BRICS 2023 SOUTH AFRICA

ENERGY SECURITY REPORT **2023**

BRICS
ENERGY RESEARCH COOPERATION PLATFORM

ENERGY SECURITY REPORT **2023**

BRICS
ENERGY RESEARCH COOPERATION PLATFORM

ISBN 978-0-7961-0628-5

The work covers the current state of energy security within the BRICS countries, as well as analyses possible areas of cooperation within the member countries. The research focuses on having access to reliable and affordable sources of energy to meet BRICS counties energy needs, this is a crucial aspect of national and global security, essential for economic development, social stability, and national defence.

The material was prepared by experts of the BRICS Energy Research Cooperation Platform based on the national information provided and with the active participation of relevant ministries of the BRICS countries. The study consists of two chapters. The first chapter is devoted to the approaches of BRICS countries to ensuring national energy security in the BRICS countries. The second chapter outlines opportunities and prospects for mutually beneficial cooperation among the BRICS countries.

The research is intended for government officials, representatives of science and business, and can be used in education.

BRICS
ENERGY RESEARCH COOPERATION PLATFORM

ACKNOWLEDGEMENTS

This report was made possible by the support and advice of many individuals and organisations. The Committee of BRICS Senior Energy Officials plays a key role in providing guidance and support at all stages of the report's cycle. BRICS ERCP would like to thank each of its members for their time, energy and enthusiasm.

The BRICS ERCP would like to acknowledge the support from the Ministry of Mines and Energy of the Federative Republic of Brazil, Ministry of Energy of the Russian Federation, the Ministry of Power of the Government of India, the National Energy Administration of the People's Republic of China, and the Department of Mineral Resources and Energy of the Republic of South Africa.

The following ERCP Experts participated in the development of the Energy Security Report: (Brazil) MASILI Gustavo Santos, RAMOS Esdras Godinho, COSTA Claudir Afonso, MEDEIROS William de Oliveira, (Russia) KIUSHKINA Violetta, NIKITAEV Vladimir, BOBYLEV Petr, ORLOV Dmitry, (China) WEI Xiaowei, XIANG Qianfei, HE Zhao, LI Lan, WANG Shunchao, LIU Chen, DING Jian and LI Ren, (South Africa) YUSUF Teslim Mohammed.

BRICS ERCP is also grateful to (Brazil) Ministry of Mines and Energy of Brazil (Russia) Russian Energy Agency by the Russian Ministry of Energy, State Atomic Energy Corporation "Rosatom", Rosenergoatom JSC, «ROSSETI», PJSC, PJSC Transneft, PJSC Gazprom, PJSC Inter RAO, JSC SUEK, (India) Ministy of Power, Ministry of New and Renewable, Ministry of Skills Development and Entrepreneurship, Bureau of Energy Efficiency and NTPC Ltd. (China) China Renewable Energy Engineering Institute (CREEI), China University of Petroleum, Beijing (CUPB), China Southern Power Grid International Co., Ltd, China Electric Power Planning & Engineering Institute (EPPEI), CNPC Economics & Technology Research Institute, (South Africa) South African National Energy Development Institute (SANEDI).

BRICS ERCP would like to express gratitude to South African Chairmanship for leading the preparation of the Energy Security Report and its publication. Overall guidance was provided by the Mr. Jacob Mbele - Director General of Department of Mineral Resources and Energy of the Republic of South Africa.

Special thanks to Yusuf Teslim Mohammed from the South African National Energy Development Institute, who coordinated, oversaw production of this report and overall publication process.

We are also very grateful to Litha Publications for the design of the cover page and University of Pretoria for the printing of the report.

CONTENTS

Alexandre Silveira

Minister of Mines and Energy of the Federative Republic of Brazil

FOREWORD

There is little doubt that energy security is a top priority issue globally, and in Brazil as well. Despite having a renewable energy profile that already reaches almost 50% in the energy matrix and almost 90% in the electric matrix, alongside with diversification and complementarity of options, we understand the need to have a reliable, safe, and just energy supply to sustain our economic and social needs.

Brazil has already made strong progress on the subject, aiming at the mitigation of technological lock-ins and the rational use of available energy sources, with a view to providing citizens with affordable, clean and reliable energy.

To enhance energy security, we need to put in place mechanisms to expand the supply of sources and their efficient use. Brazil's diversification and complementarity of options have already contributed to this goal. However, new challenges will arise, requiring a joint effort with other nations to consolidate mechanisms to strengthen the current global energy sector and mitigate geopolitical impacts.

I am confident that we can work together to ensure a more sustainable and prosperous future for our citizens, and this report is a step towards a collaborative work, unifying the efforts of BRICS members to face the new challenges regarding energy security.

Shulginov Nikolay

Minister of Energy of the Russian Federation

FOREWORD

Nowadays, the global community is facing serious strategic challenges, including energy security issues. Therefore, there is a need for more adaptable response to developments in global energy markets and the establishment of mechanisms to influence these processes. The BRICS countries can make a significant contribution to ensuring Energy Security of each country and the entire BRICS, as they possess considerable resources, scientific and innovative potential. A joint effort would promote an accelerated and harmonised development of sustainable energy, ahead of potential threats to the energy security.

As a result, the development of cooperation and through integration of science and innovative entrepreneurship with the participation of large businesses would ensure a strong basis for achieving and protecting the national interests of each state. Russia encourages fruitful cooperation among the BRICS countries in developing the BRICS Energy Research Cooperation Platform and welcomes the release of the research on the analysis of approaches to ensuring energy security. Nowadays, such a comprehensive analysis is more important than ever, taking into account the energy structures of each of our countries and understanding the priorities for maintaining sustainable economic development.

I would like to express my gratitude to the Republic of South Africa for its BRICS Chairmanship in 2023. A coordinated effort to share knowledge and expertise on energy security approaches is what our countries can best invest towards. This kind of integration is the most important and appropriate response to modern challenges.

Raj Kumar Singh

Minister of Power and New and
Renewable Energy of the Republic of India

FOREWORD

In an interconnected world where economic growth, technological advancement, and quality of life are increasingly intertwined with the availability and stability of energy resources, the concept of energy security has risen to the forefront of global discussions. As nations grapple with the challenges posed by rapid industrialisation, urbanisation, and population growth, the quest for a reliable, affordable, and sustainable energy supply has become paramount. Among these nations, the BRICS group − comprising Brazil, Russia, India, China, and South Africa, stands as a vital coalition that plays a pivotal role in shaping the global energy landscape.

This report stands as a testament to the collective commitment of scholars, policymakers, and stakeholders to unravel the complexities of energy security and contribute to the informed dialogue that will guide our global energy trajectory. We extend our sincere gratitude to all the contributors, researchers, and experts whose dedication and insights have enriched these endeavours.

Zhang Jianhua

Administrator of National Energy Administration, the People's Republic of China

FOREWORD

Currently, countries worldwide are striving to accelerating economic recovery, which has led to a surging demand for energy. Factors like climate change, the COVID-19 pandemic, and geopolitics are reshaping the global energy landscape, resulting in significant fluctuations in international energy market prices, impeded energy trade and transportation, and more notable energy security risks. Thus, the global energy governance is facing formidable challenges.

Energy security is a major concern shared by the entire world, including the BRICS. The international community as a whole share the collective mission to vigorously develop clean energy, collaborate to promote economic recovery, and emerge from the pandemic. According to our diverse resource endowments and energy structures, the BRICS have distinct pathways for ensuring energy security and promoting energy transition. Facing various energy security risks, enhancing exchanges and mutual learning hold great significance. China is willing to work with all parties to strengthen energy policy communication, to create an open and transparent environment for developing clean energy, to enhance cooperation in energy technology innovation, to strengthen coordination in regional and global multilateral energy governance, with the goals of jointly maintaining the stability of the global energy market and safeguarding global energy security.

Samson Gwede Mantashe

Minister of Mineral Resources and Energy of the Republic of South Africa

FOREWORD

South Africa, as the 2023 BRICS Presidency and in collaboration with the member countries, developed this report titled "BRICS Energy Security Report". The Energy Security Report 2023 aims to address issues of access to reliable and affordable energy sources in order to meet our energy needs. Energy security is a critical component of both national security and economic stability, as energy is essential for various sectors to thrive and remain sustainable.

Like other nations, South Africa is experiencing the challenge of increasing energy cost and availability. To mitigate these challenges, South Africa has developed critical areas to ensure energy security. These areas include policies and actions targeted at achieving reliable, affordable, and sustainable energy supply. Even though South Africa faces several obstacles in terms of energy security, it must be recognised that the country has made significant progress with regard to its energy transition. In addition, South Africa actively participates in international partnerships and collaborations that enhance energy security and fosters South Africa's' relevance amongst other nations.

Overall, achieving energy security requires a comprehensive strategy that includes infrastructure development, international cooperation, diversification, efficiency, and sustainable energy methods. These strategies can help countries become more resilient to energy disruptions, lower geopolitical risks, and advance a safe and secure energy future. The Energy Security Report outlines opportunities for cooperation amongst the BRICS countries, this is something we are looking forward to embarking on to ensure sustainable and sufficient supply of energy resources.

Lastly, I would like to acknowledge the authors of this year's BRICS Energy Security Report and Russia as co-organisers for the high quality and relevant inputs gathered in compiling this report.

INTRODUCTION

The role and contribution of the BRICS countries (Brazil, Russia, India, China and South Africa) is significant to the world economy in terms of population (40%), GDP (25% nominal and US$ 16.039 trillion), land coverage (30%), world trade (18%), and global forex (US$ 4 trillion). Given their significant contribution to the above, it stands to reason that they are responsible for a significant percentage of the global energy consumption. In fact, it is stated that the BRICS countries consume 40% of the world's energy. This is expected to grow as the contribution of the BRICS countries to global GDP increases. In accordance with the forecast of the BRICS Energy Report 2020, prepared by the BRICS Energy Research Cooperation Platform By 2040 the BRICS share in both world consumption and energy production is expected to increase to 41%.

Currently, the majority of the energy consumed by BRICS countries is generated from fossil fuels. According to an ENERDATA report (2020), the BRICS countries' total coal consumption was reported to be 5,217 metric tons in 2019. Oil consumption was 1,138 metric tons in 2019. Gas consumption was reported at 910 billion cubic meters in 2019. BRICS countries are responsible for 48% of the world's coal consumption, 22% of the world's oil consumption and 13.5% of the world's natural gas consumption.

Although most of the energy supply is fossil fuels, the BRICS countries are generating and consuming more and more renewable energy. They are currently responsible for 16% of the world's renewable energy consumption. This is expected to grow as these countries strive to meet their climate goals. According to CNPC Economics and Technology Research Institute, the BRICS groups' consumption of renewable energy has been increasing year over year, helping to drive the development of lower-carbon economies worldwide. The Institute's research shows that the percentage of electricity produced by renewable sources increased from 19 to 37% between 2010 and 2020, while the percentage of nuclear power doubled over the same period, making up the majority of the increase in global nuclear power.

The BRICS countries play an important role in the Global Energy Security System. The BRICS countries have significant weight, both in generation and in consumption of global energy resources. According to the International Energy Agency (IEA), BRICS countries account for 36.4% primary energy supply, and this is set to rise to 40–50% by 2040. The Russian Federation is an energy self-sufficient country, and according to such a basic indicator of energy security as the ratio of the production of fuel and energy resources to their domestic consumption, Russia has a significant reserve. This allows Russia to consistently become one of the world leaders in the export of key energy resources.

The BRICS countries have made commitments to reducing Greenhouse Gas (GHG) emissions. Although BRICS countries have access to fossil fuels, they also all have abundant renewable energy sources which will assist in this low carbon transition. This will make them important from a global perspective in terms of renewable energy production. Already this can be seen in China. China is currently the largest clean energy market in the world, replacing fossil fuels with renewable energy at a fast pace. In 2017, the country invested 126.6 billion U.S. dollars, accounting for 45% of the global investment in green energy, according to a United Nations report published in 2018. In China, the proportion of clean energy sources in total energy consumption increased from 14.5% in 2012 to 25.5% by the end of 2021. The fuel and energy balance of the Russian Federation is one of the most environmentally friendly (low-carbon): more than a third of electricity generation comes from nuclear power, hydropower, and other renewable energy sources, about half from natural gas.

Given their rapid growth, the BRICS countries are focused on energy security. Energy consumption affects the economic development of any country. These countries' economic growth is increasing rapidly, causing the energy demand to increase. For all countries, the interests of ensuring energy security and its concept are different and are formed from an energy point of view by categories of countries: importers, exporters, transit countries, also taking into account the category of developing countries. Approaches to achieving energy security for each country are individual but revolve around energy resources. At the same time, the historically basic concept of energy security is based on ensuring efficient and reliable energy supplies at affordable prices, with the organisation of eliminating threats to national values and goals. Purposefully, energy security is generally understood as the confidence that energy will be available in the quantity and quality that are required under given economic conditions.

This report examines the existing approaches to ensuring energy security in the BRICS countries and their tasks both now and into the future, particularly in light of their climate goals. It also highlights key areas of cooperation. It is acknowledged that the BRICS countries have energy strategies that have proven to be complementary, opening up opportunities for enhanced intra-BRICS energy cooperation to foster domestic energy security and stimulate economic growth among the bloc.

CHAPTER 1

ENERGY SECURITY SITUATIONAL PROFILE OF THE BRICS COUNTRIES

BRAZIL

[1.1]

1.1.1 GENERAL OVERVIEW

According to the International Energy Agency (IEA), energy security can be understood as "the uninterrupted availability of energy sources at an affordable price". It relates to short-term security (aimed at responding to specific or structural alterations that affect the supply of energy on an immediate level); and long-term security (related to the adequacy of investments and expansion of the energy sector to the economic, social, and, in a more recent view, environmental development of the country). This broader concept underpins the following discussion about the Brazilian energy sector.

In this aspect, energy development in Brazil has touched multiple dimensions throughout its existence, informed by physical, economic, environmental, social, technological, regulatory, and institutional dimensions - and having the Ministry of Mines and Energy (MME) as the coordinator and guide of this development. Not by chance, the first experiences with prospective energy studies, which can be called Integrated Energy Planning (IEP), date back to the early 1970s, when in consonance with the Ministry of Planning, the project called Brazilian Energy Matrix was carried out, with the subsequent adoption of the Brazilian Energy Balance (BEB) in 1979. The same period saw a robust economic growth, demanding a great expansion of the electro-energetic sector. This resulted in the construction of several works in the country, such as Itaipu Hydroelectric Power Plant, at the time the largest hydraulic power plant in the world, and the Almirante Álvaro Alberto Nuclear Power Plant, a complex that houses the Angra I and II nuclear power plants. In this period, the expansion of the sector was monopolised by the state.

In line with the short and long-term vision of energy security, the seventies also saw the most solid steps towards the diversification of the Brazilian energy matrix, aiming at making it less dependent on oil products imports, which at the time of the second oil crisis, represented 85% of the dependence on this source.

Programs such as the National Alcohol Program (Pro-Álcool) of 1975 already indicated the willingness to follow this diversification, however, it was the Brazilian Energy Model (MEB) of 1979 that was constituted as an instrument with goals to decrease this dependence, affecting both the petroleum sector and the production of mineral coal, firewood, and alcohol until

1985. Most of the goals were achieved, with external dependence on oil reducing to 43%. Thus, an important instrument for the concretisation and presentation of the potential paths for the sector resided in the figure of integrated energy planning, with sectoral plans and policies walking together in the process.

In the 1990s, new challenges arose mainly due to the decrease in the state's investment capacity in the face of successive economic impacts that occurred between the '70s and '80s. This demanded a readjustment of the sector's structure, guided by a process of de-verticalisation, creation and strengthening of a competitive wholesale market as well as a progressive liberalisation for consumers. The Brazilian Electricity Sector Restructuring Project (Re-Seb) was created by Law 9,074/1995. That decade was also marked by the creation of several actors that constitute the current Brazilian energy sector, such as:

- The regulator of the national electricity system, the National Electric Energy Agency (Aneel) in 1996;
- The advisory body to the President for the formulation of energy policies and guidelines, the National Energy Policy Council (CNPE) and the regulator of the oil, gas, and biofuels sector, the National Petroleum, Gas and Biofuels Agency (ANP), both from 1997;
- In addition, the controller of the operation of the generation and transmission facilities of the National Interconnected System (SIN), the National System Operator (ONS), from 1998.

The 1990s would hold yet another example of the use of the IEP, with the institution of the project "Re- examination of the Brazilian Energy Matrix", released in 1991, contemplating policy guidelines in several energy areas, with projections for demand for the years 1995, 2000, and 2010. Even though the decade maintained challenges on the country's horizon and demonstrations of the need for more significant structural changes, the consolidation of the CNPE favoured the coordination of energy policy with industrial, agricultural, and transportation policies[2], given the interministerial character of the Council.

It is relevant to mention that in Law 9.478/1997 itself, responsible for the creation of the CNPE and ANP, there was the definition of the objectives of the National Energy Policy, and, although it is not explicitly mentioned, it is quite clear that these are aligned with the strengthening of the energy sector in the country. It covers various aspects of energy security, whether in the expansion of supply and potential energy vectors, or in guaranteeing and improving existing and established energy chains or in the alignment between expansion and the aforementioned economic, social and environmental development.

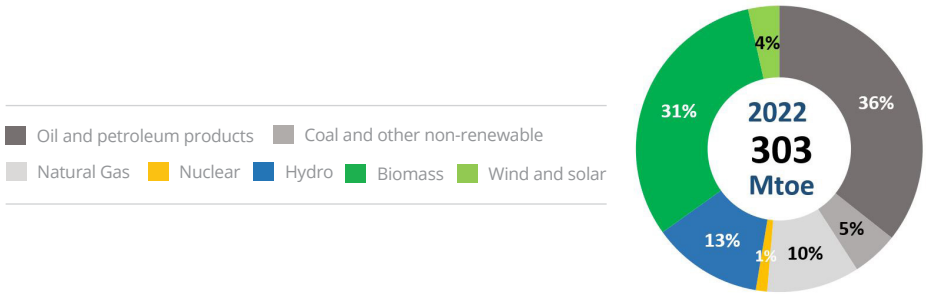
Later, in 2004, a more comprehensive legal framework was established for the new model for the electricity sector, through Law n. 10,848/2004, which sought to ensure greater competition

in the expansion of supply and the possibility of negotiating energy in the free environment, addressing challenges that had arisen during the 1990s and the first restructuring of the sector. The stimulus for greater competition and plurality of options for the energy matrix was placed even more at the core of the Brazilian energy policy. Also in 2004, the Brazilian Research Company (EPE) was created, with the purpose of "providing services in the area of studies and research to subsidise the planning of the energy sector". Again, the IEP goes hand in hand with the development of the sector, and it would be in the hands of the EPE and the MME the construction of the two main sectoral plans currently under construction: the Brazilian National Energy Plan (PNE) and the Brazilian Ten-Year Energy Expansion Plan (PDE).

The PNE explores, through scenarios, the existing perspectives of different energy vectors for 30 years, in an indicative way. In this sense, it is a plan that dialogues more with trends and panoramas, being, in some cases, a stimulator of discussions about technologies in their early stages. As from the construction of scenarios, one upper and one lower, visions are generated about aspects of the expansion and how each source and technology is inserted, both through "path maps", which present obstacles and potential solutions for each niche, and simulations, which illustratively evaluate the evolution of the matrix in the long term under different trajectories.

Unlike the PNE, the PDE is a publication with short and medium-term indications for the Brazilian energy sector, with a ten-year vision. Thus, despite remaining an indicative plan, the shorter planning period allows the realisation of a measurable plan, with more targeted analyses of the impact of policies and programs on the route already taken by the country. It is noteworthy that both plans are indicative, given the participation of the private sector built since the 1990s and 2000s, thus making sectoral planning more concerned with presenting perspectives and "clarifying the path" than determining precisely the investments and necessary expansion, which is up to the market to measure jointly.

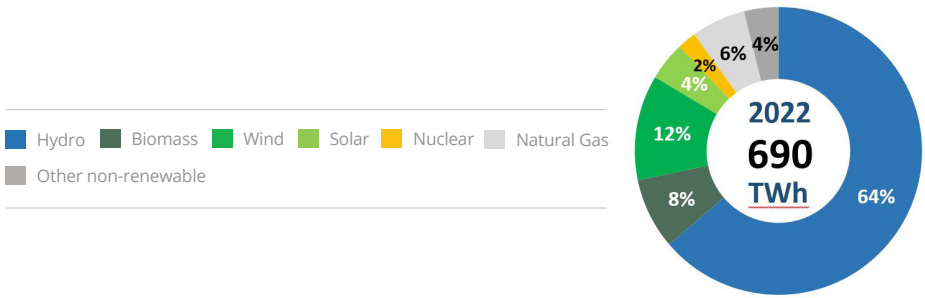
Currently, according to data from the Brazilian Energy Balance, published by the Energy Research Office (EPE) for the base year of 2022, Brazil's energy matrix, shown in Figure 1, consists of 47.4% share of renewable sources, a profile already largely renewable when compared with the world's biggest economies. The largest energy source in the mix, however, remains oil and its derivatives, followed by a strong share of biomass and hydropower. It is noteworthy that, after an extremely challenging year in 2021, with a strong water shortage and a drought that significantly impacted the use of biomass, the country managed to resume the use of renewable generation from water sources, which with the strong growth in the participation of intermittent renewables sources (solar and wind), allowed a decrease in the use of non-renewable sources, such as natural gas and coal, contributing to the increase in the renewability of the matrix.



*The hydro share includes the net import of energy. **Mtoe = 10^6 toe

Figure 1: Brazil's Total Energy Supply (2022)
Source: Brazilian Energy Balance - 2023

Similarly, the electricity matrix, shown in Figure 2, has seen a recovery in its renewability, for the reasons already explained above. The resumption of hydroelectric generation and the strong expansion of intermittent renewable generation allowed the decrease in demand for thermal generation from natural gas and coal, which helped guarantee generation in 2021, during the water shortage. Thus, for 2022, the Brazilian electricity matrix presented about 87.9% of renewable sources in its market basket, reaching 92.1% when taking only the Brazilian Interconnected System (SIN), which excludes the generation of self-producers not injected into the grid and Isolated Systems. The highlight is the strong expansion of solar generation in the Distributed Generation modality, which reached 17.3 GW of installed capacity at the end of the year, an increase of more than 90% compared to 2021.



*The hydro share includes the net import of electricity.

Figure 2: Brazil's Total Electricity Supply (2022)
Source: Brazilian Energy Balance – 2023

This largely renewable profile of its matrices is the result of continuous and pragmatic planning carried out by the country, materialized in the figure of the Ministry of Mines and Energy, which has always acted as a consensus builder among the various entities in the energy sector, to allow the timely and sustainable use of the abundant natural resources that Brazil has. In this regard, one of the pillars of energy development in the country was the fight against energy poverty, which was guided by offering clean and quality energy sources to the maximum number of Brazilian citizens, especially in the case of electricity.

Thus, since the 2000s, the country has developed programs aimed at universalizing access to electricity, initially in the policy "Luz para o Campo" (Light for the Countryside), which would later be succeeded by the "Luz para Todos" Program (Light for All), the main vector of the democratization of access to electricity in the country, having served, by 2017, more than 3.3 million households, which resulted in more than 16 million people served, accrediting it as the most ambitious electricity inclusion program in the world. Thus, as shown in Figure 3, the country currently has 99.8% electricity coverage of households, with a major transformation mainly in rural households, which had a significant increase from 77.0% coverage in the 2000s to the current 99.0%.

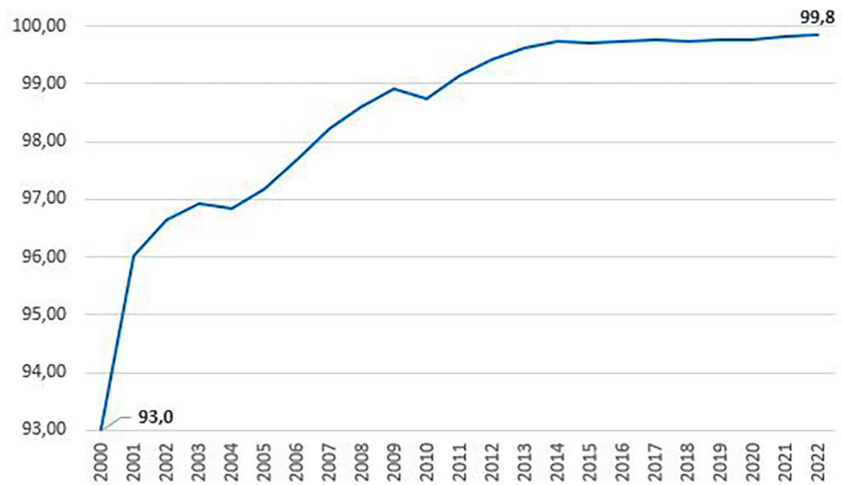


Figure 3: Share of Access to Electricity in Brazil – 2000 to 2022
Source: IBGE & SIE Brazil

Brazil has made significant progress in improving access to electricity for its population. The country has achieved a high level of electrification, with a majority of its population having access to electricity.

According to the World Bank, as of 2019, the electrification rate in Brazil reached 99.4%, indicating that nearly all households and businesses in the country have access to electricity. This high rate of electrification reflects the government's efforts to expand and improve the electricity infrastructure across the nation.

1.1.2 NATIONAL ENERGY SECURITY POLICY

The National Energy Policy guides all Government's actions in the construction of advances in the national energy sector, including policies and actions for the promotion of energy security. The objectives mentioned in the Law are as follows:

i. Preserve the national interest.
ii. Promote development, expand the job market, and value the energy resources.
iii. To protect the consumer's interests concerning the price, quality, and supply of products.
iv. Protect the environment and promote energy conservation.
v. Ensure the supply of petroleum derivatives throughout the entire national territory.
vi. Increase, on an economic basis, the use of natural gas.
vii. Identify the most adequate solutions for the supply of electrical energy in the various regions of the Country.
viii. Use of alternative sources of energy by making economic use of available inputs and applicable technologies.
ix. Promote free competition.
x. Attract investments in energy generation.
xi. Increase the country's competitiveness in the international market.
xii. Increase, on economic, social, and environmental bases, the participation of biofuels in the national energy matrix.
xiii. Ensure the supply of biofuels throughout the national territory.
xiv. Encourage the generation of electric power from biomass and by-products of biofuel production, due to its clean, renewable, and complementary character to the hydraulic source.

xv. Promote the country's competitiveness in the international biofuel market.

xvi. Attract investments in infrastructure for biofuel transportation and storage.

xvii. Foster research and development related to renewable energy.

xviii. Mitigate the emissions of greenhouse gases and pollutants in the energy and transportation sectors, including using biofuels.

In practice, even though energy security is not explicitly cited in the PNE, its transversal influence on said objectives is clear. It is also possible to highlight aspects that permeate the construction of policies and influence the promotion of energy security and independence in Brazil: (1) the incentive to diversify the energy matrix; (2) the rational, efficient and timely use of energy resources, economic inputs, and technologies available to expand supply; and (3) the economic, social and environmental development from the preservation of the nation's interests and the country's main potentials. Thus, the following are examples of policies, strategies, and programs already in place that are connected to these aspects, thus generating an interface with the promotion of energy security.

Following the success of the Pro-Alcool program, responsible for building a strong economic chain for ethanol, and considering the broad protagonism that Brazil had in the field of agriculture and cattle raising, there were other advances in the policy framework regarding the promotion of biofuels in the Brazilian energy matrix. Initially, the expansion occurred through the National Program for Biodiesel Production and Use (PNPB), in 2004, which not only fostered the construction and subsequent expansion of the use and production of biodiesel, but also inserted family farming in the process, making it central as a production figure of the inputs for the production of the fuel. In 2017, the framework was strengthened through the National Biofuels Policy (Renovabio), which sought to increase the participation of biofuels in the country's productive sectors, expanding the competitiveness and predictability of different types of biofuels in the market and contributing to meet Brazil's commitments under the Paris Agreement under the United Nations Framework Convention on Climate Change. Furthermore, the National Biokerosene Program was created in 2021, to foster the use of the fuel in aviation - a sector known for being hard to decarbonise.

Besides biomass, the promotion of renewable sources started as early as 2002, through the Incentive Program for Alternative Energy Sources (Proinfa), considered one of the largest incentive programs for the use of these sources worldwide. For perspective purposes, by 2011, Proinfa had implemented 119 projects, representing 2,649 MW of installed power divided into biomass thermal plants, small hydraulic plants, and wind power plants, with the promotion of about 150,000 direct and indirect jobs, with an estimated emissions reduction of 2.5 billion tons of CO_2/year. Even though it has not been the sole responsible for the transformation, Proinfa was one of the driving forces behind the diversification of the Brazilian electricity

matrix. The matrix maintained a renewability profile above 80% between 2000 and 2020, even with a significant deconcentration of hydraulic generation, which went from almost 89% to about 64% in 2020.

As part of using its resources in a timely manner, Brazil also sees the relevance of its potential in other energy vectors, other than those strictly renewable. In this case, it is worth citing the recent New Gas Market Program (July 2019), which sought to create the measures for the design of the new natural gas market, seeking to build a more competitive and open market for the use of the fuel. The Program continuing a process of opening that had already been started in the figures of the Petroleum Law (Law n. 9. 478/1997) and Gas Law (Law n. 11.909/2009), that brought incentives for the promotion of new agents, although they have proven to be insufficient. Another potential source is nuclear generation, with the observance of its non-emission character. Currently, the Brazilian Nuclear Policy (PNB) of 2018 is in force, "consolidating a set of guiding guidelines, with the purpose of orienting the planning, the actions, and the nuclear and radioactive activities in the country, in observance of national sovereignty, with a view to development the protection of human health, and the environment".

More recently and focusing on the perspective of energy sources for the future, the National Hydrogen Program (PNH2) aims at the organisation of actions and strategies for the development of the hydrogen economy in the country. Hydrogen is considered a fuel with great potential for use in sectors that are difficult to decarbonise and where Brazil can exert a great international role, given its generation park that is widely renewable.

The examples cited demonstrate a broad view of potentials explored by Brazil in the scope of its policies, focusing mainly on the diversity of options that the country has in its territory, but also on the mitigation of potential "technological lock-ins" that may occur in the planning. However, energy security is also related to competitiveness and advances in the sector, as well as adjustments in the expansion based on planning for demand management, that is, thought from the point of view of energy efficiency. The theme of energy efficiency will be treated in a separate topic; however, the market adjustment can be treated from the perspective of the recent Modernisation of the Electricity Sector project.

This project was instrumentalised in 2019, instituting a Working Group, responsible for indicating proposals for modernising the sector based on the pillars of governance, transparency, and legal-regulatory stability. At the end of its work, the Group presented an Action Plan with proposals for normative acts relevant to the modernisation, in short, medium, and long-term measures, generating a document with 88 actions acting on 15 fronts, including the construction of a specific committee for the adoption of proposals, the Modernisation Implementation Committee (CIM).

1.1.3 THE CHARACTERISTICS AND APPROACH TO ENERGY TRANSITION

Brazil's Long-Term Plan

As previously mentioned in the introductory chapter, the PNE is the main document in terms of evaluating the perspectives of the country's long-term energy planning, presenting potentials of the energy sector configuration along scenarios built around different trajectories. The PNE should be seen as the basis for the design of the government's long-term strategy concerning the sector's expansion. It consists of a set of recommendations and guidelines that can be used to define the actions and initiatives to be implemented in the long term.

It is relevant to mention that the proposed planning was done from the planner's perspective, indicating the main relevant issues in the period. Given this aspect, and the uncertainty inherent in the construction of a long-term plan, two major scenarios are used to define the strategy: one that reflects a more expressive growth and greater demand of expansion requirements, called Expansion Challenge; and another where per capita consumption remains relatively stable, with a vegetative growth, called Stagnation. The use of both scenarios creates a "cone of uncertainties" for the strategy, allowing it to present the multiple potentialities and paths existing in the period, acting as a "map" for the decision maker, even though the focus of the document is more concentrated on the Expansion Challenge scenario.

Brazil's Current Situation Analysis

The Brazilian electric power production and transmission system, responsible for supplying 99.4% of the country's consumption, is a large-scale hydro-thermal-wind-solar system, with a predominance of hydroelectric power plants and multiple owners. The National Interconnected System (SIN) consists of four subsystems: South, Southeast/Central-West, Northeast, and most of the North region.

The interconnection of the electrical systems through the transmission grid allows for energy transfer between subsystems, enabling synergistic gains and leveraging the diversity of hydrological regimes in the basins. The integration of generation and transmission resources ensures the safe and cost-effective supply to the market.

The installed generation capacity of the SIN is mainly composed of hydroelectric power plants distributed across sixteen hydrographic basins in different regions of the country. In recent years, the installation of wind and solar power plants has experienced significant growth, increasing the importance of these sources for meeting the market's demand. Thermal power plants, generally located near major load centres, play a relevant strategic role as

they contribute to the SIN's security. These plants are dispatched according to the current hydrological conditions, allowing for the management of water storage in hydroelectric plant reservoirs to ensure future supply. The transmission systems integrate different energy production sources and enable the supply to the consumer market.

- **Generation:** The installed capacity in the SIN as of May 2023 totals 184.6 GW, of which 109.4 GW (59.3%) comes from hydroelectric power plants; 26 GW (14.1%) from conventional and nuclear thermal power plants; and approximately 49.2 GW (26.6%) from small hydroelectric power plants, biomass, wind, and solar power plants. It is estimated that by the end of 2027, the installed capacity in the SIN will reach 208 GW, with an increase of approximately 5 GW in conventional and nuclear thermal power plants, reaching 31 GW, and about 17.5 GW in small hydroelectric power plants, biomass, wind, and solar power plants, totalling 66.7 GW.

- **Transmission:** The Basic Grid of the SIN covers almost the entire national territory, extending from the state of Pará to Rio Grande do Sul, from the coast to Acre. The only isolated capital is Boa Vista, in Roraima. The Basic Grid of the SIN is a system with multiple owners and, as of the end of 2022, it totalled 179,311 km of transmission lines, with nominal voltages ranging from 230 kV to 800 kV. Of these, 70,044 km correspond to 500 kV lines, and 22,020 km refer to ±600 kV and ±800 kV high-voltage direct current (HVDC) bipole lines.

- **Distribution:** The electricity distribution system in Brazil consists of various concessionaire companies that are responsible for delivering the electricity produced by power plants to end consumers. This system is regulated by the National Electric Energy Agency (ANEEL, in Portuguese), which defines the rules and guidelines for the electric sector in the country. Distribution companies are responsible for maintaining and expanding the distribution networks, ensuring the supply of electricity in a safe and continuous manner. ANEEL establishes quality indicators for the service provided by the distributors, monitoring the duration and frequency of power interruptions. The limits of these indicators vary among the concessionaires and over time, being important for monitoring and improving the quality of the energy service provided to consumers. There are over 90 million consumer units in Brazil, with the residential class accounting for 87% of this number.

- **Other technologies:** The electricity distribution systems already have a large number of distributed generation installations, generating electricity directly at the consumer units, predominantly installed on rooftops and other directly connected units injecting power into the distribution grids. This generation has been growing significantly in recent years, with an estimated capacity exceeding 20 GW by the end of 2023.

Additional data and highlights about the Brazilian electric sector, such as the evolution of installed generation and transmission capacity, electricity production, consumer market, international exchanges, hydro-meteorological data, and others, can be obtained by accessing the Monthly Bulletin of Electric System Monitoring, available on the Ministry of Mines and Energy's website.

Brazil's Energy Efficiency in the PNE

As already mentioned in the introduction, energy efficiency is one of the most effective and priority issues for meeting energy demand, both by contributing to energy security by reducing the use of natural resources and pollutant emissions, and by the gains in competitiveness built into its policies. Efficiency is, in practice, one of the main tools for energy security and transition and is considered by the IEA to be the "first fuel for a sustainable global energy system"[8]. It is worth noting that initiatives aimed at efficiency are not recent in the country, with the creation of the Brazilian Labelling Program (PBE) occurring in the early 80s.

Considering the "Expansion Challenge" scenario, gains in electrical efficiency could contribute to reducing the need for about 321 TWh of electricity consumption, about 17% of total consumption, in 2050. This meaning avoiding more than twice the energy consumption of Brazil's industrial sector in 2019 or an expansion of installed capacity for generation equivalent to more than two Itaipu plants in their total power. When potential efficiency gains in the fuel sector are added, the contribution could reach 77 million toes, about 13% of total energy consumption by 2050.

The opportunities for harnessing energy efficiency potentials are possible across a wide range of economic sectors, and it is observed in long-term studies the contribution of the industrial, transportation, and building sectors in terms of total efficiency-related gains. Thus, the development of plans and measures to take advantage of these opportunities need to contemplate both the improvement of existing and tested mechanisms and the promotion of new public policy mechanisms in Brazil in the area of energy efficiency.

The PNE points out that the level of governance, however, is complex given the large number of parties involved and the slow insertion of energy efficiency projects. This calls for a long-term perspective, and there is a need for articulation between different links in the chain of utilisation, from formulation and regulation of mechanisms at the governmental level to the effective implementation by final consumers – who, in turn, may be impacted by economic or behavioural rationality issues.

Currently, some of the main instruments for promoting energy efficiency in force in the country, according to the PNE, are:

- The Brazilian Labeling Program, which is characterised as an instrument of information to the final consumer, assisting in the choice of more efficient products, through the publication of the National Energy Conservation Label (ENCE);
- The National Program for the Conservation of Electrical Energy (PROCEL), created in 1985, directs resources to be applied to projects that make investments in studies, capitation, and energy efficiency programs, under the Program for the Application of Resources (PAR/PROCEL);
- The National Program for Rational Use of Petroleum Derivatives and Natural Gas (CONPET), created to encourage the rational use of fuels in relevant sectors, such as residential, commercial, industry, and transportation;
- The National Plan for Energy Efficiency (PNEf), built to present actions and guidelines aimed at promoting energy efficiency, with guidelines for public policies aimed at the final consumer sectors;
- Aneel's Energy Efficiency Program (PEE/Aneel), which established the percentage destination of the Net Operational Revenue (ROL) of the electricity distribution in the country, for investments in R&D and energy efficiency; and
- The Energy Efficiency Law (Law n. 10.295/2001), which established minimum efficiency indexes for equipment sold in Brazil and in buildings, with the minimums defined by the Managing Committee for Energy Efficiency Indicators (CGIEE), coordinated by the MME, with the participation of civil society.

As part of the construction of the long-term strategy for energy efficiency in the country, three main challenges were mapped out in the PNE, with three corresponding recommendations indicating paths that could be used by the decision-maker in the face of the drawn scenario. Regarding the challenges, the following stand out:

- The mapping of the low availability of information on the potential and costs of energy efficiency opportunities, given that the capillarity of information for the consumption profile is very high, requiring data at the sectoral level to provide inputs for the evaluations;
- The institutional coordination and integration of the different initiatives related to efficiency; and
- The creation of an energy efficiency culture in society, since in active demand, management consumers are a determining part of the equation, and mechanisms are needed to encourage such actions.

Regarding the recommendations, the following can be highlighted:

- Ensuring the collection of data and information about the energy efficiency market, strengthening, and improving data collection systems, expanding the scope, and considering the impact of digital transformation and smart meters in the collection logic. In addition, it was indicated actions such as defining periodic updates of field surveys within the agenda for using resources from PAR/Procel, PEE/Aneel, and R&D/Aneel, making adjustments to allow the arrangement and seeking synergies between existing institutional structures, reducing the costs of these surveys;
- Review the institutional framework related to energy efficiency, to encourage the participation of the distribution concessionaire, since currently, the distribution remuneration occurs per energy consumed, discouraging reductions in consumption;
- Promote information and education about the contribution of energy efficiency in the country, reducing information asymmetries about its performance and importance.

1.1.4 DECISION MAKING CONSIDERATIONS AND PRINCIPLES

The government's actions in the energy sector have undergone transformations due to the growing complexity of the production systems, transport and distribution of energy, which can be further enhanced by the prospects of greater decentralisation, liberalisation of choices of the sector's actors and energy markets. The configuration of the Brazilian energy sector, with the need to attract the private sector to effect expansion, impacts how the government acts, with the PNE pointing out a set of guiding principles to direct the improvement of the legal and infra-legal framework for the sector. The ten principles were presented in the PNE in the following terms:

i. **Technological Neutrality:** It is a concept that aims to allow competition between all technologies. The adequacy of resources in the context of greater participation of non-controllable renewable sources should be achieved through a market design that ensures due technological neutrality in the required expansion so that the reliability of supply is guaranteed.

ii. **Fostering Competition:** Free competition must be guaranteed in all segments that can count on competitive mechanisms of allocation, with a diversity of agents, free entry and exit of participants, and avoiding situations of market power. It should also promote (or not prevent) new forms of institutional and commercial arrangements and technological innovations. Where competition is not possible, regulation should be transparent, isonomic, and non-discriminatory, and establish fair and justifiable tariffs, in order to ensure the welfare of society.

iii. **Isonomy:** There should be no asymmetric or discriminatory treatment between agents (on the supply and demand side), between contracting environments (free or regulated), or of access to essential infrastructure.

iv. **Efficiency:** The allocation of resources should be guided primarily by the pursuit of efficiency. In this sense, markets should function so that prices reflect market conditions and costs and risks are appropriately allocated. It is necessary to ensure competition on the supply side, recognise the role of free consumer choice for the proper functioning of the market, encourage the rational use of energy, and ensure the coordination of actions to expand generation, transmission, and distribution.

v. **Predictability:** It is fundamental that the authorities of the sector define clear, transparent, and predictable rules to reduce the uncertainties of investments, generating a business environment capable of fostering efficiency, in order to drive the progressive consolidation of sustainable energy development in Brazil. Otherwise, any legal or regulatory change to be implemented must count on a due evaluation of its impacts and a transition period for the agents to adapt.

vi. **Simplicity:** It is necessary to pursue policies that guarantee the legal security of contracts in order to reduce risks and encourage investments, avoiding overly complex clauses and rules. Simplicity and objectivity in the formulation of the rules for the sector should be prioritised. It is not about oversimplification in an already highly complex sector, but, on the contrary, avoiding the addition of unnecessary regulatory and legal complexity, when a simpler and more direct formulation is possible.

vii. **Transparency:** Industry officials must be accountable and responsible for what they do or choose not to do in the conduct of their respective mandates. The process of public access to decisions on public policy for the sector, planning, regulation, and operation, should continue to be encouraged. Such decisions must be registered and preceded by a regulatory impact assessment. All subsidies, their costs, and the distribution of the benefits and costs among all agents in the sector must be made public.

viii. **Coherence:** Decisions regarding the energy sector must observe an integrated viewpoint, which is capable of fostering competitiveness, economic efficiency, consistency, and harmony of the energy sector as a whole, guaranteeing the security of supply and long-term predictability, as well as intra-generational and inter- generational justice.

ix. **Sustainability:** The energy sector must be aligned with the promotion of sustainable development, based on the best international practices and economic efficiency, seeking to take advantage of the comparative advantages of national natural resources or through public policies that value its environmental attributes.

x. **Precaution:** Decisions in the energy sector often have long-term consequences. In an environment of uncertainties and transformations, with the possibility of high-impact and unexpected events, it is more appropriate to look for options that create more flexibility for possible corrections in the face of unexpected contexts and for policies that promote results rather than defining the means to achieve them. In particular, in the case of technological routes, innovation itself can bring about the overcoming of specific technologies, considered the most appropriate in a given context, but which may turn out to be radically transformed, leading to the difficulty in overcoming technological obsolescence and the regret of energy policy choice based on selected technologies.

1.1.5 THE RISKS, CHALLENGES AND THREATS TO ENERGY SECURITY

Brazil faces several risks, challenges, and threats to its energy security, which can have significant implications for its economy, society, and overall development. It is essential to acknowledge the risks, challenges, and threats that Brazil faces in ensuring energy security. Brazil's heavy reliance on hydroelectric power presents a vulnerability, as fluctuating water levels can impact electricity generation. Climate change and extreme weather events further compound this issue, emphasising the need for diversified energy sources and infrastructure resilience. Some of the key concerns include:

- **Heavy Reliance on Hydroelectric Power:** Brazil's energy matrix heavily relies on hydroelectric power, which makes the country vulnerable to fluctuations in water availability. Droughts and changes in precipitation patterns can lead to reduced water levels in reservoirs, affecting electricity generation and supply stability.
- **Climate Change and Extreme Weather Events:** Brazil is susceptible to extreme weather events like droughts, floods, and storms, which can disrupt energy infrastructure and supply chains. Climate change exacerbates these risks, making it crucial for Brazil to diversify its energy sources and strengthen infrastructure resilience.

- **Energy Infrastructure Vulnerability:** The energy sector's infrastructure may be vulnerable to natural disasters, accidents, or cyber-attacks, which could lead to disruptions in energy supply and transmission.
- **Energy Subsidies and Price Volatility:** Government subsidies for energy can distort market dynamics and lead to price volatility. Managing these subsidies effectively is essential to ensure energy affordability without compromising long-term sustainability.
- **Limited Interconnection and Grid Reliability:** Brazil's vast geographical expanse poses challenges in interconnecting regions and maintaining grid reliability. Adequate transmission infrastructure and grid management are necessary to balance energy supply and demand across the country.
- **Economic and Political Instability:** Economic downturns or political uncertainties can impact energy investments, regulatory frameworks, and decision-making, potentially affecting long-term energy planning and development.
- **Energy Dependence on Imports:** Despite being a significant oil and gas producer, Brazil also imports a considerable portion of its energy resources. Relying on international markets for energy supply exposes the country to geopolitical risks and price fluctuations.
- **Environmental Concerns:** The growth of energy-intensive industries and deforestation can lead to environmental degradation and contribute to climate change. Balancing energy development with environmental conservation is a pressing challenge for Brazil.
- **Social and Community Impact:** Large-scale energy projects, such as hydropower dams, can have social and environmental consequences for local communities, leading to conflicts and social unrest.
- **Transition to Clean Energy:** While Brazil has been making strides in renewable energy, transitioning away from fossil fuels poses challenges due to existing infrastructure, economic interests, and social implications.

Addressing these risks and challenges requires a comprehensive approach that includes diversifying the energy mix, improving energy efficiency, enhancing infrastructure resilience, promoting renewable energy adoption, and implementing effective energy policies and regulations. By taking proactive measures, Brazil can strengthen its energy security and ensure sustainable and reliable energy supply for its citizens and industries.

Points of Recommendation

As part of the design of the long-term strategy proposed by the PNE, the document defines a set of recommendations and potential guidelines to be followed, segmented into three types: Crosscutting Topics; Sources and Technologies; and Energy Transportation

Infrastructure. Since they dialogue with the entire sector and have a structural impact, the recommendations referring to crosscutting topics are presented below, with the potential to influence both sources and technologies, as well as economic sectors and transportation infrastructure.

The various changes resulting from new configurations and profound transformations of the global energy sector are the beacon of the topics presented here. It is mainly associated with aspects such as the energy transition, understood here as the decarbonisation of the energy matrices in response to climate change; by the decentralisation of energy resources; and by the greater digitalisation in the production and use of energy. It is noted that the evolution of research, development, and innovation (RD&I) has the power to accelerate technological transformations in the country, on the horizon of the PNE. The transversality of the topics is directly connected to energy security aspects and can affect the promotion or even the addressing of issues that have the potential to significantly change the panorama of energy guarantees. Thus, the transversal issues mapped out have their recommendations listed below, as described in the PNE.

Energy Transition

As previously mentioned, the concept of the energy transition is directly related to the decarbonisation of economies and environmental preservation, generating potential disruptions in the world energy matrix. As recommendations mapped out for the 30-year horizon, the PNE indicated:

- Promotion of the synergy of public policies and associated market designs, seeking to expand the coherences and potentials of both, with the establishment of public policies being attentive both to the improvement of successful mechanisms and the promotion of new ones;
- The adaptation of appropriate institutional, regulatory, and market design arrangements to enhance the energy transition;
- The development of flexible strategies to deal with uncertainties, based on the country's competitive advantages, prioritising policies that avoid technological lock-in;
- Strengthen international strategic alliances and networks to develop greater flexibility in the strategic choices associated with the transition;
- And articulate energy policies with ST&I and education policies, with the development of new capacities and the creation/enlargement of competitive advantages.

Climate Change

Climate change is characterised by the definition of the United Nations Framework Convention on Climate Change (UNFCC - 1992), which indicates it as a transformation "directly or indirectly attributed to human activity altering the composition of the global atmosphere, and which is additional to that caused by natural climate variability observed over comparable periods. It is associated with negative anthropogenic actions on climate change. The recommendations focused on:

- Enhance and expand the information base, computational tools, and methodologies for improving climate products and services, improving the climate change approach in planning;
- Increasing the articulation with other sectorial plans, synergising it with industry, transport and mobility, mining and low carbon agriculture plans, etc.;
- Creation of a plan to mitigate risks related to the security of supply in cases of extreme events.

Decarbonisation

Given the concepts of energy transition and its relation to climate change, decarbonisation is an integral part of the strategy, acting as a theme to reduce greenhouse gas emissions and carbon intensity in the economy, potentially the main objective of the policies to promote a low-carbon economy. The recommendations permeated through:

- Produce GHG emission abatement cost curve, with an inventory of activities in all sectors to confirm their contribution potentials and transaction costs;
- Promote continuous evaluation of alternatives for national positioning in international negotiations on climate change;
- Monitoring of mitigation policies for the energy sector;
- Structuring of new products and promotion of energy efficiency and innovation actions related to mitigation;
- Mapping of initiatives, information bank, and risks associated with the transition to a low carbon economy;
- Articulation with other sectors and decision-makers in the area to guarantee the coherence and consistency of policies for the implementation of decarbonisation measures;
- In addition, stimulate the possibilities that the use of hydrogen allows for the decarbonisation of sectors, especially those with difficult emission abatement, such as transportation.

Decentralisation

The topic of decentralisation assumes that recent technological phenomena, such as digitalisation, the Internet of Things, and artificial intelligence can have significant impacts on society and its relationship with the consumption of services, use of transport and access to communication, and, of course, energy consumption. In this aspect, we did not seek to analyse only decentralisation from the point of view of monopolistic market designs, but rather the process of decentralisation of information flows, investment decisions, production, and service provision, with the electricity sector being observed in three dimensions: technological, market designs and the construction of new businesses. The recommendations presented were:

The definition of the granularity of information between distributors, prosumers (i.e., consumers who also produce), and other agents;

- The unbundling of distribution and marketing services in different agents, with new remuneration models for distribution services;
- Achieving greater integration between transmission and distribution networks;
- Creation of a competitive market-oriented to the requirements of the systems on an isonomic basis;
- Creation of commitment mechanisms between the parties for the provision of services;
- The development of a roadmap for biomethane use;
- The development of a system for monitoring the quality of fuels obtained from waste, to ensure compliance with the specifications;
- And better articulation between stakeholders in projects related to liquid biofuels and biogas/biomethane.

Energy Consumer Behaviour

Taking into account the transformation of the role of consumers in the face of technological advances in the energy sector, and noting that growing trends (such as greater environmental awareness, population aging, climate change, digitalisation, and smart cities) may impact the decision-making process and relationship with the energy sector, the PNE indicated that these changes may play a relevant role in the regulatory environment, enhancing the emergence of disruptive business models. In this aspect, the following recommendations were proposed:

- Investment in research to understand the behaviour of the Brazilian energy consumer;
- Improve forecasting models for the electric power load curve, because of the greater participation of prosumers, which can add greater uncertainty to the daily load profile;

- Improve institutional governance over government initiatives with effects on energy consumer behaviour; and
- Improve regulatory frameworks and energy market designs.

Sharing Economy

Here, the topic refers to the recent increase in the popularity of shared services, with the sharing economy being used to describe the model of consumption of goods and services based on peer-to-peer sharing, commonly connected through an online platform. The movement, coupled with advances in mobile communication networks, has the potential to generate a sharp increase in the complexity and predictability of the national energy and electricity system. The referring recommendations were:

- Regulate peer-to-peer energy trading;
- Improve the operation and planning of the electricity sector to take into account the effects of a more sharing economy.

1.1.6 DIGITALISATION IN ENERGY PRODUCTION AND USE

In the same scope of the Sharing Economy, increased access and connectivity to digital media have accelerated the diffusion of information and communication technologies (ICT), generating demands for greater collection and analysis of large amounts of data, with automation aspects. This could be seen recently during the COVID-19 pandemic, in which changes in energy consumption profiles based on the increased digitalisation of processes that were once strictly face-to-face generated a change in the population's electricity consumption profile, with increased residential participation. The PNE mapped the following recommendations:

- Enhance regulatory framework and market design, considering the potential to build new architectures of interconnected power systems;
- Ensure effective interoperability of equipment, guaranteeing standardisation of devices and synergy among the various players;
- Improve the operation and planning of the electricity sector to take into account greater digitalisation in the production and use of electricity;
- Articulate with information security and data protection authorities to establish greater global resilience of the power system and information privacy;

- Articulate with authorities in the area of urban mobility to establish more attractive and efficient mobility options;
- Development of regulatory mechanisms to include protection against cyber-attacks.

Research, Development, and Innovation

With the advance of digitalisation, there is an increased need for the transformation of the Brazilian economy towards greater technological development. This transformation will depend on the country's ability to monitor, improve and expand investments in Research, Development, and Innovation (RD&I); convert the investments into products and patents; have adequate mechanisms for financing innovation; and reduce the average time of the processes associated with RD&I and the granting of patents and intellectual property to international standards. In this aspect, four recommendations were identified:

- Map the investments in R&D in the energy area, with the structuring of a database;
- Disseminate experiences and knowledge from RD&I projects in the energy sector;
- Increase the articulation between public and private agents and the RD&I sector in energy;
- In addition, strengthen governance and institutional alignments, being fundamental for the plans and strategies of public policies to align with the needs of the energy sector.

South American Energy Integration

Finally, a last crosscutting topic relates to the exploration of the regional potentialities of Latin America and the Caribbean. Since the region has access to sources with great complementarities, and can strongly attend to local needs, it is relevant to point out examples of concretised integration projects with the generation of mutual gains, such as Itaipu, belonging to both Brazil and Paraguay. It is indicated that integration can become more effective, with the country being able to play a central role as a driver of this integration. As a result, the recommendations are as follows:

- Develop socio-environmental studies for the feasibility of integration projects, particularly in the Amazon region;
- Resume studies of inventory and regional potential;
- Uniformed trade agreements and arrangements, identifying regulatory barriers that may generate misalignment to integration among countries;
- Structure the base of information and data models;
- Direct efforts towards the harmonisation of market designs;

- Articulate with the competent authorities the creation of a legal framework for the solution of regional conflicts; and
- Ensure non-discriminatory access to international interconnections.

1.1.7 THE MONITORING, EVALUATION AND FORECAST OF THE ENERGY SECTOR SECURITY

The Brazilian government monitors, evaluates, and forecasts the energy sector security through various mechanisms and institutions to ensure a reliable and stable energy supply for the nation. Here are some key approaches used:

- **Regulatory Authorities**: Brazil has regulatory bodies like the National Agency of Petroleum, Natural Gas, and Biofuels (ANP), the National Electric Energy Agency (ANEEL), and the Brazilian Electricity Regulatory Agency (EPE). These agencies are responsib le for overseeing the energy sector, setting regulations, and monitoring compliance with energy policies.
- **Energy Balance and Projections**: The Ministry of Mines and Energy (MME) publishes an annual Energy Balance report that provides detailed information on the country's energy production, consumption, imports, and exports. Additionally, they release 10-year energy projections that assess future energy demand and supply scenarios.
- **National Energy Plan (PNE)**: The Brazilian government formulates a National Energy Plan, which is a long-term strategy that outlines energy policies, targets, and initiatives for the coming years. The plan considers various factors like economic growth, technological advancements, and environmental sustainability.
- **Energy Security Assessments**: The government regularly conducts energy security assessments to identify potential risks and vulnerabilities in the energy sector. These assessments consider factors like supply-demand imbalances, potential disruptions in energy supply chains, and the impact of external factors on energy availability.
- **Emergency Response Mechanisms**: To address unforeseen energy crises or disruptions, Brazil has established emergency response mechanisms. These include contingency plans, energy reserves, and coordinated responses among relevant government agencies and industry stakeholders.
- **Energy Market Monitoring**: The Brazilian government keeps a close watch on the energy market, including electricity, oil, gas, and renewable energy sectors. Monitoring mechanisms help identify price fluctuations, market dynamics, and potential supply issues that may affect energy security.

- **Environmental Monitoring and Compliance**: Brazil's commitment to environmental sustainability involves monitoring the impact of energy projects on the environment and ensuring compliance with environmental regulations. Projects are assessed for their ecological impact, and measures are taken to mitigate any adverse effects.
- **Research and Development**: The government invests in research and development initiatives to explore new energy technologies and improve energy efficiency. This enables the country to stay abreast of technological advancements and adapt to changing energy landscapes.
- **International Cooperation**: Brazil collaborates with international organisations and other countries to exchange best practices, data, and expertise related to energy security. This helps in understanding global energy trends and accessing resources during energy crisis.

By employing these monitoring, evaluation, and forecasting strategies, the Brazilian government aims to strengthen the energy sector's security and sustainability, ensuring a stable and resilient energy supply for the nation's economic and social development.

1.1.8 STATUTORY AND REGULATORY CONTEXT

Resolution No. 29 (December 12, 2019), issued by the National Energy Policy Council (CNPE), establishes the general criterion for supply adequacy assessment in terms of energy, based on the conditioned expected value at a certain confidence level of energy non-supplied (CVaR of Unsupplied Energy), and the conditioned expected value at a certain confidence level of marginal operating cost (CVaR of CMO). Through this Resolution, CNPE also defines the general criterion for supply adequacy assessment in terms of power supply, based on explicit risk metrics of power non-supplied (Loss of Load Probability - LOLP) and conditioned expected value at a certain confidence level of power non-supplied (CVaR of Unsupplied Power).

Ministry of Mines and Energy Ordinance No. 593 (February 20, 2020), defines the parameters to be used in the application of the supply adequacy metrics for energy supply assessment in the System, established in CNPE Resolution No. 29/2019:

- Conditioned expected value at a certain confidence level (CVaR) of energy non-supplied (ENS): CVaR1%(ENS) ≤ 5% of the annual energy demand of the SIN;
- Conditioned expected value at a certain confidence level (CVaR) of marginal operating cost (CMO): CVaR10%(CMO) ≤ R$800/MWh;
- Explicit risk of power non-supply (LOLP): limited to 5% for the SIN on an annual basis;

- Conditioned expected value at a certain confidence level (CVaR) of power non-supplied (PNS): CVaR5%(PNS) ≤ 5% of the maximum instantaneous demand of the SIN.

To assess the conditions for electricity consumption supply in a five-year horizon, from the perspective of supply energy security, ONS carries out operational planning studies formalized in the Energy Operation Plan (PEN) 4. PEN's main inputs are: the supply adequacy criteria established by CNPE; the energy supply contracted through public auctions (whose implementation schedules are monitored by SNEE/MME); and load forecasts for the annual operation planning of the SIN (disaggregated by subsystem), as well as its quarterly revisions, carried out jointly by ONS, the Electricity Trading Chamber (CCEE), and the Energy Research Company (EPE). It is important to highlight that PEN is reviewed annually and is available on the ONS website.

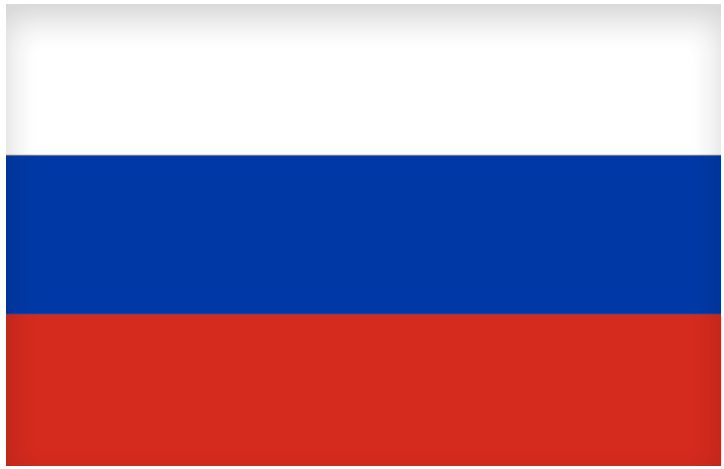
1.1.9 TRANSMISSION ADEQUACY MEASURES

The reliability of the SIN's Basic Network is determined based on the following criteria established in Submodule 2.3 of the Network Procedures - Premises, Criteria, and Methodology for Electrical Studies5:

- The system's performance must ensure no voltage or loading violations occur, and no load shedding is required due to single contingencies (n-1 criterion).
- Single contingencies are simulated by the loss of a single system element, such as a transmission line, transformer, transformer bank, generating unit, HVDC link, or voltage control equipment, such as a reactor, capacitor, or synchronous or static compensator.
- In addition to single contingencies, double losses are also considered in the following situations:
  - Double losses of transmission circuits in the Operating Network that share structures or the same right-of-way.
  - Double losses of circuits crossing regions prone to natural phenomena and/or wildfires that may affect them.
- In the case of double contingencies, controlled load shedding (whether automatic or not) is acceptable to avoid the risk of power, frequency, or voltage instability in a region, state, or capital, with subsequent uncontrolled load shedding.
- To comply with the aforementioned criteria, resources such as thermal generation, interchange restrictions, network topology alteration, or the use of Special Protection Systems (SEP) should be employed.

- Additionally, in the case of double contingencies, load-shedding schemes, such as Regional Load Shedding Schemes (ERAC), can be implemented. In the event of islanding, the resulting subsystems must remain stable.
- In exceptional situations, even more restrictive criteria that aim to preserve load supply continuity for double and, eventually, multiple contingencies may be adopted, provided they are properly justified by technical analysis and previously submitted to the Electric Sector Monitoring Committee (CMSE):
  i. During the commissioning and initial operation period of new installations and equipment.
  ii. After major disturbances or recurrent unplanned outages that have led to load shedding, until the causes of the disturbances are identified and resolved.
  iii. During special events of significant relevance, public events, or national, regional, or local commemorations.
- On the other hand, after exhausting all available resources, less restrictive performance and safety criteria may be used, duly justified by technical or techno-economic analysis and previously submitted to CMSE and ANEEL in the following exceptional situations:
  i. Unfavourable energy scenarios, as assessed by ONS in the scope of energy operation planning.
  ii. Transmission system constraints, such as those resulting from incomplete topology, particularly related to the integration of isolated power systems into the SIN.
  iii. Supplying loads through simple radial transmission systems or a single transformer.
  iv. Conjunctural situations resulting from unavailability of major transmission trunks.
- The security of the SIN's electrical operation is assessed over various study horizons, from real-time operation based on pre-established security curves, to analyses five years ahead. In particular, the longer-term assessment conducted by ONS regarding the conditions for electricity consumption supply, from the perspective of the electrical network's performance and supply security, is consolidated in the Medium-Term Electrical Operation Plan (PAR/PEL) for the SIN, made available annually on the ONS website.

RUSSIA



[1.2]

1.2.1 THE CURRENT SITUATION

The energy sector of the Russian Federation, which is based on the fuel and energy complex, makes a significant contribution to the national security and socio-economic development of the country. The fuel and energy complex of the Russian Federation includes the oil, gas, coal and peat sectors, electric power and heat supply, and plays a key role in generating revenue for the budget system of the Russian Federation. It accounts for about one-third of all fixed capital investments in the Russian Federation, about 40% in the federal budget revenue structure, and more than half in Russian exports (in value terms).

The Russian Federation is among the world leaders in terms of hydrocarbon reserves, production and export of energy resources, and in hydropower and nuclear power, including construction of nuclear power plants abroad. The Russian Federation is a key player in the global energy system, providing 10% of global primary energy production, 5% of global primary energy consumption, about 20% of global fossil fuel energy sources trade (11%, 25% and 16% of global exports of oil and petroleum products, gas and coal, respectively).

Among the world's largest economies, the fuel and energy sector of the Russian Federation is one of the most environmentally friendly (low-carbon): nuclear power, hydropower and other renewable energy sources account for more than a third of electricity generation, while natural gas accounts for about half of it.

The Russian energy infrastructure, which is based on the Unified Energy System of Russia, the Unified Gas Supply System, and the trunk pipeline system for transporting oil and petroleum products, main and distributing heat networks, is one of the longest in the world and operates under various climatic conditions, from the Arctic to the subtropical zone.

The Russian Federation supports energy cooperation between countries involved in the global regulatory system, which is becoming an important factor in the development of world energy sector and ensuring energy security within the process of overcoming global challenges through consolidation of efforts in economic partnership in the following priority areas: assistance and provision of mutual support for the diversification of energy sources and types of energy resources; development, protection and security of critical energy infrastructure

and transit; increasing energy efficiency, including joint development and exchange of energy-efficient and clean energy technologies; increasing efficiency of the clean energy sources use, including use of natural gas; integration of environmentally safe technologies for production, storage and consumption of energy resources.

1.2.2 NATIONAL ENERGY SECURITY POLICY

The Russian Federation pursues a balanced and economically sound energy policy based on the efficient use of all energy sources, including fossil fuel, new and renewable sources, with a focus on advanced environmentally friendly technologies and environmental protection.

For the Russian Federation energy security is the most crucial component of national security, the basis of the economic security system. Through implementation of a model based on the principle of interconnectedness and fair risk sharing between all participants of the energy chain and the balance of interests not only of energy producers and consumers, but also of transit countries, the level of energy security of the Russian Federation is ensured at an optimal level, preventing its deterioration and mitigating risks and crises directly related to the country energy supply. Ensuring energy security of the Russian Federation is the prerogative of the state. It is achieved through a system of legislative, regulatory, and other measures adequate to the identified threats and destabilizing factors.

The country's energy security is based on ensuring the protection of the country's economy and population from threats to national security in the energy sector, while ensuring the fulfilment of requirements for fuel and energy supply to consumers stipulated by the legislation of the Russian Federation, as well as the fulfilment of export contracts and international obligations of the Russian Federation.

The energy security system of the Russian Federation is defined by acts of the President of the Russian Federation, federal laws and the Government of the Russian Federation, and decisions of the Security Council of the Russian Federation. The content of the state policy in the field of energy security is the provision by the state bodies of the Russian Federation of the necessary legal, organisational, economic and other conditions for providing the state and its citizens with energy resources, preventing damage to the stable provision and development of the economic potential of the state and the functioning of entities and facilities of the fuel and energy complex.

The goal of the national policy in the field of energy security is to ensure the regulatory level of the country's energy security in the conditions of challenges, threats and risks specified in the Energy Security Doctrine of the Russian Federation, approved in 2019 by the Decree

of the President of the Russian Federation (hereinafter referred to as the Energy Security Doctrine), and other strategic planning documents in the field of national security of the Russian Federation.

The principles of ensuring energy security are legality, priority of the domestic market, stability of tax policy and normative and legal regulation in the field of energy, procurement of material, financial and human resources of the fuel and energy complex companies, rational nature and resource management and energy efficiency, public-private partnership, consideration of the interests of all energy security entities and the population, integration into international security systems, consideration of environmental safety requirements, continuity of the energy security process.

The document is a set of official views, fundamental ideas and basic principles that reflect the nature of state activities within the framework of ensuring energy security of the Russian Federation. The systematic and harmonious balance of strategic planning documents in the energy sector of the Russian Federation makes it possible to build a clear structure and relationship between the basic principles of state activity and the mechanisms for implementation of the state policy in the field of ensuring energy and economic security.

1.2.3 THE CHARACTERISTICS AND APPROACH TO ENERGY TRANSITION

The fundamental document in the sphere of national security, which includes energy security, is the National Security Strategy of the Russian Federation, with the Economic Security Strategy of the Russian Federation also providing general framework. National energy security issues in Russia are inextricably entwined with strategic planning for the energy sector development. The Energy Strategy of the Russian Federation for the period up to 2035, approved by an order of the Government of the Russian Federation in 2020 (hereinafter referred to as the Energy Strategy), takes into account the fundamental connection between the development of energy sector and ensuring national security, primarily energy security. The strategies of spatial, scientific and technological development and development of the mineral resource base of the Russian Federation make up a unified approach to achieving the national interests of the Russian Federation, taking into account the focus of state management in the field of energy. The forecast of the scientific and technological development of the fuel and energy complex of Russia for the period up to 2035 (hereinafter referred to as the S&T Development Forecast) takes into account the fundamental interconnections of the technological development of the country's energy with ensuring national security, including energy security in external and domestic environment and trends in the development of the Russian economy and energy.

The accelerated transition to more efficient, flexible and sustainable energy, capable of adequately responding to the emergence and rapid transformation of new challenges and threats of a hybrid nature is embedded in the priorities of the national energy policy of the Russian Federation. One such priority is to guarantee energy security not only for the country as a whole, but also at the level of the constituent entities of the Russian Federation, especially those located in geostrategic territories.

The key activity areas to ensure energy security of the Russian Federation include improving state management in the field of energy security; maintaining the mineral resource base of the fuel and energy complex and the main production assets of companies of the fuel and energy complex at the level necessary to ensure energy security; ensuring international legal protection of the interests of the Russian fuel and energy complex and power engineering sector companies; supporting export of these companies' products, technologies and services.

One of the important activity areas is the systematic implementation of import substitution in activities critical for the sustainable functioning of the fuel and energy complex, including localisation of production of foreign equipment or creation of its domestic analogues, development of technology (including information and telecommunications) and software. This is one of the strategic tasks for the technological independence of the Russian fuel and energy complex, which ensures energy security.

Under the impact of the technological sanctions, the Russian Federation has continued to transform its scientific and industrial policy to ensure technological sovereignty, especially in terms of technologies and equipment supplied by unfriendly countries. The expansion of scientific and technological cooperation with friendly countries has increased the total energy potential for the implementation of alternative integration processes in the existing cooperation based on common priorities and complementary interests in ensuring and strengthening energy security.

Currently, the Russian energy policy is appearing to be reorienting from resource and raw material-based to resource-innovative development with a shift from quantitative increase in indicators to qualitative change in the structure of energy consumption, increase in the level of energy services, technological energy saving and modernisation, advanced electrification, development of oil and gas chemistry and other new industries.

The Russian Federation supports the efforts of the international community to achieve the global goals of reducing the risks of climate change and providing affordable and reliable energy for the world population but opposes an accelerated energy transition that does not take into account the national specificity through the rejection of the development and use of fossil fuel-based energy.

The transition of the Russian Federation to a sustainable development trajectory with a low level of greenhouse gas emissions (hereafter referred to as GHG emissions) is being carried out by gradually changing the economic structure through its diversification in correspondence with the growing climate challenges. The formation of a national system to promote the reduction of GHG emissions, the creation of conditions for priority stimulation of investments in projects to introduce low- and carbon-free technologies in the economy sectors and the achievement of synergistic effects from the implementation of measures in relation to the sustainable development goals of the Russian economy are carried out and ensured by addressing the tasks set out in the Strategy of socio-economic development of the Russian Federation with low greenhouse gas emissions until 2050, approved in 2021 (hereinafter referred to as the Strategy of low-carbon development).

Adaptation of the public administration spheres, economic sectors and regional infrastructure of the Russian Federation to climate change is associated not only with the need to minimise the emerging complex risks, but also with the creation of conditions for the implementation of emerging favourable opportunities, taking into account the competitiveness and sustainable economic growth of the Russian Federation within the context of energy transition.

All this has led to the work on updating and prolonging the current Energy Strategy for the period until 2050, which sets as a goal a qualitatively new state of the energy sector of the Russian Federation, including a balance between:

- Accessibility, guaranteed and cost-effective provision of the population and the national economy with fuel and energy products and services, and realisation of the export potential of the Russian Federation;
- Achievement of greenhouse gas emission reduction targets in the energy sector and ensuring “carbon neutrality” of the Russian Federation no later than 2060;
- Technological sovereignty and competitiveness of the fuel and energy industries.

In the priority innovation area the Russian Federation carries out goal-oriented activities to implement new approaches to the development of low-carbon energy of full life cycle in the field of nuclear power generation, hydrogen energy, renewable energy sources, as well as energy storage, using new domestic breakthrough science-intensive solutions for the entire technological chain of obtaining and using energy resources that simultaneously meet the requirements of cost-effectiveness, environmental friendliness and reliability. Such solutions in the global space determine not only the level of competitiveness and technological independence as one of the main strategic aspects in ensuring an acceptable level of energy security, but also play a crucial role in providing the basis for the future energy industry.

Low-carbon and renewable energy sources account for 85% of the Russian electricity mix (as of early 2023), of which gas-fired power generation accounts for 47% and nuclear, hydro and renewables – 38%.

The country has a significant scientific and technical background in the field of nuclear power generation, solar and wind energy. The country is among the world leaders in the development of nuclear, thermonuclear and plasma technologies. A high-tech industry for the production of photovoltaic cells and wind turbines has been created from scratch. Technologies for the production of zero and low-carbon hydrogen, equipment for its use and storage, including fuel cells, energy storage technologies, including those based on lithium and sodium-ion batteries and flow batteries, are being actively developed.

The geographical location, peculiarities and characteristics of the country's territory, large deposits of rare and critical minerals, as well as the laid scientific groundwork allow for the successful development of almost any type of environmentally friendly and low-carbon technologies in the energy sector, including those based on the principles of integrated use of advanced technologies.

Achieving a qualitatively new level of the energy sector development in the Russian Federation is facilitated by targeting regulatory and legal instruments and measures to stimulate and support a smooth transition to low-carbon energy, organising and ensuring overall coordination and coherence of the government measures on science and technology, infrastructure and human resources.

In order to make effective management decisions when planning the development of different types of low-carbon energy in the Russian Federation, the coherence of the government support measures and the unified focus of various scientific, technical and innovation projects, taking into account all the risks associated with investment in the development of modern domestic environmentally friendly and low-carbon technologies with a long timeframe for implementation on an industrial scale, are of paramount importance.

At the same time, the development of the Russian fuel and energy complex is largely export-oriented, not only in relation to traditional energy resources (coal, oil and petroleum products, natural gas), but also to the new ones, in particular hydrogen, and therefore the risks associated with the politicisation of all global energy markets are being considered.

Amid the new challenges and rapidly transforming hybrid threats in the period of rising geopolitical tensions the top priorities for the Russian Federation are protecting national interests, maintaining a steady pace of the sustainable economic development and a high standard of living.

Significant energy changes due to the political West sanctions against the backdrop of the COVID-19 pandemic impact, the geopolitical conflict over the Special Military Operation, resulting in the restructuring and destabilisation of the global energy markets and world trade in general, including export-import regulation, logistics, shipping insurance, currency and payment system, have created a serious strategic challenge to energy security and demonstrated the importance of strengthening requirements for its enhancing and managing risks posed to it.

1.2.4 INDUSTRIAL SECTORS PARTICIPATION IN ENSURING NATIONAL ENERGY SECURITY

The contribution of the sectors (energy companies) of the fuel and energy complex to ensuring the energy security of the country is determined by their ability, based on the effective use of internal and external resources, to provide reliable energy supply to economic entities and the population without harming the economic and environmental security of the country.

Under normal conditions (under conditions of an acceptable level of energy security risk), the activities of energy companies ensure satisfaction of the full (sufficient) volume of demand with economically available and high-quality resources and services. Under extreme conditions, the Russian fuel and energy complex companies maintain stable and guaranteed provision of the minimum required volume of energy supply needs, ensuring sustainable development of the country's economy at present and in the future and implementing the national strategy in the global market.

In the context of unprecedented sanctions pressure, the main organisational principles of ensuring energy security of the Russian Federation and system reliability of energy systems are being implemented in a stricter manner.

In order to ensure the country's energy security, energy companies are constantly carrying out research, development, experimental design and survey work aimed at continuous improvement and optimisation of industrial processes. They are also conducting research into ways of reducing and neutralising GHG emissions at facilities in the technological industrial chain.

Companies implement a policy of import substitution and localisation of the production of analogues of imported products in the country, in current activities they implement investment projects to ensure technological independence, including through the priority use of domestic software and hardware in all areas of activity.

Efficient investments in all parts of the energy chain of the country's fuel and energy complex, ensuring safety, technical reliability and accident-free operation of industry facilities; ensuring the security of critical information infrastructure of fuel and energy complex facilities; improving energy efficiency at the national and international levels in the development and use of energy resources ensures energy security of the Russian Federation while fulfilling its internal and external obligations.

The unique geographical and geopolitical location of the Russian Federation creates the essential conditions for ensuring reliable transportation of fuel and energy resources. In the current situation of changes in the energy markets, the Russian Federation is shaping its export and infrastructure policy affecting the intra-industry objectives of the Russian fuel and energy complex.

Oil Industry

The Russian economy features an extensive oil industry capable not only of fully satisfying domestic demand but also of providing substantial export opportunities. Its importance in export and budget revenues and its close cooperation with other sectors and industries of the national economy determine its role. Moreover, Russian oil is highly competitive on the world market. The oil industry is one of the most sustainable production complexes in the Russian economy and provides the main contribution to the Russian gross domestic product formation.

A distinctive feature of the Russian oil industry is a significant concentration of vertically integrated oil companies (VINKs) covering all stages of the technological process. The largest Russian companies involved in crude oil production and transportation of oil and oil products are Rosneft Oil Company, PJSC LUKOIL, «Surgutneftegaz» PJSC, Transneft, Gazprom Neft PJSC and Tatneft PJSC.

The principal activities of the companies are hydrocarbon exploration, production of crude oil, gas and gas condensate, refining and petrochemicals, marketing of crude oil, gas and refined products. Companies ensure achievement of strategic objectives of oil complex development in terms of country's energy security by meeting domestic demand for oil and refined petroleum products in a steady, continuous and cost-efficient manner, by participating actively in meeting global demand for oil and refined petroleum products, without prejudice to domestic demand, and by investment and innovation modernising in order to improve energy, economic and ecological efficiency of complex operation.

To achieve the strategic objectives of ensuring energy security of the Russian Federation, oil companies solve many problems, such as: provide oil reserves expanded reproduction

through geological exploration and prompt preparation of fields development; create new large oil complexes; improve oil production technologies; develop transport infrastructure, including pipelines, to increase efficiency and diversify the structure and directions of oil and petroleum products transportation; development of oil refining aimed at increasing the depth of oil refining and improving the quality of petroleum products; reduction of losses at all stages of the technological process.

Russia has the world's longest and most efficient system of domestic and export pipelines, as well as over 450 million tons of capacities for transshipment of liquid hydrocarbons in seaports. According to the Russian Energy Security Doctrine, the Russian main pipelines system for transportation of oil and petroleum products is classified as a key element of the country's energy infrastructure.

The largest oil pipeline company of the Russian Federation, Transneft, with a total pipeline length of more than 67 thousand km, transporting more than 80% of Russian oil, is one of the largest oil and petroleum product transportation companies in the world and has proven solutions in the field of ensuring physical and technological safety in the transportation of oil and petroleum products.

The company performs strategic tasks in the field of energy security of the Russian Federation by implementing a set of measures for technological monitoring of the condition of the main pipeline infrastructure; construction, reconstruction and modernisation of oil and petroleum products trunk pipelines and production facilities using advanced technologies and innovations that ensure a high level of reliability, industrial and environmental safety; ensuring the physical security and anti-terrorist protection of oil and petroleum products trunk pipelines; managing the quality of oil and petroleum products, maintaining and ensuring the quality of export oil flows throughout the transportation route in accordance with the requirements of applicable intergovernmental and national standards, as well as EAEU technical regulations; and developing and diversifying supply channels to domestic and foreign markets.

Gas Industry

The gas industry of the Russian Federation is one of the backbone sectors of the national economy and is crucial for ensuring energy and economic security of the country. The industry occupies an important place in reliable and efficient provision of the country's needs in fuel and energy resources and covering seasonal unevenness of energy demand, creates a resource for sustainable socio-economic development, providing the economy with the most affordable and environmentally friendly type of fossil fuels.

The gas industry provides for the expansion of raw materials and non-commodity exports, as well as a significant share of tax revenues to the state budget. The largest gas production companies are PJSC Gazprom, Rosneft Oil Company, Novatek PJSC, LUKOIL and "Surgutneftegaz" PJSC.

The key element of ensuring energy security of the Russian Federation is the maintenance of technological unity, reliability, manageability, continuity and safety of the Unified Gas Supply System (hereinafter referred to as the UGSS), owned by PJSC Gazprom, which ensures sustainable operation of the system's facilities as a unique technological complex.

The solution of the strategic objectives of the gas complex in the field of energy security of the country is ensured by replenishment of the resource base of gas supplies; development of hydrocarbon production, transportation and processing capacities; development of gas transportation infrastructure; rationalization of the fuel and energy balance both at the state and regional levels; joint responsibility of all gas producers and consumers in terms of ensuring coverage of peak consumption periods in the autumn-winter period; improving the regulation of network gas prices; improvement of the principles of gas transportation tariffs state regulation; development of innovative and technological potential of the gas industry, improvement of its technical, economic and environmental efficiency based priority use of Russian technologies, core importance of carbon footprint reduction; implementation of updated approaches to security risk management, involving unified evaluation criteria and decision-making levels.

In order to ensure the guaranteed level of energy security of the constituent entities of the Russian Federation, reliable gas supply to the population, socially important and strategic facilities is carried out, and measures to increase the level of gasification, taking into account the peculiarities of regional fuel and energy balances, are underway. Priorities in this field contribute to solving socially important tasks of the country. PJSC Gazprom bears the main burden of ensuring sustainable gas supplies to all consumer groups, including the times of peak consumption periods.

In order to improve the level of the Russian Federation energy security and to minimise the negative impact of challenges and threats, PJSC Gazprom carries out systematic work covering all areas of activity: increasing the availability of natural gas reserves and resources; ensuring the dynamics of investments in the gas industry at a level not lower than the overall dynamics of investments in the country's economy and energy sector; development of infrastructure for production and sale of gas motor fuel; development of gas processing and gas chemistry capacities; development of domestic cost-effective technologies for large and medium-tonnage liquefied natural gas (hereafter referred to as LNG) and infrastructure for LNG production,

storage, transportation and use; development of small-scale LNG production; development of a tanker fleet for transportation of LNG under the Russian flag, which will be serviced by Russian companies; development of the main gas transportation infrastructure for gas supplies to the domestic market and to the countries of the Asia-Pacific region (an increase in the share of countries in the volume of Russian gas exports (transported through pipelines and LNG)); formation of a common Eurasian Economic Union gas market and ensuring competitive participation of Russian organisations in it; creation of a mechanism to control and exclude competition that violates the economic interests of the Russian Federation in the world markets of natural gas transported through pipelines and LNG.

In order to improve energy security in terms of providing high-tech resource reservation systems, the company also developing underground gas storage (hereinafter referred to as UGS) facilities (hereinafter referred to as UGS). To ensure energy security UGS facilities help to stabilise the operation mode of gas pumping units and infrastructure of gas fields; provide maximum flexibility and reliability of gas supplies within the regions of the Russian Federation, including regulation of peak fluctuations in gas demand and seasonal unevenness of gas consumption; promptly provide the necessary volumes of gas for export in accordance with the situation on the world markets, including reducing risks associated with rush demand and extreme gas prices; reduce the cost of investment by optimizing the technical characteristics and operating mode of pipeline equipment.

Coal Industry

The coal industry of the Russian Federation as a branch of the fuel and energy complex is strictly aimed at achieving the key goal of energy security – to ensure reliability of energy supply to consumers. The role of the coal-based power generation is significant because of its ability to increase energy security due to coal reserves endowment and storage capacity.

The coal industry occupies a special place in the country's economy, making a significant contribution to strengthening energy security, increasing export potential, and developing the social sphere. The coal industry is one of the core industries of the Russian fuel and energy complex, one of the most important sources of budget revenues, for a number of coal regions it is the main source of budget filling. The largest companies in the coal industry are JSC SUEK, UK Kuzbassrazrezugol JSC, Management Company ELSI LLC, JSC "Russian Coal", Holding Company SDS-Coal JSC, Mechel-Mining JSC, CC Kolmar LLC, PJSC Raspadskaya.

Coal is an important energy resource in the country's energy system, ensuring reliable and stable energy supply, especially in regions where access to other types of energy resources is limited. The modern Russian coal industry is a high-tech enterprise with complex security,

supply, transportation, service and processing systems. Coal enterprises are core for 31 single-industry Russian towns with a total number of 1.5 million people, providing employment in coal mining regions.

Coal generation is highly important both in the cost of all energy-intensive products and in providing the population with inexpensive heat and electricity, thereby increasing purchasing power. The industry covers the bulk of the domestic metallurgy needs. In some of the country's regions coal generation remains the most affordable option.

The solution of the coal sector strategic tasks in the field of energy security of the country is ensured by stable provision of domestic needs in coal products and the development of export supplies; significant explored and forecast coal reserves; high-quality premium coking coal with abnormally low content of sulphur and phosphorus, possessing a unique set of physical and chemical properties; introduction of modern, resource-saving and safe technologies in the development of new deposits and innovative coal mining methods; introduction of clean coal technologies; maintaining high technological standards; improvement of industrial and environmental safety standards; modernisation of coal enterprises in order to increase production and operational efficiency; development and improvement of transport and logistics infrastructure, including country's largest commercial seaports; increase of export potential, including export to the Asia-Pacific region.

The vertically integrated system, built on the basis of the business model of Siberian Coal Energy Company (hereinafter - JSC SUEK) with extensive reserves of high-quality coal, profitable mining assets and modern processing plants with quality control system, with a wide range of coals with low sulphur and nitrogen content, as well as favourable geographical location and representation in all key markets contributes to ensuring and strengthening the energy security of the country. JSC SUEK creates highly socially significant conditions for the sustainable development of the eastern regions of the country; implements state-of-the-art technologies in the anchor industries and investment programs for deep modernisation of mining facilities, transport infrastructure and measures to improve coal quality; works to develop high-quality deposits and expand coal preparation facilities, strengthening its presence in premium markets in the Asia-Pacific region.

Electric Power Industry

Electric power industry is the main system-forming industry of the Russian Federation, which bears for social responsibility for reliable energy supply to consumers and for the development of the energy system in the future. Electric power industry plays a huge role in ensuring the operation of all sectors of the economy and in the stable development of the economy. Large-

scale interchangeability of the main energy resources is only possible in the production of electrical energy, which determines the main contribution of the electric power industry to ensuring the country's energy security.

The energy system of the Russian Federation consists of the Unified Energy System of Russia and geographically isolated energy systems. The total installed capacity of power plants in Russia at the beginning of 2023 is 253 813 MW.

At the same time, the total installed capacity of power plants of the Unified Energy System of Russia at the beginning of 2023 is 247 601.8 MW, which is 0.41% higher than the values at the beginning of 2022 (246 590.9 MW). In 2022, 1610.7 MW of new generating capacities were put into operation, while 972.2 MW were withdrawn.

The electric power complex ensures the achievement of strategic goals and objectives in the area of the country's energy security on the basis of interrelated responsibility of the energy market entities and clear coordination of their interaction; maintenance of reliability of functioning of technological facilities and energy systems with the use of safety hierarchical monitoring systems and implementation of technical re-equipment of the energy sector; maintaining operational readiness and system reliability of required characteristics of power equipment; priority of systemic management of the functioning of energy systems in emergency situations; reducing vulnerability, ensuring manageability and survivability of infrastructure and facilities of the fuel and energy complex, including reservation of their capacities and creation of fuel reserves, including to ensure its supply during peak consumption periods, in emergency situations; ensuring an economically efficient combination of the use of centralised power and heat supply systems with the development of distributed power generation and intellectualization of energy systems, as well as with the use of local resources, including renewable energy sources; expansion of investment programmes for renewal of the main production assets, creation of new generating capacities and grid assets based on modern technologies.

In order to reduce risks and neutralise threats to energy security, companies in the electric power sector are working on long-term planning of energy systems development, optimal construction of the energy system of the future, which will be able to respond flexibly to changes in the structure of electricity generation and consumption due to the increasing share of RES in the electricity generation structure, the emergence of an increasing number of active users – «prosumers», the spread of technologies for reverse power supply in the power grid and technology demand management.

Planning is conducted taking into account not only the overall reliability and economic efficiency, but also the balance by types of resources and synchronization with the prospects of socio-economic and spatial development of the country.

In order to strengthen the energy security of the Russian Federation the participants of the Russian energy market carry out purposeful work to implement a set of measures covering all spheres of industry activity in market conditions, preventing dangerous situations for the stable energy supply of consumers with affordable electricity and heat of acceptable quality in reasonable and agreed volumes of their needs under the actual conditions.

«ROSSETI», PJSC, PJSC Inter RAO, PJSC «RusHydro», Gazprom Energoholding LLC, JSC "Quadra – Power Generation", Rosenergoatom JSC, etc. are among the largest participants of the Russian energy market and system-forming important electricity producers energy security condition of which is of crucial importance for the overall energy security of the industry and the country as a whole.

«ROSSETI», PJSC, which manages 2.45 million kilometers of power transmission lines and electric substations with a total transformer capacity of 826,000 MVA, is addressing the strategic objectives in the area of energy security of the Russian Federation by implementing a set of measures: introducing its own innovative developments and technologies; continuously building up its competence and experience in the construction of electric grid facilities, preventing and eliminating accidents and emergencies at the facilities; organisation of effective technological infrastructure in compliance with the world standards.

The backbone holding of the Russian energy industry, the RusHydro Group, makes a special contribution to ensuring the energy security of the Russian Federation and plays a crucial role in the economic and social development of the country. The RusHydro Group is the largest producer of electricity based on hydropower, operating other types of generation, combining all types of power plants (except nuclear) with more than 600 generation facilities. The company provides the dominant share of low-carbon generation; carries out crucial work in the development of the Far East's energy sector, characterised by large-scale operation of small-scale energy facilities in extreme weather conditions and infrastructural isolation.

PJSC Inter RAO also meets challenges of ensuring energy security of generation and sales of electric energy. The priority areas of energy security of Inter RAO Group are: import substitution of foreign equipment to exclude its impact on the reliable and safe operation of generation facilities; expansion of construction of new generating facilities for the energy supply of the Eastern Landfill; increasing the efficiency of production facilities; introduction of domestic innovative developments and technologies.

The Unified Energy System of Russia provides centralised operational dispatch management, in order to ensure active energy protection and implement measures aimed at identifying, assessing and eliminating real and potential threats of energy security. The activity is taken

place by the "System Operator of the United Power System", Joint-Stock Company ("SO UPS", JSC), which ensures sustainable energy supply and quality of electricity that meets the requirements of technical regulations and other regulations by continuously managing the production, transmission and distribution of electricity.

Within the framework of ensuring the reliable operation of the Unified Energy System of Russia, the System Operator manages the UES electric power regime and performs the following functions in the field of energy security: analysis of the power system stability, formation of a dispatching schedule of power plant loads; operational management of the regime of power systems in real time; advanced long-term planning of the development of electric power systems; the parallel modes operation management of the UES in Russia with the power systems of foreign countries; participation in monitoring the actual technical condition of energy facilities and investigation of violations affecting the system reliability of the UES; development and maintenance of relay protection systems, automatic mode control and emergency automation; ensuring reliable operation of technological systems of dispatch centres, establishing and maintenance of the system of backup dispatch centres.

A crucial role in ensuring reliable operation of the electric power industry of the Russian Federation is played by organisations of the commercial infrastructure of the energy market, which include the Association "NP Market Council" and JSC "ATS".

The Commercial operator ("ATS" JSC) provides the organisation of trade in the wholesale of electricity and capacity market: determination of volumes and costs under contracts of wholesale market participants, trading system access, organisation of commercial accounting, price and volume calculation on the results of competitive selection for the day ahead, determination of the components of prices for electric energy and capacity, mandatory for use by guaranteeing suppliers when selling electricity in retail markets.

The Association "NP Market Council" performs the functions of self-regulation of wholesale and retail trade in electric energy and capacity: maintaining a register of wholesale market entities; making a decision on assigning or depriving the status of a wholesale market entity; developing and amending the agreement on joining the trading system, regulations of the wholesale market; resolving disputes in accordance with the rules of the wholesale market; developing of a common position of market entities on draft regulatory legal acts; monitoring of the price situation in the markets; supporting of the generation support program based on the use of renewable energy sources; participating in the work of regional tariff regulatory authorities.

Moreover, ensuring energy security of the Russian Federation is facilitated by strengthening intersystem ties with the power systems of neighbouring states, which allows, among other

things, to carry out the functions of reservation and emergency mutual assistance, expanding scientific, technological and innovative cooperation in the field of electricity.

State policy in the field of electric power is aimed at implementing economic relations in the industry, which are based on a number of fundamental principles, including ensuring energy security of the Russian Federation, technological unity of energy and provision of reliable power supply to consumers, etc.

Nuclear Industry

The nuclear industry provides a reliable and stable energy supply by maintaining a stable level of alternative energy generation, thereby minimising the risks caused by a misbalance in the fuel and energy sector with a predominant share of fossil energy and fluctuations in the generation of energy from other alternative sources.

Nuclear energy of the Russian Federation is an important part of the country's energy sector, since nuclear energy potentially has the necessary qualities for a possible replacement of a significant part of fossil fuels-based traditional energy. The nuclear industry of the Russian Federation has a well-developed production and construction base and sufficient nuclear fuel production capacity. At the same time, emphasis is put on ensuring nuclear safety and, above all, the safety of nuclear power plants during their operation.

The strategic company of the Russian Federation in the nuclear industry is the State Atomic Energy Corporation "Rosatom" (ROSATOM). The task of ensuring safety and environmental protection during the use of nuclear energy, as well as preventing emergencies and accidents at nuclear and radiation-hazardous facilities is solved using all the main mechanisms of state and non-state management with the participation of various structural divisions of Rosatom and its organisations.

In order to achieve the strategic goals of ensuring the energy security of the Russian Federation, the nuclear industry solves the tasks and implements a set of measures to ensure an adequate raw material base for nuclear energy and the exploitation of uranium deposits in the Russian Federation and abroad; ensure stable operation of existing nuclear power plants' (hereafter referred to as NPP) power units for reliable power supply to consumers; maintain in a safe condition and decommissioning of shutdown NPP power units in accordance with the principles of ecological acceptability and responsible waste management; modernize operating power units and replace outgoing ones that have exhausted their operating life; ensure the production capacities of nuclear engineering and construction and installation organisations necessary for the commissioning of power units in the country and abroad.

Rosatom develops and implements advanced technologies in the field of nuclear energy that ensure competitiveness, technological sovereignty and resource independence, as well as conditions for the parallel operation of thermal and fast neutron reactors and the closure of the nuclear fuel cycle, increasing economic efficiency of nuclear fuel production and creating new types of fuel.

Provision of consumers with electric and thermal energy produced at NPP is carried out exclusively with guaranteed safety assurance as the highest priority in its activities. Rosenergoatom, JSC, part of the electric power division of Rosatom State Corporation, is responsible for all stages of NPP life cycle.

The Concern performs a set of internal and external measures aimed at the stable and safe operation of NPP and ensuring energy security of the industry as a whole: comprehensive and targeted inspections of NPP safety status with the identification of possible general problems and negative trends during operation; effective control over the timely implementation of implemented measures to improve the safety and stability of NPP; identification and analysis of positive practices and effective working methods implemented at NPP to improve safety level; assessment of NPP readiness for abnormal situations related to the impact of adverse seasonal weather events.

Renewable Energy

One of the most pressing tasks involves integrating new types of renewable energy generation into the market, like comprehensive solutions using storage, hydrogen technologies and hybrid systems.

Built from the ground up in 2013 the country's renewable energy industry is developing quite actively. The share of installed capacity of renewable energy sources in the energy system of the Russian Federation accounts for 2.4 %. The total installed capacity of renewable energy generation facilities (excluding hydropower stations with installed capacity over 50 MW) is 5.94 GW.

Many state-owned and non-state-owned companies have already entered the renewable energy market. Among the tasks of ensuring energy security for the fuel and energy complex, in addition to direct construction and ensuring reliable and accident-free operation of generating facilities in the field of renewable energy, it is important to develop a new localized production of high-tech equipment and materials for generation based on renewable energy sources.

The achievement of the industry's objectives is ensured by the participation of major strategic companies of PJSC «RusHydro», State Atomic Energy Corporation "Rosatom" (ROSATOM), as well as companies including Hevel Group and Solar Systems LLC (in the field of solar energy), Fortum PJSC and EL5-Energo PJSC (in the field of wind power and solar energy), TGK-1 PJSC and HydroDevelopment PJSC, etc.

Renewable energy is one of the attractive energy security solutions for remote isolated hard-to-reach areas where imported conventional fuels are used.

PJSC «RusHydro» operates solar, wind power plants and geothermal plants with a total capacity of 0.8 GW; actively putting into operation modern local energy facilities, like automated hybrid energy complexes (hereinafter referred to as AHES) built with the use of modern technologies based on renewable energy sources, energy storage systems and automated control; carries out measures aimed at completing and building new hydro power plants (including small ones) and establishing conditions for pumped-storage power plants (hereafter referred to as PSP).

In the Russian Federation, as in other countries, and at the IAEA sites, nuclear energy is promoted as a "green energy" and as part of renewable energy. In its activities Rosatom carries out measures to build small modular reactors in order to provide energy supply of remote and isolated areas; to implement technologies for large-scale environmental-friendly production of hydrogen based on the use of energy from nuclear reactors; to develop solutions in the field of wind energy, having created a high-tech production of 2.5 MW wind plants through a subsidiary of the State Corporation – NovaWind JSC.

1.2.5 THE MONITORING, EVALUATION AND FORECAST OF THE ENERGY SECTOR SECURITY

In order to respond to challenges and threats to energy security in a timely manner and to react promptly to trends and their changes, external and internal threats and risks in the field of energy security are monitored, including the development of proactive actions to minimise possible damage associated with existing and potential threats, continuous assessment of the impact on ongoing changes, revision of the focus of measures and selection of the most effective ways to manage energy security in accordance with the actualization of the tasks of the strategic directions for the development of the energy sector of the Russian Federation. Energy security risk management is carried out within the framework of the state energy policy of the Russian Federation.

Monitoring, assessment and forecasting of the state of energy security, as well as a number of other risk management tasks, are carried out by the Ministry of Energy of the Russian

Federation jointly with federal and regional executive authorities, as well as leading companies in the energy sector.

To ensure energy security and further development of the energy sector in the Russian Federation a number of measures have been taken to develop the domestic market for products and services of the fuel and energy sector, create a flexible mechanism for responding to changes in the global energy markets and accelerate the establishment of technological sovereignty and increase the competitiveness of the Russian energy companies.

The priority areas of work in the domestic market are as follows: ensuring reliable and sustainable supply of Russian consumers with energy resources, increasing the level of security of energy facilities and their critical information infrastructure in the face of the risk of terrorist and sabotage threats, systematically promoting import substitution and extending socially oriented and cost-effective gasification to social facilities.

The priority areas of work in foreign markets include diversification of export and export logistics of energy resources, building new supply channels for companies of the fuel and energy complex and countering discrimination against Russian fuel and energy companies in the global energy markets.

The strategic resources and production potential of the energy sector of the Russian Federation are supported not only by the efficient solution of internal energy development tasks using its own priority potential, but also by the stable capacity building in energy security strengthening, which is also determined by the aggregate interaction of sectoral complexes. In order to ensure uniformity of requirements to the security and reliability of the fuel and energy complex functioning, the government implements the state policy aimed at harmonising national legislation in this area.

The country has a powerful, self-sufficient, in terms of natural resources, and diversified fuel and energy complex, capable, with appropriate scientific and technological development and modernisation, of solving almost any task of domestic socio-economic development and ensuring a place among the lead energy exporters.

INDIA

[1.3]

1.3.1 NATIONAL ENERGY SECURITY POLICY

Energy is fundamental to all economic activity, and the availability of affordable and reliable energy plays a pivotal role in fostering economic growth and in achieving our Sustainable Development Goals. Aligning global energy demand with sustainable sources and an uninterrupted flow of energy from diverse suppliers through reliable and responsible supply chains is important for strengthening energy security.

India's energy demand will increase exponentially in the coming years, which demands strategic interventions to ensure that this demand is met with affordable and reliable energy supply. This will be achieved through a number of measures, such as increasing the domestic exploration and production footprint, promoting the efficient use of available energy sources, accelerating the pace and scale of commercial deployment of mature clean energy technologies such as solar, wind, nuclear power, bioenergy, hydro power, pumped storage, etc. and accelerating the development and deployment of other emerging and new technologies such as electrolysers, high-efficiency fuel cells and ACC battery storage, among others.

1.3.2 INDIA'S APPROACH IN ENERGY TRANSITION

India is deeply committed to a low-carbon development strategy. India's historical contribution to global emissions (since 1890) is about 4%, despite being the fifth largest economy and home to 17% of the world's population. At 2.4 tCO_2e, India's per capita GHG emission is far below the world average of 6.3 tCO_2e. India had pledged, in its NDC in COP21 in Paris, that by 2030 it will have 40% of its power generation capacity coming from non-fossil sources. India achieved this target in 2021 – well ahead of the target date. It had also pledged that, by 2030, it will reduce the emission intensity of its economy by 33%, India has already achieved this target.

In Glasgow, India announced that it will enhance its NDC to achieve about 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030, and to reduce the energy intensity of its economy by 45% by that date. It will achieve these targets. In the 2022 Climate Change Performance Index (CCPI), India has been ranked amongst the top five performing countries.

During the 27th Conference of the Parties (COP27), India submitted its Long-term Low Emission Development Strategy to the United Nations Framework Convention on Climate Change (UNFCCC). This approach has four key considerations as briefed below:

- India has contributed little to global warming, its historical contribution to cumulative global GHG emissions being minuscule despite having a share of ~17% of the world's population.
- India has significant energy needs for development.
- India is committed to pursuing low-carbon strategies for development and is actively pursuing them, as per national circumstances.
- India needs to build climate resilience.

The Government has recently launched the National Carbon Credit Trading Scheme (CCTS) to develop India's first-ever domestic carbon market with the objective to ensure long-term investments in GHG emission reduction technologies, projects and processes towards accelerated decarbonisation of the Indian economy. The CCTS 2023 will also incentivise progressive Indian companies who have already charted their low-carbon growth trajectories. The emphasis on reducing carbon emissions is in line with India's target to achieve its updated NDC by 2030 and its vision of becoming net zero by 2070.

The Government has launched programmes for promoting green hydrogen, green energy, green mobility, green buildings, and green equipment and policies for the efficient use of energy across various economic sectors. Ethanol blending with petrol, the National Green Hydrogen Mission, the promotion of electric vehicles and the tremendous push on the renewable energy front are some of the significant initiatives that India is pursuing towards a clean and green energy future. These initiatives play an important role in India's Energy transitions and provide for large-scale green job opportunities. The Government is providing financial incentives through schemes such as Production Linked Incentives (PLI) to support these initiatives and promote sectoral growth.

In January 2022, the Union Cabinet, chaired by the Honourable Prime Minister, approved the National Hydrogen Mission. The Mission aims to aid the Government in meeting its climate targets and making India a green hydrogen hub. This aims to produce 5 million tonnes per annum of green hydrogen by 2030 and the related development of renewable energy capacity. Green hydrogen and green ammonia are envisaged to be the fuels of the future to replace fossil fuels. The production of these fuels by using renewable energy is one of the major requirements for environmentally sustainable energy security in the country.

Recognising energy efficiency as the first fuel, India's visionary approach aims to propel a comprehensive transformation in energy efficiency measures, in line with the SDG target of doubling the global rate of energy efficiency improvement by the year 2030, echoing the concept of Lifestyle for the Environment (LiFE), which was introduced by Prime Minister Narendra Modi at COP26 in Glasgow on 1 November 2021, calling upon the global community of individuals and institutions to drive LiFE as an international mass movement towards "mindful and deliberate utilisation, instead of mindless and destructive consumption" to protect and preserve the environment.

From 2014 to date, India has added a total power generation capacity of over 184 GW. The total installed capacity to date is 421 GW, with peak demand reaching 234 GW. The Government is focused towards increasing the capacity to produce clean energy through new technology and innovation in line with India's goal of achieving net-zero emissions by 2070.

Promoting renewable energy has been at the heart of India's energy transition journey. We have witnessed remarkable growth in solar and wind installations, making India one of the world's largest renewable energy markets. India's renewable energy capacity is the fourth largest in the world. The installed renewable capacity increased from 76 GW in 2014 to 176 GW currently. Around 122 GW of renewable energy capacity is at various stages of implementation.

However, to have round the clock renewable energy, huge storage capacity is required. To meet this requirement, the Government has come out with a policy to encourage pumped hydro power (PHP) projects. The Government is also focused on augmenting the battery storage capacity in the country. The aim is to build around 100 GW of battery storage capacity in the coming years, out of which around 50 GW will also be available for exports.

The Government has undertaken various measures to strengthen the transmission and distribution network in the country. From 2013 to date, more than 1.8 lakh circuit kilometers of transmission lines have been added, thereby connecting the entire country to a single grid that runs on one frequency with the One National Control Centre. The inter-regional capacity is now 112 GW. The distribution system has been further strengthened through various government schemes such as the Revamped Distribution Sector Scheme, Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY), the Integrated Power Development Scheme (IPDS) and Saubhagya. A total of 2 900 new sub-stations were added, 3 900 sub-stations were upgraded and 8.73 lakh circuit km of HT and LT lines were added or changed, resulting in a robust distribution system.

1.3.3 MAJOR RISKS, CHALLENGES, THREATS AND RISK FACTORS FOR ENERGY SECURITY

The COVID-19 pandemic has globally underscored the importance of strengthening energy security and the resilience of supply chains of energy sources and critical materials. India aims for an affordable and accessible energy supply for all. It is necessary to maintain a proper and balanced supply chain of all energy sources. In this regard, there is a need to promote open, transparent, stable and competitive international energy markets, ensuring transparent, resilient, undisrupted, sustainable, inclusive and diversified supply chains, and advancing a wide variety of options, technologies, leveraging synergies to enhance energy security and prevent disruptions in energy markets to avert any potential risks to our economic and energy outlook.

In 2014, India set a target of 10% ethanol blending by 2022, and a 20% blending by 2030. India had already achieved an ethanol blending of 10% in 2022, and has augmented its energy security and also translated it into a forex savings of over USD 6.5 billion over the last nine years. Based on the experience of achieving 10% ethanol blending five months in advance of the goal, the deadline for achieving 20% ethanol blending (E20) has been advanced from 2030 to 2025.

India's electricity demand has grown at a CAGR of 4.5%, while peak demand grew at a CAGR of 5.6% between 2018 and 2023. However, the future demand growth rates are likely to be higher due to a growing electrification of the economy, electric vehicles, green hydrogen, etc. To meet the increasing demand in a more sustainable manner, India is diversifying its energy mix, including renewables. With an aggressive supply-side transition, with an installed capacity of over 43% from non-fossil sources, India has set a target of achieving 50% of installed capacity from non-fossil fuels by 2030, which includes about 270 GW of solar capacity by 2030, and is rapidly pursuing this objective. However, concentration of renewable energy supply chains and related technologies and raw materials is a major impediment and needs to be addressed.

1.3.4 MONITORING, EVALUATION AND FORECAST OF THE ENERGY SECTOR SECURITY

Grid Controller of India, through its National Load Despatch Centre (NLDC) and five Regional Load Despatch Centres (RLDCs), ensures the integrated operation of the national power system. Coordination with RLDCs, scheduling, and dispatch of electricity, achieving maximum economy and efficiency in the operation of the national grid, and ensuring stability of the power system are some of the important functions that have been carried out.

1.3.5 PARTICIPATION OF ENERGY COMPANIES/ROLE PLAYERS IN ENSURING THE STUDY GOAL

The India power sector is mainly governed by the Ministry of Power, with support from public and private energy utilities that are playing a significant role in ensuring the energy security of the country. These organisations/utilities work in close coordination with the Government of India to develop such policies that will help India meet its energy needs sustainably.

- Central Electricity Regulatory Commission (CERC): This is an independent statutory body entrusted by the Government of India with the task of regulating the Indian power sector.
- Central Electricity Authority (CEA): This is a statutory organisation entrusted with the responsibility to advise the central government on matters relating to the National Electricity Policy, formulating short-term and prospective plans for the development of the electricity system, and coordinating the activities of the planning agencies for the optimal utilisation of resources to subserve the interests of the national economy and provide reliable and affordable electricity to all consumers.
- POWERGRID: The corporations responsible for development of the inter-state transmission system in the country for the evacuation of power from central sector projects and IPPs, and discharge all functions of supervision, planning and coordination related to the development of an efficient, economic and reliable inter-state transmission system.
- Grid Controller of India: GRID-INDIA has the onerous responsibility of operating the all-India synchronous grid, one of the largest and most complex in the world, ensuring reliability and security. India is ranked third in the world in terms of electricity generation, electricity consumption, installed generation capacity and the size of its transmission system. The power sector in India has seen a transformational change with progressive policy-level reforms and effective implementation of the same in recent years. GRID-INDIA, through its National Load Dispatch Centre (NLDC) and five Regional Load Despatch Centres (RLDCs), facilitates the inter-state transmission of power to utilities across India, ultimately reaching over 1.38 billion people.
- The Bureau of Energy Efficiency: The Bureau is spearheading the task of improving energy efficiency in various sectors of the economy through regulatory and promotional mechanisms. The Bureau of Energy Efficiency coordinates with designated consumers, designated agencies and other organisations, recognises, identifies and utilises the existing resources and infrastructure in performing the functions assigned to it under the Energy Conservation Act. Over the past years, it has successfully implemented several innovative energy-efficiency schemes and national programmes such as the PAT Scheme, Standards and Labelling Programme for Energy Efficient Appliances, UJALA, Energy Conservation Building Codes (ECBC), Demand-side Management, the Energy Data Management Unit, etc.

The recently launched National Carbon Credit Trading Scheme is another significant initiative being led by the Bureau of Energy Efficiency, along with the Ministry of Environment, Forests and Climate Change.

- The NTPC currently contributes over 24% of the total electricity produced in India. By 2032, the NTPC is targeting non-fossil fuel-based capacity to make up nearly 50% of the company's portfolio, which includes a renewable energy capacity of 60 GW and a total portfolio of 130 GW. It will be coordinating closely with NITI Aayog to develop its net-zero GHG emissions roadmap.
- The Government has decided to invite bids for 50 GW of renewable energy capacity annually for the next five years, i.e. from the 2023–24 financial year until the 2027–28 financial year. Solar Energy Corporation of India Ltd. (SECI), NTPC Ltd. and NHPC Ltd. are notified by the Government as Renewable Energy Implementing Agencies (REIAs) for calling such bids.

India is on a strong development trajectory, which will lead to an increase in energy demand. With a young population, growing urbanisation, digitalisation and the widespread adoption of new technology, India's primary focus is on providing universal access to affordable and sustainable energy in line with the Sustainable Development Goals. With its ambitious agenda, India has been leading the way in energy transition and is emerging a world leader. The current installed electricity capacity in the country is 421 GW. It is estimated that, by 2030, the installed electricity capacity will be 777 GW, an increase of about 85% over the current capacity, and 65% of this capacity will be from non-fossil fuel-based sources, indicating a significant increase over our NDC commitment of achieving 50% of non-fossil fuel-based installed electricity capacity by 2030. An enabling policy environment along with strong international collaborations and partnerships will continue to be the cornerstone of the energy transition goals of the country.

CHINA

[1.4]

1.4.1 GENERAL OVERVIEW

China is a major energy producer and consumer in the world, and the green and low-carbon transition is constantly advancing in depth. In 2021, the proportion of coal, oil and natural gas in China's energy production structure was 67.0%, 6.6% and 6.1% respectively. The proportion of non-fossil energy reached 20.1%, and the proportion of clean energy production increased by 0.8% over the previous year. In 2021, China's total consumption of primary energy was 5.24 billion tons of standard coal, up 5.2% year on year. The proportion of coal consumption in total energy consumption decreased to 56.0%, and the proportion of oil consumption decreased to 18.5%. The proportion of natural gas consumption increased to 8.9%, the proportion of non-fossil energy consumption increased to 16.6%, and the proportion of clean energy consumption reached 25.5%.

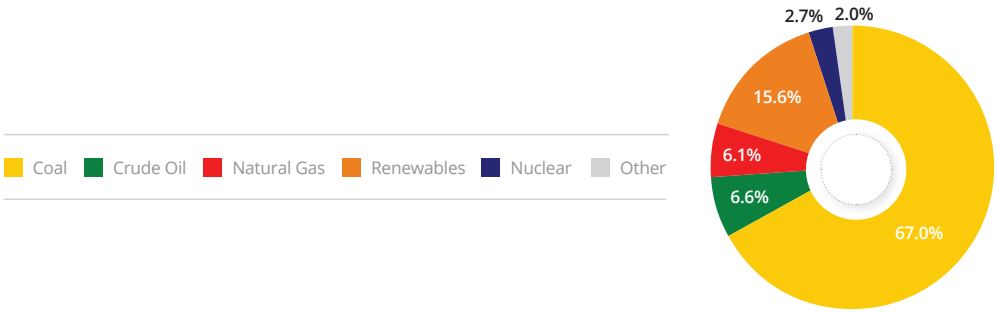


Figure 4: Contributors to China's Primary Energy Supply

In 2021, China's total electricity production was 8.4 trillion kWh, increasing 9.8% over last year. The power generation structure continued to be optimised, and the proportion of coal power generation fell to 60.0%, down 0.8 percentage points from the previous year. The proportion of non-fossil power generation increased to about 34.6%, an increase of 0.7 percentage points over the previous year.

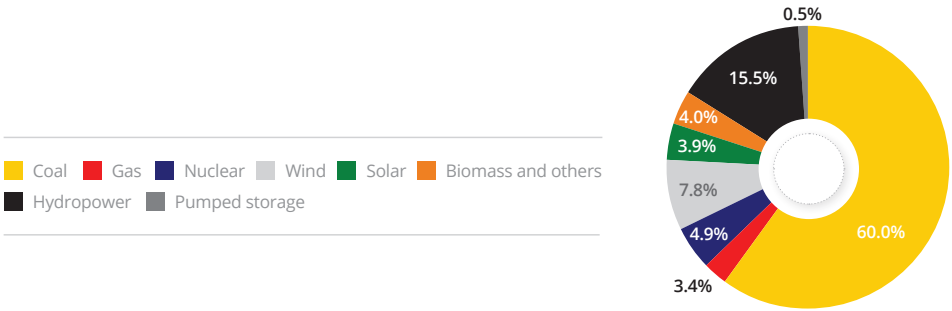


Figure 5: Contributors to China's Electricity Supply

China has always prioritised ensuring safe and reliable energy supply, coordinated development and security, and ensured safe and reliable energy supply in promoting the comprehensive green transition of the economy and society.

Ensuring public wellbeing and improving people's lives is China's fundamental goal in energy development. China is ensuring that urban and rural residents have access to basic energy supply and services, as a fundamental element in building a moderately prosperous society in all respects and supporting rural revitalization. From 2016 to 2019, the total investment in transforming and upgrading rural power grids reached RMB830 billion, and the average power outage time in rural areas was reduced to about 15 hours per year. The quality of power services for rural residents has improved significantly. From 2013 to 2015 China implemented an action plan to ensure access to electricity for every citizen and completed this historic task by the end of 2015.

1.4.2 NATIONAL ENERGY SECURITY POLICY

China's energy strategy in the new era endeavours to promote reforms in energy consumption, energy supply, energy technologies and energy system, and strengthen comprehensive cooperation with other countries to realize energy security in an open environment, boosting the high-quality development of the energy sector.

To address climate change and implement green and low-carbon development, China is accelerating work on 1+N policies for peaking carbon emissions and achieving carbon neutrality. The country has released a top-level design document for peaking carbon emissions and achieving carbon neutrality and is working on an action plan for peaking carbon emissions

before 2030, with implementation plans for fields and sectors such as energy, industry, urban and rural construction, transport, and agriculture and rural areas. Support plans are being created in areas such as science and technology, fiscal funding, finance, pricing, carbon sinks, energy transition and coordination of pollution reduction and carbon emission reduction, with clearer timetables and roadmaps. The country is shaping policies and actions with clear objectives, reasonable assignment of labour, effective measures, and sound coordination, ensuring that all efforts deliver positive results.

In terms of energy supply, coal will be used in a cleaner and more efficient way, and greater efforts will be made to explore and develop petroleum and natural gas, discover more untapped reserves, and increase production. China will speed up the planning and development of a system for new energy sources, properly balance hydropower development and ecological conservation, and develop nuclear power in an active, safe, and orderly manner. China will improve systems for energy production, supply, storage, and marketing to ensure energy security. China considers energy security as an important component of its national security system and the modernisation of its capabilities.

1.4.3 THE CHARACTERISTICS AND APPROACH TO ENERGY TRANSITION

China has rolled out policies and measures to improve the mechanism for a green-oriented and low-carbon transition of energy across the country. The country will speed up building a clean, low-carbon, safe, and highly efficient energy system while deepening reforms of mechanisms and innovation in the energy sector.

Based on the endowment of energy resources, China applies the principle of building the new before discarding the old in a well-planned way, taking overall consideration of various available energy resources. With growing capacity to ensure energy supply, it has moved faster to build a new energy system. The proportion of clean energy sources has increased significantly. Success has been achieved in the green and low-carbon transformation of the country's energy mix.

China is vigorously developing non-fossil energy. China has made rapid progress in building large-scale wind and photovoltaic power stations on infertile and rocky terrain and in deserts. It has steadily developed offshore wind farms, actively promoted rooftop photovoltaic power generation in urban and rural areas and encouraged distributed wind power generation in rural areas. China has built a structured matrix of hydropower stations in the basins of major rivers, especially those in the southwest. In accordance with local conditions, it has developed

solar, biomass, geothermal and ocean energy, and power generation through urban solid waste incineration. It has developed nuclear power in a safe and orderly manner and has worked on developing hydrogen energy. China has accelerated the construction of a new power system to adapt to the steady increase in the proportion of new energy and promote the efficient use of renewable energy. The proportion of clean energy sources in total energy consumption increased from 14.5% in 2012 to 25.5% by the end of 2021. The installed capacity of renewable energy was more than one billion kilowatts, accounting for 44.8% of China's overall installed capacity. The installed capacity of hydropower, wind power, and photovoltaic power each exceeded 300 million kilowatts, all ranking the highest in the world.

China is advancing the clean and efficient use of fossil energy. To promote the clean and low-carbon development of coal-fired power, China has upgraded coal-fired power plants to conserve resources, reduce carbon emissions and make their operation more flexible, and transformed heating facilities. It has implemented stricter energy-saving standards for newly installed coal-fired generating units. The efficiency and pollutant control levels of these units are on par with the most advanced international standards. China has promoted clean end-use energy by replacing coal with natural gas, electricity, and renewable energy. It has actively supported clean heating in winter in northern China. It has made the use of natural gas more efficient in urban areas, as well as in industrial fuel, power generation, and transport, and promoted natural gas combined cooling, heating, and power (CCHP). It has launched a campaign to upgrade the quality of refined oil products. In less than 10 years China achieved the upgrading that took developed countries 30-plus years, and its refined oil products are now of the best quality by international standards. As a result, vehicle pollutant discharge has been effectively reduced.

1.4.4 THE RISKS, CHALLENGES AND THREATS TO CHINA'S ENERGY SECURITY

China's energy development faces several rigid constraints, including a large volume of energy production and consumption, a relatively high proportion of fossil fuels such as coal, and a high degree of dependence on oil and natural gas imports.

Firstly, China's total energy consumption is enormous. In the process of industrialisation, consumption continues to rise, and in order to meet the growing energy demand, energy supply is under great pressure. Rapid economic development and urbanisation drive further upgrades in energy consumption, and ensuring sufficient energy supply has become an urgent concern in China.

Secondly, China has abundant coal reserves, but relatively limited natural gas and oil reserves. Its energy structure is highly dependent on fossil fuels, placing high demands on the country's transition to cleaner and more sustainable energy sources.

Thirdly, China's reliance on foreign countries for oil and natural gas is significant. In 2022, over 70% of the country's oil consumption and 40% of its natural gas consumption depended on imports from other countries, exposing China to risks in energy security. Diversifying the development and utilisation of domestic energy resources and gradually reducing dependence on imports are of practical significance for ensuring a long-term and stable energy supply.

Facing these challenges of energy security, China will promote energy development and transformation from the following aspects.

- Reform to improve the energy consumption structure by containing unnecessary consumption. China is determined to carry out the principle of prioritising energy conservation and has tightened the control of total energy consumption and energy use intensity and enforced energy conservation in all areas of social and economic development. It resolves to adjust its industrial structure. It emphasizes energy conservation in the process of urbanisation and works to develop a green and low-carbon transport system. China encourages hard work and thrift and calls people to conserve energy and work and live with green energy and move faster towards an energy-saving society.

- Reform to build a more diversified energy supply structure. In the direction of green development, China has been vigorously promoting the clean and efficient utilisation of fossil energy, prioritising the development of renewable energy, developing nuclear power in a safe and orderly manner, and raising the proportion of non-fossil energy in the energy supply structure. China has intensified efforts for the exploration and exploitation of oil and gas resources, to increase reserve and production volumes. China has been building the production, supply, storage and sales systems for coal, electricity, oil and gas, while improving energy transportation networks, storage facilities, the emergency response system for energy storage, transportation and peak load management, and enhancing its supply capacity for safer and higher-quality energy.

- Reform to improve energy technologies to upgrade the industry. China is implementing the innovation-driven development strategy, building a system that nurtures innovation in green energy technologies, and upgrading energy technologies and equipment in an all-round way. China has strengthened basic research on energy, innovation in generic

and disruptive technologies, and original and integrated innovation. China has started to integrate digital, big-data and AI technologies with technologies for clean and efficient energy exploration and exploitation, with a focus on smart energy technologies, to turn these technologies and related industries into new growth drivers for industrial upgrading.

- Reform to optimise the energy system for faster growth of the energy sector. China is determined to promote energy market reform, to marketise energy commodities and form a unified and open market with orderly competition. China is furthering energy pricing reform, to create a mechanism in which the market determines the price. China has been working to modernize its law-based energy governance system, developing new models of efficient energy management. It has strengthened planning and policy guidance for the energy sector and improved the regulatory system of the energy industry.

- Comprehensive cooperation with other countries to realize energy security in an open environment. Under the principle of equality and mutual benefit, China is opening its door wider to the world. China promotes green and sustainable energy, and endeavors to improve energy infrastructure connectivity. China has been an active participant in global energy governance, increasing energy cooperation and exchanges with other countries, and facilitating international trade and investment in the energy sector. China has joined the international community in building a new model of energy cooperation and maintaining energy market stability.

1.4.5 THE MONITORING, EVALUATION AND FORECAST OF THE ENERGY SECTOR SECURITY

Ensuring a stable and secure energy supply is a paramount priority for the Chinese government as it seeks to sustain its remarkable economic growth, support its burgeoning population, and address environmental concerns. To achieve this crucial objective, China employs a multifaceted approach that involves meticulous monitoring, rigorous evaluation, and strategic forecasting of its energy sector security. Through the coordinated efforts of the National Energy Administration (NEA) and other key institutions, the government formulates policies and implements measures to optimise energy utilisation, diversify its energy mix, and enhance energy efficiency. This comprehensive analysis delves into the methods employed by the Chinese government to monitor, evaluate, and forecast energy sector security, highlighting the key mechanisms, long-term plans, forecasting models, and international cooperation initiatives that contribute to China's steadfast commitment to energy stability and sustainability. By exploring these strategies, China aims to not only secure its energy future but also contribute to global energy stability and environmental sustainability.

SOUTH AFRICA

[1.5]

1.5.1 GENERAL OVERVIEW

Currently, South Africa's economic growth depends significantly on fossil fuel-based energy systems. In the latest available energy balance from the South African Department of Mineral Resources and Energy (DMRE) dated 2018, coal contributed 65% towards the primary energy supply. The remainder was made up of crude oil which contributed 18%, renewables with 11%, natural gas with 3% and nuclear with 2%. The primary energy supply in this case includes local energy production and imports less exports.

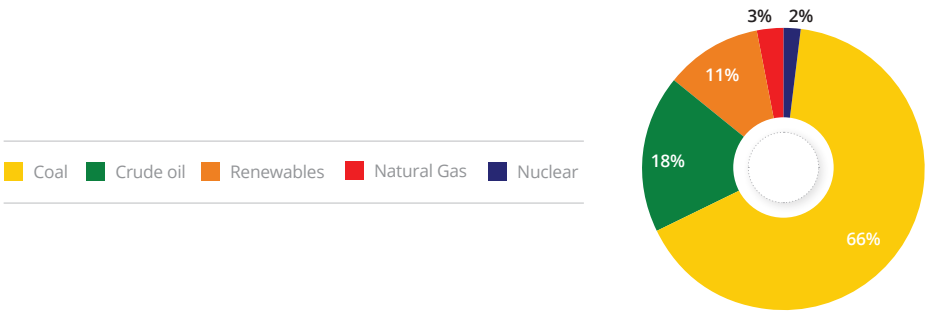


Figure 6: Contributors to South Africa's Primary Energy Supply

Coal is the main source of electricity generation. According to a report by UK PACT and GreenCape, coal contributed about 90% of the power generated in 2022. The remaining 10% consists of 3% nuclear, 5% natural gas and 2% renewables (wind, solar, landfill gas etc.).

South Africa's energy sector is guided by the White Paper on the Energy Policy. The White Paper on the Energy Policy was developed to clarify government's policy regarding the supply and consumption of energy for the next decade. Further sections of this chapter explains this energy sector and policy framework in detail.

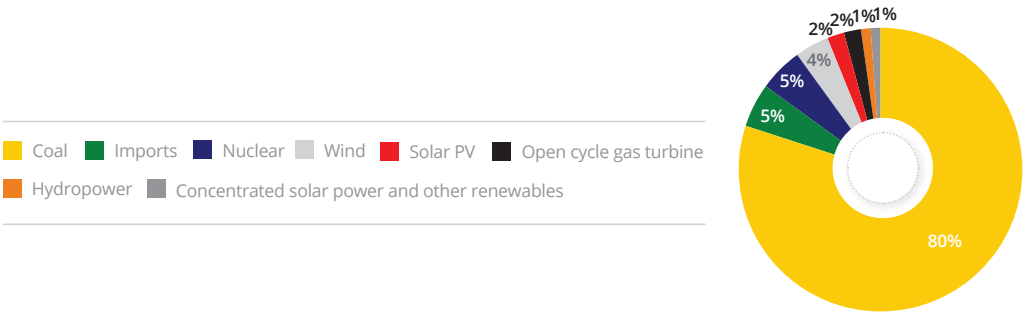


Figure 7: Contributors to South Africa's Electricity Supply

In addition, the lack of electricity availability, resulting in loadshedding, is of concern. Currently, South Africans face loadshedding on a regular basis as demand for electricity outstrips supply and the country continues to strive to maintain the Energy Availability Factor (EAF) of generation fleet to avoid shortages or disruptions. Electricity availability and accessibility play a pivotal role in economic development, growth, and sustainability. As such, the lack of electricity availability has become a constraint to economic growth, impacting negatively on the country's Gross Domestic Product (GDP).

However, the South African government has developed and is implementing an Energy Action Plan to bring about an end to loadshedding. This Energy Action Plan will not only increase electricity availability, but it will do so in a way that gives cognisance to South Africa's short-term and long-term climate change commitments.

Despite load shedding challenges, South Africa has a well-developed electricity network. It also has one of the highest rates of electricity access in sub-Saharan Africa. According to the Department of Energy and Mineral Resources (DMRE), 86.15% of the population had access to electricity in 2018, as shown in Figure 8.

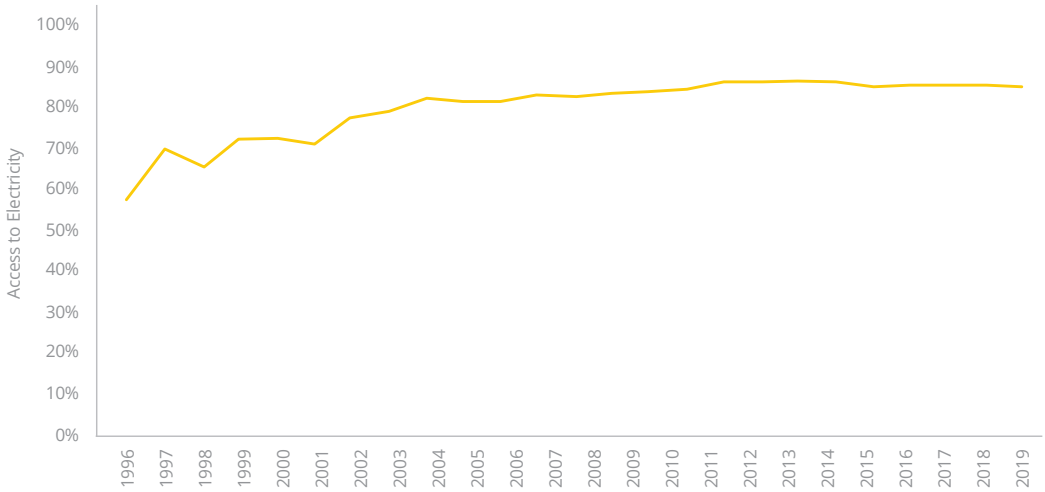


Figure 8: Access to Electricity in South Africa

Although coal currently supplies the majority of South Africa's energy, it is expected that the contribution of coal will decrease over time as South Africa strives to meet its commitments to keeping Greenhouse Gas (GHG) emissions in the range of 350-420 million tonnes of carbon dioxide equivalent (Mt CO_2e) by 2030. South Africa is increasingly focusing on environmental considerations in its energy security approach. It seeks to reduce GHG emissions, promote clean energy technologies, and address air pollution concerns associated with coal-based energy generation. Balancing environmental sustainability with energy security is a key objective for South Africa.

Already significant progress has been made in incorporating renewable energy sources into South Africa's energy mix. In 2021, coal accounted for 81.4% of South Africa's primary energy consumption. In 2022, the contribution of coal decreased to 80.1%. Although some of this reduction may be due to loadshedding and reduced economic activity, it is also due to increased renewable energy. An additional renewable energy capacity of 748 MW from Independent Power Producers (IPPs) was commissioned during 2022, bringing the total IPP renewable energy on the national electricity grid to 5.826 GW. This capacity has been added through South Africa's globally acclaimed renewable energy procurement programme. This programme, under the DMRE, aims to bring more renewable energy onto the electricity grid. The IRP 2019 highlights the pathway of decarbonisation of the electricity sector with the predominant inclusion of renewable energy in the form of solar and wind. Moving towards greener energy sources is not only part of South Africa's plan to reduce GHG emissions, but also to guarantee energy security.

Furthermore, strategies and frameworks have been developed by the South African government to govern and facilitate a Just Energy Transition that is both practical and fair. It is focused on sustaining economic growth and bettering the lives of all South Africans at the same time ensuring that the ambitious emission reduction trajectory under the Paris Agreement and its own Nationally Determined Contribution (NDC) is achieved.

The Just Transition Framework provides a guideline for the South African energy sector to transition to a low-emission and climate-resilient economy. The energy sector is a significant contributor to the South African economy. Not only is energy supply critical for all other sectors of the economy, but the energy sector directly and indirectly employs an estimated 667,300 people, with coal (40%) and crude oil (38%) accounting for the majority proportion of the work forces. It is estimated that the coal mining sector employs 80,000 people directly and another 200,000 to 300,000 in the value chain. If each of these workers have 5 to 10 dependents, then the coal mining sector supports between 2 and 4 million people. The transition away from coal to renewables must ensure that those in the coal mining sector and its value chain are reskilled to be employed in the renewables sector and its value chain. The Just Transition Framework prioritises decarbonisation of the economy and thereby, creation of quality green jobs, deployment of renewable energy generation, and increased sustainable economic growth for a resilient and net- zero South African economy. Furthermore, Framework focuses on three broad areas listed below:

- Reskilling and upskilling existing workers so that they are better equipped to navigate the transition.
- Aligning the skills development system with the anticipated labour force needs of the future, particularly focused on green jobs to support a just transition; and,
- Ensuring foundational skills through the education system to improve the adaptative capacity of the broader workforce.

As the country grapples with the triple challenge of unemployment, inequality and poverty, it notes that the energy transition can bring about opportunities that help with mitigation or alleviation of such issues.

Whilst there is a great deal of focus on the decarbonisation of the electricity sector as the country, the country acknowledges that there is a further opportunity that needs to be unlocked which is to decarbonise the broader energy sector and hard-to-abate sectors. This was discussed at the 26th Conference of Parties (COP26). It was also at this COP that a Just Energy Transition Partnership (JETP) was announced. The European Union, Germany, UK, France, and USA pledged a total of $8.5bn to South Africa for the decarbonisation of the country's energy sector.

The Just Energy Transition Investment Plan (JET-IP) highlights South Africa's intent and plans to use this money as well as highlighting the need for more support and investment for the decarbonisation agenda. This plan is centralised around decarbonising and modernising the electricity grid, green hydrogen production and new energy vehicles which requires a total budget of $75bn to be spent from 2023-2027. Green hydrogen opportunities are being thoroughly explored in the country to not only supports local decarbonisation but also the global decarbonisation agenda through exports of green hydrogen. This is based on key advantages that South Africa has such as endowment of excellent solar and wind resources, availability of land and endowment of platinum group metals (PGM's) required for green hydrogen value chains.

Along with having secured funding from the JETP, South Africa is also actively engaged in regional energy cooperation initiatives to enhance energy security. It collaborates with neighbouring countries to develop cross-border energy infrastructure, promote energy trade, and share resources. Regional cooperation fosters energy interconnections, diversifies energy sources, and supports the development of a regional energy market.

1.5.2 NATIONAL ENERGY SECURITY POLICY

South Africa has a comprehensive policy and regulatory framework that addresses energy security considerations. This framework includes regulations for energy planning, pricing mechanisms, renewable energy targets, energy efficiency standards, and emergency response plans. Regular evaluations and updates to policies ensure their effectiveness in addressing energy security challenges.

South Africa's energy sector is guided by the White Paper on the Energy Policy. The White Paper on the Energy Policy was developed to clarify government's policy regarding the supply and consumption of energy for the next decade. The main objectives of the White Paper are the following:

- Increasing access to affordable energy services;
- Improving energy governance;
- Stimulating economic development;
- Managing energy-related environmental impacts; and
- Securing supply through diversity.

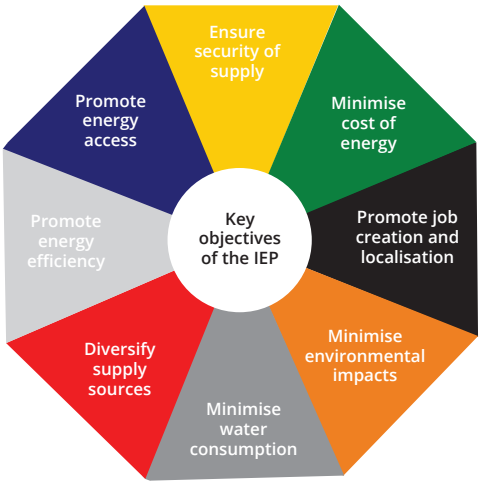
Under the main objectives in the White Paper, government prioritises energy security by promoting access to affordable energy services for disadvantaged households, small

businesses, small farms, and community services; and encouraging a diversity of both supply sources and primary energy carriers.

The policy framework encompasses various elements and strategies to enhance energy security. The framework includes legislation, regulations, and guidelines to promote energy planning, renewable energy deployment, energy efficiency standards, pricing mechanisms, and emergency response plans. Regular reviews and updates ensure the effectiveness of policies in addressing energy security challenges. The policy framework promotes the transition to cleaner energy sources, the implementation of carbon reduction measures, and the promotion of sustainable development principles. Supporting the White Paper, the Integrated Energy Plan (IEP) was designed to consider South Africa's energy needs from 2015 to 2050. The purpose of this plan was to:

- To guide the development of energy policies and, where relevant, set the framework for regulations in the energy sector;
- To guide the selection of appropriate technologies to meet energy demand (i.e. the types and sizes of new power plants and refineries to be built and the prices that should be charged for fuels);
- To guide investment in and the development of energy infrastructure in South Africa; and
- To propose alternative energy strategies which are informed by testing the potential impacts of various factors such as proposed policies, introduction of new technologies, and effects of exogenous macro-economic factors.

There are eight key objectives under the IEP, one of which is ensuring security of supply.



Under the IEP, scenarios were created to quantify energy demand and identify possible future energy generation for South Africa. In all scenarios, it was clear that coal technologies continue to play a role in the future energy mix. Solar also plays a significant role as the cost of solar technologies was projected to continue declining in the foreseeable future.

The Integrated Resource Plan (IRP) is a subset of the IEP, focused only on electricity. It is an electricity infrastructure development plan based on least-cost electricity supply and demand balance, taking into account security of supply and the need to protect the environment.

The IRP 2019 provided a forecast of electricity demand and a view of the new generation capacity to be brought onto the grid by 2030. Included in this new generation capacity is 2.5 GW of hydro, 6 GW of solar photovoltaic, 14.4 GW of wind and 2.088 GW if storage. As of 2030, coal is expected to remain the main energy source, but its contribution decreases between now and 2030 as coal power plants that have reached end-of-life are decommissioned.

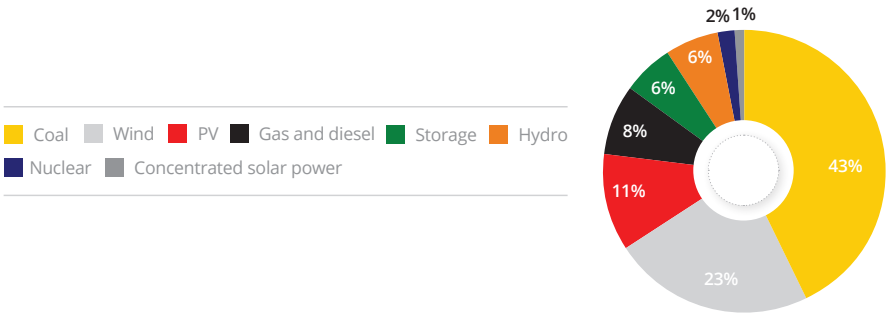


Figure 9: Electricity Generation Mix in 2030

The IRP 2019 is currently being reviewed and updated by the DMRE. The White Paper, IEP and IRP are further supported by various other government documents as outlined below:

Table 1: Energy Regulation and Policy

Title	Description
White Paper on Renewable Energy, November 2003	The White Paper on Renewable Energy sets out government's vision, policy principles, strategic goals, and objectives for promoting and implementing renewable energy in South Africa.
Nuclear Energy Policy, October 2008	The Nuclear Energy Policy outlines government's vision for the development of an extensive nuclear energy programme by ensuring that government's objective on the prospecting and mining of uranium ore and the use of uranium (or other relevant nuclear materials) as a primary resource of energy must be regulated and managed in a manner that will be for peaceful purposes.
National Energy Act, 2008	The National Energy Act aims to ensure that diverse energy resources are available in sustainable quantities and at affordable prices in South Africa. The Act also provides for the increased use of renewable energies, contingency energy supplies, the holding of strategic energy feedstock and carriers, and adequate investment in energy infrastructure.

Title	Description
Petroleum Products Act, 1977	The Petroleum Products Act exists to provide measures for the saving of petroleum products and an economy in the cost of the distribution thereof, and for the maintenance and control of a price; therefore, for control of the furnishing of certain information regarding petroleum products. It also provides for the licensing of persons involved in the manufacturing and sale of certain petroleum products.
Nuclear Energy Act, 1999	The Nuclear Energy Act was established to regulate the acquisition and possession of nuclear fuel and certain nuclear and related material and certain related equipment. It was also established to prescribe measures regarding the discarding of radioactive waste and the storage of irradiated nuclear fuel. The Nuclear Energy Act provided for the establishment of South African Nuclear Energy Corporation Limited (NECSA).
The Gas Act, 2001	The Gas Act establishes a national regulatory framework for gas and a National Gas Regulator as the custodian and enforcer of the national regulatory framework.
Electricity Regulation Act No. 4 of 2006	The Electricity Regulation Act 4 of 2006 was enacted to establish a national regulatory framework for the electricity supply industry; to make the National Energy Regulator the custodian and enforcer of the national electricity regulatory framework and to provide for licences and registration as the manner in which generation, transmission, distribution, trading and the import and export of electricity are regulated.

1.5.3 THE CHARACTERISTICS AND APPROACH TO ENERGY TRANSITION

South Africa's energy transition is driven by its climate commitments which ensure its ambitious emission reduction trajectory is consistent with the UNFCCC, the Paris Agreement and subsequently its own NDC targets. South Africa has committed to keeping emissions to a range of 350-420 Mt CO_2e by 2030. The South African cabinet has approved a goal to reduce GHG emissions to net zero by 2050. It is reported that the energy sector is responsible for about 80% of South Africa's GHG emissions. About half of this is from the production of electricity and liquid fuels. Given this sector's significant contribution to South Africa's GHG emissions, it is not possible for South Africa to achieve its targets without transforming the energy sector.

South Africa's approach to energy transition is also influenced by other factors such as its unique socio-economic context, energy resources, environmental challenges, and policy priorities. These are some key characteristics and approaches that define South Africa's energy transition. The country possesses significant coal reserves, which have historically

been a dominant energy source for electricity generation. The country's energy transition involves reducing the reliance on coal and diversifying the energy mix towards cleaner and more sustainable sources. South Africa has substantial renewable energy potential, including solar, wind, biomass, and hydropower resources. The country has recognised the importance of harnessing these renewable sources and has implemented policies and programmes to promote their development. The Renewable Energy Independent Power Producer Procurement Program (REIPPPP) is one such programme which aims to bring renewable energy onto the national electricity grid.

South Africa adopts an Integrated Resource Planning approach to guide its energy transition. The IRP outlines the country's energy mix targets, infrastructure development plans, and policy frameworks for a specified period. It considers factors such as energy demand, resource availability, environmental considerations, and socio-economic impacts to ensure a balanced and sustainable energy system. The IRP 2019 contains a view of the new generation capacity to be brought onto the grid by 2030, including increased renewable energy.

Along with the IRP, President Cyril Ramaphosa established the Presidential Climate Commission (PCC) with the purpose of understanding how to transform the energy sector. Its overarching mandate is to oversee and facilitate a just and equitable transition towards a low-emissions and climate-resilient economy.

The PCC is working on what is calls the 'Just Energy Transition.' The Just Energy Transition focuses on the 'transition of South Africa's energy sector as the country navigates the shift away from coal towards cleaner sources of energy whilst ensuring that the lives and communities that are tied to high-emitting energy industries (e.g., coal) are not left behind in the shift towards a low emissions economy. The energy transition must be fair and perceived to be fair.'

Defining a Just Transition for South Africa

"A just transition aims to achieve a quality life for all South Africans, in the context of increasing the ability to adapt to the adverse impacts of climate, fostering climate resilience, and reaching net-zero greenhouse gas emissions by 2050, in line with best available science.

A just transition contributes to the goals of decent work for all, social inclusion, and the eradication of poverty.

A just transition puts people at the centre of decision making, especially those most impacted, the poor, women, people with disabilities, and the youth—empowering and equipping them for new opportunities of the future.

A just transition builds the resilience of the economy and people through affordable, decentralised, diversely owned renewable energy systems; conservation of natural resources; equitable access of water resources; an environment that is not harmful to one's health and well-being; and sustainable, equitable, inclusive landuse for all, especially for the most vulnerable".

The Presidential Climate Commission (PCC) has convened a series of public debates on South Africa's evolving energy mix, focusing on the electricity system. Some of the priorities identified by the PCC are tabulated below:

Table 2: Outcomes from the PCC's Work on the Just Energy Transition

Title	Description
Electricity	**In the electricity sector, the priorities are to:** ■ Manage the decommissioning of the retiring coal generation fleet in tandem with the development of renewable energy generation at scale and pace; ■ Timeously strengthen the transmission grid infrastructure to accommodate the shift to renewable energy; and ■ To modernise the electricity distribution system.
New Energy Vehicles (NEVs)	**In the NEV sector, the priorities are to:** ■ Localise the NEV supply chain, setting the base for NEV manufacturing and component manufacturing; ■ Protect sector employment and promote new growth in sustainable manufacturing; ■ Incentivise investments in NEV-charging infrastructure; and ■ Convert public transport and private vehicles to NEVs.
Green Hydrogen	**In the green hydrogen sector, the focus is to:** ■ Set South Africa up to become a world-leading exporter of green hydrogen by incubating local green hydrogen ecosystems; and ■ Undertaking critical planning, feasibility, and proofs of concept; and developing the necessary skills.
Skills Development	Investment is needed to ensure that skills are in place to match the growth in new clean sectors and support worker transition.

Given South Africa's unique socio-economic context, the country's approach to the energy transition incorporates considerations for local economic development and job creation. Currently, the South African economic growth significantly depends on fossil fuel-based energy system. Electricity usage and accessibility are correlated and play a pivotal role in economic development, growth, and sustainability. Subsequently, the lack of energy availability has become a constraint to economic growth with GDP of the country reducing due to loadshedding and the energy crisis. The REIPPPP includes provisions for local content and socio-economic development. The aim is to stimulate local industries, create employment opportunities, and drive economic growth in renewable energy sectors.

The country acknowledges the need for a just transition as it moves towards a more sustainable energy future. The country recognises the social and economic implications of phasing out certain industries, such as coal mining and related sectors. Efforts are made to support affected communities and workers through reskilling, job creation in alternative sectors, and social support programs. The country grapples with the triple challenge of unemployment, inequality and poverty and it notes that the energy transition can bring about opportunities that help with mitigation or alleviation of such issues.

It is also important to note that South Africa actively engages in international collaboration and partnerships to support its energy transition goals. The country participates in global initiatives, such as the Paris Agreement, and collaborates with other nations on research, technology transfer, and capacity building. International collaboration helps South Africa access expertise, leverage funding, and share best practices in the energy transition. An example is the Just Energy Transition Partnership (JETP) that was announced at COP26 where the European Union, Germany, UK, France, and USA pledged a total of $8.5bn the decarbonisation of South Africa's energy sector.

Overall, South Africa's characteristics and approach to energy transition involve diversification of the energy mix, harnessing renewable energy potential, integrated resource planning, considerations for energy security and affordability, local economic development, just transition principles, energy efficiency measures, a supportive policy framework, and international collaboration. These strategies aim to achieve a sustainable, low-carbon energy system that supports economic development, social welfare, and environmental protection.

Progress To Date

Although South Africa faces many challenges in terms of its energy security and its energy transition, it must be acknowledged that South Africa has made great strides. Some highlights include:

- South Africa has established a comprehensive policy and regulatory framework to support its energy transition. This includes legislation, regulations, and incentive programs that promote renewable energy deployment, energy efficiency, and GHG emission reduction.

- The South African Government launched the world-class REIPPPP which has managed to successfully channel substantial private sector expertise and investment into grid-connected renewable energy in the country. To date, there have been six bidding windows under this programme, four of which have projects connected to the grid, totalling about 6 GW of installed capacity.

- South Africa has placed significant emphasis on energy efficiency and demand-side management as part of its energy transition strategy. The country implements energy efficiency measures across sectors, promotes energy-saving practices, and encourages the adoption of energy-efficient technologies. The country is very aware of the fact that managing energy demand helps optimise resource utilisation and reduce GHG emissions.

- Over the years, the DMRE has promoted energy efficiency and implemented a range of strategies for demand-side management measures in cooperation with Eskom, public sector institutions, and the private sector. The measures implemented by government have meant that South Africans have prioritised and continue to pursue energy efficiency. It has also meant that South Africa has one of the leading measurement and verification sectors in the world.

- Reforms are taking place to the structure of Eskom to open up the electricity market in South Africa. Apart from these changes, various legislative changes have taken place to encourage private sector power generation. The Electricity Regulation Act was amended to raise the threshold for requiring a license from 1 to 100 MW for private generation. Since this change, private sector companies have launched 100 projects which will bring more than 9 GW to the grid. Subsequently, the threshold was removed altogether to allow for private solar and wind projects of any size to be built without requiring a license. Municipalities can now also procure electricity independently following the amendment of the Regulations on New Generation Capacity.

It must also be kept in mind that South Africa is in a good position to be at the forefront of renewable energy development and roll-out. It has good sites for solar and wind and it is a leading mining country and renowned for its mineral resources.

1.5.4 THE RISKS, CHALLENGES, THREATS TO ENERGY SECURITY

The Challenge of Immediate Energy Security

South Africa, like other countries around the world, is in the midst of an unprecedented energy crisis. One of the biggest challenges currently facing South Africa is the electricity supply constraints. South Africa's coal-fired power plants are old, and their performance is deteriorating. The commissioning of Medupi and Kusile power plants was delayed, and these power plants have been subject to several performance issues since commissioning. In prior years, the supply constraints with the decreasing energy availability factors of generation plants, delayed implementation of new generation capacity and, most recently, electricity

grid capacity constraints have contributed to slowing down economic growth. Furthermore, coupled with the lack of new generation capacity brought onto the grid, has led to shortfalls in generation capacity. When there is insufficient supply to meet demand, Eskom is forced to reduce demand through load shedding. Load shedding is done to protect the grid and prevent a blackout. Load shedding is the single biggest constraint on South Africa's economic growth.

Government is taking action to address the immediate crisis. It has established the National Energy Crisis Committee (NECOM). This committee comprises all government departments and Eskom. Its objective is to solve the electricity crisis as quickly as possible. President Cyril Ramaphosa also appointed a minister of electricity to oversee all aspects of the electricity crisis response, including the work of NECOM. Coming out of NECOM is a plan to eliminate load shedding. The Energy Action Plan has two main objectives:

i. First, to improve the performance of Eskom's existing power stations; and
ii. Second, to add as much new generation capacity to the grid as possible, as quickly as possible.

It plans to achieve the above by removing barriers to new generation capacity and unlocking energy from many different sources as part of a collective national effort. At the same time, it plans to diversify South Africa's energy sources and achieve energy security in the long term.

The Energy Action Plan is primarily about achieving electricity security, but it also includes bringing more renewable energy online, thus contributing to the Just Energy Transition. It aims to bring more than 10 GW of new renewable energy capacity onto the national electricity grid in the short term.

Impacts of Climate Change

Given concerns around climate change, there is global pressure to shift energy production towards a greener path where South Africa must manage the developmental tensions entailed in such choices. Climate change has caused the globe to rethink the extractive nature of energy production and brought on the need to transition to low-carbon energy technologies and economies. The global net-zero targets have imposed pressure on countries to implement projects at an unprecedented scale which has never been done before. The capacities of renewable energy required globally requires a global partnership.

The impacts of climate change for Africa are significant. Africa is said to warm twice as fast as the other countries in the globe and this further comes with the prediction that it will be much more severely affected by climate change. South Africa is already experiencing climate change

impacts such as droughts and floods. Floods in two different provinces of South Africa in the last two years have resulted in major social and economic challenges. This adds to some of the risks that the country faces in implementation of a just energy transition and improved energy security.

However, the implementation of the energy transition in a country with an energy crisis has brought about conflicting views. On the one hand, there is a need to grow the economy, re-industrialize and to create jobs which can use the transition to a green economy as a mechanism to do so. However, on the other hand, the country grapples with reduced energy availability and loadshedding which questions the path to decommission coal-fired generation.

There are also macro questions relating to the environmental sustainability of coal-dependent energy generation. This is particularly important for South Africa, as it is an active participant in such important global forums as the UNFCCC.

The Need for Procurement of New Generation Capacity

South Africa's IRP2019 has identified the preferred generation technologies and capacities required to meet expected electricity demand growth up to 2030 and its NDC. It addresses the short to long term challenges that the country faces and provides much needed policy in the area of energy security and affordability.

Currently, South African energy supply is dominated by coal as energy source, with nuclear, gas, diesel and renewable sources that contribute electricity to the national grid. The existing generating coal fleet is reaching end of life and with the abundance of coal resources, new investments will need to be made in more efficient coal technologies such as High Efficiency Low Emission (HELE) technology, including supercritical and ultra-supercritical power plants with Carbon Capture, Utilisation and Storage (CCUS) to comply with climate and environmental requirements.

Furthermore, the government needs to accelerate the procurement of new generation capacity.

South Africa recognises the role of nuclear power in ensuring security of energy supply and meeting the challenge of climate change. The Nuclear Energy Policy outlines the South African government's vision for the development of an extensive nuclear energy programme. In accordance with IRP2019, DMRE will commence with preparations for a Nuclear Build Programme towards an additional 2.5 GW to the grid and is considering Small Modular Reactors (SMRs) to take into account the pace and scale the country can afford. South Africa is

the only country in Africa with a commercial nuclear power plant, the Koeberg Power Station, which accounts for around 5% of the country's electricity production. It reaches its 40-year end of design life in 2024 and plans are already in place to extend its design life and nuclear safety license for another 20 years. The extension of design life of the Koeberg Power Station is critical for continued energy security in the period beyond 2024.

Government of South Africa is also committed to Just Energy Transition (JET) and has begun investing in clean technologies to ensure transition from high to low carbon economy, while ensuring security of energy supply. Since the introduction of the REIPPP in 2011, over 6 GW of wind and solar have been connected to the grid. A further 2.6 GW of capacity has been procured through Bid Window 5, which included Battery Energy Storage Systems (BESS) technologies and will begin to add capacity from early 2024. The amount of new generation capacity procured through Bid Window 6 for wind and solar power will be doubled from 2.6 GW to 5.2 GW. The IRP2019 recommended plan calls for a total of about 33% renewable energy share of the installed capacity by 2030.

The IRP makes provision for distributed and embedded generation, therefore the government of South Africa to accelerate private investment in distributed generation and easy distributed energy generation regulations. The licensing threshold was removed for new embedded generation projects that are connected to the grid and have an off-taker as part of the Schedule 2 of the Electricity Regulation Act. The Government also changed the regulations to allow municipalities to procure power independently and diversify generation by allowing parties other than Eskom to generate electricity. South Africa government to accelerate rooftop solar photovoltaic through feed-in tariffs and also enable businesses and households to invest in rooftop solar and contribute to the national grid.

In addition to its local development, South Africa is promoting development in other countries of Southern Africa, a policy designed to enable it to import more power across the Southern African grid. A key project is the Grand Inga in the Democratic Republic of Congo (DRC). South Africa signed a draft treaty for its development with the government of the DRC. South Africa through Eskom also participates and trades electricity through the South African Power Pool (SAPP). Increased collaboration and alignment at regional level is key to unlocking already identified generation and transmission infrastructure projects.

Unbundling of Eskom is important for the much-needed procurement of new generation capacity. At the 2019 State of the Nation Address, the President announced that Eskom would be unbundled into three wholly owned subsidiaries, namely generation, transmission, and distribution. This unbundling is seen an important enabler for the accelerated procurement of new capacity which is needed to ensure electricity security. To date, Eskom has established

separate divisional boards and managing directors for generation, transmission and distribution. A legally binding agreement to transfer Eskom's transmission division to its wholly owned subsidiary, National Transmission Company South Africa SOC Limited (NTCSA), was executed in December 2021. There are now only two remaining conditions to give effect to the suspensive sale agreement of NTCSA, namely the licenses to operate and obtaining lender consent where required. The licenses are expected shortly. The Cabinet also recently approved the Electricity Regulation Amendment Bill which establishes the Independent Market and System Operator.

Investment Required in Grid Infrastructure

To bring more capacity onto the grid, particularly renewable energy, investment is required to expand the grid infrastructure. Eskom's Generation Connection Capacity Assessment (GCCA) 2023 Phase 1 report states that there is no longer grid capacity in the Northern Cape which is the location of choice for solar systems due to its high levels of irradiation. The grids in the Western and Eastern Cape, where the wind resource is good, are also constrained. These grid capacity constraints have meant that only six of the 56 bids submitted during Bid Window 6 of the REIPPPP attained preferred bidder status.

To address the above, Eskom plans to increase the transmission infrastructure by approximately 8 400 km of extra-high-voltage lines and 119 transformers to bring on board 58 970 MVA of transformer capacity over the next 10 years. Despite this, grid capacity still remains a challenge in the short term as it can take up to seven years to build a new transmission line, when considering the various approvals required.

The Role of Gas/Constrained Gas Supply

Gas has always been an important part of the energy mix in South Africa. South Africa consumes about 180 Petajoules per annum (PJ/a) of gas, predominantly in the synfuels and industrial sectors. Its importance is also expected to grow as it is cited to be the transition fuel, replacing coal and diesel, as South Africa moves towards renewable energy. Currently, gas is supplied from Pande-Temane in Mozambique and from Sasol operations via the Lilly pipeline. However, supply of gas is expected to be constrained from 2025 as the Pande-Temane gas fields are declining. Unless these gas fields can be extended, South Africa needs to secure alternative supplies of gas at affordable prices in the near future.

To address this challenge, work is being done on extending the Pande-Temane gas fields, using Floating Storage Regasification Units to produce Liquified Natural Gas (LNG), increasing exploration and forging relationships with other African countries for supply and market

access, South Africa has signed cross-border gas trade agreements with Mozambique and Namibia. Exploration to assess the magnitude of local recoverable shale and coastal gas are being pursued and must be accelerated. Co-operation with neighbouring countries is being pursued and partnerships are being developed for joint exploitation and beneficiation of natural gas within the SADC region. The Southern African Development Community (SADC) is also developing a Gas Master Plan, to identify the short- and long-term infrastructure requirements to enable the uptake of a natural gas market.

South Africa's Petroleum Refineries

South Africa's fuel imports have increased significantly as production at four out of six refineries come to a halt. Sapref, the largest refinery in Southern Africa and responsible for a third of the country's fuel supply, closed its doors early in 2022. Government's plans to take over Sapref have also been delayed post the flooding in KwaZulu-Natal which caused severe damage to the plant. Currently, only two refineries remain operational as it has become cheaper to import fuel as opposed to refine locally. The only refineries operating are crude refinery and a synfuels refinery. One refinery came back online in 2023.

The closure of domestic refineries and the increased reliance on imports poses a risk to South Africa's energy security. It requires that either additional refining capacity be developed locally or the move towards NEV is accelerated.

The Need to Reskill and Strengthen Capacity

To achieve South Africa's climate commitments, it will need to move from coal to renewable energy. However, the coal sector is an important sector, directly employing around 93,000 people in 2021 and indirectly employing and supporting far more people. Coal production is also geographically concentrated with 80% occurring in Mpumalanga. Around 1.1 million people live in these districts, most being supported as a result of coal mining. Any move from coal to renewables needs to offset job losses in the coal sector by localising the renewable energy value chain. For this reason, one of the focus areas of the PCC's Just Transition Framework is skills development. The transition strategies and framework prioritises decarbonization of the economy and thereby, creation of quality green jobs, deployment of renewable energy generation, and increased sustainable economic growth for a resilient and net- zero South African economy. The following priorities in terms of skills developed are highlighted in the Just Transition Framework:

- Reskill and upskill existing adult workers so that they are better equipped to navigate the transition;

- Align the skills development system with the anticipated labour force needs of the future, particularly focused on green jobs to support a just transition; and
- Ensure foundational skills through the education system to improve the adaptative capacity of the broader workforce.

In addition to reskilling, there is a need to strengthen governance and government capacity at the national, provincial, and municipal levels. Governance has been severely weakened in South Africa as a result of state capture, the loss of capable managers, erosion of accountability, and lack of professionalism. Strengthening government capacity is important as government has a key role to play in ensuring future energy security. Policy development and long-term policy certainty are essential to enable the implementation of the Just Energy Transition. Only government can develop this policy and provide the certainty needed.

The Just Transition Framework acknowledges the important role that government plays. It sees national government as having a crucial leadership and policy role to play in implementing the just transition. Provincial and local governments are also critical in responding to spatially specific climate impacts and coordinating just transition measures in their provinces and municipal areas. Capacity building is required to ensure that government is equipped to undertake the necessary work to implement the Just Energy Transition such as cost-of-supply studies, tariff designs, technical skills upgrades, electricity planning (distribution and generation), NEV planning, energy investment etc. Additional municipal capacity is also required to enable implementation.

Development of New Fuels and Technologies

Through its REIPPPP, South Africa has seen an increase in solar, wind, and hydropower. However, investment into the development of new fuels and technologies is needed to ensure future energy security and facilitate the implementation of the Just Energy Transition. Developments in hydrogen and NEVs are cited by the Just Energy Transition.

The Just Energy Transition aims to set South Africa up to become a world-leading exporter of green hydrogen by incubating local green hydrogen ecosystems. Apart from producing and exporting hydrogen, hydrogen is also expected to be an important contributor to South Africa's future energy security. It is energy dense, making it easier to store and transport. It can be produced through electrolysis of water using wind and solar which South Africa has in abundance.

Transitioning from conventional vehicles to NEVs is also considered important for South Africa's future energy security. The Just Energy Transition has a focus on localising the NEV supply chain, setting the base for NEV manufacturing and component manufacturing. More research, development and investment are required to make South Africa a leader in the NEV space.

In addition to hydrogen and NEVs, there are other fuels and technologies being explored that may also be an important part of South Africa's future energy mix.

Energy Cost

The International Energy Agency (IEA) defines energy security as the uninterrupted availability of energy sources at an affordable price. As such, energy security is not only about availability of energy sources to meet demand, but also about pricing.

South Africa used to have the cheapest electricity in the world. Electricity prices were not cost-reflective and increases were kept below inflation. This historically low price of electricity has encouraged investment in South Africa, but also contributed towards the current electricity crisis. However, average electricity prices increased by over 582% between 2007 and 2021 in a bid by Eskom to make electricity prices more cost-reflective. It is not only electricity prices that have been increasing. Fuel prices have also been increasing due to the low global supply and high global demand for oil.

Rising electricity and fuel prices lead to higher inflation. It affects the prices of other essential goods like food and medicine. Increasing electricity and fuel prices negatively impact income, employment, and the economy. In implementing the Just Energy Transition, it is important that the affordability of energy is prioritised.

Financing the Just Energy Transition

The funding required to ensure future energy security and implement the Just Energy Transition is a challenge. An estimate of the funding required from now until 2027 is tabulated below:

Table 3: Just Energy Transition Funding 2023 – 2027

Sector	Funding Required (ZAR billion)
Electricity sector	711.4
NEV sector	128.1
Green hydrogen sector	319
Skills development	2.7
Municipal capacity	319.1
Total	**1 480**

Forming partnerships to unlock this funding is important. One such partnership is the Just Energy Transition Partnership between South Africa and the International Partners Group comprising the European Union, Germany, France, the United Kingdom, and the United States. The aim of this partnership is to unlock US$8.5 billion in finance and investments to implement some of the initiatives identified in the Just Energy Transition.

Obtaining funding is important, but as important are the terms associated with this funding. Obtaining funding with terms that allow energy to be provided to South Africans at an affordable price is critical.

Securing Energy Infrastructure

Contributing to the current electricity crisis is sabotage of electricity infrastructure. In January 2023, Eskom stated that theft and sabotage were one of the main reasons for the poor electricity availability. According to reports, sabotage was reportedly taking place for political reasons, by disgruntled employees that had missed out on opportunities and contractors to ensure they were given more work.

Addressing these challenges and mitigating the associated risks requires a comprehensive approach that encompasses policy reforms, infrastructure upgrades, renewable energy deployment, energy efficiency measures, water management strategies, stakeholder collaboration, and long-term planning. South Africa's energy security relies on proactive measures to ensure a reliable, affordable, and sustainable energy supply that supports economic development, social welfare, and environmental sustainability.

The Main Areas for Ensuring Energy Security

South Africa focuses on several key areas to ensure energy security. These areas encompass strategies and measures aimed at achieving a reliable, affordable, and sustainable energy supply. South Africa recognises the importance of diversifying its energy sources to reduce reliance on a single fuel or technology. The country aims to transition away from coal and increase the share of renewable energy, natural gas, and nuclear power. Diversification helps mitigate supply risks, reduces environmental impacts, and promotes energy resilience.

There is a strong emphasis placed on renewable energy deployment to enhance energy security. The country has implemented policies and initiatives, such as the REIPPPP, to promote the development of renewable energy projects. Expanding renewable energy capacity reduces dependence on fossil fuels and contributes to a more sustainable energy mix. South Africa prioritizes energy efficiency and demand-side management as critical components of

its energy security strategy. The country implements measures to improve energy efficiency across sectors, encourages the adoption of energy-efficient technologies, and promotes demand response programs. Managing energy demand helps optimise resource utilisation and reduces strain on the energy system.

The country emphasizes the development, maintenance, and upgrading of energy infrastructure to ensure a reliable and resilient energy supply. This includes power generation plants, transmission and distribution networks, storage facilities, and fuel transportation infrastructure. Enhancing infrastructure resilience helps minimise disruptions and supports the integration of renewable energy sources.

South Africa recognises the importance of energy access for all citizens. The country strives to improve energy access in under-served communities, particularly in rural areas. Policies and programmes are implemented to extend electricity and clean cooking solutions, ensuring equitable access to reliable and affordable energy services. Addressing energy poverty enhances social development and inclusivity.

South Africa has established a comprehensive policy and regulatory framework to support energy security objectives. The framework includes legislation, regulations, and incentive programs that promote renewable energy deployment, energy efficiency, grid stability, and market competition. A stable and predictable policy environment attracts investments and facilitates the transition to a secure and sustainable energy system.

South Africa actively engages in international cooperation and partnerships to enhance energy security. The country participates in global initiatives, collaborates with other nations on research and technology transfer, and shares best practices. International collaboration facilitates knowledge exchange, access to funding, and the adoption of global standards and innovations.

1.5.5 THE MONITORING, EVALUATION AND FORECAST OF THE ENERGY SECTOR SECURITY

The government department that oversees the energy sector in South Africa is the Department of Mineral Resources and Energy (DMRE). Its mandate is to ensure that energy resources are available, and that there's access to energy services in an affordable, reliable and sustainable manner, while minimising the associated adverse environmental impacts. It was established in June 2019 through the merger of the Department of Mineral Resources and the Department of Energy (DoE) into a single department.

Although supported by many other government entities, it is the DMRE who will continue to monitor and evaluate South Africa's energy security and progress made towards securing future energy security.

South Africa implements monitoring, evaluation, and forecasting mechanisms to assess and ensure the security of its energy sector. These processes involve various aspects to monitor energy production, consumption, infrastructure, risks, and policy effectiveness. South Africa maintains a robust system for collecting energy data from various sources, including energy companies, regulatory bodies, and government agencies. This data includes information on energy production, consumption, imports, exports, infrastructure, and prices. Accurate and up-to-date data collection enables policymakers and analysts to monitor and evaluate the energy sector's security.

South Africa tracks specific indicators to assess the energy sector's security. These indicators may include energy supply-demand balance, import dependence, infrastructure reliability, diversification of energy sources, price volatility, and emergency response capabilities. Monitoring these indicators allows policymakers to identify potential vulnerabilities and take appropriate actions to mitigate risks.

South Africa employs energy modelling techniques and forecasting tools to assess future energy demand, supply, and security scenarios. These models take into account factors such as economic growth, population trends, technological advancements, and policy changes. By forecasting energy requirements, South Africa can anticipate potential shortfalls, plan for infrastructure development, and explore alternative energy options.

Risk assessments are conducted to identify and evaluate potential threats to energy sector security. These assessments may include analysing geopolitical risks, natural disasters, cyber threats, supply disruptions, and climate change impacts. Based on the findings, South Africa formulates strategies and measures to enhance security and resilience, such as diversifying energy sources, investing in infrastructure, and promoting energy conservation and efficiency.

South Africa evaluates the effectiveness of energy policies and regulations in enhancing energy sector security. Regular assessments and reviews are conducted to analyse policy implementation, identify gaps or shortcomings, and adjust strategies as needed. This iterative evaluation process ensures that policies are aligned with changing energy dynamics and contribute to the overall energy security objectives.

The country maintains mechanisms for emergency preparedness and response to potential energy crises or disruptions. It establishes contingency plans, stockpiles strategic reserves, and develops emergency response procedures to mitigate the impact of supply disruptions or disasters. Regular drills and simulations are conducted to test and enhance emergency response capabilities.

South Africa monitors technological advancements and innovations in the energy sector to identify opportunities for enhancing energy security. It promotes research and development of new energy technologies, encourages the adoption of advanced monitoring systems, and fosters collaboration with industry and academia to leverage technological solutions for energy sector security.

South Africa engages in international exchanges, cooperation, and collaboration on energy sector security. The country participates in global initiatives, collaborates with other nations on research, technology transfer, and capacity building. International cooperation helps South Africa gain insights into global energy trends, best practices, and enhances its energy security strategies. By implementing robust monitoring, evaluation, and forecasting practices, South Africa aims to enhance the security of its energy sector. These practices enable policymakers to make informed decisions, identify potential risks, and formulate effective strategies to ensure a reliable, affordable, and sustainable energy supply for the country's development.

What are South Africa's immediate priorities? South Africa's immediate focus is on eliminating loadshedding through the implementation of the Energy Action Plan. As such, over the short term, the Minister of Electricity and NECOM will be monitoring the implementation of the actions identified in this plan and evaluating their impact on loadshedding. What are South Africa's long term objectives? South Africa's long-term focus is on transforming the energy sector to meet its climate commitments. The Just Energy Transition plan consists of actions that need to be taken in the near term, between now and 2027. For the energy sector, these actions are primarily focused on renewable energy, NEVs and green hydrogen. Through the Just Energy Transition Partnership, the PCC is working with other countries and stakeholders to leverage the funding needed to implement these actions. The PCC, being tasked overseeing and facilitating a just and equitable transition towards a low-emissions and climate-resilient economy, will monitor the implementation of these actions and evaluate their effectiveness at transitioning the energy sector from predominantly coal-based to renewables.

CHAPTER **2**

BRICS ENERGY SECURITY PROSPECT OF COOPERATION FOR SUSTAINABLE DEVELOPMENT

[2.1]

PURPOSE OF COOPERATION AND AREAS OF CORPORATION

The BRICS nations occupy a prominent position in the global energy landscape, utilizing a diverse array of energy sources that encompass both fossil fuels (coal, oil, and natural gas) and renewable resources (solar, wind, hydro, biofuels, and geothermal). To progress towards a sustainable future, in tandem with their dynamic economic, societal, and policy advancements, fostering cooperation and collaboration among the BRICS countries becomes imperative. Leveraging each nation's distinct specialties will prove instrumental in achieving these shared objectives through the implementation of innovative, efficient, and economically viable methodologies.

Energy security stands as one of the paramount concerns for the BRICS group, comprising Brazil, Russia, India, China, and South Africa. Acknowledging the pivotal role of stable and accessible energy supplies in driving economic growth and prosperity, these nations are willing to forge collaborations to fortify their energy security. Embracing a multi-faceted approach, BRICS endeavours to diversify energy sources, foster energy trade and investment, and enhance renewable energy cooperation. The group has set its sights on robust energy infrastructure, energy efficiency initiatives, and expanding energy access to all segments of their populations. Through coordinated policy efforts, research, and technology cooperation, the BRICS nations aim to balance energy security with environmental sustainability, forging a path towards a resilient and sustainable energy future.

The BRICS nations recognise the imperative of diversifying their energy sources to mitigate dependency on any single energy type. From traditional sources like oil, natural gas, and coal to the flourishing potential of renewable energies like solar, wind, and hydroelectric power, collaboration in diversification ensures a more secure and resilient energy landscape. Moreover, the group places significant emphasis on energy trade and investment among its members, streamlining the flow of energy resources and technologies within the bloc, fostering mutual growth and development.

2.1.1 AREAS OF COLLABORATION

Several key areas of collaboration emerge in this context:

- **Diversification of Energy Sources:** BRICS countries collaborate to diversify their energy mix by investing in different types of energy resources. This includes cooperation in traditional sources like oil, natural gas, and coal, as well as a joint focus on developing and deploying renewable energy sources such as solar, wind, hydro, and bioenergy. Diversification taking into account the peculiarities of the fuel and energy balances and the tasks of developing the energy sector of each country helps reduce their dependence on a dominant energy source and enhances resilience against supply disruptions or price fluctuations.

- **Energy Trade and Investment:** BRICS can, on the basis of cooperation, develop information-integrated mechanisms for predicting negative situations and unified interstate risk management systems in the energy sector to form proposals for measures, activities and solutions aimed at strengthening the energy security of the BRICS countries in the world space.

- **Renewable Energy Cooperation:** Collaboration in renewable energy development is one of the aspects of BRICS' energy security efforts. The group shares knowledge, experiences, and best practices in the adoption and promotion of renewable energy technologies. They may also jointly invest in renewable energy projects, harnessing the vast potential of clean and sustainable energy sources.

- **Energy Efficiency Initiatives:** The BRICS nations collaborate on energy efficiency initiatives to optimise energy consumption and reduce wastage. Sharing best practices and expertise in energy-efficient technologies helps them achieve their energy security goals while minimising their overall energy footprint.

- **Research and Technology Cooperation:** Joint research and technology cooperation in the energy sector enable the BRICS countries to innovate and adopt advanced solutions for energy production, distribution, and consumption. Collaborative research projects and technology exchanges foster technological advancements and competitiveness in the global energy landscape.

- **Policy Coordination:** BRICS members engage in policy coordination to address common energy challenges and harmonize their energy-related policies. This collaboration helps create a conducive environment for energy investments, trade, and sustainable energy development.

- **Emergency Response and Crisis Management:** The BRICS group may discuss the possibility to establish their own mechanisms for emergency response and crisis management in the energy sector and may consider cooperation during times of supply disruptions or natural disasters to mitigate the impact on energy availability and ensure timely responses when necessary.
- **Energy Infrastructure Development:** BRICS countries cooperate in the development and improvement of energy infrastructure, including pipelines, power grids, and storage facilities. This ensures efficient and reliable energy distribution within and between the member countries, reducing vulnerability to infrastructure-related disruptions.
- **Capacity Building and Skills Development:** Collaborative efforts to build human resource capacity and skills development in the energy sector are important for promoting sustainable energy development and enhancing energy security.

By pooling their resources, expertise, and capabilities in these key areas, the BRICS countries strengthen their collective energy security, foster economic growth, and contribute to sustainable development while addressing global energy challenges.

2.1.2 COOPERATION IN ENERGY SECURITY

The BRICS countries play an important role in the Global Energy Security System. The BRICS countries have significant weight, both in generation and in consumption of global energy resources. Each BRICS nation possesses unique specialties and strengths when it comes to energy supply and consumption, which can offer advantages for areas of collaboration within the group:

- **Brazil**: Brazil has a significant advantage in the production of renewable energy, particularly from sources such as hydroelectric power and bioenergy. The country boasts a vast network of rivers that enable extensive hydroelectric generation, making it a global leader in this field. Additionally, Brazil has made significant strides in the development of biofuels, particularly ethanol from sugarcane. Its expertise in renewable energy technologies can be leveraged to promote sustainable energy practices and advance renewable energy projects within the BRICS collaboration.
- **Russia**: Russia, being a key player in the global energy system, is among the world leaders in terms of hydrocarbon reserves, production and export of energy resources, hydropower and nuclear energy, including the construction of nuclear power plants abroad. Possessing a powerful self-sufficient strategic resource and the production potential of a diversified

fuel and energy complex, it has one of the most environmentally friendly fuel and energy balances and has tremendous experience in the production of fossil fuels and their transportation. Russia has a developed energy infrastructure that provides a reliable and sustainable supply of energy resources and services in the energy sector in various natural and climatic conditions - from the Arctic to the subtropical zone, and is distinguished by a cost-effective combination of the use of centralised electricity and heat supply systems with the development of distributed generation of electrical energy and digitalisation of energy systems, as well as using local resources, including renewable energy sources. Russia's experience in solving the problems of ensuring energy security can be valuable for the BRICS.

- **India**: India has emerged as a leader in renewable energy adoption, particularly in the solar and wind energy sectors. The country has made substantial investments in renewable energy projects and is committed to achieving ambitious renewable energy targets. India's expertise in scalable renewable energy projects and energy-efficient technologies can offer valuable insights to other BRICS nations, encouraging sustainable energy transitions and technology transfers.

- **China**: China is the world's largest consumer and producer of coal and a major player in the production of renewable energy. The country has demonstrated significant advancements in renewable technologies, particularly in solar panel manufacturing and wind power installations. China's expertise in large-scale energy projects, as well as its growing commitment to transitioning towards cleaner energy, can foster cooperation within BRICS to accelerate renewable energy deployment and promote sustainable practices.

- **South Africa**: South Africa possesses abundant coal reserves and has traditionally relied on coal for a significant portion of its energy needs. However, the country is also making strides in diversifying its energy mix by investing in renewable energy sources, such as solar and wind. South Africa's experience in managing the transition from fossil fuels to renewable energy can offer valuable lessons to other BRICS countries seeking to balance energy security with sustainability.

The specialisation of each BRICS nation in different aspects of energy supply and consumption creates opportunities for collaboration. By leveraging their respective strengths, the BRICS can engage in knowledge sharing, technology transfers, and joint investments to address common energy challenges and promote sustainable energy development. BRICS experience in energy sector collectively form a diverse pool of resources that can facilitate mutual growth, enhance energy security, and contribute to global efforts to combat climate change. BRICS nations have recognised the importance of collaboration to enhance energy security, with a particular focus on diversification of energy sources, energy trade and investment, and renewable energy cooperation.

2.1.3 CHALLENGES FACING COOPERATION OF BRICS NATIONS IN ENERGY SECURITY

While the BRICS countries have the potential to achieve significant benefits through cooperation on energy security, they will also face several challenges in their collaborative efforts:

- **Diverse Energy Priorities**: Each BRICS nation may have different energy priorities based on their domestic needs, economic structure, and resource availability. Balancing these diverse priorities and finding common ground on energy strategies can be challenging, especially when considering the varying degrees of reliance on fossil fuels and the pace of transitioning to renewable energy sources.
- I**nfrastructure and Investment Disparities**: The level of energy infrastructure and investment capacity can vary significantly among BRICS nations. Disparities in infrastructure and investment can impact the ability to connect and facilitate energy trade and may require additional investments to strengthen energy interconnections.
- **Technology Transfer and Intellectual Property**: Cooperation on advanced energy technologies, including the renewable energy sector, may involve technology transfer and intellectual property rights concerns. Negotiating technology-sharing agreements while protecting intellectual property rights can be complex.
- **Regulatory and Policy Frameworks**: Diverse regulatory and policy frameworks in each BRICS country can present challenges for harmonising energy policies and facilitating cross-border trade. Aligning regulations and standards may require diplomatic efforts and sustained cooperation.
- **Energy Security Risks and Vulnerabilities**: Despite collaboration, the BRICS countries may still face energy security risks and vulnerabilities due to their reliance on global energy markets. External factors such as international price fluctuations, supply disruptions, or geopolitical events could impact the energy security of individual member countries.
- **Capacity Building and Expertise Sharing**: Collaborating on complex energy projects and technologies may require enhanced capacity building and expertise sharing among the BRICS nations. Ensuring that all countries benefit from shared knowledge and technology may require additional efforts in training and skills development.
- **Environmental Considerations**: While promoting energy security, BRICS countries must also address environmental concerns. Balancing the need for energy development with sustainable and eco-friendly practices will be an ongoing challenge, particularly in countries heavily reliant on fossil fuels.

Despite these challenges, the BRICS countries can overcome them through continued dialogue, mutual understanding, and a shared commitment to energy security and sustainability. Addressing these challenges will require a willingness to compromise, openness to innovation, and a focus on the long-term benefits of collaboration for economic growth, energy security, and environmental protection.

CONCLUSION

The BRICS nations encompass a range of collaborative opportunities, spanning from diversification of energy sources to policy coordination, where each country can contribute and benefit. Highlighting their respective strengths, the BRICS countries synergistically strive for enhanced energy security. Brazil stands as a frontrunner in renewable energy, boasting significant expertise in the production and research of biofuels. Russia is one of the world leaders in terms of hydrocarbon reserves, production and export of energy resources, has a powerful, self-sufficient production potential of a diversified fuel and energy complex and a developed energy infrastructure. India spearheads technological advancements in renewable energy, with a strong focus on solar and wind energy installations. China, the world's largest consumer of renewable energy, occupies a central position in the clean energy market. Its significant investments in clean energy research, production, and manufacturing drive innovation and technology development. South Africa, with substantial reserves of coal, specializes in managing energy production from this fossil fuel. Despite its focus on coal, South Africa has also demonstrated a commitment to renewable energy adoption.

FINAL THOUGHTS AND FORWARD-LOOKING STATEMENTS

The path to energy security and sustainability for the BRICS countries may be fraught with challenges, but there is ample reason for hope. With steadfast dedication to continued dialogue and mutual understanding, these nations can forge a formidable alliance to surmount obstacles. Embracing a shared commitment, they can rise above differences and find common ground to address energy security concerns. It will necessitate a willingness to compromise and an openness to innovation, paving the way for novel solutions to intricate problems. As they press forward, focused on the long-term benefits, the BRICS can unlock boundless potential for economic growth, bolstering their resilience in the face of energy challenges while nurturing a greener and more environmentally conscious tomorrow. Together, they can embark on a journey of sustainable progress, leaving a positive impact on global energy security and environmental preservation.

Disclaimer

This report is prepared by the BRICS Energy Research Cooperation Platform. It contains information and analysis related to energy security in BRICS countries. The Energy Security Report is intended to provide information, findings, and insights based on the data and research available up to the time of its preparation. BRICS countries or any of its representatives, employees or experts shall not be liable for any direct, indirect, incidental, consequential, or any other damages arising from the use of this report, or any information contained within it. This includes but is not limited to financial losses, business interruptions, data loss, or any other related issues. Where applicable, external sources and references are cited in this report. The BRICS Energy Research Cooperation Platform efforts to ensure the accuracy and credibility of the sources used. However, we do not have control over the content or availability of external sources, and we cannot guarantee their ongoing accuracy.

Report Citation:
BRICS Energy Research Cooperation Platform.
2023 BRICS Energy Security Report, Johannesburg, August 2023.

BRICS
ENERGY RESEARCH COOPERATION PLATFORM

BRICS 2023
SOUTH AFRICA

BRICS
ENERGY RESEARCH COOPERATION PLATFORM