BRICS ENERGY REPORT 2021

BRICS INDIA 2021

BRICS
ENERGY RESEARCH COOPERATION PLATFORM

BRICS Energy Report

2021

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Study By

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Commissioned on behalf of

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4th Floor, Sewa Bhawan, R.K.Puram
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FOREWORD

The BRICS Energy Report is the study prepared by experts of the BRICS Energy Research Cooperation Platform. This work presents the past trends as well as current state of energy consumption and production of the five member states. It also presents the recent developments in the energy sector of the BRICS countries and the impact of COVID19 pandemic. The steps taken to manage the impact of the pandemic are also a part of this report.

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 three sections. The first section is dedicated to the introduction to the energy sector of the five BRICS countries. The second section provides a general overview of the energy sector of the member countries, demand and supply assessment of the key energy sources, commitment towards NDCs and the recent initiatives in the sector. The third section shows a comparative analysis of the BRICS energy sector along with the impact and consequences of COVID-19 on BRICS countries' energy sector.

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

ACKNOWLEDGEMENT

The BRICS Energy Report – 2021 is the outcome of the collaborative efforts of the committee of the BRICS Senior Energy Officials. BRICS ERCP acknowledged the support provided by the officials from the Ministry of Mines and Energy of the Federative Republic of Brazil; Ministry of Energy of the Russian Federation; Bureau of Energy Efficiency, Ministry of Power of the Government of India; National Energy Administration of the People's Republic of China; and Ministry of Mineral Resources and Energy of the Republic of South Africa.

The Indian Chairship extends its profound thanks to following ERCP experts: Paulo Cesar Magalhães Domingues from Ministry of Mines and Energy of Brazil; Konstantin Grebennik, Anna Gerasimova, Alexey Davidenko from Ministry of Energy of Russian Federation; Abhay Bhakre, Arijit Sengupta, Siddarth Dhar, Sumit Mudgal from Bureau of Energy Efficiency, Ministry of Power Government of India; and all energy officials from National Energy Administration of China and Department of Mineral Resources and Energy of South Africa.

BRICS ERCP would like to express gratitude to India Chairship for leading the preparation of the Report and its publication. Overall guidance was provided by the Director General, Bureau of Energy Efficiency, Ministry of Power of Government of India.

Special thanks to Souvik Bhattacharjya, Balaji Raparthi, Yatharth Sharma and Mani Juneja from The Energy and Resources Institute for coordinating, overseeing the production and publication of the Report.

Bento Albuquerque

Minister of Mines and Energy of the Federative Republic of Brazil

I would like to congratulate the Government of India for the leadership and coordination of BRICS in 2021.

Brazil welcomes the adoption of the updated BRICS Energy Report, which is a valuable tool to understand the landscape in which we operate, especially as we overcome the impacts of the COVID-19 pandemic.

We look forward to continuing engagement in order to advance the vast potential of cooperation within the BRICS.

N. Shulginov

Minister of Energy of the Russian Federation

The Russian Federation supports international efforts aimed at providing general access to cheap, reliable, sustainable and modern sources of energy, development of technologies, promotion of rational environmental management. In the last few years, BRICS countries have managed to achieve substantial progress in stated directions. The "BRICS Energy Report 2021", prepared by the experts of the BRICS Energy Research Cooperation Platform, clearly demonstrates the new vectors of energy policy of the BRICS countries.

Taking into account the size of the BRICS economies and, above all, the scale of the energy sectors, we believe that our energy cooperation can become one of the additional factors in ensuring global sustainable development.

I welcome the publication of the "BRICS Energy Report 2021" and convinced that joint energy studies of BRICS countries are an important tool for energy dialogue. They allow us to express a common point of view on the issues of the development of energy complexes and global energy markets, as well as to define directions for the implementation of future joint projects.

I commend the Indian Chairmanship for preparing a broad energy agenda covering all key areas of modern energy and holding the corresponding BRICS events in 2021 at the highest level.

Raj Kumar Singh

Minister of Power, Government of India

BRICS platform has been quite effective in strengthening collaboration and safeguarding common interests of the five major economies. BRICS cooperation on Energy is an important agenda of the member countries.

Energy is the key driver for the economic development of the Nation. The energy sector is witnessing major transitional effects due to the commitments to reduce greenhouse gas emissions under the Paris Agreement. Therefore, restructuring the power sector, phasing out of old and inefficient coal-based power production and large-scale uptake of renewable energy is essential to achieve such goals.

India intends to introduce this year's BRICS Energy Report that provides an update to the energy sectors of the BRICS member countries. The report also highlights the impact of COVID19 pandemic and the steps taken by each member country to minimize the adverse impact. I am confident that this report will strengthen the BRICS Energy Research Cooperation Platform (ERCP) and enhance BRICS contribution in ensuring energy security.

ZHANG Jianhua

Administrator of the National Energy Administration of China

This year marks the 15th anniversary of the establishment of BRICS. In the 15 years, we have witnessed the continued improvement of our cooperation mechanism, expansion of collaboration areas, and enhanced global influence, which shows unique charm in maintaining and practicing multilateralism. Facing a pandemic and major changes both unseen in a century, BRICS countries maintained the momentum of cooperation while boosting domestic economic recovery, lending important impetus to the efforts by the five countries and beyond to combat the coronavirus and rebuild the economy.

To accelerate the implementation of the 2030 Agenda, economic recovery through green and low-carbon development represents a compelling consensus shared by the international community. More than 100 countries around the world have pledged to reach carbon neutrality, who are actively promoting energy transition. As Chinese President Xi Jinping pointed out in his remarks at the 12th BRICS Summit, all of us are indeed passengers in the same boat. When the wind is strong and the tides are high, we must be even more focused on our direction. We must keep pace and work as a team to break the waves and navigate steadily toward a brighter future. BRICS countries have respective strengths in energy resource endowments and technical innovation. Facing the common opportunities and challenges of development and transition, BRICS countries hold broad cooperation perspectives in enhancing energy security and low-carbon energy transition. In this context, we BRICS countries should secure new prospects amidst changes. We should work together to enhance all-round cooperation in energy field, explore the future course for green recovery and energy transition, and contribute BRICS' share to tackling common challenges brought by climate change.

This year, at the Indian Presidency's active initiative, BRICS countries overcame difficulties and jointly completed BRICS Energy Report 2021 and BRICS Energy Technology Report 2021 as the ERCP outcomes for this year. The reports update the latest development in energy fields and the progress combating Covid-19, which are of great importance. China is willing to stand with all other countries, actively practice green development philosophy, and contribute to promoting intra-BRICS practical cooperation in energy.

Samson Gwede Mantashe

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

Energy plays a key role in the development of every country and for the African continent access to modern energy service is linked to the achievement of the Sustainable Development Goals (SDGs). Sub-Saharan Africa is rich in energy resources, yet only 290 million of the 950 million people have access to electricity.

Electricity consumption per capita in the region is less than that needed to power a 50 watts light bulb continually. Efforts to promote electrification are gaining momentum but are outpaced by population growth. This severe shortage of essential electricity infrastructure is undermining efforts to achieve more rapid social and economic development.

South Africa joins its BRICS member countries in a continued effort to call for universal access to safe, affordable and reliable, and modern sources of energy within the global energy governance system.

Universal access to energy features highly on the energy sectoral cooperation of BRICS and South Africa commends the Indian Presidency for having elevated this even higher. The BRICS Energy Report 2021 highlight our common and shared goal of (i) expanding access to ensure energy security of the population to improve living standards and ensuring social stability; as well as (ii) creating cleaner, low-carbon energy systems to reduce the negative impact on the climate and environment, among others.

This is to be achieved through a jointly agreed programme of action among BRICS member states, which include the following; namely; (i) Smart energy infrastructure development;(ii) Development of renewable and low-carbon energy (based on natural gas, renewable energy; and sources, including nuclear energy and hydrogen sources); and (iii) improving the efficiency of development, processing, and supply of fossil energy resources.

For South Africa and the African continent the aforementioned direction of BRICS member countries of energy cooperation as stipulated in the BRICS Energy Report 2021 resonates with similar targets set in our country's National Development Plan 2030, as well as the African Union Agenda 2063.

1. INTRODUCTION

BRICS countries have an imperative role to play in the global energy agenda in line with their share in the world's energy production and consumption. Hence, numerous mechanisms have been established in BRICS to further deepen cooperation in the field of energy. Since the first BRIC Summit in Yekaterinburg, Russia in 2009, BRICS countries have expressed the need for co-operation in the field of energy and energy efficiency. In the Delhi Declaration 2012, the leaders mentioned the need for multilateral energy co-operation within BRICS framework.

In 2015, in accordance with the strategy for BRICS Economic Partnership adopted at the BRICS Ufa Summit, the first BRICS Energy Ministerial was held, marking the institutionalization of energy co-operation within BRICS. In order to pursue energy co-operation through joint research and technology projects, tech transfer, conferences, lectures and seminars and exchange of best experience and practices, a Memorandum of Understanding in Energy Saving and Energy Efficiency was signed, which resulted in the creation of the Working Group on Energy Savings and Energy Efficiency, in 2015. The working group met for the first time under India's Chairship at Vizag in 2016, issuing a joint statement on charting an Action Plan for the Working Group on Energy Savings and Energy Efficiency.

In the Xiamen Declaration of 2017, BRICS leaders encouraged continued dialogue on the establishment of a BRICS Energy Research Co-operation Platform (BRICS ERCP). This led to the establishment of BRICS ERCP Platform, which was agreed upon and acknowledged in the Johannesburg Summit Declaration in 2018. Meetings of BRICS ERCP commenced in 2019 under a committee of senior officials under the Brazilian Chairship, during which the terms of reference of BRICS ERCP were adopted.

BRICS Energy Cooperation is not just about challenging the prevalent system but reforming it as well with the objective of achieving sustainability in energy consumption. Energy consumption is linked with the climate change issues and, in this regard, BRICS has emerged as a thought leader in providing potential and pragmatic solutions. With a quarter of world's GDP and about one-third of the world energy consumption, policies adopted by BRICS countries will have a substantial impact on influencing climate change policies in the international arena.

BRICS ERCP is now a global platform for promoting energy based sustainable development, sharing of advanced energy technologies, expansion of cooperation on educational programs, as well as exchange of statistical data and plans on the development of national energy systems and information on best practices and regulatory frameworks in the energy sector. The platform also aims at creating synergies in BRICS energy co-operation across various platforms—Academic Forum, BRICS Science, Technology and Innovative Initiative, Program of Economic Co-operation and New Development Bank.

2. OVERVIEW OF ENERGY SECTOR DEVELOPMENT AND RELATED SUSTAINABILITY COMMITMENTS

2.1 Brazil

2.1.1 General overview of energy sector

i. Energy Consumption

In 2020, Brazil's Total Energy Supply represented more than four times the value of 1970, showing growth of 3.0% per annum in the period (2% in the world). This is due to strong industrial growth mainly in the first two decades, accompanied by the expansion of household consumption throughout the period. In the last two decades there has been a greater expansion of electricity consumption and demand for transport fuels.

The difference between the Total Energy Supply and the Total Final Consumption (including the energy sector's own consumption), resulted from losses in the energy transformation and distribution processes. Brazil, highly reliant on electricity supply from hydropower plants, has low generation by thermoelectric plants and, as a result, has a level of losses much lower than the world average. Worldwide, the percentage of total losses in relation to supply is more than twice the Brazilian indicator.

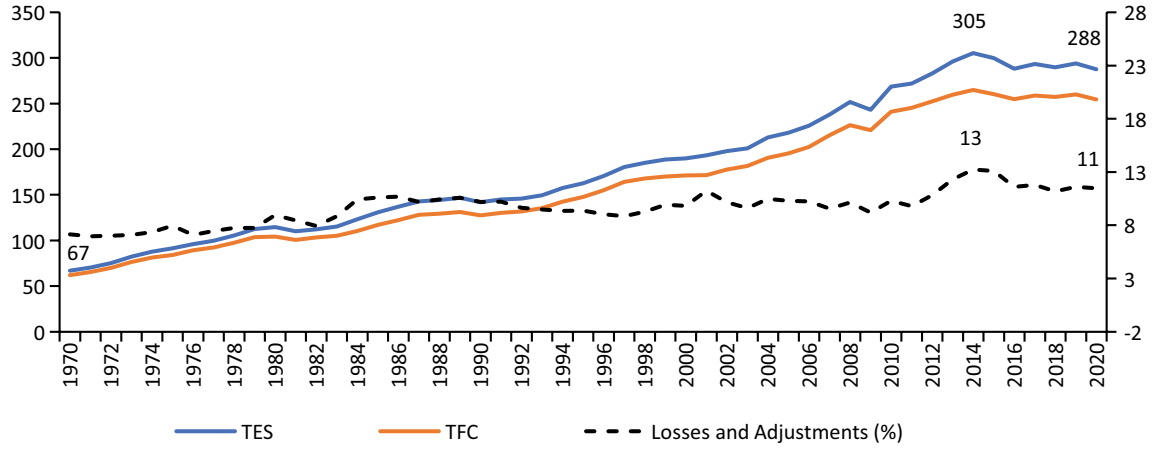

Figure 1: Total Energy Supply (TES) and Total Final Consumption (TFC) in Brazil

Source: SIE Brazil

Energy consumption in the industrial sector (including consumption in the energy sector) has a greater share in almost the entire period. In the last 15 years, industrial consumption has lost its share, mainly for transport sector. The residential sector, although with high growth in the electricity consumption and cooking gas, lost its share due to the firewood replacement in cooking food, which is 5 to 10 times less efficient in use than gas. In 1970, the residential sector had the largest share of Total Final Consumption, mostly related to firewood.

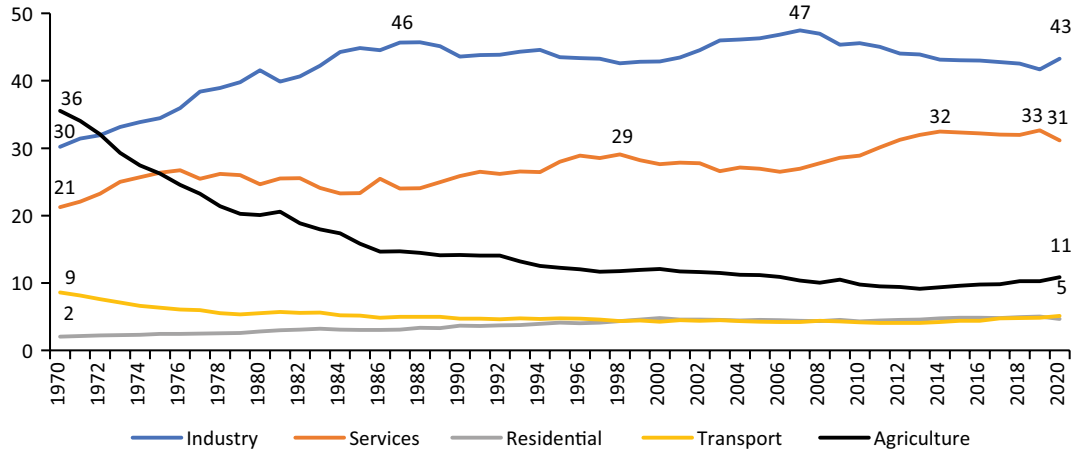

Figure 2: Total Total Final Consumption by sector in Brazil

Source: SIE Brazil

The per capita domestic energy supply in Brazil was 1.35 toe in 2020, almost doubling the 1970 indicator, and lower than the 2014 indicator, the record. In 2020, the Brazilian indicator represented 75% of the world indicator, of 1.8 toe/inhabitant. Figure 3 shows the evolution of the Brazilian indicator, from 1970 to 2020.

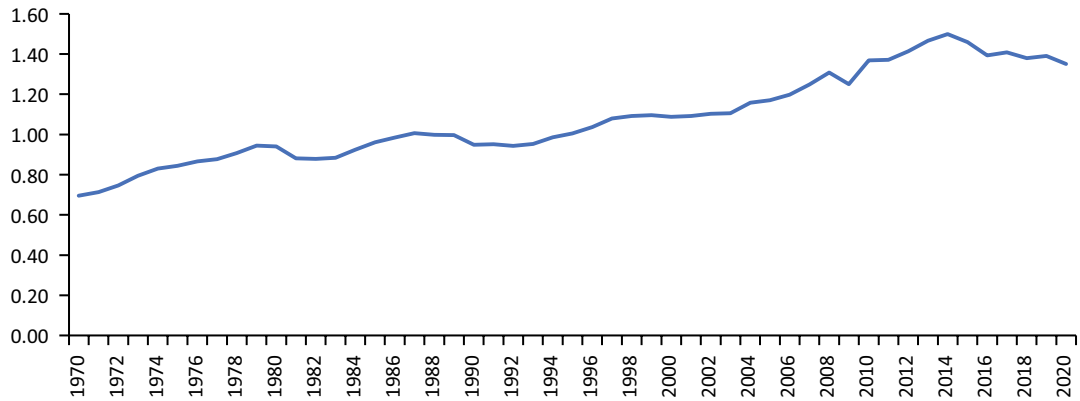

Figure 3: Total Energy Supply Per Person in Brazil

Source: SIE Brazil

The Domestic Electricity Supply grew 5.4% per annum between 1970 and 2020, whereas in the 1970s it grew at 11.8% per annum. In 2020, the supply was 646 TWh, almost 1% lower than the value in 2019, due to the effects of the COVID-19 pandemic. Due to quarantine measures adopted in several regions of the country, economic activities suffered a significant reduction and, therefore, a general slowdown, however for 2021, an increase between 4 and 5% is expected in the indicator.

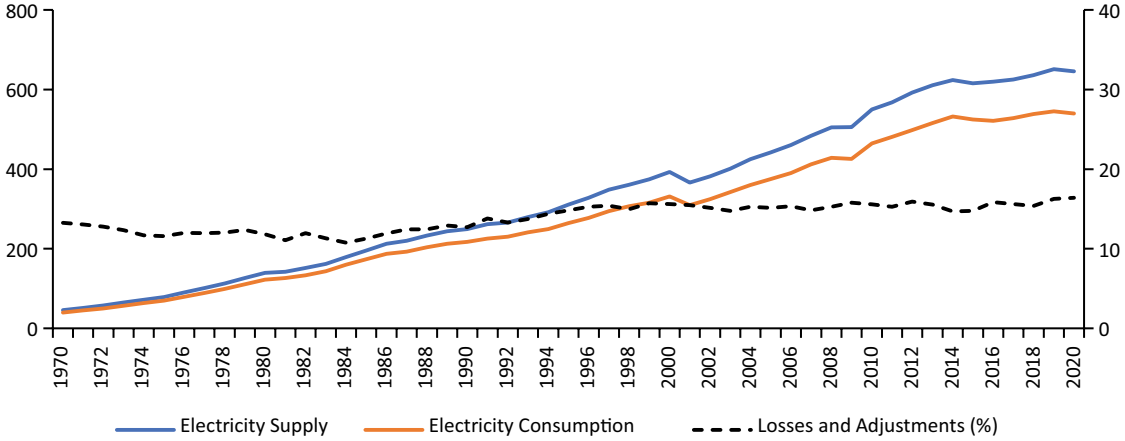

Figure 4: Electricity Supply and Consumption in Brazil

Source: SIE Brazil

In 2020, the percentage of electricity losses in distribution and transmission was 16% of the energy supply, almost twice the worldwide indicator. This is due to: a) the Brazilian territorial dimensions, with great transmission of hydraulic and wind generation between regions and; b) unbilled consumption, resulting from improper connections.

The per capita electricity supply in Brazil grew at 3.8% per annum between 1970 and 2020, an indicator much higher than the country's total energy supply, of 1.3% per annum. Worldwide, the per capita electricity supply grew at 1.7% per annum between 1970 and 2020. In 2020, the indicator in Brazil was 3,034 kWh/inhabitant, 11% lower than the world's 3,420 kWh/inhabitant.

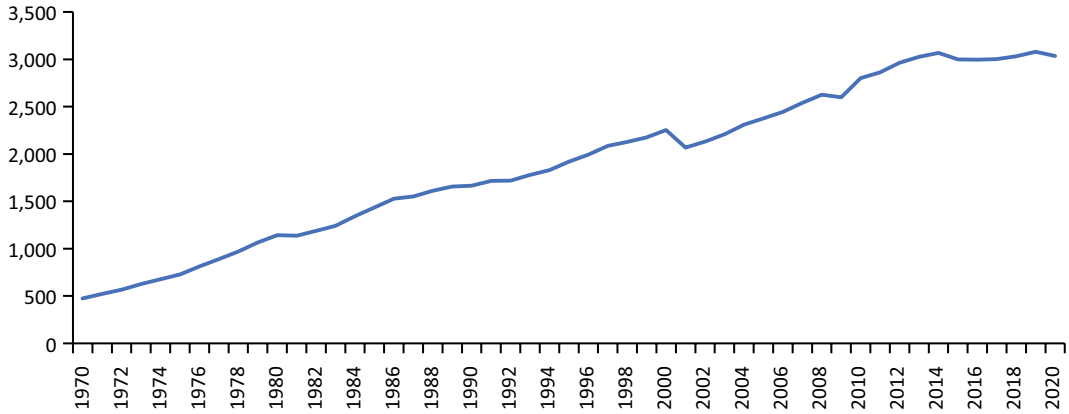

Figure 5: Electricity Supply Per Person in Brazil

Source: SIE Brazil

The industrial sector consumption (including the energy sector) has always been responsible for the largest share in the electricity final consumption, with an increasing trajectory until 1986 and decreasing thereafter. Residential, Services and Agricultural sectors occupied a greater proportion from 1986 onwards.

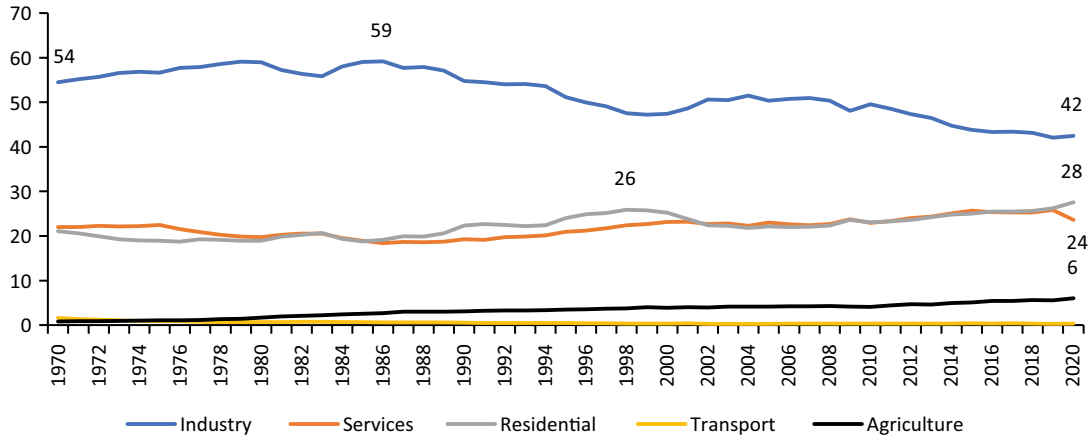

Figure 6: Electricity Final Consumption by sector in Brazil

Source: SIE Brazil

ii. Energy Mix

Brazil migrated from an economy based on oil and wood in the early 1970s (more than 90% of total energy) to a more balanced economy in terms of energy. Now, oil and wood account for about 40% of total energy demand, with natural gas, the noblest biofuels, nuclear, wind and solar making up the difference. This change is mainly due to the migration of the rural population to urban cities and government policies to promote modern renewable energy sources.

The Brazilian energy sector is one of the least carbon intensives in the world, as renewable energies represent almost half of the total energy supply (48.4% in 2020). While Brazil emits 1.4 t CO2/toe, the world emits 2.3 t CO2/toe. Contributing to Brazil's low indicator are: a) renewables share above 80% in the electricity supply, b) solid bioenergy share above 40% in industrial energy consumption, and net bioenergy share above 20% in transport consumption. In 2020, bioenergy had the highest proportion of domestic supply (33.7%), already surpassing the oil indicator.

Table 1: Total Energy Supply By Source in Brazil (toe and %).

	million toe			% share		
Sources	**2000**	**2010**	**2020**	**2000**	**2010**	**2020**
Oil	86,7	101,7	95,2	45,6	37,9	33,1
Coal	13,0	14,5	14,0	6,8	5,4	4,9
Gas	10,3	27,5	33,8	5,4	10,2	11,8
Other Fossils	1,0	1,1	1,7	0,5	0,4	0,6
Nuclear	1,8	3,9	3,7	1,0	1,4	1,3
Hydro	30,0	37,7	36,2	15,8	14,0	12,6
Bioenergy	47,3	82,2	97,1	24,9	30,6	33,7
Wind	0,0	0,2	4,9	0,0	0,1	1,7
Solar	0,0	0,0	0,9	0,0	0,0	0,3
Other Renewables	0,0	0,0	0,0	0,0	0,0	0,0
Total	**190,0**	**268,7**	**287,6**	**100,0**	**100,0**	**100,0**
of which, Renewables	*40,7*	*44,7*	*48,4*	*40,7*	*44,7*	*48,4*
of which, Fossils	*58,4*	*53,9*	*50,3*	*58,4*	*53,9*	*50,3*

Source: SIE Brazil

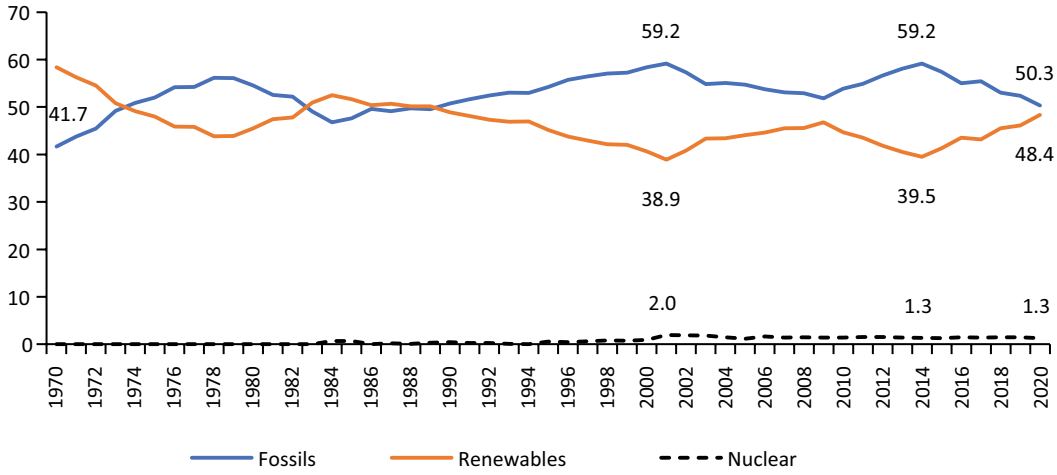

Figure 7: Share of total energy supply by source in Brazil (%)

Source: SIE Brazil

In the Brazilian Electricity Supply, the hydraulic participation in the total generation has always been preponderant, close to 90%, between 1970 and 2000, and being close to 66% in recent years. The record participation occurred in 1994, with 94.1% of the supply (including imports from the Paraguayan Itaipu share). Environmental constraints have limited further expansion of hydroelectric plants, especially large ones. In addition, a long dry period that started in 2011 reduced the capacity factor of hydraulic generation by more than 30%.

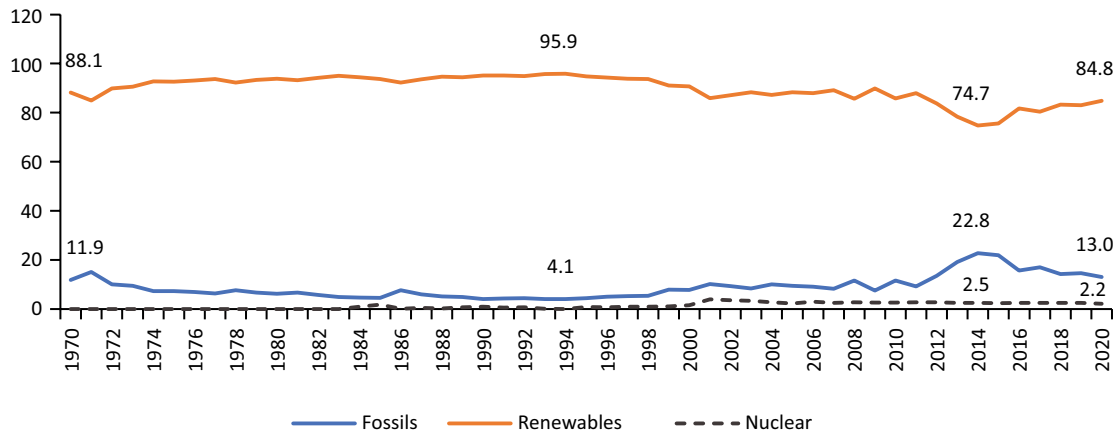

Figure 8: Share of Electricity Production by Source in Brazil

Source: SIE Brazil

Other energy sources such as bioenergy, wind and solar are replacing the hydraulic generation share declining, so that renewable sources continue to maintain a prominent proportion in the electricity supply.

Table 2: Electricity Supply by Source in Brazil (TWh and %).

	TWh			% share		
Sources	**2000**	**2010**	**2020**	**2000**	**2010**	**2020**
Oil	13,6	13,8	7,7	3,5	2,5	1,2
Coal	7,7	7,0	11,9	1,9	1,3	1,8
Gas	4,1	36,5	53,5	1,0	6,6	8,3
Other Fossils	5,3	6,6	11,1	1,3	1,2	1,7
Nuclear	6,0	14,5	14,1	1,5	2,6	2,2
Hydro	348,7	437,9	421,0	88,7	79,6	65,2
Bioenergy	7,9	31,9	58,7	2,0	5,8	9,1
Wind	0,0	2,2	57,1	0,0	0,4	8,8
Solar	0,0	0,0	10,7	0,0	0,0	1,7
Other Renewables	0,0	0,0	0,0	0,0	0,0	0,0
Total	**393,3**	**550,4**	**645,9**	**100,0**	**100,0**	**100,0**
of which, Renewables	356,6	472,1	547,6	90,7	85,8	84,8
of which, Fossils	30,6	63,9	84,3	7,8	11,6	13,0

Source: SIE Brazil

iii. Import & Export

Brazil produces around 3 million oil barrels per day and is the ninth largest oil producer in the world. It is estimated that this oil production could reach 5.3 million barrels per day by 2030, and that net exports of 1.2 million barrels per day in 2020 could rise to 3.3 million in 2030, raising the importance of Brazil in the international oil trade.

Table 3: Oil Foreign Trade in Brazil (million m³)

	Imports	Exports	Net Trade (a)	% of TFC
2010	19,7	-36,6	-17,0	-16,4
2011	19,3	-35,1	-15,8	-15,0
2012	20,0	-31,0	-10,9	-9,9
2013	22,9	-23,0	-0,2	-0,1
2014	20,3	-30,1	-9,8	-8,1
2015	17,3	-42,8	-25,5	-22,2
2016	9,0	-49,2	-40,2	-38,1
2017	8,4	-60,5	-52,1	-51,7
2018	10,8	-62,5	-51,7	-52,5
2019	10,0	-71,3	-61,3	-62,1
2020	9,7	-79,6	-69,8	-68,2

(a) If negative: net exports and vice versa.

Note: Derivatives not included.

Source: SIE Brazil.

Net oil exports have grown substantially over the last decade (more than 300%), as a result of increased production and stability in the refinery load. The high expansion of biodiesel and ethanol use in transport, the substitution of fuel oil for natural gas and the reduced economic growth have contributed to the stagnation of petroleum products consumption.

Table 4: Gas Foreign Trade in Brazil (billion m³)

	Imports	Exports	Net Trade (a)	% of TFC
2010	12,6	0,0	12,6	44,0
2011	10,5	0,0	10,5	36,5
2012	13,2	0,0	13,2	38,8
2013	17,0	0,0	17,0	42,5
2014	19,3	0,0	19,3	44,1
2015	18,4	0,0	18,4	42,6
2016	11,7	0,0	11,7	31,6
2017	10,7	0,0	10,7	27,3
2018	10,6	0,0	10,6	28,4
2019	9,8	0,0	9,8	26,4
2020	9,6	0,0	9,6	27,5

(a) If negative: net exports and vice versa.

Note: Derivatives not included.

Source: SIE Brazil.

Brazil has experienced a sharp decline in natural gas imports over the past decade. Gross imports decreased by 24% between 2010 and 2020. Dependence on imports in relation to total natural gas consumption decreased from 44% in 2010 to 27.5% in 2020. This is due to the strong increase in domestic natural gas production (more than 7% per annum) and, to the low growth of the total demand (2% per annum) due to the economic instability in Brazil.

Table 5: Coal Foreign Trade in Brazil (million tonnes)

	Imports	Exports	Net Trade (a)	% of TFC
2010	15,9	0,0	15,9	75,6
2011	17,9	0,0	17,9	80,0
2012	16,5	0,0	16,5	70,8
2013	18,0	0,0	18,0	71,1
2014	20,4	0,0	20,4	75,0
2015	20,3	0,0	20,3	76,1
2016	19,5	0,0	19,5	77,1
2017	21,2	0,0	21,2	83,3
2018	21,0	0,0	21,0	85,4
2019	18,9	0,0	18,9	79,2
2020	16,1	0,0	16,1	74,6

(a) If negative: net exports and vice versa.

Note: Derivatives not included.

Source: SIE Brazil.

Brazil exports a large part of its steel production, whose industrial process requires the use of metallurgical and steam coal, almost all imported. Some thermal power plants in Brazil's northeast region also uses imported coal. Brazilian coal production is destined for most of the thermal power plants in the southern region. Thus, net coal imports represent between 70 and 85% of the total demand for this product, depending on the world and national economies. The United States of America, Australia and Colombia are the main coal suppliers to Brazil.

2.1.2. Assessing demand and supply of key energy sources

Brazil uses and imports metallurgical coal, intended for: coke production in coke ovens; steam coal, intended for power generation and industrial processes; and metallurgical coal coke, intended mainly for blast furnaces in the steel industry.

The metallurgical coal use occurs exclusively in coke plants for the coke production and there is no domestic production.

Depending on the demand for steam coal to be injected into the steel industry's blast furnaces, imports vary between 50% and 60% of the total steam coal demand. In coke, the imports dependence is lower, between 10% and 20% of the total demand.

Coal as a whole has limited use in Brazil, having its a share in the total energy demand five times smaller than in the world.

Table 6: Coal Production, Import, and Export in 2020 in Brazil

Flow	kt			% Over Total Consumption		
	Metalurgic Coal	Heat Coal	Coal Coke (d)	Metalurgic Coal	Heat Coal	Coal Coke (d)
Production (+)	0	5.481	8.512	0	44	85
Importation (+)	9.209	6.857	1.358	99	55	14
Exportation (-)	0	0	0	0	0	0
Stock Changes and Others (a) (+/-)	65	172	100	1	1	1
Total Consumption (-)	**9.274**	**12.510**	**9.970**	**100**	**100**	**100**
Transformation	9.274	6.620	0	100	53	0
Electricity Generation	0	6.620	0	0	53	0
Coking Plants	9.274	0	0	100	0	0
Final Consumption	0	5.891	9.970	0	47	100
Industry (b)	0	5.891	9.970	0	47	100
Transport	0	0	0	0	0	0
Services	0	0	0	0	0	0
Others (c)	0	0	0	0	0	0

Notes: (a) stock changes, losses and adjustments included; (b) Energy Industry Own Use included; (c) residential, agriculture and non-energetic uses included; (d) all coke has final use in siderurgy.

Source: SIE Brazil.

Brazil has net exports in fuel oil and aviation kerosene. In other petroleum products an external dependence is verified. The sum of all derivatives, in toe, shows for 2020 a net external dependence of 4% in relation to total demand, lower than the average of 10% in recent years, due to COVID-19, which affected consumption mainly in oil products use in transport.

In Brazil, 1/3 of the total energy demand comes from oil derivatives, an indicator similar to that of the OECD countries, and higher than that of the non-OECD countries, which is 1/4.

Table 7: Crude Oil and Derivatives Production, Import and Export in 2020 in Brazil

Flow	% Over Total Demand							
	Oil (a)	Diesel Oil (b)	Fuel Oil	Pure Gasoline (c)	Naphtha	Kerosene (d)	Liquefied Petroleum Gases	Petroleum coke
Production (+)	167	79	576	90	63	144	72	72
Importation (+)	10	22	1	19	39	14	27	39
Exportation (-)	78	2	477	9	1	60	0	11
Stock Changes and Others (e) (+/-)	1	0	0	0	-2	1	1	-1
Total Consumption (-)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Tansformation	100	4	17	0	0	0	0	18
Electricity Generation	0	3	17	0	0	0	0	0
Other (f)	100	1	0	0	39	0	0	18
Final Consumption	0	96	83	100	61	100	100	82
Industry (g)	0	4	55	0	0	0	12	82
Transport	0	78	27	100	0	100	0	0
Services	0	0	1	0	0	0	7	0
Others (h)	0	14	0	0	61	0	81	0

Notes: (a) crude and shale oil included; (b) biodiesel not included (c) ethanol not included. Production includes refineries, gas plants and petrochemical; (d) illuminating and aviation; (e) stock changes, losses and adjustments included; (f) refinery, recycling and transfers included; (g) energy industry own use included; (h) residential, agriculture and non-energetic uses included.

Source: SIE Brazil

Natural gas in Brazil is used in two ways: Humid Gas and Dry Gas. All gas produced from natural resources is classified as wet, while dry gas comes from gas plants (UPGNs) and from foreign trade. So, for wet gas, the entire gross production is accounted for identifying the non-utilized and reinjected fractions, for energy uses in oil and gas production and exploration and the volume processed in the UPGNs. The UPGNs products are dry gas and petroleum derivatives, also called natural gas liquids.

In 2020, for every 100 units of total wet gas consumption, 176 units were produced, 76 of which were destined almost exclusively for reinjection and non-utilized. For every 100 units of total consumption, 80 were destined for UPGNs, 9 for electricity generation on production platforms and 11 for other uses on platforms.

In 2020, Brazilian net imports accounted for 4% of electricity supply, the lowest indicator since the country began importing the Paraguayan part of the Itaipu hydropower plant. In 1997, the indicator was the triple, the highest in the time series.

Services and residential sectors consumption accounted for 43% of the total electricity supply in 2020, an indicator 40% above the non-OECD block and 20% below the OECD block. In fact, the development of nations with the urbanization process leads to greater use of electricity in these sectors.

Table 9: Gas production, import and export in 2020 in Brazil

Flow	TWh	% over Consum-ption
Production (+)	621.198	96
Importation (+)	25.113	4
Exportation (-)	395	0
Domestic Supply	**645.915**	**100**
Final Consumption	540.042	84
Industry (a)	229.163	35
Transport	2.014	0
Services	127.586	20
Residential	148.844	23
Agroculture	32.436	5
Losses	105.873	16

Notes: (a) Energy industry own use included; (b) Transmission and distribution losses.
Source: SIE Brazil.

2.1.3 Commitment towards NDC & selected SDGs

Brazil commits to reduce its greenhouse gas emissions in 2025 by 37%, in relation to 2005 and commits to reduce its emissions in 2030 by 43%, in relation to 2005. The Brazilian government committed itself in the Summit of Leaders on the Climate to an objective of achieving climate neutrality (net-zero emissions) in 2050, bringing forward by ten years the indication signaled in the revision of the Nationally Determined Contribution presented in 2020. Brazil's NDC is considered to be one of the most ambitious in the world because of the following elements:

1. The target refers to absolute emissions rather than relative factors, such as carbon emission intensity and historical growth trends.
2. It addresses the economy as a whole and not only specific sectors.
3. The magnitude of its targets (37% and 43%), which are above those of many developed countries.
4. It includes an intermediate target for 2025, forcing a low-emission path throughout the decade and not only in 2030.

2.1.4 Recent initiatives and emerging challenges in energy transition

Many countries, including Brazil, have joined to promise carbon neutrality by 2050 at the leaders' climate summit, taken in April 2021. For this, the energy transition must continue gaining space in the international agenda. This is a very important subject, involving not only energy, but geopolitics, economy, environment, climate, multilateralism, among other issues.

In order to build the energy of the future, Brazil has been acting on two main fronts.

First, creating the conditions to accelerate investments in clean energy based on mature and competitive technologies. This is done by improving the design of the markets, promoting reforms, strengthening the legal and regulatory environment and operating with predictability. The reforms to the agenda for the modernization of the electricity sector in Brazil have prepared it to expand the renewable energies supply in a safe and competitive way. There is also the "More Light for the Amazon" program, allowing access to clean energy for isolated communities in the amazon region. In the field of fuels, the national policy on biofuels, Renovabio, with its decarbonization objectives and a market of certificates that promotes the competitive and sustainable use of biofuels in the transport sector, enabling biofuels to represent 25% of total fuels in this sector by 2020. Also, the new law for natural gas in Brazil has been approved in 2021, modernizing the legal framework of the sector, stimulating competition and growth in the use of natural gas, which has been adopted by many countries as one of the main sources of transition to a low carbon economy.

The second main front of the government's action has been reinforcing the foundations of new technologies and business models that will be necessary to maintain the speed of decarbonization in the next decades. This means guiding investments and providing resources for Research, Development & Innovation and for the training of qualified professionals, both from the private and public sector. The National Council for Energy Policy – CNPE has been acting in this direction. In 2021 the council has prioritized application resource R&D technologies that enable the energy transition, such as storage, hydrogen, advanced biofuels, nuclear, technologies for generating sustainable thermal energy and minerals strategy for the energy sector, by mention some. The Brazilian hydrogen program and the future fuel program were also determined, with a focus on sustainable fuels.

Thus, Brazil, which just has an energy matrix among the world's most renewable, absolutely outstanding among the main economies, with 48% renewables in 2020, maintains its commitment to the energy supply expansion and social sustainability.

These initiatives and many others are included in a wide spectrum of energy policies, consistent and aware of the priorities of the Brazilian population and our international commitments to reduce carbon emissions.

2.2 Russia

2.2.1. General overview of energy sector

Oil Industry

In 2020, the volume of oil and gas condensate production amounted to 513 million tons.

The dynamics of oil production in 2020 was influenced by the commitments of the Russian Federation made in accordance with the OPEC+ agreement and provided for a reduction in the volume of industrial production.

31 oil fields, containing liquid hydrocarbon reserves, were commissioned in 2020. The implementation of existing mining projects continued, including in the Arctic zone on the continental shelf of the Russian Federation.

Gas industry

Russia has retained the 1st place in gas exports, which corresponds to the goal-setting of the Energy Strategy to be in the top three world leaders and indicates a flexible response to the dynamics of the global gas market.

In 2020, the volume of natural and associated petroleum gas production amounted to 692.9 billion cubic meters. The volume of production of liquefied natural gas (LNG) amounted to 41.6 billion cubic meters.

Within the framework of solving the strategic task of expanding the use of NGV fuel in the Russian economy the volume of consumption of natural gas as a motor fuel amounted to 1.1 billion cubic meters.

Work continues within the framework of the development of gas supply and gasification systems in the regions of the Russian Federation. The level of gasification in the Russian Federation as of January 1, 2020 was 70.9%, and the level of potential (technical gasification) while maintaining the current structure of regional fuel and energy balances was 82.9%.

In 2020, the total gas consumption in Russia amounted to 463.1 billion cubic meters, which is 3.3% lower than in 2019. Gas consumption volumes decreased primarily due to warm weather conditions in the autumn-winter period of 2019/2020, as well as due to a decrease in production caused by the COVID 19 pandemic and the implementation of regime and quarantine measures.

The share of natural gas in the energy balance of Russia in 2020 was about 54%, thus having not changed significantly in recent years. The main consumers of natural gas in Russia are electricity and heat producers (33%), the population (11%), the oil industry (10%), the municipal and household sector (8%), the agrochemical industry (7%), and metallurgy (6%).

By the end of 2020, 101 gas-engine refueling stations were put into operation, while 70 of them were commissioned at the expense of state support. This allowed to increase the total number of gas filling stations by 20% compared to the level at the beginning of the year. In addition, more than 10 thousand units of equipment were re-equipped at the expense of subsidies. Due to this, the consumption of gas-engine fuel has increased by 10% by the end of 2020.

Russia's work on the external gas market, including in the Asian direction, was no less active. In 2020, supplies were increased through the Power of Siberia gas pipeline, the export of which exceeded 4 billion cubic meters during the reporting year. In December 2020, another section of the gas transportation infrastructure was introduced in China for the distribution of gas entering the country through the Power of Siberia pipeline, which will, in particular, increase the supply of Russian gas to the Beijing area. In addition, in 2020, the reliability of supplies to Europe and Turkey has been significantly increased due to the launch of the Turkish Stream offshore gas pipeline through the Black Sea. Seven countries are already receiving gas with a low carbon footprint with the help of a new high-tech pipeline. This is a real contribution of the Russian Federation to the achievement of European environmental goals.

Coal industry

In 2020, 402.1 million tons of coal were produced in Russia. Russia's share in the global coal market was 16%.

Coal production in January-April 2021 fully recovered after the recession in the crisis period of 2020. The shipment of coal products to the domestic market, thus taking into account import supplies, amounted to 180.1 million tons (excluding own needs).

In 2020, exports in the total volume of coal supplies reached 58.8%, thereby exceeding the planned values of the document by 55.6-57%.

Electric power industry

The volume of electric energy consumption in the Russian Federation in 2020 amounted to 1050.4 billion kWh. The commissioning of new capacities and the modernization of existing facilities continues in the electric power industry. The volume of new generation inputs amounted to 2 GW, of which 1.2 GW is based on renewable energy sources. More than 3 GW of inefficient capacities were decommissioned. Electricity generation by power plants in 2020 amounted to 1063.7 billion kWh.

The installed capacity of power plants in the Russian Federation as of 01.01.2021 was 251 096,5 MW.

In 2020, the installed capacity of power plants of the UES of Russia decreased by 1023,3 MW due to the decommissioning of inefficient and unclaimed generating capacities in the system.

The structure of the installed capacity of the UES of Russia is dominated by thermal generation (66.56%) followed by hydrogenation (20.95%) and nuclear generation (11.97%). Renewable energy sources account for about 3 GW.

Systematic work is being carried out to increase the availability of energy infrastructure. According to the World Bank report, since 2013, Russia's position in the Doing Business rating in terms of "connecting to the power supply system" has changed from 183 to 7 in 2019. The period for connecting consumers to the power grid has been reduced from 281 to 41 days.

Renewable energy sources

In 2020, 1207.4 MW of new renewable energy capacity was put into operation on the wholesale electricity and capacity market. The total capacity of renewable energy facilities operating as of January 1, 2021 in the wholesale and retail markets of electric energy and capacity is 3 GW.

An important direction is to stimulate the implementation of renewable energy construction projects in the retail electricity markets, including in the territory of isolated energy districts. In 2020, a number of projects were implemented in such energy districts.

2.2.2. Commitment towards NDC & selected SDGs

In 2020, in order to implement the Paris Climate Agreement, the Decree of the President of the Russian Federation "On reducing greenhouse gas emissions" was issued.

In accordance with this Decree Russia announced its first Nationally Determined Contribution (NDC). In particular, it is planned to reduce greenhouse gas emissions by 2030 to 70% relative to the level of 1990, thus taking into account the maximum possible absorption capacity of forests and other ecosystems and subject to sustainable and balanced socio-economic development of the Russian Federation. It also outlines national priorities for adaptation to climate change and support for developing countries.

In 2021 was adopted the Federal Law "On Limiting Greenhouse Gas Emissions". The law introduces the necessary terminology base (greenhouse gases, carbon footprint, climate projects, carbon credits, etc.). From January 1, 2023, the largest GHG emitters (with greenhouse gas emissions of more than 150 thousand tonnes of carbon dioxide equivalents per year until 2024 and 50 thousand tonnes of carbon dioxide equivalents per year after 2024) will be required to report their emissions. Carbon reporting data will be accumulated in the register of greenhouse gas emissions and will become the basis for monitoring the implementation of greenhouse gas emission targets.

The law forms the legal basis for the implementation of climate projects (projects aimed at reducing greenhouse gas emissions or increasing their absorption) and the circulation of carbon units (a new category of property rights is introduced, i.e. carbon units). The criteria for climate projects, the procedure for verifying the results of climate projects, and the procedure for maintaining the register of carbon units will be established for this purpose.

The emergence of a new market for the circulation of carbon units will allow Russian organizations to reduce the carbon footprint of their products and services, as well as involve interested organizations in activities to reduce greenhouse gas emissions and increase their absorption, which will generally contribute to the modernization of production facilities, the introduction of new technologies, and improving the quality of natural greenhouse gas sinks, including forests.

In addition, a draft strategy for the long-term development of the Russian Federation until 2050 with a low level of greenhouse gas emissions was prepared. The strategy provides two main scenarios of low-carbon development, i.e. basic, which is taken as a basis, and intensive. The basic scenario provides for a large-scale increase in the energy efficiency of the Russian economy, full provision of a balance of forest reproduction, expansion of the area of their protection, and a significant reduction in continuous logging. The intensive scenario provides for an increase in generation based on renewable energy sources, as well as large-scale electrification and digitalization of transport and technological processes in industries, the rejection of continuous logging, and almost complete coverage of forests with fire protection means.

At the same time, at the end of 2020, the Russian Government approved the "roadmap" for the implementation of an experiment on the establishment of special regulation of greenhouse gas emissions in the Sakhalin Region. On the example of the Sakhalin Region, an inventory of greenhouse gas emissions and absorption will be carried out, the necessary infrastructure for supporting climate projects will be developed, and a regional system for trading greenhouse gas emissions will be formed. To this end was developed the draft federal law on conducting an Experiment. The draft law also introduces mandatory requirements for regulated organizations whose activities are accompanied by greenhouse gas emissions of more than 50 thousand tons of CO2-eq. (20 thousand tons after 2024) upon submission to the authorized body of carbon reporting and compliance with the established emission quota.

As part of the formation of the experiment infrastructure, an inventory of greenhouse gas emissions and absorption was carried out in 2021, according to the results of which a greenhouse gas inventory of the region was formed, and economic activities that account for more than 80% of greenhouse gas emissions in total will be identified. It is assumed that in the future other interested constituent entities of the Russian Federation can be integrated into this trade system.

Thus, the methods and tools of carbon regulation, mechanisms for creating conditions for the introduction of technologies for reducing emissions and increasing the absorption of greenhouse gases will be tested in practice, the methodology for forming a verification system, accounting for emissions and absorption of greenhouse gases will be worked out, and the prerequisites for international recognition of domestic approaches will be laid during the experiment.

2.2.3. Recent initiatives and emerging challenges in energy transition

Oil industry

In 2020-2021 the improvement of tax policy in the oil industry continued, aimed at stimulating work on the search, assessment, exploration and production of hydrocarbons in certain territories of the Arctic zone of the Russian Federation, as well as at stimulating oil production at unique fields characterized by large residual oil reserves and difficult production conditions. It was active development of the modernization of oil refining industries and the development of oil and gas chemistry.

The main changes in the tax system of the oil industry include the abolition of the production allowance, which covers about 105 million tons in 2020, with the right to switch to the excess-profits tax regime, as well as the abolition of the viscosity allowance.

In 2021, the Government of the Russian Federation approved the General Scheme for the Development of the Oil Industry for the Period up to 2035.

Gas industry

To solve the problem of developing the production and consumption of LNG, as well as the entry of the Russian Federation in the medium term among the world leaders in its production and export, Federal Law has been adopted, according to which the list of persons who are granted the exclusive right to export natural gas in a liquefied state has been expanded.

In 2021, the Government of the Russian Federation approved General Scheme for the Development of Gas Industry Until 2035, as well as adopted the Action Plan for the Development of the Market of small-scale Liquefied Natural Gas and Gas Engine Fuel in the Russian Federation Until 2025 and the Long-Term Program for the Development of Liquefied Natural Gas Production in the Russian Federation.

These documents are aimed at solving the tasks set in the Energy Strategy for the development of the industry, including removing administrative barriers for the construction of small-scale LNG production, storage and use facilities, the operation of vehicles powered by natural gas, stimulating demand for natural gas as a gas engine fuel, and the production of vehicles using LNG.

Coal industry

A powerful impetus to the development of the coal industry and the creation of conditions for increasing the competitiveness of coal companies will be given by the implementation of the Coal Industry Development Program Until 2035 approved in 2020 which includes measures for the restructuring of the industry, technical re-equipment, intensification of coal production, radical increase in labor productivity and achievement of world standards in the field of environmental protection.

Renewable energy sources

In 2020 the Government of the Russian Federation has taken a number of measures in order to improve the current mechanism for stimulating the production of electric energy based on the use of renewable energy sources in the retail electricity and capacity markets.

In particular it was clarified the rules for conducting competitive selection of investment projects for the construction of generating facilities operating on the basis of the use of renewable energy sources in order to include such projects in the schemes and programs for the development of the electric power industry of the constituent entities of the Russian Federation.

Was developed a draft mechanism for introducing certificates of origin of electric energy. Within the framework of the draft law, it is defined that a low-carbon certificate is an electronic document issued upon the production of electric energy using nuclear energy and/or using renewable energy sources at a qualified generating facility (solar, wind and hydroelectric power plants).

Hydrogen energy

In order to increase the production and expand the scope of use of hydrogen as an environmentally friendly energy carrier, as well as Russia's entry into the world leaders in its production and export, the Government of the Russian Federation approved in 2020 the Action Plan ("Roadmap") "Development of Hydrogen Energy in the Russian Federation Until 2024" and in 2021 - the Concept for the Development of Hydrogen Energy in the Russian Federation.

The action plan provides for the improvement of the regulatory framework, the formation and implementation of measures of state support for projects for the production, storage, transportation and use of hydrogen, strengthening the positions of domestic companies in the markets for finished products, as well as conducting research and development work on critical directions of development of science and technology.

In 2021, the Action plan provides for the development of proposals for the selection of priority projects in the field of hydrogen energy and the formation of their list, which in turn will be supplemented on an as-needed basis. In 2021, it is also planned to form a register of existing and promising technologies in the field of hydrogen energy, develop proposals for stimulating and state support for the development of hydrogen energy, as well as determine the list of documents necessary for updating or developing documents of the national standardization system in the fields of production, transportation, storage, and use of hydrogen and methane-hydrogen mixtures.

The Concept for the Development of Hydrogen Energy, give the assessment the current state of hydrogen production and consumption, the resource and technological potential of Russia in the promising market of hydrogen energy carriers, and will also formulate priorities for the development of hydrogen energy with the definition of short-term, medium-term, and long-term goals.

In 2021, a management system for the implementation of these documents was formed, which includes an Interdepartmental Working Group on the Development of Hydrogen Energy in the Russian Federation, a Scientific and Technical Council and a project office on the basis of the Federal State Budgetary Organization "Russian Energy Agency" of the Russian Ministry of Energy. Russian Energy Agency will support the activities of the Interdepartmental Working Group and provide information analytical support for the implementation of the Action Plan and the Concept.

It was started the development a comprehensive national program to support the development of the low-carbon hydrogen energy industry in the Russian Federation.

The largest energy companies in Russia are currently developing feasibility studies for pilot hydrogen energy projects aimed at both exporting hydrogen and using it in various sectors of the Russian economy.

2.3 India

2.3.1. General overview of energy sector

i. Energy Consumption

India is a major force in the global energy economy. In the last decade, starting from 2010-11, India's energy consumption increases with a CAGR of 4.11%. The continuous rise in energy consumption is supported by a growing population and increased per capita income. Energy demand has steadily increased across all sectors, including agriculture, industry, commercial and residential, and is expected to continue to grow. In 2010-11 total energy consumption was 540.26 Mtoe which increases to 776.58 Mtoe in 2019-20(P).

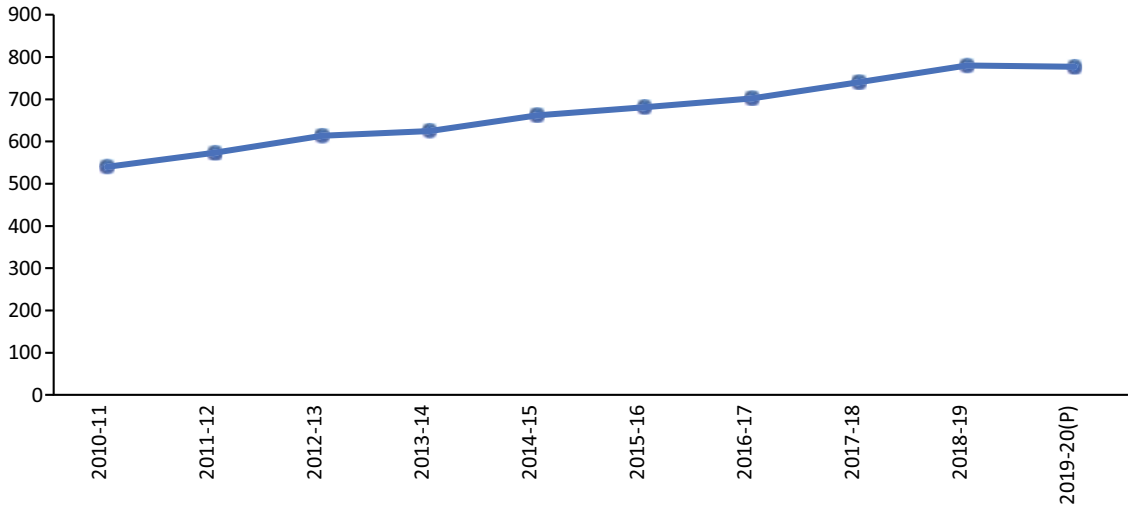

Figure 9: Yearwise energy consumption in India

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

Due to the increase in industrialization and government endeavors to provide uninterrupted power supply to all, per capita energy consumption increased with a CAGR 2.65% from 2010-11 to 2019-20 (P). Although the per capita energy consumption is increasing but it still much lower than the world average of 2.58 toe per person (IEA World Energy Balance 2020). The energy use per person in tonne(s) of oil equivalent starting from the year 2010-11 is shown in Figure 16.

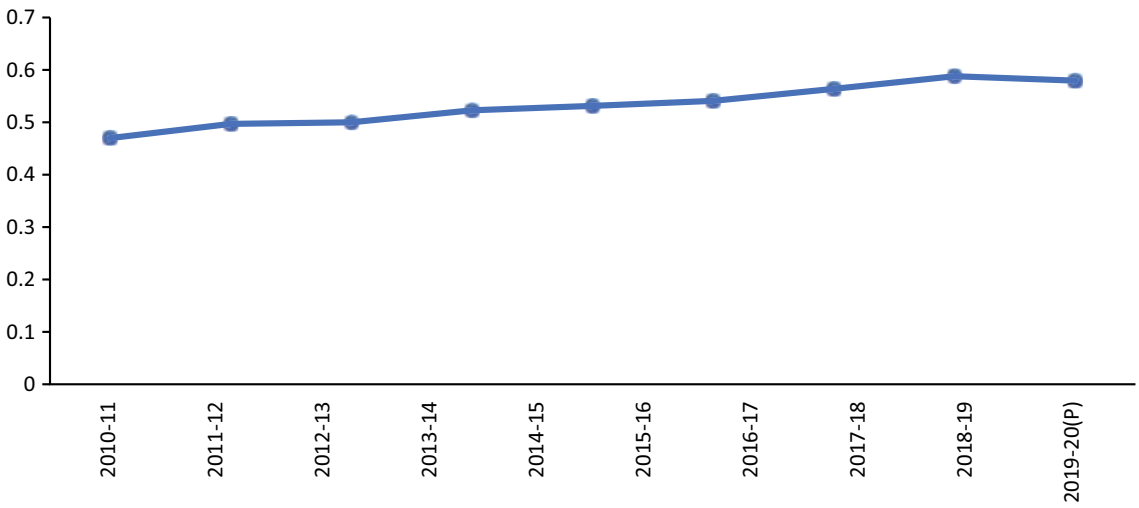

Figure 10: Energy use per person in India

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India.

The total electricity generation increases yearly with a CAGR of 5.63% from the year 2010-11 to 2019-20. In 2010-11, total electricity generation was 844.74 TWh which increases to 1383.41 TWh in 2019-20(P).

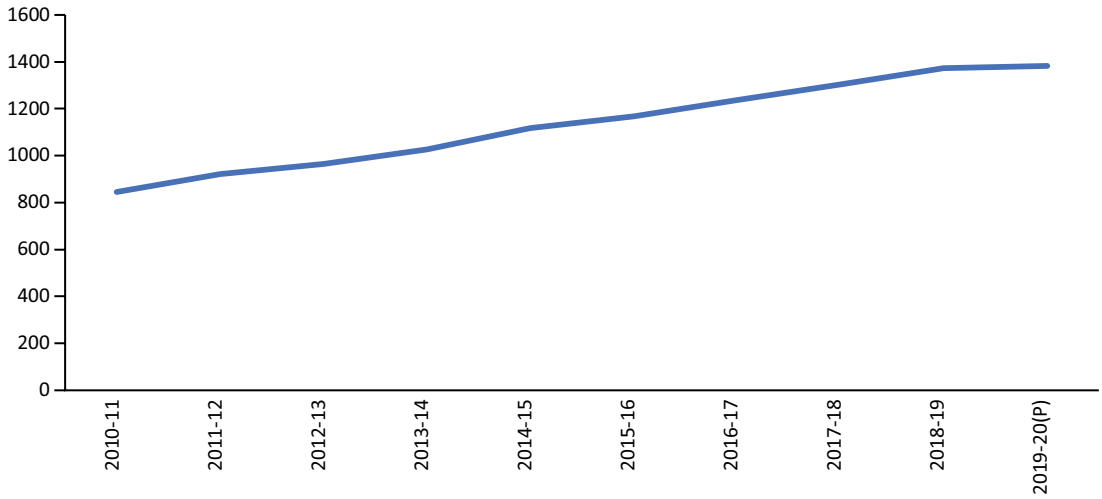

Figure 11: Electricity use per person in India

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India.

Of the total consumption of electricity in 2019-20, the industry sector accounted for the largest share (42.69%), followed by domestic (24.01%), agriculture (17.67%), and commercial sectors (8.04%).Of the total consumption of electricity in 2019-20, the industry sector accounted for the largest share (42.69%), followed by domestic (24.01%), agriculture (17.67%), and commercial sectors (8.04%).

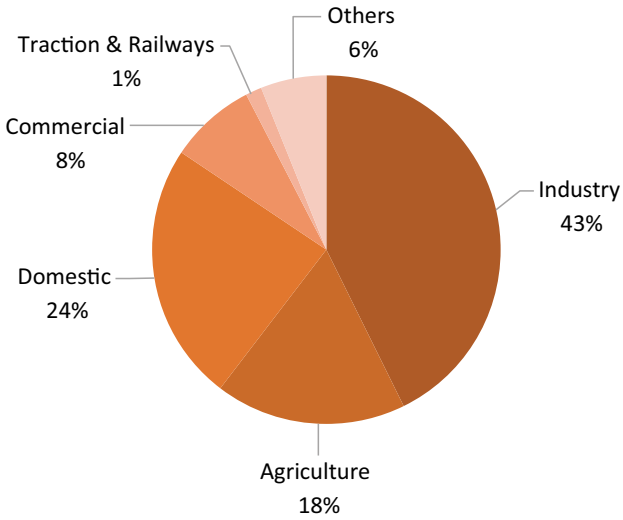

Figure 12: Consumption of electricity by sector in 2019-20 in India

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

ii. Energy Mix

India's energy system is primarily based on coal for power generation, oil for transport and industry, and biomass for residential heating and cooking. Bioenergy and most coal supply are produced in the country, while oil and natural gas are mainly imported. The consumption of energy from Coal and Lignite was highest, accounting for about 43.86% of the total consumption during 2019-20, followed by Crude Oil (32.76%).

Table 10: Share of energy consumption by source in India.

Share of Energy Consumption by Source in 2019-20(P) (%)	
Coal	43.86
Lignite	1.48
Natural Gas	7.60
Crude Petroleum	32.76
Low Carbon Sources (Nuclear, Renewable Energy including Hydro)	14.30

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

India is the world's second-largest producer of coal, next to the People's Republic of China. The share of coal in both the energy mix and the power mix in India is predominantly high, and in 2020 fossil fuel provided around 74% of the total electricity generation. Due to the impact of government policies to promote renewable energy sources, the share of electricity from low carbon sources is increasing continuously since 2016.

This is well captured by the fact that while the installed capacity of renewable sources of electricity generation excluding hydro from utilities grew at 12% in the previous year (2020 over 2019), that of thermal sources grew only at 1.91%.

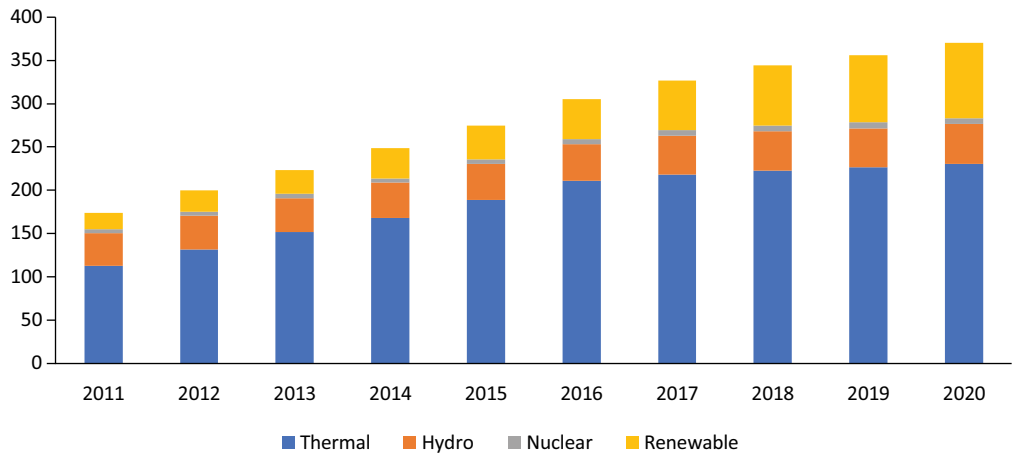

Figure 13: Sourcewise installed capacity of electricity generation in India

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

iii. Import & Export

There has been an increasing trend in the net import of coal over the years. Over the last ten years, the Net Import of coal steadily increased from 67.04 MTs in 2010-11 to 210.87 MTs in 2014-15. This was followed by a marginal decline in the succeeding two years but again started increasing though the increase in 2019-20(P) over 2018-19 was only 5% compared to 13% in 2018-19 over 2017-18.

Table 11: Share of Electricity Production by Source in 2020 in India.

	Coal	Gas	Oil	Nuclear	Hydropower	Wind	Solar	Other Renewables
Electricity Production, TWh	946.93	52.11	0.13	44.55	163.51	60.41	58.73	15.58
Share of Electricity Production (%)	70.56	3.88	0.01	3.32	12.18	4.50	4.38	1.16

Source: BP Statistical Review of World Energy

India is also highly dependent on imports of crude oil to meet domestic consumption. Imports of crude oil have increased from 163.60 MTs during 2010-11 to 226.95 MTs during 2019-20(P). While the increase of 0.20% in the imports of crude oil during 2019- 20(P) over 2018-19 is marginal, the net imports of crude oil in the last ten years from 2010-11 to 2019-20(P) at an overall CAGR of 3.70%.

Table 12: Year-wise foreign trade in coal in India

Year	Coal (MT)		
	Gross Imports	Exports	Net Imports
2010-11	68.92	1.88	67.04
2011-12	102.85	2.02	100.83
2012-13	145.79	2.44	143.35
2013-14	166.86	2.19	164.67
2014-15	212.10	1.24	210.86
2015-16	203.95	1.58	202.37
2016-17	190.95	1.77	189.18
2017-18	208.27	1.50	206.77
2018-19	235.24	1.31	233.93
2019-20(P)	248.54	1.05	247.49
Growth rate of 2019-20 over 2018-19 (%)	12.95	-12.64	5.80
CAGR 2010-11 to 2019-20 (P) (%)	15.32	-6.29	15.62

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

Table 13: Year-wise foreign trade in crude oil in India

Year	Crude Oil (MT)		
	Gross Imports	Exports	Net Imports
2010-11	163.60	0.00	163.60
2011-12	171.73	0.00	171.73
2012-13	184.80	0.00	184.80
2013-14	189.24	0.00	189.24
2014-15	189.43	0.00	189.43
2015-16	202.85	0.00	202.85
2016-17	213.93	0.00	213.93
2017-18	220.43	0.00	220.43
2018-19	226.50	0.00	226.50
2019-20(P)	226.95	0.00	226.95
Growth rate of 2019-20 over 2018-19 (%)	0.20	0.00	0.20
CAGR 2010-11 to 2019-20 (P) (%)	3.70	0.00	3.70

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

India is one of the largest importers of crude oil, but at the same time it is also one of the largest exporters of refined oil, given the presence of refineries to take advantage of the country's location between crude oil-producing nations in the Middle East and its consumers in the rest of Asia. India exports refined petroleum products to the USA, UK, Australia, and also to oil-producing countries like Iraq and UAE. The export of petroleum products increased from 59.08 MT during 2010-11 to 65.69 MT during 2019-20(P) at a CAGR of 1.19"%. However, due to an increase in domestic demand coupled with a series of shutdowns in refineries, the export of petroleum products in 2019-20(P) decreased by (-) 21.08% from the previous year 2018-19.

Table 14: Year-wise foreign trade in petroleum products in India.

Year	Petroleum Products (MT)		
	Gross Imports	Exports	Net Imports
2010-11	17.38	59.08	-41.70
2011-12	15.85	60.84	-44.99
2012-13	16.35	63.41	-47.06
2013-14	16.70	67.86	-51.16
2014-15	21.30	63.93	-42.63
2015-16	29.46	60.54	-31.08
2016-17	36.29	65.51	-29.22
2017-18	35.46	66.83	-31.37
2018-19	33.35	61.10	-27.75
2019-20(P)	43.79	65.69	-21.90
Growth rate of 2019-20 over 2018-19 (%)	31.30	7.51	-21.08
CAGR 2010-11 to 2019-20 (P) (%)	10.81	1.19	-6.91

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

In the last few years, India invests heavily in building LNG import terminals and pipelines to import and supply gas across the country. With the Government's plan to raise the share of natural gas in the country's energy mix to 15% by 2030, the import of LNG is expected to rise in the future. The import of Natural Gas stood at 33.89 BCM during the year 2019-20 (P) compared to 28.74 BCM in 2018-19, recording an annual growth of 17.91%.

Table 15: Year-wise foreign trade in natural gas in India

Year	Natural Gas (BCM)		
	Gross Imports	Exports	Net Imports
2010-11	12.93	0.00	12.93
2011-12	18.00	0.00	18.00
2012-13	17.61	0.00	17.61
2013-14	17.80	0.00	17.80
2014-15	18.61	0.00	18.61
2015-16	21.39	0.00	21.39
2016-17	24.85	0.00	24.85
2017-18	27.44	0.00	27.44
2018-19	28.74	0.00	28.74
2019-20(P)	33.89	0.00	33.89
Growth rate of 2019-20 over 2018-19 (%)	17.91	0.00	17.91
CAGR 2010-11 to 2019-20 (P) (%)	11.30	0.00	11.3

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

India's exports of electricity to neighboring countries started rising compared to gross imports since 2016-17. The export of electricity increased from 128 GWh in 2010-11 to 9491 GWh in 2019-20(P), with a CAGR of 61.29%. Compared to the previous year, 2018-19, the export of electricity grew by 12.07%. Import has also shown an increasing trend during the past periods but at a slower pace except for 2018-19.

Table 16: Year-wise cross-border trade in electricity in India.

Year	Electricity (GWh)		
	Gross Imports	Exports	Net Imports
2010-11	5611	128	5483
2011-12	5253	135	5118
2012-13	4795	154	4641
2013-14	5598	1651	3947
2014-15	5008	4433	575
2015-16	5244	5150	94

Table 16: Year-wise cross-border trade in electricity in India.

Year	Electricity (GWh)		
	Gross Imports	Exports	Net Imports
2016-17	5617	6710	-1093
2017-18	5072	7203	-2131
2018-19	4396	8469	-4073
2019-20(P)	6351	9491	-3140
Growth rate of 2019-20 over 2018-19 (%)	44.47	12.07	-22.90
CAGR 2010-11 to 2019-20 (P) (%)	1.39	61.29	-

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

2.3.2 Assessing demand and supply of key energy sources

Availability of coal has shown an increasing trend from 2010-11 to 2019-20(P) with a CAGR of about 5.73%. The total availability of coal in 2019-20(P) stood at 1002.15 MT as compared to 958.25 MT in 2018-19, indicating a total increase of 43.90 MT in a year. Out of the 1002.15 MT available for consumption in 2019-20(P), a significant portion (72.93%) is produced domestically, and 248.54 MT is imported.

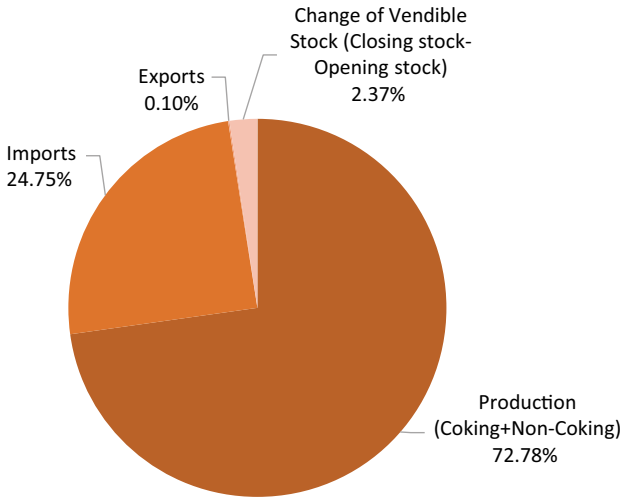

Figure 14: Breakup of Availability of Coal in 2019-20 (P)

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

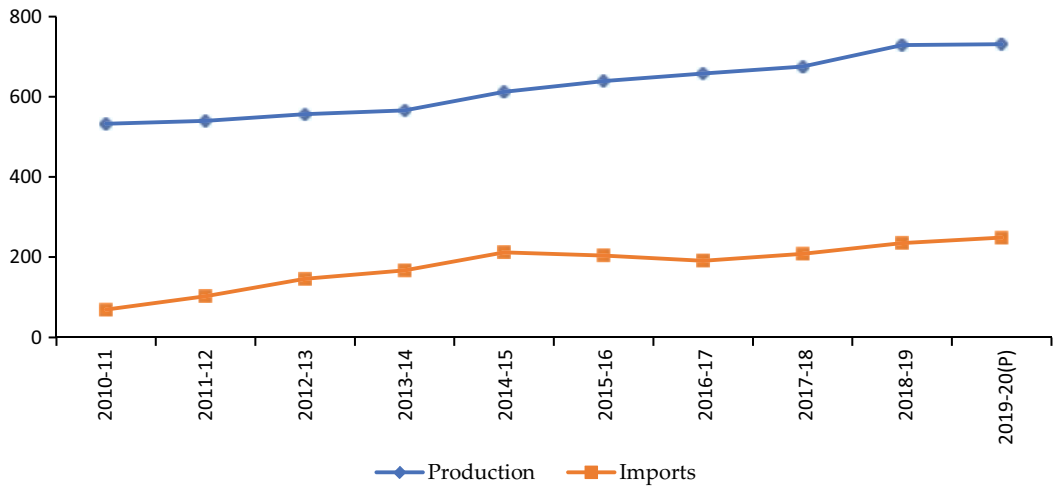

Figure 15: Year wise production and import of coal in India

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

There has been a marginal change of -0.60% in the availability of crude oil in the country over the previous year. The availability of Crude Oil decreased from 260.70 MT in 2018-19 to 259.12 MT during 2019-20(P). This is attributed to a marginal decrease in the production of domestic

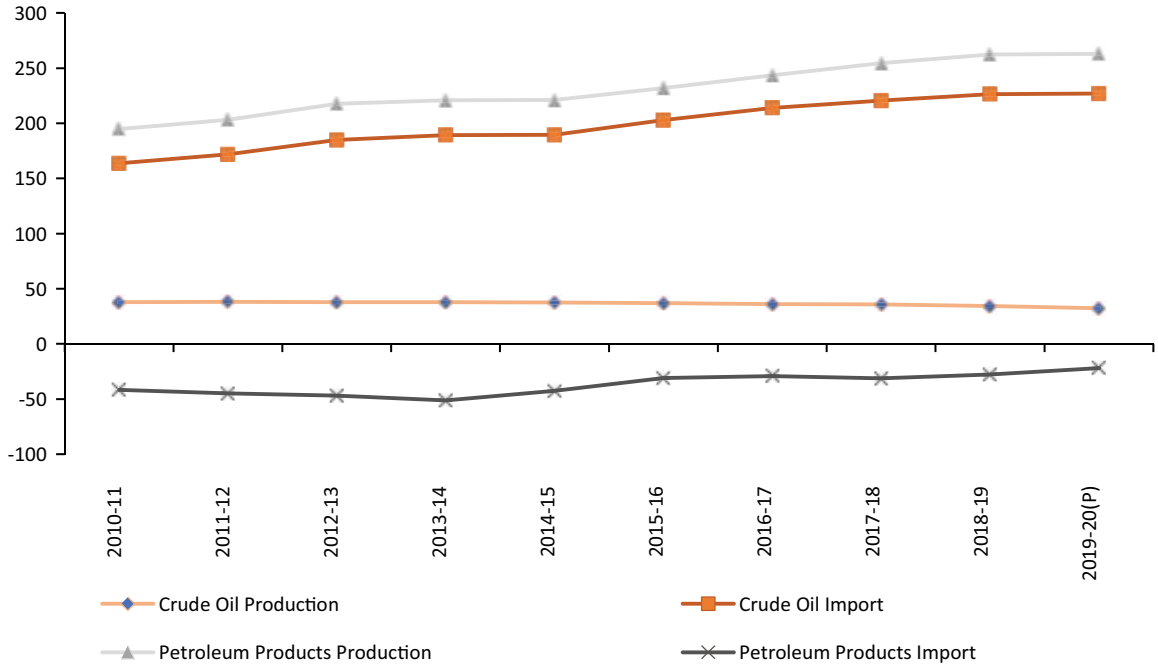

Figure 16: Year wise production and import of crude oil and petroleum products in India

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

crude oil. Production of Petroleum Products during 2018-19 was 262.36 MT and remained steady at 262.94 MT in 2019-20(P). However, due to a better growth rate in imports (31.30%) than in exports (7.51%) in 2019-20 over 2018-19, the total availability of petroleum products in the country has increased from 234.61 MT in 2018-19 to 241.05 MT in 2019- 20(P).

Electricity available for supply increased from 8,11,635 GWh in 2010-11 to 13,11,176 GWh in 2019-20(P), thus recording a CAGR of 5.47% during this period. The availability of electricity increased at 0.27% in 2019-20(P) over its value in previous year.

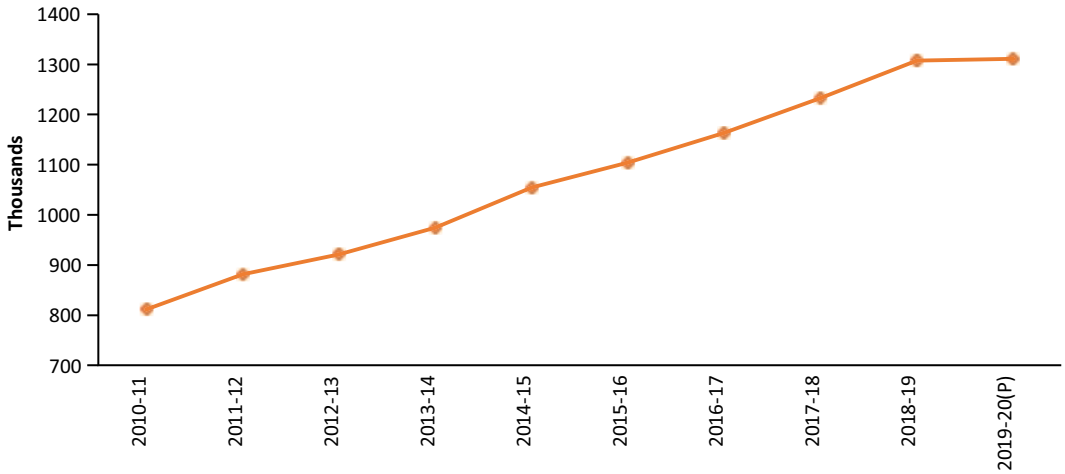

Figure 17: Yearwise net availability of electricity in India

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

2.3.3 Commitment towards NDC & selected SDGs

India's energy transition is characterized by its ambitious targets. By the year 2022, India seeks to provide all households in the country 24×7 power. By 2022, India also seeks to install 175 GW of renewable energy (RE) capacity. These national targets are aligned with India's climate commitments made at the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC), also known as the Paris Agreement, which came into force in November 2016.

In its Nationally Determined Contributions (NDCs), India committed to three targets to be achieved by the year 2030. It includes the following main elements:

1. To reduce the emissions intensity of GDP by 33%–35% by 2030 below 2005 levels;
2. To increase the share of non-fossil-based energy resources to 40% of installed electric power capacity by 2030, with the help of the transfer of technology and low-cost international finance, including from Green Climate Fund (GCF);

3. To create an additional (cumulative) carbon sink of 2.5–3 Giga tonne CO_2e through additional forest and tree cover by 2030.

As per, UN Environment Emission Gap Report 2019, developed countries like the USA, Republic of Korea, EU, Canada, Japan, and Australia needs additional policy initiatives to meet their NDC commitments requirement whereas developing nations like India, China, Argentina; with their stated policies are already on the track of meeting their NDC targets.

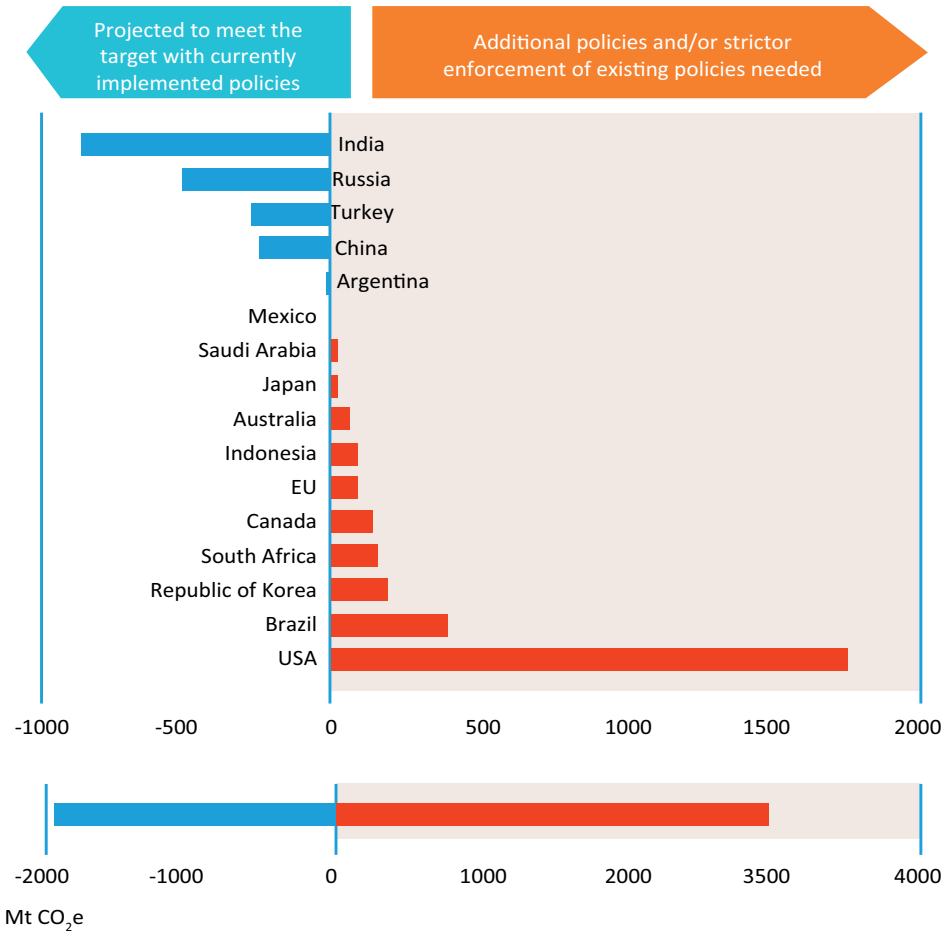

Figure 18: Countries status to meet NDC.

India's NDC is currently rated "2°C compatible" by the Climate Action Tracker (CAT. An updated NDC reflecting India's current policy projections would be rated "1.5°C Paris Agreement compatible". At the Secretary General's summit in New York, India announced its intention to reach a target of 450 GW of renewables by 2030. The ramp-up of renewables in India can provide access to affordable power to all. For three consecutive years, renewable energy investment topped fossil fuel-related power investments, and in 2018, solar investments exceeded those in coal.

India adopted Sustainable Development Goal 7 (SDG-7) to ensure access to affordable, reliable, sustainable, and modern energy to all. The goal stresses more focused attention to improve access to clean and safe cooking fuels and technologies, improve energy efficiency, increase renewable sources, and promote sustainable and modern energy for all.

The targets adopted as a part of the Goal 7 of SDGs 2030 Agenda are as follows:

1. Ensure universal access to affordable, reliable, and modern energy services.
2. Increase the share of renewable energy in the national energy mix substantially.
3. Double the national rate of improvement in energy efficiency.

Providing secure, affordable, and sustainable energy to all is an important policy priority in India, and significant progress has been made towards the United Nations Sustainable Development Goals (SDGs), notably SDG7 on energy. In April 2018, the Government of India (GoI) announced that India had achieved its goal of providing electricity to every village in India. Indian experiences can be taken up as a case study for Universal Access to Energy as we have taken some landmark initiatives towards electrification of all households. Under Pradhan Mantri Sahaj Bijli Har Ghar Yojana – 'Saubhagya' free electricity connections to all households were provided. There were around 3 Crore un-electrified households in the country as of October 2017 and as on March 2019, almost 100% electrification of households have been achieved.

India is also progressing towards the second SDG 7.1 objective – access to clean cooking. GoI programs to support clean cooking focus on increasing the usage and financing of LPG, with the explicit aim of empowering women and improving their health. The Pradhan Mantri Ujjwala Yojana (PMUY) scheme provides women living below the poverty line with a free LPG connection, subsidized refills, and courses on using LPG.

To increase the share of renewable energy capacity (SDG 7.2), the Government set a renewable capacity goal of 175 GW by 2022, targeting 60 GW of utility-scale solar photovoltaic (PV), 40 GW of rooftop solar PV, 60 GW of wind power, 5 GW of small hydro and 10 GW of bioenergy.

Even though primary energy consumption increases on a yearly basis, energy intensity has reduced by 27% over the past ten years. The decrease in energy intensity is due to government initiatives to improve energy efficiency. Efficiency gains were achieved mainly in the industrial and service sectors, as well as in residential buildings. The Energy Intensity (at 2011-12 prices) decreased from 0.2747 Mega joules per rupee in 2011-12 to 0.2232 Mega Joules in 2019-20 (P). The GoI is on track to surpass the global SDG 7.3 of doubling the global rate of improvement in energy efficiency to 2.7% per annum.

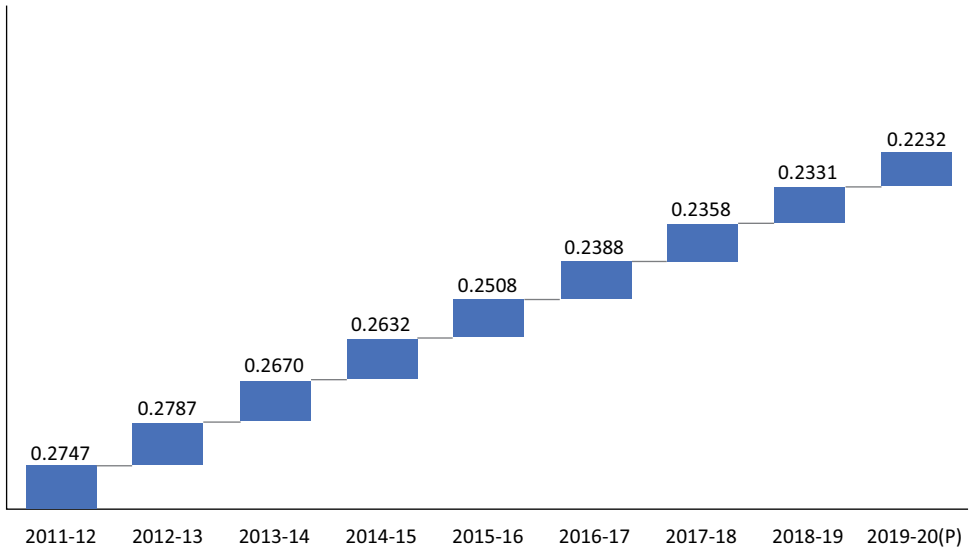

Figure 19: Energy Intensity in Megajoules per Rupee from 2011-12 to 2019-20 (P) in India

2.3.4 Recent initiatives and emerging challenges in energy transition

The rapid increase in access, affordability, and the urbanization energy consumption is expected to increase further in the coming years. India's development path focuses on the need for rapid economic growth, which is an essential precondition to poverty eradication and improved standards for living while at the same time focusing on sustainable growth for maintaining ecological balance. The recent initiatives taken by the Government to ensure a smooth energy transition are:

1. **Growth of Renewable Sector:**
    - In the last 6 years, India's installed Renewable Energy (RE) capacity has increased by over two and a half times and stands at more than 141 Giga Watts (including large Hydro).
    - The installed solar energy capacity has increased by over 15 times and stands at 41.09 GW.
    - India's RE capacity is the 4th largest in the world. Its annual RE addition has been exceeding that of coal-based thermal power since 2017.
2. **Ease of Investment in Renewables:**
    - During the last 7 years, over USD 70 billion investment has been made in RE in India.
    - India has a very liberal foreign investment policy for renewables allowing 100% Foreign Direct Investment (FDI) through the automatic route in the sector.

- Established dedicated Project Development Cells (PDC) and FDI cells in all Ministries for handholding and facilitating domestic and foreign investors. PDCs have been established to develop investible projects in coordination between the Central Government and State Governments and thereby grow the pipeline of investible projects in India and increase FDI inflows.
- Developed Renewable Energy Investment Promotion and Facilitation Board (REIPFB) Portal to provide one-stop assistance and facilitation to the Industry and Investors to develop projects and bring new investment to the RE sector in India.

3. Industry's Commitment:

- Several members from the industry have voluntarily declared RE goals and committed to the Carbon Disclosure Project (CDP), Renewable 100% (RE100), and Science-based targets (SBTs) to reduce greenhouse gas emissions.

4. Green Tariff:

- Rules are being framed for a "Green Tariff" policy that will help electricity Distribution Companies supply electricity generated from clean energy projects at a cheaper rate than power from conventional fuel sources.
- The Government is also promoting Green Hydrogen with obligations for Fertilizers and Refining industries (Green Hydrogen Purchase obligations).

5. Initiatives to Increase Investment in Renewables:

- Viability Gap Funding options for Offshore Wind Energy.
- Green Term Ahead Market and Green Day Ahead Market.
- Rules for facilitating renewable energy through Open Access.
- Renewable energy procurement through exchanges will also be notified to promote non - conventional resources of energy.

6. Unlocking National Energy Efficiency Potential (UNNATEE):

- Strategy Plan towards Developing an Energy Efficient Nation (2017-2031)
- Potential to reduce 438 Million ton CO2 to 623 Million ton CO2 by 2030 by adoption of energy efficiency measures

Table 17: Initiatives shaping India's Energy Transition

Initiatives Shaping India's Energy Transition	
Electrification	» **Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA):** Empowering rural and urban households through access to reliable and affordable electricity » **Green Energy Corridor (GEC):** Synchronising grid-connected renewable energy with India's national transmission network » **National Smart Grid Mission (NSGM) and Smart Meter National Programme (SMNP):** Modernising India's power sector into a secure, adaptive, sustainable, and digitally-enabled ecosystem.
Renewable Energy	» **National Solar Mission (NSM):** The 100 GW solar ambition at the heart of the world's most extensive renewable energy expansion program » The Wind Energy Revolution: Leveraging India's robust wind energy sector to boost clean energy manufacturing and the rural economy » **National Biofuels Policy and SATAT:** Building value chains to reduce fuel imports, increase clean energy, manage waste, and create jobs » **Small Hydro Power (SHP):** Harnessing the power of water to integrate remote communities into the economic mainstream. » **National Hydrogen Energy Mission (NHEM):** Exploring the commercial viability of a versatile clean fuel » **Production-Linked Incentive (PLI) Scheme:** Integrating India into the global clean energy value chains » **National Biofuels Policy and SAYAY:** Building value chains to reduce fuel imports, increase clean energy, manage waste and create jobs
Energy Efficiency	» **Unnat Jyoti by Affordable LEDs for All (UJALA):** Bringing affordable, energy-efficient lighting and appliances to citizens
Clean Cooking	» **Pradhan Mantri Ujjwala Yojana (PMUY):** Delivering LPG gas to households for Clean Fuel and Better Life
Industrial Decarbonisation	» **Perform, Achieve and Trade (PAT):** Enhancing energy efficiency and curtailing emissions of hard-to-abate industrial sectors
Sustainable Transport	» **Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME):** Driving India's vision for reliable, affordable, and efficient electric mobility » **Indian Railways Plans to Go Green:** Fuelled by environmental conservation, racing towards net-zero carbon emissions by 2030 » Sustainable Aviation: Integrating cleaner fuels, energy efficiency, and ecosystem preservation with aircraft and airport operations

Table 17: Initiatives shaping India's Energy Transition

Initiatives Shaping India's Energy Transition	
Smart Cities	» **Smart City Mission (SCM):** Developing sustainable and resilient urban habitats via 'smart solutions' » **The Green Buildings Market:** Constructing resource-efficient, sustainable and resilient buildings
City Gas Distribution	» **India's CNG and PNG Network:** Increasing the adoption of the 'green' fossil fuel for vehicles, households, and industries
Cooling Action	» **India Cooling Action Plan (ICAP):** Incentivising the air conditioner industry to build a sustainable cooling value chain
Skilling	» **Skill Council for Green Jobs (SCGJ):** Building a skilled and specialized workforce to deliver India's sustainable development goals
Global Initiatives	» **International Solar Alliance (ISA):** Harnessing the infinite power of the Sun for sustainable human development » **Clean Energy Ministerial (CEM):** Fostering international co-operation for a technology-driven transition to a global clean energy economy » **Mission Innovation (MI):** Investing in innovation in breakthrough clean energy technologies to deliver impact at scale

2.4 China

2.4.1. General overview of energy sector

i. Energy Consumption

In 2020, China's total energy consumption was close to 5 billion tons of standard coal, an increase of 2.2% over the previous year. Coal consumption was 4 billion tons, a year-on-year increase of 0.6%, accounting for 56.8% of total energy consumption, and a year-on-year decrease of 0.9%. Oil consumption was approximately 660 million tons, a year-on-year increase of 2.3%, accounting for 18.9% of total energy consumption, with a year-on-year decrease of 0.1%. Gas consumption is about 320 billion cubic meters, an increase of 7.2%, accounting for the total energy consumption of 8.4%, an increase of 0.4%.

ii. Energy Mix

The energy consumption mix was further optimized. Non-fossil energy consumption accounted for 15.9% of total energy consumption, a year-on-year increase of 0.6%. Clean energy consumption accounted for 24.3% of total energy consumption, a year-on-year increase of 1.0%. According to recent data on energy consumption structure, the proportion of coal consumption has shown a downward trend, and the proportion of clean energy consumption has continued to increase.

iii. Import & Export

In 2020, in accordance with the domestic energy supply and demand situation, China flexibly utilized the international market and gave full play to the role of import supplementary regulation, and energy imports maintained a relatively rapid growth throughout the year.

In 2020, China imported 540 million tons of crude oil, a year-on-year increase of 7.3%; refined oil 28 million tons, representing a decrease of 2.7%; natural gas 140 billion cubic meters, up by 5.3%. Coal imports were 300 million tons, a year-on-year increase of 1.5%; coal exports were about 3 million tons, a year-on-year decrease of 47.1%.

2.4.2 Assessing demand and supply of key energy sources

In 2020, the energy supply chain was basically stable. Energy production companies have overcome the adverse effects of the epidemic and actively promoted the resumption and increase of production. The industrial energy production above designated size has grown steadily throughout the year, which effectively guaranteed energy supply and security.

In 2020, China's total energy production reached approximately 4.1 billion tons of standard coal, a year-on-year increase of 2.8%. Among them, coal production was 3.9 billion tons, a year-on-year increase of 1.4%. The production of crude oil was 195 million tons, a year-on-year increase of 1.6%. The production of natural gas reached nearly 200 billion cubic meters, a year-on-year increase of 9.8%.

In 2020, the electricity consumption of the whole society reached 7.5 trillion kWh, a year-on-year increase of 3.1%. The total installed nuclear power capacity was nearly 50 million kW, and the power generation is 366.2 billion kWh, a year-on-year increase of 5.0%. The installed capacity of conventional hydropower reached nearly 340 million kW, and the power generation was 1.3 trillion kWh, an increase of 4.1% year-on-year. The newly installed wind power capacity was 72.38 million kW, a year-on-year increase of 34.6%, and the power generation capacity was 446.5 billion kWh, a year-on-year increase of 15.1%. The newly installed solar power generation capacity was nearly 50 million kW, and the power generation was 261.1 billion kWh, an increase of 16.6% year-on-year.

2.4.3 Commitment towards NDC & selected SDGs

China has made important contributions to adopting the Paris Agreement and has made active efforts toward implementing it. In September 2020, China announced that it would scale up its nationally determined contributions and adopt more vigorous policies and measures. China aims to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060. In December 2020, China further announced that it will lower its carbon dioxide emissions per unit of GDP by over 65 percent from the 2005 level, increase the share of non-fossil fuels in primary energy consumption to around 25 percent, increase the forest stock volume by 6 billion cubic meters from the 2005 level, and bring its total installed capacity of wind and solar power to over 1.2 billion kilowatts.

As the largest developing country in the world, China historically ensured power access for people without electricity in 2015. China attaches great importance to the renovation and upgrading of the rural power grid and makes great efforts to strengthen the weak links in the process. China has carried out targeted programs for renovating and upgrading power grid in small towns and central villages, connecting motor-pumped wells in rural plain areas to the grid, and supplying poor villages with electricity for industrial and commercial use. In 2019, we achieved the first goal of rural power grid transformation and upgrade, achieving a rural power supply reliability rate of 99.8%, a comprehensive voltage qualification rate of 97.9%, and basically achieved full coverage of stable and reliable power supply services in rural areas across the country. China has completed poverty alleviation projects based on solar PV power generation as scheduled, with a total installed capacity of 26.36 million kW, an annual revenue of about 180 million from power generation, benefiting more than 100,000 village, about 4.15 million households in poverty.

2.4.4 Recent initiatives and emerging challenges in energy transition

(1) Accelerating the pace of clean and low-carbon transformation

China continues to promote the consumption of renewable energy and continues to promote the construction of major clean energy projects. Two documents related to Responsibility and Weight of Renewable Energy Power Consumption and Consolidated Supervision Program of Clean Energy Consumption were issued.

(2) New business formats and new models are developing vigorously

China accelerated the construction of demonstration projects for comprehensive energy applications. By the end of 2020, 28 micro-grid projects have started construction, some of which have been put into operation. 24 “Internet +” smart energy pilot projects were completed and approved. China actively promoted the construction of energy storage demonstration projects and charging facilities. China also completed the screening of energy storage demonstration projects and the construction of a standardized information platform for energy storage.

2.5 South African Republic

2.5.1. General overview of energy sector

i. Energy Consumption

The primary energy consumption of South Africa has increased steadily in the past few decades. The energy consumption has increased by more than four times since the 1960s and at a compounded annual growth rate of almost 3 percent. However, in the past one decade this rise in the total energy consumption has been sluggish as there has been only a 3 percent increase between 2009 and 2019. The total primary energy consumption was 130 Mtoe in 2019, increasing from 126 Mtoe in 2018.

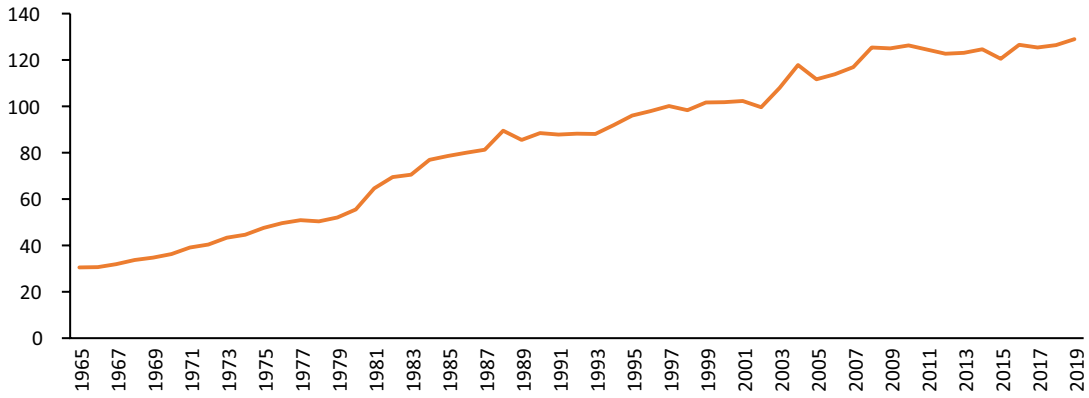

Figure 20: Primary energy consumption in South Africa

Source: BP Statistical Review of World Energy

The energy usage per capita was around 2.2 Mtoe in 2019 which has witnessed a slight increase from 2.18 Mtoe in 2018. There has not been a significant increase in the total energy usage per capita as in the last two decades it has increased at a compounded annual growth rate of 0.6 per cent only. Additionally, the energy usage per capita has declined almost by 12 per cent between 2009 and 2019.

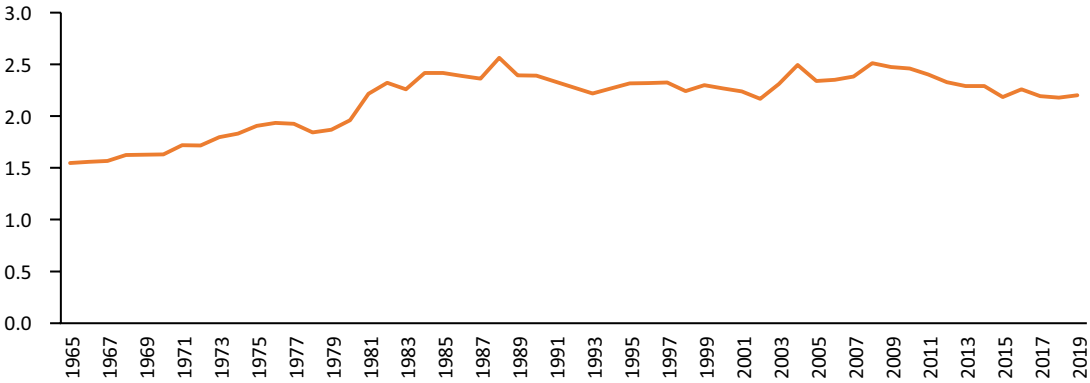

Figure 21: Energy use per person in South Africa

Source: BP Statistical Review of World Energy

The total electricity generation of the country was 222 TWh in 2019-20 declining from 235 TWh in 2018-19; however, the overall electricity generation has almost doubled since the 1980s. The total electricity generation after witnessing a steady increase till 2009 has declined by 4 percent till 2020. Since coal dominates the electricity generation, this decline has been due to the reduction in performance of the overall coal fleet.

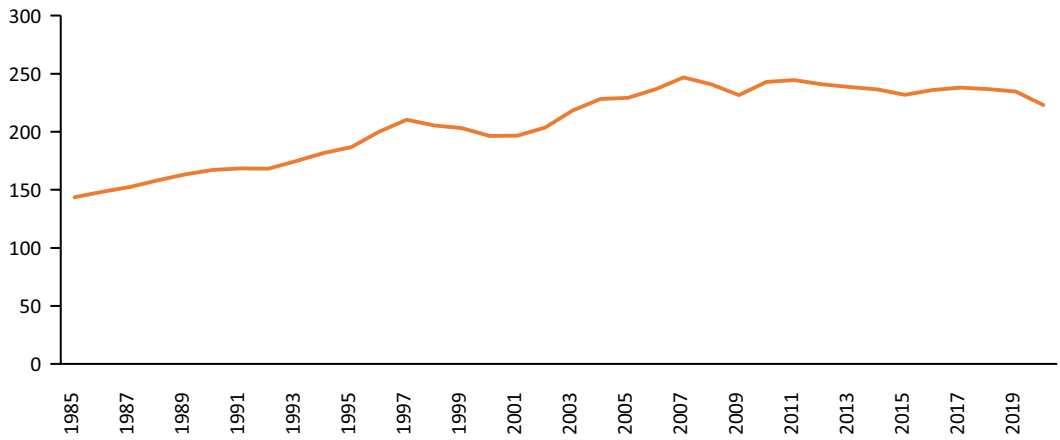

Figure 22: Electricity generation in TWh

Source: BP Statistical Review of World Energy

The per capita electricity consumption was 3760 kWh in 2019-20 after a reduction of more than 7 % from 2018-19. The overall per capita electricity consumption has also decreased by 26"% since 2010, and decreased at a compounded annual growth rate of 2.5"%. This has been because of the reduction in total electricity generation and an increase in the population.

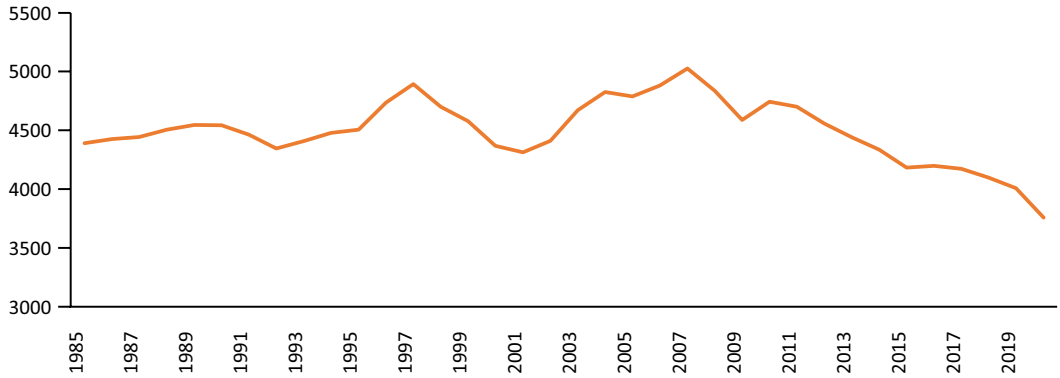

Figure 23: Electricity use per person in South Africa

Source: BP Statistical Review of World Energy

Out of all the sectors, the industrial sector dominates the total electricity consumption consuming around 9300 ktoe out of the total 17600 ktoe (around 52%) in 2018-19. This is followed by the residential sector (24%), the commercial and public services sector (18%), agriculture and forestry (3%) and the transport sector (2%).

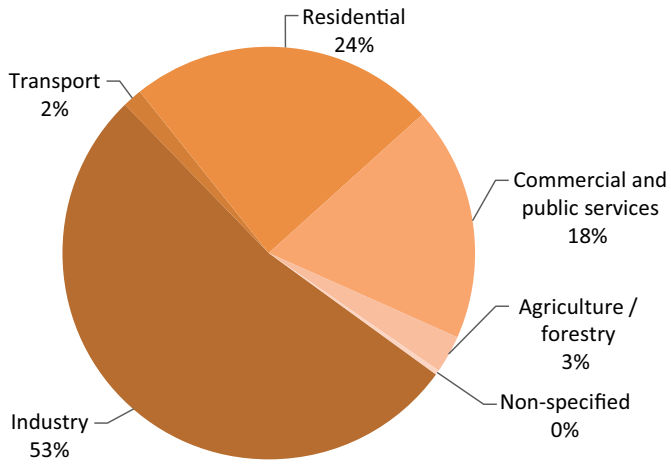

Figure 24: Consumption of electricity by sector in 2018-19 in South Africa

Source: IEA 2021

ii. Energy Mix

South Africa's indigenous energy resource base has been dominated by coal and contributed around 70 per cent of the total energy consumption source in 2018-19. This is because of the abundancy of coal in the region and the relative lack of suitable alternatives to coal. However, the dependence on coal has been steadily declining from the past few decades now in the country. The share of coal in the overall energy mix has declined by 6 per cent in the last one decade and additionally at a compounded annual growth rate of 1 per cent. Followed by coal, the next most dominant energy source in the country is oil which made around 22 per cent of the overall energy mix in 2018-19, followed by gas (3%), nuclear (2.3%), wind (1.1%), solar (0.9%) and hydro (0.1%).

Table 18: Share of energy consumption by source in South Africa.

Share of Energy Consumption By Source (%)		
	2009	2019
Oil	20.0	22.0
Coal	75.0	70.6
Solar	0.0	0.9
Nuclear	2.3	2.3
Hydro	0.3	0.1
Wind	0.0	1.1
Gas	2.3	2.9
Other renewables	0.1	0.1

Share of Energy Consumption By Source (%)		
	2009	2019
Fossil Fuel	97.3	95.4
Low Carbon Sources	2.7	4.6

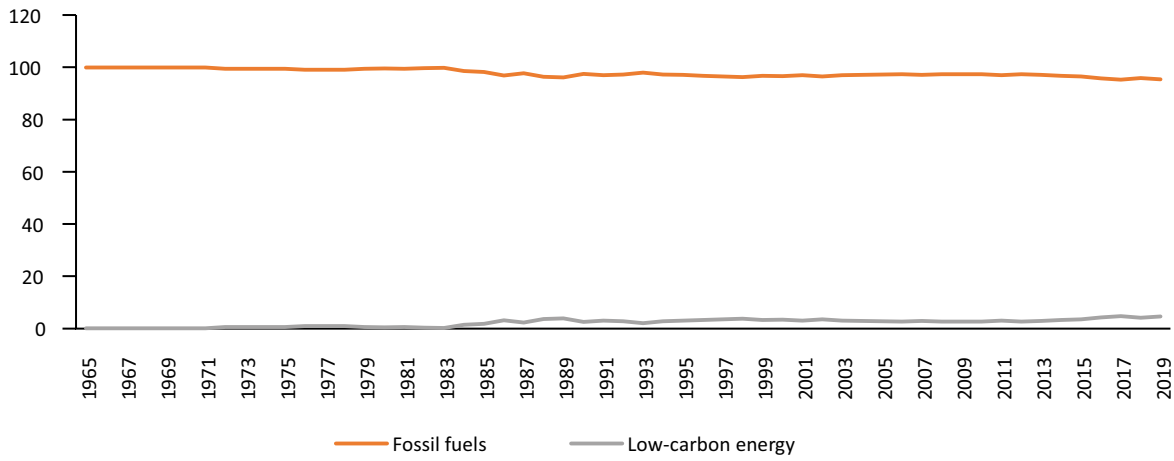

Figure 25: Share of energy consumption by source in South Africa

Source: BP Statistical Review of World Energy

Similar to the overall energy mix, coal dominates the electricity generation mix as well. The share of coal in electricity generation was around 92% in 2010 and around 85% in 2020. The other important sources of fuel for electricity production apart from coal were nuclear, wind, solar and oil in the 2019-20. Though their shares in 2010 in the overall electricity mix have been very low, they were the following: nuclear (5.3%), oil (1.2%), hydro (0.9%), gas (0.3%) and both wind and solar were non-existent. This changed to 5.2%, 2.3%, 0.5%, 0.8%, 3% and 2.6% respectively in 2020. Thus, fossil fuels have been dominant in the overall electricity generation mix constituting around 94% in 2009-10 but it reduced to 89% in 2019-20. On the other hand, the share of low carbon energy sources was around 6.3% in 2009-10 that increased to 11.4% in 2019-20.

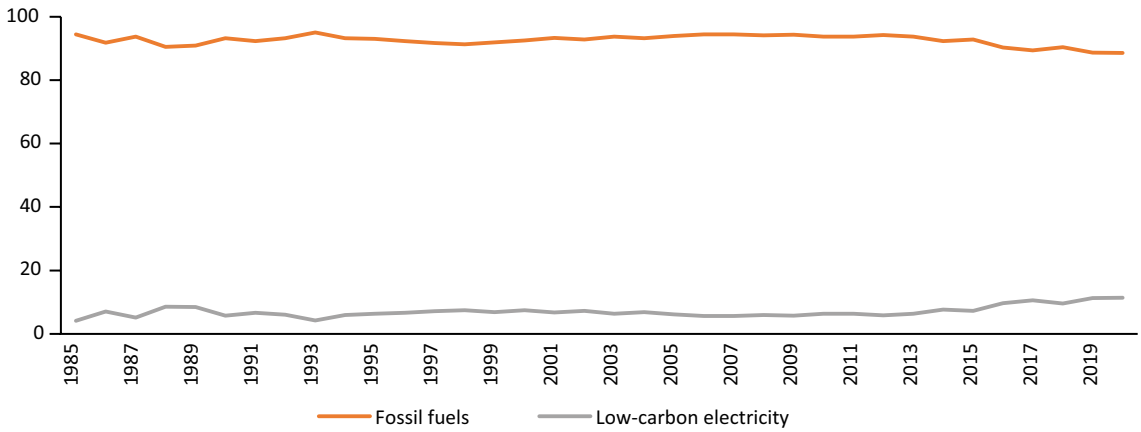

Figure 26: Share of Electricity Production by Source in South Africa

Source: BP Statistical Review of World Energy

Table 19: Share of Electricity Production by Source in 2020 in South Africa

	Coal	Gas	Oil	Nuclear	Hydropower	Wind	Solar	Other Renewables
Electricity Production, TWh	190.6	1.7	5.1	11.5	1.2	6.6	5.7	0.4
Share of Electricity Production (%)	85.5	0.8	2.3	5.2	0.5	3.0	2.6	0.2

2.5.2 Assessing demand and supply of key energy sources

2.5.3 Commitment towards NDC & selected SDGs

South Africa deposited its first NDC with the UNFCCC in October 2015, committing to keeping national greenhouse gas emissions within a range from 389 Mt CO2-eq for 2025 and 2050. South Africa remains committed to addressing climate change based on science, equity and sustainable development. The country then published a draft version of their updated NDC commitments in March 2021 for public consultation. In its updated NDC draft, South Africa commits to limiting absolute emissions level in the range of 398–440 MtCO2e (incl. LULUCF) by 2030. The upper limit was changed downwards compared to the NDC of 2016, the lower limit remained unchanged. Thus, the key recommendations on South Africa's draft updated 2021 NDC have been the following:

» The upper limit of South Africa's NDC appears to be consistent with a 3°C temperature increase. A rapid and just transition to enable achievement of the lower limit of the target range is vital to protect human health as well as climate.

» In 2021 more than ever, interventions which yield high returns on investment to be prioritised. As such, it was recommended that the NDC includes consideration of co-benefit interventions which deliver benefits for the climate, public health, and the economy. Furthermore, many such interventions can be found in the energy, food and agriculture, and transport sectors, detailed in the appendix.

» The acknowledgement of the healthcare sector as one which is highly impacted by climate change should be matched with an acknowledgement of the need for healthcare sector adaptation and resilience, as detailed in the National Climate Change Adaptation Strategy.

3. BRICS ENERGY AS THE BASIS FOR SUSTAINABLE GLOBAL DEVELOPMENT

3.1 Comparative analysis of BRICS energy sector and sustainable development

In 2019, the primary energy consumption by BRICS nations was 5335 Mtoe which is 38.25% of total world primary energy consumption (13946 Mtoe). China consumes 24.27% of total world primary energy consumption, followed by India (5.83%), Russia (5.11%), Brazil (2.12%), and South Africa (0.92%).

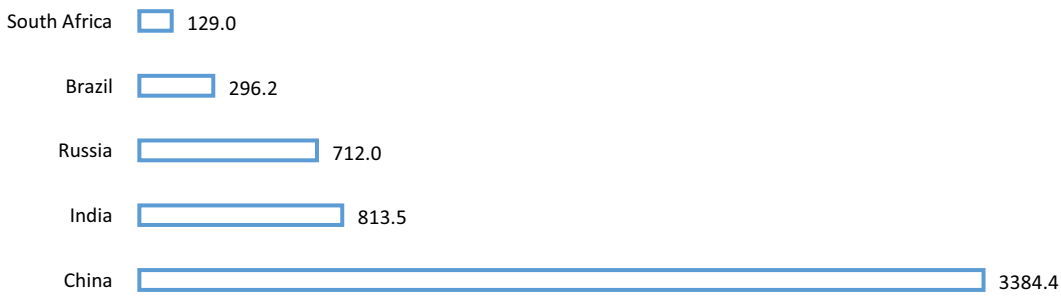

Figure 27: Primary energy consumption by BRICS nations

Source: BP Statistical Review of World Energy

In 2019, BRICS nations generated 10613.44 TWh electricity which is 41.0% of total electricity generated worldwide (25899.81 TWh). In 2020, the share of electricity generation by BRICS nations increased to 41.9%. In 2020, China generated 29.5% of the world's total electricity generation, followed by India (5.2%), Russia (4.0%), Brazil (2.3%) and South Africa (0.9%).

Figure 28: Electricity generated by BRICS nations in 2020

Source: BP Statistical Review of World Energy

Due to the significant differences in the geographical granularities and energy systems of the BRICS countries, each country faces different challenges in the development of the energy sector and sets different development goals. Despite all the challenges faced by BRICS nations, the share of renewable resources in their total primary energy consumption has been increasing continuously for the last five years. This shows the efforts taken by BRICS nations to have a smooth transition from fossil fuels to low carbon sources.

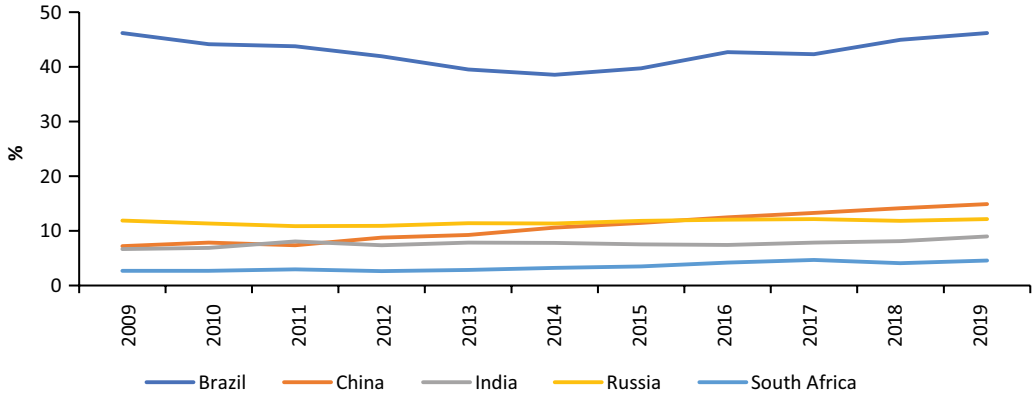

Figure 29: Share of primary energy from renewable sources in BRICS nations

In line with NDC commitments, BRICS nations are continuously working to reduce their carbon emissions. In the last two decades, starting from 2000, Russia, China and India reduced their CO_2 emission significantly by 41.10, 35.48%, and 20.69%, respectively. Brazil and South Africa reduced their CO_2 emission by 7.14% and 5.00%. Although carbon reduction by Brazil in the last two decades is comparatively more minor but still CO_2 emissions per unit of GDP (PPP) of Brazil are lowest among BRICS nations.

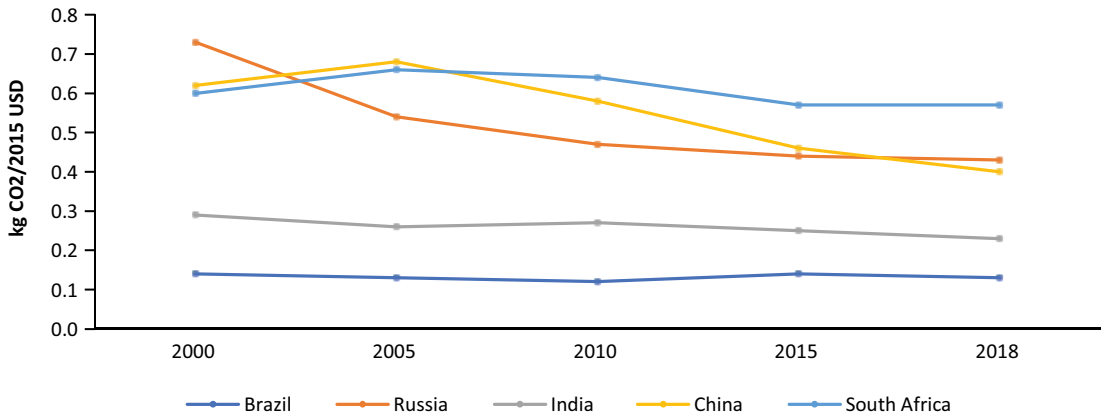

Figure 30: CO_2 emissions per unit of GDP (PPP) in BRICS nations

BRICS countries have several similar tasks and priorities in the energy sector. The main common development goals include:

» Building sustainable, efficient energy systems and diversifying the energy balance and supply structure to ensure uninterrupted, affordable energy supply and meet domestic energy needs to create a favourable environment for sustainable economic growth;

» Expanding access to energy to ensure energy security of the population to improve living standards and ensuring social stability.

» Maximum efficient utilization of domestic available energy resources.

» Creating clean, low-carbon energy systems to reduce the negative impact on the climate and environment.

To achieve these goals, the BRICS countries mutually agreed on the following objectives:

» Development and deployment of energy-saving technologies throughout the entire energy supply chain from production to final consumption.

» Smart energy infrastructure development;

» Development of renewable and low-carbon energy (based on natural gas, renewable energy sources, nuclear energy, hydrogen sources);

» Improving the efficiency of development, processing, and supply of fossil energy resources;

» Increasing the use of low carbon sources in the energy mix is an eco-friendly and economically efficient fuel, facilitating the transition to low-emission economies and increased access to energy and sustainable development.

» Diversification of energy consumption in the transport sector;

3.2 Impact and consequences of COVID-19 on BRICS countries' energy sector and mitigation strategies

Brazil

The Covid-19 pandemic imposed an important resilience test on the world with regard to public health, the economy and particularly the energy sector, which has led to the establishment of very severe and costly measures for countries and society in general.

In Brazil, the total energy demand in 2020 fell by 2.2%, with fossil fuels being the most affected by the COVID-19 pandemic, especially in the air transport and light vehicle sector. Renewable sources were practically unaffected by the pandemic in 2020, with a 2.5% growth in Brazil, supported by increases in sugarcane, wind, solar and biodiesel products.

To mitigate and overcome the impacts brought by the pandemic, few measures had to be taken. All these actions ensure the pillars of energy planning based on respect for contracts, regulatory coherence, stability, transparency and dialogue with society, always seeking the public interest.

For the success of these actions, Brazilian sought to establish an efficient governance system at the strategic, technical, operational and structuring levels. Thus, committees were created to deal with the crisis, such as the Crisis Committee of the Civil House of the Republic Presidency, the Executive Committee of the Ministry of Mines and Energy, sectorial committees and the Pró-Brazil program.

In addition, the government advanced reforms to restore market confidence and, therefore, reduce exchange rate volatility. As the exchange rate affects the equipment CAPEX, it is important that measures are taken both during and after the pandemic.

With regard to the electricity sector, the main action was to pursuit reducing tariff pressure on low-income consumers, ensuring the chain sustainability, predictability due to uncertainties and respect for contracts.

In the oil and natural gas sector, in order to contain operating costs, Petrobras cut daily production, hibernated platforms in shallow water fields, in addition to temporarily stopped gas pipelines and gas processing units.

Russia

The pandemic of coronavirus infection COVID-19 in 2020 negatively affected almost all sectors of the Russian fuel and energy complex, mainly due to a decrease in demand, but also, albeit to a significantly lesser extent, a consequence of quarantine measures at work.

In the oil industry, where, along with the pandemic, the OPEC + agreement should be taken into account, compared to 2019, oil production (-8.6%), export supplies (-12.7%) and primary processing (-5.4%) decreased.

In the gas industry, the pandemic, along with other factors, had a negative impact on the production of natural and associated gas (-6.1%), and affected export supplies (-2.4%) and domestic consumption (-3.3%).

In the electric power industry, both consumption (-2.3%) and electricity generation (-3.0%) decreased.

To reduce the impact and overcome the economic consequences of the COVID-19 pandemic in the energy sector, the Government of the Russian Federation took a number of measures in 2020, including support for industry companies, which made it possible by the end of the year to level the situation and ensure a gradual increase in the main parameters of the Russian fuel and energy complex.

India

The pandemic has created an unprecedented set of challenges for the entire power sector value chain. Due to the nationwide lockdown imposed by the Government of India, power demand from

March 2020 to April 2021 reduced by 25-30% and reached to 2009 level. On 22 March 2020, the day of voluntary 'Janata curfew,' daily power demand dropped by 15% on a year-on-year (y-o-y) basis.

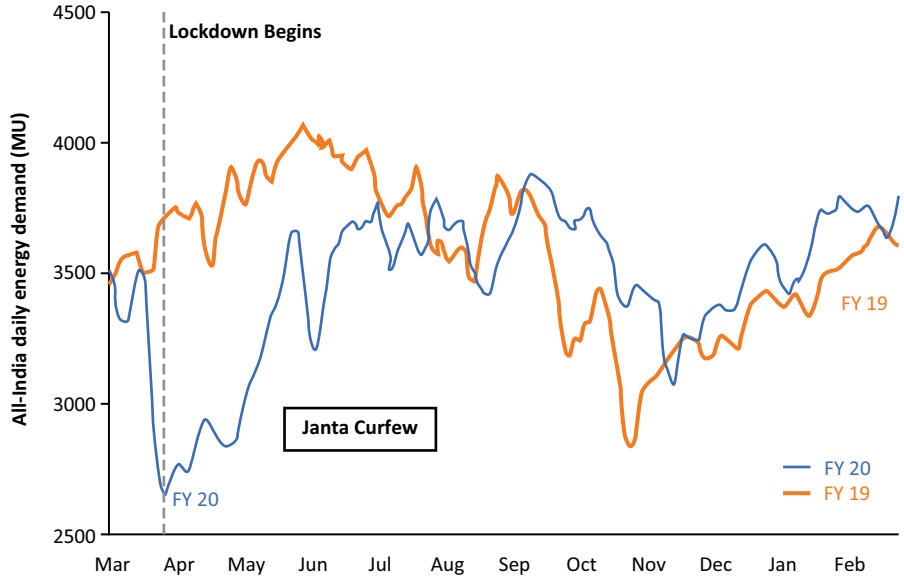

Figure 31: Electricity demand in India during Covid-19

Source: Regional Load Dispatch Center

With reduced demand levels, inefficient & expensive power plants have either been asked to cease generation and remain on standby or to reduce their output. On the other hand, renewable energy power plants have not been subjected to any generation restrictions due to the 'Must Run' status awarded to them under the regulations. Both these factors have resulted in a further dip in capacity utilization levels for the baseload power plants.

Apart from the reduced demand levels, the pandemic has also pilled the financial issues for the power sector companies. The weakest link in the value chain – the Distribution Companies - has come under increased financial distress or cash crunch levels. The situation has worsened as many states have extended waivers and deferrals of electricity bills to their customers. This has impacted revenue realization of the Discoms, which in turn has impacted all the key stakeholders in the value chain – Generator companies, Transmission companies, Fuel supply companies, and lenders.

As lockdown restriction eased, power demand in India also recovered in line with the rise in commercial and industrial (C&I) activity, as reflected in the Purchasing Managers' Index (PMI) trends. The y-o-y change in monthly demand is strongly correlated (0.88) with the composite PMI values observed between March 2020 and February 2021.

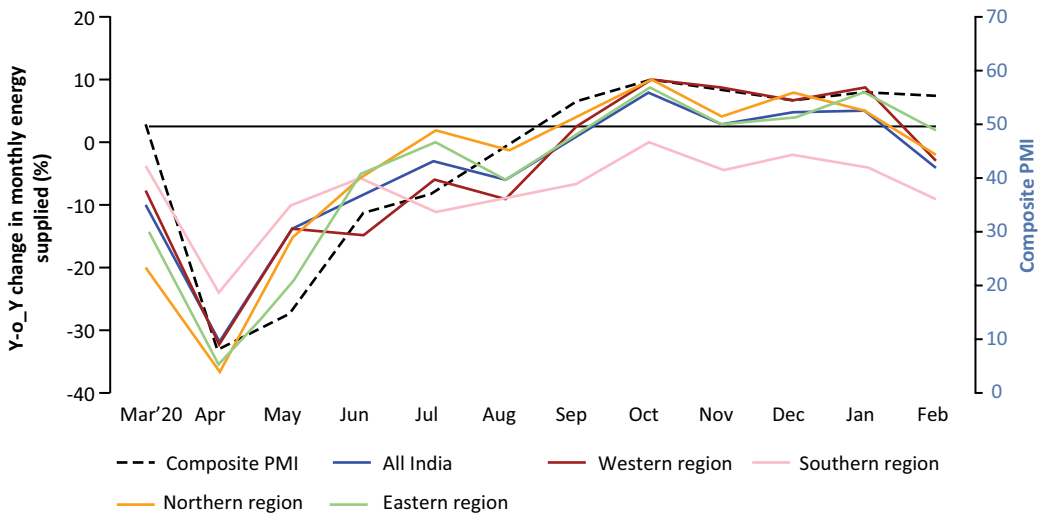

Figure 32: Recovery in power demand

To boost the health of DISCOMs, Government of India announced two main policy measures: (i) an INR 90,000 crore (~USD 12.1 billion) stimulus package and (ii) permission to expand state government borrowing limits.

» **Stimulus package:** The package offers a loan to DISCOMs to pay off generators, on the condition that they and state governments undertake various ambitious reforms. States are required to guarantee the entire loan amount and to ensure that subsidies are paid to DISCOMs monthly or quarterly, instead of once per year. State government departments are also required to install smart meters or prepaid meters in all state government departments to ensure timely payment of electricity dues to DISCOMs.

» **Expanding state borrowing limit policy:** Permission to expand borrowing limits is also subject to conditions, namely: (i) implementing a Direct Benefit Transfer (DBT) cash transfer system for electricity subsidies in at least one district by the end of the year and (ii) DISCOMs bringing down losses associated with the cost of supply and revenue collection.

» **Leeway in process for scheduling power:** As of last year, power companies were instructed to not supply power until a bank guarantee or a letter of credit (for the entire value of power supplied) was opened by DISCOMs to guarantee payment. DISCOMs that failed to comply were denied access to spot markets. During the COVID-19 crisis, a reduction of 50% in the guarantee mechanism was allowed. Further, surcharges for late payment have been reduced from 1.5% of bills to 1%, for the period March 24 to June 30, 2020. Again, however, these measures do not tackle root problems and risks for DISCOM revenue uncertainty.

China

China established a coordination mechanism to solve problems in energy supply and the resumption of enterprising production, tracked the supply and demand situation, and made every effort to ensure energy supply during the epidemic.

First, to ensure the safety and stability of the power system. China strengthened the organization and guidance for power production, promoted the resumption of all major power generation companies and power grid companies, and ensured sufficient supply and stable operation of the national power system. China guaranteed the power supply for key sectors, guided electric power companies to carry out "one household, one case" guarantee for hospitals, quarantine and isolation centers, pandemic prevention and control supplies companies, and medical support teams, etc. The power companies were guided to deeply analyze the electricity demand of the sectors, and established targeted power supply models and 24-hour contact mechanism. By playing the role of large power grid in optimizing the allocation of resources, China flexibly adjusted the power surplus and shortage among provinces, vigorously optimized the operation mode, and maintained the security and stability of the power grid and power supply.

Second, to ensure adequate supply in the oil and gas market. China vigorously increased oil and gas exploration and development efforts, and focused on increasing reserves, production and imports to ensure a stable supply of oil and gas. China enhanced the resource allocation efforts and improved the supply guarantee program for key areas, stabilizing oil product market, and ensuring clean heating gas supply and including the refined oil and LNG vehicles in the green channel, to ensure abundant oil inventories in key areas. The supply of refined oil products across the country was stable. Chinese government also instructed local energy authorities and related oil and gas companies to scientifically arrange services in oil and gas stations, strengthening their own epidemic prevention and control efforts. China promoted the resumption of all major oil and gas companies to ensure stable oil and gas production across the country.

South Africa

South Africa was not spurred from the devastating economic effects of COVID- 19. In this regard, the country adopted the Economic Recovery and Reconstruction Plan to respond to the challenge of the pandemic. The need to ensure security of energy supply has been identified as a critical intervention by the aforementioned Plan. Central to this is to accelerate the implementation of the Integrated Resources Plan (2019) ensure security and diversification of energy sources.

The IRP guides the country's approach towards procurement of energy sources in a socially just manner, to support commitments undertaken in the Paris Agreement, and while supporting efforts to diversify generation sources, taking into account national and regional development imperatives.

5. CONCLUSION

BRICS nations play a very important role in the system of international energy security as well as energy cooperation and their partnership therefore plays vital role in the global energy landscape. The demographic as well as energy profile of the BRICS member countries is undergoing a shift which has been further fueled by the impact of the COVID19 pandemic. The developments in the coming decade will include an expanding middle-class population leading to higher urbanization rates and rising industrialization which will demand more energy resources. The overall energy consumption in the member countries and per capita energy consumption levels will increase (with possible exception of Russia). However, the pace of this increase will depend on many factors, including energy efficiency measures.

The member countries have faced impacts of the COVID19 pandemic last year and took individual steps to reduce these impacts. Overall, the energy profiles were affected by respective national lockdowns in the countries, downturn in transportation and overall economic slowdown which led to reduction of both the energy supply and demand. To mitigate and overcome the negative trends brought by the pandemic, national governments undertook a set of measures which were relatively successful, especially in terms of maintaining stable and reliable energy supply to consumers. The events of 2020-2021 prove that energy planning remain an important pillar and efficient government systems played a major role in the development of energy sector.

The major challenge faced by the BRICS states in energy is finding proper ways to correlate energy production and consumption increase with climate goals. The development of renewable energy is an imperative among the BRICS partnership to keep them on track of their NDC commitments and achievement of SDGs. The share of renewable resources in their total primary energy consumption has been increasing continuously for the last five years, and this trend will continue.

However, other means of ensuring stable energy supply and reliable baseload generation must be explored. In the light of major role played by fossil fuels in the current energy mix more efficient and cleaner ways to use traditional energy sources is essential for quick reduction in emissions. Clean coal technologies and switch to natural gas, including LNG, feature prominently in BRICS states energy policy. They also endeavor to develop hydro and nuclear energy and expand the use of biofuels as sources of clean low or zero emissions energy generation. In the long run, development of a hydrogen based economy may play an important role in the energy supply and cleaning hard-to-abate sectors in the BRICS member countries as well. Comprehensive national programs to support the development of the low-carbon hydrogen energy industry have been adopted in the recent past in BRICS member countries. Cooperation in the field of hydrogen energy including existing and promising technologies may bring significant benefits to BRICS nations.

Shifting to the alternative forms of energy will also create a more unified global economy in a world that is cleaner and more energy efficient. The BRICS countries can serve as role models for cleaner low-emission development for less developed countries. The objective of decarbonization of key sectors like industry and the residential sector is also taken care of. This would mean guiding

investments and providing resources for Research, Development & Innovation and for the training of qualified professionals, both from the private and public sector.

The BRICS member countries aim to build a sustainable and efficient energy system that can ensure affordable and sustainable clean energy supply and meet domestic energy demands of the nations. Ensuring energy security and providing energy access to the population is also imperative as to improve the living standards and ensuring social stability.