel infrastructures, which results in institutional and technological inertia that hinders Russia's transition into a low-carbon economy (Tynkkynen 2020). On the other hand, the country has enough energy resources to become a great ecological power and has been seeking a 'modernisation leap' towards a more efficient and sustainable energy industry, supported by the development of national digital technologies (Mitrova and Yermacov 2019).

Russia has established a system of energy generation capacity auctions. Local rules were made more flexible for renewable energy projects and capacity limits were reduced (Malik 2019). The government is assessing ending subsidies to fossil generator tariffs and equalising electricity tariffs (Eri Ras and Skolkovo 2019). Russia also plans to increase domestic gas supply and is at the forefront of research on the production of blue hydrogen (Irena 2017).

8 Cooperation among BRICS countries for the dissemination of renewable energy sources and natural gas

Three key vectors underpin energy cooperation among BRICS countries: support to the development of national energy systems, technological cooperation and better conditions for energy investments.

In the area of research, development and innovation, cooperation among BRICS countries is becoming increasingly more important through specialised training, consulting jobs, knowledge-sharing and technological transfers. In 2018, BRICS countries created the Energy Research Cooperation Platform, which gathers experts, private companies and research institutes to coordinate common interests in promising research and development fields, new technologies and innovative policies. The BRICS Energy Technology Report was developed under this framework (BRICS ERPC 2020), highlighting strategic areas and technologies in the joint development of sustainable energy, including:

- Scientific and technical cooperation: equipment to generate clean energy, storage and general use of renewable energy sources.
- Clean energy technologies: use of biomass, storage systems based on lithium-ion batteries, increased solar panel efficiency, integration of solar energy stations with energy storage.
- Electricity sector: network monitoring technologies, smart grid, smart meters, integrated data and geodata analysis systems, telemetry, and complete network automation.
- Natural gas: systems for the automated processing and interpretation of seismic data, geophysical equipment, production platforms and computerisation of production.

The platform is supported by two additional initiatives. The BRICS Network University is a partnership between universities that offers online training on priority areas of research identified by the block's countries and is overseen by their respective national ministries of education. The BRICS Think Tank Council is a cooperative platform for think tanks in BRICS countries, whose goal is to facilitate joint research and debate, led by the countries' respective foreign relations ministries.

The i-BRICS Network is a joint network project for technological innovation and digital transformation, based in Xianmen (China). It connects technology parks, incubators and accelerators to increase joint support for start-ups. Finally, the BRICS 2020 Economic Partnership seeks to improve public-private partnerships in research and development and common-interest technologies.

BRICS countries are characterised by emerging markets which, as a general rule, are able to field less technological and financial resources and whose challenges include expanding infrastructure and access to energy while implementing new low-carbon economic models, making financing crucial to energy transition. In 2014, BRICS countries inaugurated the New Development Bank, a cooperation tool to finance infrastructure projects and promote development. The financing system is also supported by the BRICS Interbank Cooperation Mechanism, which gathers financial institutions of all five countries to mobilise private investments in infrastructure projects (NDB 2019).

Cooperation among BRICS countries also occurs under the framework of bilateral trade agreements and investment deals, where energy complementarities provide various collaboration opportunities.

China is the largest investor and has significant technological capacity in low-carbon energy sources, leading to a high potential for technological cooperation, especially in the fields of battery storage, photovoltaic solar panels, electric vehicles, pathways for hydrogen production and the computerisation of electrical energy plants. China is also a vast energy consumer, which allows for trade deals with producer countries in the group, such as Russia, which is the world's second largest oil exporter to China and whose natural gas trade was bolstered by the construction of the Altai and Power of Siberia pipelines. Russia also has significant potential for hydroelectric power and other renewable energy sources along its eastern border, which might be explored to meet the demands of the Chinese market. On the other hand, China has investments in natural gas liquefaction in Siberia and can contribute towards harnessing hydroelectric power and wind energy at the border. Therefore, Chinese-Russian relations involve a mutual interest in strengthening energy ties, leading to political and economic interdependence.

Russia is also considering extending its sales of liquefied natural gas to India and Brazil. In addition, cooperation in civil nuclear energy has traditionally been important in Russian foreign relations, while common interests place it among the highest priority clean energy sources for all BRICS countries. Russia has uranium sale agreements with China and India, and joint ventures with China for the development of integral fast reactors. It hopes to establish agreements with South Africa and India for the transfer of technology in nuclear plant projects and cooperation agreements with Brazil for the supply of uranium and the construction of stationary nuclear plants. India, in turn, considers the possibility of increasing investments in Russia's arctic region, in new projects involving oil, gas and renewable energy sources.

Brazil is also one of China's oil suppliers, while China, in turn, invests in Brazilian pre-salt. The country also stands out in the bioenergy field and stands to obtain significant gains as other BRICS countries open their biofuel markets, in addition to transferring ethanol, co-generation and hybrid car technologies. Brazil and South Africa have special cooperation opportunities in the areas of bioenergy, bioelectricity and biofuels, given that South Africa has a competitive sugar industry and the potential to produce bioenergy from sugarcane (ESI Africa 2020).

Finally, hydrogen has the potential to establish an important axis for integration and energy cooperation among BRICS countries, whereby countries with a more developed technological base, such as China and Russa, can supply technology, whereas Brazil, South Africa and India can export clean hydrogen through the development of integrated projects for renewable energy generation and electrolysers. In other words, a collaborative

approach among BRICS countries towards hydrogen could supplement national initiatives, allowing for countries to capture complementarities in supply and demand patterns and unlock synergies in the use and development of infrastructure, making electricity a commodity that is commercialised by distant countries, beyond transmission grids. In addition, countries can unlock public and private funds for research and development and promote financing projects for hydrogen technology, in addition to increasing the focus on cross-cutting research areas.

9 Conclusion

BRICS countries have a high participation in the world's energy consumption and production, especially of fossil fuels, but they have been increasing their commitments to reduce CO_2 emissions, even if late compared to countries in the Organisation for Economic Co-operation and Development (OECD). It is worth highlighting that natural gas can represent an important step in BRICS countries' de-carbonisation. Despite peculiarities in each country's energy transition process, the block has demonstrated the role of strengthening international energy cooperation as a crucial tool to increase investment and develop new, sustainable technologies and processes, improve policies and programmes, and explore trade gains, contributing to sustainable development.

1. This Policy Research Brief is based on Losekann and Tavares (2021, forthcoming). It is one of the products of a joint executive cooperation project between Brazil's Institute for Applied Economic Research (Ipea) and the Economic Commission for Latin America and the Caribbean (ECLAC).

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4. Data for natural gas and diesel oil (South Africa 2019a).

5. 1.4 tonne of oil equivalent (toe) per person in 2019, which is below the world average of 1.85 toe/person in 2016 (EPE 2020b).

6. Alternative source auctions (*Leilões de Fontes Alternativas*—LFA) were introduced to meet the growth of the market in a regulated environment and expand the role of renewable sources—wind, biomass and small hydroelectric plants (SHPs).

7. RenovaBio is a market model for the purchase and sale of carbon credits based on certificates, called CBIOs. Producers (of ethanol, biodiesel, biomethane, biokerosene, etc.) volunteer to certify their production and receive CBIOs, which are listed in the stock exchange (B3), where they can be purchased by distributors who are required to meet annual CBIO purchasing targets or by over-the-counter stock investors.

8. While China's progress in renewable energy sources is impressive, in the current scenario it is crucial to more rapidly include clean energy sources and carbon capture, to allow for the decommissioning of almost all of the country's coal-based thermoelectrical infrastructure reaching the end of its life span and the stagnation of CO_2 emissions in absolute terms, according to a new nationally-determined contribution (NDC) from the Paris Accord (i.e. reach the peak of CO_2 emissions by 2035 and become carbon neutral before 2060).

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