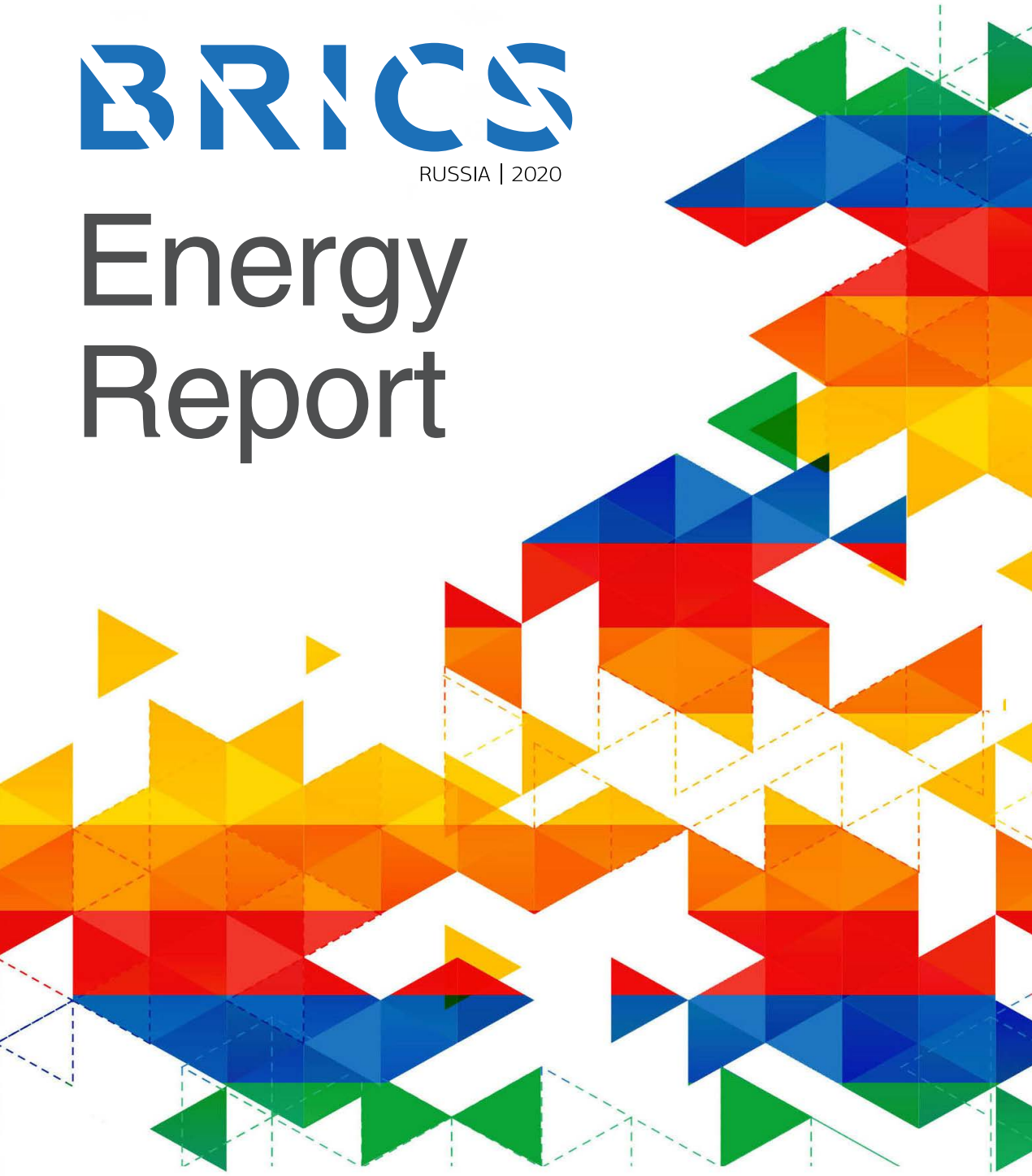
BRICS

RUSSIA | 2020

Energy Report



BRICS
ENERGY RESEARCH COOPERATION PLATFORM

BRICS

RUSSIA | 2020

ENERGY REPORT

BRICS
ENERGY RESEARCH COOPERATION PLATFORM

ISBN 978-5-9143803-3-2

The work presents the current state and plans for energy development in the BRICS countries, as well as analyzes possible areas of cooperation within the Group. The research focuses on the synergy and complementarity between the energy systems of the five countries, while emphasizing their significant role in the global energy system. The analysis also shows the need to strengthen the role of BRICS in the global energy agenda.

The material was prepared by experts of the BRICS Energy Research Cooperation Platform based on the national information provided and with the active participation of relevant ministries of the BRICS countries. The study consists of two sections. The first section is devoted to the study of the features of the energy systems of each of the BRICS countries. The second section assesses the role and place of BRICS in the global energy sector, considers complex strategic goals that are of interest to all the countries of the Group, and assesses the prospects for energy transformation in the next 20 years.

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

ACKNOWLEDGMENTS

This Report was made possible thanks to the support and advice of many individuals and organizations.

The Committee of BRICS Senior Energy Officials plays a key role in providing guidance and support at all stages of the Report's cycle. BRICS ERCP would like to thank each of its members for their time, energy and enthusiasm.

BRICS ERCP would like to acknowledge the support from the Ministry of Mines and Energy of the Federative Republic of Brazil, Ministry of Energy of the Russian Federation, Ministry of Foreign Affairs of the Russian Federation, Ministry of Power of the Government of India, Ministry of Petroleum and Natural Gas of the Government of India, Ministry of Coal of the Government of India, Ministry of New and Renewable Energy of the Government of India, Ministry of Statistics and Programme Implementation of the Government of India, National Energy Administration of the People's Republic of China, Ministry of Mineral Resources and Energy of the Republic of South Africa.

The following ERCP experts took part in the research: (Brazil) Andre Luiz Rodrigues Osório, João Antonio Moreira Patusco, (Russia) Vyacheslav Kulagin, Dmitry Grushevenko, Nikita Kapustin, (China) Xu Xiaodong, Gu Hongbin, He Zhao, Yan Bingzhong.

BRICS ERCP are also graceful to (Russia) the Energy research institute of the Russian academy of science, (India) NITI Aayog of the Government of India, (China) China Electric Power Planning & Engineering Institute, China Renewable Energy Engineering Institute, (South Africa) South African National Energy Development Institute.

BRICS ERCP would like to express gratitude to Russian Chairmanship for leading the preparation of the Report and its publication. Overall guidance was provided by the Deputy Minister of Energy of the Russian Federation Anton Inyutsyn.

Special thanks to Olga Yudina, who coordinated, oversaw production of the Report and overall publication process.

We are also very grateful to Ilya Klimov for the design of the cover and the illustrations included in this Report and Danila Rozhkovets for the logo design.

CONTENT

Welcome Remarks 08

Introduction 18

CHAPTER 1

ENERGY SECTORS OF THE BRICS COUNTRIES

1.1 BRAZIL 22

1.1.1 General overview 22

1.1.2 Energy sectors 25

1.1.3 Prospects for International Cooperation – goals, priority areas 30

1.2 RUSSIA 32

1.2.1 General overview 32

1.2.2 Energy industries 42

1.2.3 Prospects for international cooperation – goals, priority areas 62

1.3 INDIA 64

1.3.1 General overview 64

1.3.2 Energy industries 70

1.3.3 Prospects for international cooperation – goals, priority areas 76

1.4 CHINA 78

1.4.1 General Overview 78

1.4.2 Energy industries 83

1.5 SOUTH AFRICA 105

1.5.1 General overview 105

1.5.2 Energy industries 112

1.5.3 Prospects for international cooperation – goals, priority areas 113

CHAPTER 2

BRICS ENERGY SECTOR AS THE BASIS FOR SUSTAINABLE GLOBAL DEVELOPMENT

2.1	STRATEGIC DEVELOPMENT GOALS	114
2.2	CURRENT STATE AND PROSPECTS OF ENERGY DEVELOPMENT IN THE BRICS COUNTRIES	117
2.3	COVID-19 INFLUENCE ON BRICS COUNTRIES ENERGY SECTOR AND ANTI-CRISIS MEASURES	125
Conclusions		136

Bento Albuquerque

Minister of Mines and Energy
of the Federative Republic of Brazil

I would like to congratulate the Government of the Russian Federation for the masterful coordination of BRICS in 2020 and in particular of the ministers of energy meeting.

In this regard, I praise the adoption the BRICS Energy Report. This document is the result of the most commendable work of our experts and will strengthen and deepen our ties based on our common challenges and the exchange of best practices in the energy sector

As an energy superpower BRICS countries can play a pivotal role in guaranteeing not only our group's energy security but also the world's one in the future. To that extent the BRICS Energy Report is a first step in the right direction to enhance and diversify even further our already robust cooperation.

Alexander Novak

Minister of Energy of the Russian Federation

Right in front of you the very first study prepared within the BRICS Energy Research Cooperation Platform: a report on the development of the five countries' energy sectors. For the first time, our countries present to the world community the vision of BRICS role in the world energy sector.

The BRICS approach to energy cooperation is primarily based on the complementarity of the energy strategies of our countries. We have similar approaches to international cooperation, as well as common goals, including ensuring universal access to energy resources, energy security, and the fight against energy poverty.

BRICS today is about a third of the world's energy consumption and will account for more than 40% by 2040. We, as major energy powers, must work together to strengthen the role of the BRICS countries in the global discussion of energy issues, to shape and promote the view of the five countries on the global energy agenda, and to promote stability and predictability of energy markets. Such coordinated efforts will contribute to enhancing the sustainability and energy security not only of the BRICS countries but the entire world.

I am convinced that this report will commence the activities of the BRICS Energy Research Cooperation Platform aimed at obtaining substantiated data about key trends in the global energy sector and determining the BRICS contribution to ensuring energy security. BRICS ERCP researchers and experts will be able to propose consistent and independent estimates that will become an intellectual alternative to the analytical reports that are currently predominant on the market.

Raj Kumar Singh

Minister of Power
of the Republic of India

Energy is one of the most vital components of infrastructure for the inclusive economic growth and development of nations. The sustained growth with continuous transformation according to new challenges has been characteristic of Indian power sector.

The journey of power sector on growth trajectory has continued in India with focus on reliable, economic and quality power to all. The Government of India has been working tirelessly during such testing times during this COVID era to ensure stable, affordable, sustainable, and uninterrupted supply of power to meet demand, especially for essential services, such as healthcare.

The ensuing report presents general overview of the energy sector, energy industries and prospects of cooperation among the BRICS countries.

Zhang Jianhua

Administrator of National Energy Administration of China

The BRICS has always been an essential platform for major emerging markets and developing countries to strengthen collaboration and safeguard common interests. With joint efforts of the top leaders from the five member states, the BRICS spirit of openness, inclusiveness, and win-win cooperation has been upheld by all members to strengthen unity and address challenges together. Pragmatic cooperation have been achieved in various fields, especially in this year, facing crucial changes in the international landscape, BRICS countries have pulled and supported each other to overcome all the difficulties, made all-out efforts to overcome the impact of the COVID-19 pandemic and thus fully promoted economic recovery and set a model for building a new type of major-power relationship around the world. As President Xi Jinping illustrated at the Plenary Session of the BRICS Brasilia Summit in 2019, "Faced with profound changes rarely seen in a century, major emerging markets and developing countries like us must grasp the trend of the times. We must respond to the call of our people, and shoulder our responsibilities. We must remain true to our unwavering commitment to development and strengthen solidarity and cooperation for the well-being of our people and for the development of our world."

Energy cooperation is an indispensable part of pragmatic cooperation in the economic field of BRICS countries. Among the five countries, there are both energy producers and energy consumers. Each country has its own advantages in resource endowment and technological innovation. Strengthening energy cooperation and seeking ways to energy development and transition will not only help to jointly fight against external risks and climate change, but also have a positive impact on the global energy transition and sustainable development.

According to the consensus reached at the Forth Meeting of BRICS Energy Ministers, with the active initiative by Rotating Presidency of Russia, the BRICS countries have overcome many difficulties and completed the BRICS Energy Report and BRICS Energy Technology Report – the first two cooperative reports under the ERCP framework. I hope that there will be more fruits under the ERCP framework in the future. China is always looking forward to working with all parties to promote energy technology for BRICS and wide around the world with more extensive and mutually beneficial cooperation, so as to lay a solid foundation for the sustainable development of mankind.

Samson Gwede Mantashe

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

The South African government remains committed to decrease greenhouse gas emissions, restructure its electricity sector and improve prospects for lower electricity prices by gradually and responsibly reducing the share of coal in total electricity production through the uptake of renewable energy, gas, hydro and other complementary technologies. Our recently approved Integrated Resource Plan for the period up to 2030 guides our efforts, and calls for an energy mix that would contribute to both our energy security and stability objectives, as well as our commitments under the Paris Climate Agreement.

South Africa therefore welcomes and supports the BRICS Energy Report, as an innovative and futuristic tool to advance our own just transitions towards affordable, reliable, accessible and secure energy for all, while advancing sustainable development, job creation, skills development and economic growth. This Report could be of use not only to BRICS members, but also foster strengthened partnerships and mutually beneficial energy trade between BRICS and all regions in the world.

South Africa wish to acknowledges the effort of the BRICS 2020 Chairship under the Russian Federation for its efforts in forging all BRICS countries into a common programme, drawing on the strengths of the collective, but also allowing for space that will further nurture national actions towards a shared goal.

We have collectively, under your leadership, enhanced the international energy dialogue and presented our countries, collectively and individually, with diverse and innovative options that can drive regional and global energy market growth and stability, access and development. We look forward to working together as BRICS over the next coming years as we continue on this progressive and all-embracing path in global energy governance.

INTRODUCTION

The development of energy cooperation within the framework of BRICS has been on the agenda of the leaders of the BRICS countries since the initial summit, which was held in 2009 in Yekaterinburg (Russia).

The first meeting of BRICS energy Ministers was held in Moscow (Russia) in 2015. The Moscow Ministerial meeting marked the beginning of institutionalization of energy cooperation within the BRICS framework and was the first practical step in implementing the BRICS Strategy for Economic Partnership in the energy sector.

The key result of the meeting was the signing of a Memorandum of understanding on energy conservation and energy efficiency between the BRICS ministries and departments responsible for energy and energy efficiency, which provides for active cooperation in improving the energy efficiency of national economies.

The Memorandum also provided for exploring the possibility of further institutionalization of energy cooperation within the framework of BRICS.

The BRICS countries differ significantly in the degree of energy self-sufficiency, the structure of the fuel and energy balance, the level of development of energy infrastructure and the organization models of domestic energy markets.

At the same time, given the high volatility of world energy prices, the rapid development of new energy technologies, the development of new sources of hydrocarbons and significant progress in energy efficiency, in other words, in the context of the global transformation of the global energy system, the need to strengthen the role of BRICS in reforming the international energy architecture becomes obvious.

In the joint s tatements the leaders of the BRICS countries have repeatedly emphasized that energy derived from fossil fuels will continue to play a leading role in the energy balance for the foreseeable future, and that fossil fuels remain one of the most important sources of energy and the basis for the energy security of the BRICS countries. At the same time, the BRICS countries consistently advocate ensuring universal access to energy resources. Recognizing that shifts in the energy sector are unique for each country, depending on its national conditions, the Association will strive to expand the use of

clean and renewable energy sources and improve the efficiency of the use of fossil fuels. Traditionally, great importance is given to the development of nuclear energy as a clean, affordable and reliable source of energy.

In the Ministerial declaration adopted in 2019 in Brazil BRICS Ministers noted that BRICS countries have energy strategies that have proven to be complementary, opening up opportunities for enhanced intra-BRICS energy cooperation to foster domestic and global energy security and stimulate economic growth. Cooperation on energy holds common interest and represents a win-win situation for BRICS countries.

Having accumulated extensive experience in discussing energy issues in a five-party format, the countries decided in 2018 to create the BRICS Energy Research Cooperation Platform. In 2019, the Ministers of energy approved the Terms of Reference for the BRICS Energy Research Cooperation Platform (BRICS ERCP).

The BRICS ERCP will promote sustainable energy development through cooperation in energy research, technology, policy and innovation, and develop a broad dialogue on energy issues to ensure universal access to affordable, reliable, sustainable energy supply, strengthen the energy security of the BRICS countries, and ensure greater support for BRICS in global discussions on energy issues.

At the initial stage the priority areas for the BRICS Energy Research Cooperation Platform were identified, which included technological cooperation, digitalization, renewable energy sources, bioenergy, coal, natural gas, including LNG, sustainable transport, energy efficiency, smart grids, as well as studies on energy sectors development in the BRICS countries.

Based on the selected priorities, the topic for the first research of the BRICS ERCP was selected — an Overview of the energy sector of the BRICS countries. This document was prepared by the participants of the BRICS ERCP, based on national statistics of the BRICS countries. It provides a consolidated vision of the future of energy for the BRICS member countries, based on their national documents and joint statements on energy issues presented as the result of BRICS summits and meetings of BRICS Energy Ministers and contains independent and unaffiliated assessments of the prospects for energy development of the BRICS countries and their role in the global energy sector.


011 01010 011
01010 011
011 01010
01010
011 01010
01010 011
011 01010
01010 011
011 01010 011

CHAPTER 1

ENERGY SECTORS OF THE BRICS COUNTRIES

BRAZIL

RUSSIA

INDIA

CHINA

SOUTH AFRICA

[1.1]

BRAZIL

1.1.1_GENERAL OVERVIEW

ENERGY PRODUCTION

In 2018, Brazil produced 306.8 million toe of primary energy, including 14 million toe of non-used energy and natural gas reinjection (in 2019: 327 and 17 million toe, respectively). For the first time in its history, Brazil had a surplus of energy: 1.5% of the total demand (in 2019: 5% surplus). In oil, production exceeded consumption by 52.5%, being the key source for the Brazilian surplus (in 2019: 64%). Concerning the other sources, in 2018, there were deficits: 10.8% in oil products, 28.4% in natural gas, 84.3% in mineral coal and 5.5% in electricity.

Oil represented 43.7% of primary production and bioenergy, 29.5%.

By 2029, energy production is expected to grow at 5.5% per year, and should reach 520 million net toe, excluding 31 million toe of unused energy and reinjection. This production will exceed the Total Primary Energy Supply (TPES) by 140 million toe and will provide an energy surplus of over 35%.

Energy expansion accumulated investments up 2029 are estimated at 610 billion dollars, 78% in oil and gas, 19% in power energy and 3% in biofuels. This amount should represent 12% of Brazilian total investments in the period.

ENERGY CONSUMPTION

The TPES for 2018 was 288.7 million toe (in 2019: expected increase of 1.5%), equivalent to 1.37 toe per capita and 2% of world energy. Renewable sources accounted for 45.2% – this indicator is three times higher than the world average, 14%. The indicator for renewables comprises 31% of bio-energy, 12.6% of hydraulics, 1.4% of wind and 0.1% of solar. In non-renewable sources, oil accounted for 34.5%, natural gas with 12.4%, mineral coal with 5.8% and others with 2%.

Until 2029, total energy demand should grow 2.54% per year, reaching 380 million toe, and equivalent to 1.7 toe per capita.

IMPORT AND EXPORT

In 1979 Brazil had its largest net energy deficit: 45.9% of TPES. Oil had a deficit of 90% and oil products had a surplus of 8%. This year, the sum of imports and exports represented 50.8% of TPES.

In 2018, Brazil had an energy surplus for the first time, with exports surpassing imports. The sum of these two indicators accounted for 48.5% of the TPES.

Unlike 1979, in 2018, Brazil imported 9.6 million toe of oil and exported 55.7 million toe, and in oil products, it had a net deficit of 222 thousand bep per day. In other sources, there were also deficits, such as 10.6 billion m^3 in natural gas; 22.8 million t in mineral coal; and 35 TWh in electricity.

ENERGY MIX EVOLUTION

The 1970s were characterized by a strong economic growth (more than 8% per year in GDP growth) and high urbanization, with consequences for the energy matrix structure, whose renewable sources fell from a 57.6% share (1970) to 45.3% (1980). In this period,

while firewood fell from 47% to 26.9%, hydraulics rose from 5 to 9.6% and sugarcane products rose from 5.3 to 8%. Firewood was replaced by LPG because of urbanization. Sugarcane products grew due to the institution of the National Alcohol Program in 1975.

The lowest share of renewables in the Brazilian energy matrix occurred in 2001 (39%), when a drought greatly reduced hydraulic generation and increased the thermoelectric generation by fossil sources. As of this year, the evolution of renewables has grown, reaching 45.2% in 2018 (in 2019: increasing of 0.7 percentage point).

Until 2029, current energy expansion studies show that renewables reach 48% in Brazil's 2029 energy matrix.

GOVERNANCE, PLANNING AND REGULATORY FRAMEWORK

The pillars for the management of the energy sector in Brazil are:

- Improved governance standards;
- Regulatory stability;
- Predictability;
- Transparency;
- Sustainability and
- Guarantee for receivables.

The annual elaboration of 10-year Energy Expansion Plan supports the actions to be taken in order to ensure the necessary energy supply. These plans provide guidelines for conducting auctions for electricity, transmission lines, biofuel production and oil blocks.

In 2019 it was instituted the National Energy Plan, with horizon above 30 years, in order to guide potential power supply paths in light of new technologies and possible exhaustion of resources. The Plan will be reviewed every five years.

MAIN CHALLENGES

To find the economic-financial balance of the entrepreneurs vis-a'-vis prices and tariffs consistent with the purchasing power of the population.

Maintain the institutional and legal framework in order to maintain low judicialization and high attractiveness for national and foreign investors.

Practice, for commodities, internal prices based upon international ones.

Propose subsidies to leverage certain technologies and know the right time for the re-establishment of free competition.

Reconcile the legitimate interests of the different energy sectors with the national interest.

Be prepared for economic national or international break-ups and catastrophes in order to mitigate the resulting effects.

Maintain a satisfactory renewable energy matrix, without compromising the population's access to energy.

Monitor the National Interconnected System's power generation dispatch in order to reconcile intermittent wind and solar generation and seasonal generation of hydraulic energy and sugarcane biomass.

1.1.2_ENERGY SECTORS

LIQUID FUEL

Proved oil reserves, without natural gas liquids, were 2,136 million m^3 at the end of 2018, equivalent to 14 years of production in the same year. 2018 production was 150.5 million m^3 (2.59 million bbl/day) and that of 2019 was 161.96 million m^3 (2.79 million bbl/day), showing an increase of 7.6 % (in 2019: useful life of reserves decreases to 12.5 years).

Natural gas liquids production is about 75 thousand bbl/day.

Oil processed at refineries was 96.8 million m^3 in 2018 and 96.9 million m^3 in 2019.

The installed refining capacity was 2.4 million bbl/day at the end of 2018, with a 73% utilization factor. In toe, diesel represented 39% of the total refining load, and gasoline, 20.1%.

Brazil is a net importer of oil products, with an external dependence of around 11% of total needs. In diesel, the dependency is close to 23% (214 thousand bbl/day). In gasoline, slightly above 10% (48 thousand bbl/day), and in naphtha, above 60% (149 thousand bbl/day). It is a net exporter of fuel oil (158 thousand bbl/day) and aviation kerosene (33 thousand bbl/day). The indicators are from 2019, and include bunker.

The average price of oil products, at the exit of the refinery, follows international references, adequately remunerating the producer. Social prices are charged for LPG, to the detriment of higher prices for automotive gasoline.

By 2029, oil production is expected to grow at 7.1% per year, reaching 5.54 million bbl/day, with just over 60% being made available for export, and the rest, for refineries. An expansion of close to 100 thousand bbl/day is expected in the installed refining capacity, which will reach 2.5 million bbl/day. Under these conditions, oil products continue to have a deficit of around 11% of domestic needs.

Investments in exploration, production and refining, expected until 2029, are about US $ 470 billion and account for 77% of total investments in energy expansion.

Oil and oil products are expected to lose a little more than two percentage points in the TPES structure.

The auctions for oil blocks continue to be proposed in order to guarantee the expansion of reserves and oil production.

NATURAL GAS

Proven natural gas reserves stood at 368.9 billion m^3 at the end of 2018, equivalent to 9 years of production in the same year. The production in 2018 was 40.9 billion m^3, and in 2019, 44.7 billion m^3, showing an increase of 9.5%, being the gas was considered wet and including liquids, reinjected and not used. In 2019: useful life recoils to 7.6 years.

From the wet gas production, 51% is processed in the gas plants, 36% is reinjected and not used, and 13% is used in the oil and gas sector's own energy consumption.

Brazil, a dry natural gas importer, imported 10.6 billion m^3 in 2018 and 9.8 billion m^3 in 2019. The imports fluctuation is influenced by a greater or a lesser gas thermoelectric generation.

In 2018, the total demand for natural gas was 35.9 million toe (net production and imports), with the main uses: 30% for power generation, 26% for industry, 20% for energy sector consumption and 12% for natural gas liquids production. About 75 thousand bbl/day of natural gas liquids were produced in the plants.

The New Gas Market program is underway, which aims to make transport and marketing operations more competitive, making the product more accessible to consumers.

Until 2029, the production of natural gas is expected to grow close to 8% per year, reaching around 92 billion m^3.

Investments in gas exploration, production and refining are part of the oil activities, previously mentioned.

The participation of natural gas in the 2029 energy matrix may be stable or rise by 2 percentage points, depending on the effects of the New Gas Market program, which would increase its participation to 14%.

COAL

The proven reserves of mineral coal are enough to cover more than 500 years of current production. In 2018, 5 million tons were produced and 21 million tons were imported (in 2019: production of 5.4 million tons and importation of 18.4 tons). National coal has about 75% of its use in thermoelectric generation and the rest in industrial activities.

From the total demand for mineral coal in 2018, amounting to 25.5 million t, 28% went to thermoelectric plants, another 28% went to industry and 44% went to coke plants, for the production of coal coke. The steelmaking industry consumes around 60% of Brazil's total coal demand.

In 2018, 1.8 million tons of coal coke were imported to complement national production.

In 2029, the coal production is expected to reach 2.4 million tons, and imports, 24 million tons. The estimated import of coal coke is 1.5 million t. With these results, coal is expected to lose 1 percentage point in the 2029 energy matrix structure, reducing their participation to 4.8%.

Hydro generation capacity factor recovery is expected, from 43% in 2018, to historical levels of 53%, which will provide less coal and oil products for power generation.

ELECTRIC POWER SECTOR

IIn 2018, electricity consumption stood at 535.4 TWh, 10% of which to self-producers consumption, without public grid using (in 2019: increasing of 1.9% in demand). In terms of electricity sectorial consumption, 37.5% was in industry, 25.4% in residential sector, 25.6% in commerce and services, 5.6% in agriculture and 5.9% in the energy sector. Per capita consumption was 2,550 kWh.

Domestic generation stood at 601.4 TWh and net imports, at 35 TWh, resulting in a total supply of 636.4 TWh (in 2019: increasing of 4.2% in generation and reduction of 29% in importation).

Electricity losses accounted for 15.9% of the offer, of which about 5% are due to commercial losses, not billed.

In the supply structure, hydraulic generation (including imports) remained at 66.6%, bioenergy at 8.5%, wind at 7.6%, solar at 0.5%, natural gas at 8, 6%, nuclear with 2.5%, and other fossils with 5.6%. In total, renewables was 83.3%, an indicator more than three times the world average. In 2019: renewables stand at 83%, but the sum of wind and solar increases 1.4 percentage point, reaching to 9.6%.

At the end of 2018, the installed power generation capacity was 163.4 GW, 83% of which renewable (in 2019: 172.3 GW and 83.6% of renewables). The average expansion in the last 5 years was 7.3 GW. Noteworthy was the wind power expansion, from 2.2 GW in 2013 to 14.4 GW in 2018, and to 15.4 GW in 2019. Another wind power highlight is its capacity factor, above 40%, almost twice the world indicator (25%).

Solar energy is also noteworthy, nearly doubling the installed capacity in 2019, reaching 4.44 GW, with an increase of 94% over 2018.

Until 2029, the power supply is expected to grow at 3.6% per year, reaching 942 TWh. Renewables increased 4% in supply, reaching 87%, with highlights on wind (16.5%) and solar (3.6%) energies, the sources that will have the greatest expansion. Hydraulic generation is expected to lose around 9 % in the supply structure. The portion imported from Paraguay, from the Itaipu power plant, will decrease over time, in absolute and relative figures.

In 2029, the power generation installed capacity should reach 246 GW, with an average annual expansion of 7.5 GW. Fossil fuels, with a focus on natural gas, will increase 3 percentage points in the structure, reaching 44 GW (18% share). Solar and wind, with 54 GW, will raise almost 12 percentage points. The relative increase in fossil capacity is intended to generate power energy in the intermittencies of solar and wind power.

The foreseen nuclear expansion is 1.4 GW, corresponding to the Angra 3 power plant, and should start operating at the end of the period.

Transmission lines are expected to expand 56,000 km, with the network reaching a total of 203,000 km in 2029.

The investments planned for 2029 for the power sector are US$ 118 billion, equivalent to 19% of the total investments in energy infrastructure.

RENEWABLES

In 2018, renewable sources totaled 130.5 million toe, equivalent to 45.2% of TPES. Of this amount, 89.6 million toe, or 31.7% of TPES, correspond to bioenergy (in 2019: 93.9 million toe and 31.9%, respectively).

Bioenergy is composed of liquid (ethanol and biodiesel) and solid fuels (firewood, charcoal, sugarcane bagasse, bleach and others). In 2018, the total demands for these enwergy sources were: 31.6 million m^3 of ethanol, 5.4 million m^3 of biodiesel, 78 million tons of firewood, 158 million tons of sugarcane bagasse and 33 million tons of bleach.

In terms of total bioenergy sectoral uses (in toe), industry accounts for 36%, transportation for 22%, energy sector (bagasse in ethanol production) for 16%, power generation for 11%, residential for 7% and others with 8%.

Until 2029, bioenergy grows at 2.74% per year (121 million toe), above the TPES (2.54% per year). Biodiesel (7% per year) and Cellulose bleach (6% per year) are the main drivers of bioenergy good indicator. Ethanol grows at a more modest rate, just below 2% per year.

The investments planned for bioenergy expansion are about US$ 18 billion, equivalent to 3% of total investments.

ENERGY EFFICIENCY

In Brazil, for every 100 units of TPES, 88% reach the final consumption, including the energy industry own use. In the world, 76% reach the final consumption. This comparative advantage in Brazil (12 %) is due to the low proportion of power generation by thermoelectric plants, processes that cause high thermal losses.

Thus, from a global point of view of energy use, Brazil is much more efficient than most countries in the world.

In another dimension of efficiency, that of energy consumption per unit of GDP, in Brazil, the indicator is 0.098 toe/thousand US$ of GDP, and in the World, is 0.119 toe/thousand US$ of GDP, in terms of constant PPP dollar 2011, from the World Bank.

By 2029, avoided energy consumption due to energy efficiency will reach 21 million toe, or 6% of final energy consumption. In power energy, the avoided consumption is 40 TWh, or 5% of the final consumption of this source. The energy-to-GDP ratio is expected to decline 3%, going to 0.095 toe/thousand US$. The relationship between final energy consumption and total energy demand is expected to remain at 0.88.

1.1.3_PROSPECTS FOR INTERNATIONAL COOPERATION – GOALS, PRIORITY AREAS

In terms of energy international cooperation, the following goals could be mentioned: Attraction of investments to the power and energy sector, both renewables and non-renewables; promotion of biofuels policies; promotion of energy security associated to the diversification of each country's energy matrix, according to national possibilities and available resources; pursue venues for cooperation in energy transition as a mean of sustainable development; coordinate positions in energy fora, with due respect to national priorities and policies.

Brazil maintains fruitful exchange of energy information with many international organizations – such as the United Nations, the Latin American Energy Organization (OLADE)

and the International Energy Agency (IEA). Such exchange of information involves monthly and annual data on energy supply and demand, energy infrastructure, prices and tariffs, and policies on energy planning and expansion.

In addition, Brazil actively participates in a number of international fora to address a number of energy related issues, such as: the Biofuture Platform; the International Agency for Renewable Energy (IRENA); the Renewable Energy Policy Network for the 21st Century (REN21); the International Solar Alliance; the Clean Energy Ministerial (CEM); the G-20 Energy Sustainability Working Group (ESGW); the Energy and Climate Partnership of the Americas (ECPA), the BRICS; among others.

Brazil has electric connections with neighboring countries – transmission lines with Argentina (2000 MW and 50MW), Uruguay (500 MW and 70MW), Paraguay (14000 MW and 50MW) and Venezuela (200 MW). There are other minor interconnections with Bolivia, Colombia and Paraguay. Brazil also has gas pipelines reaching Argentina (2,8 millions m^3/day) and Bolivia (30 million m^3/day).

[1.2]

RUSSIA

1.2.1_GENERAL OVERVIEW

ENERGY MIX (PRODUCTION, CONSUMPTION, EXPORT AND IMPORT)

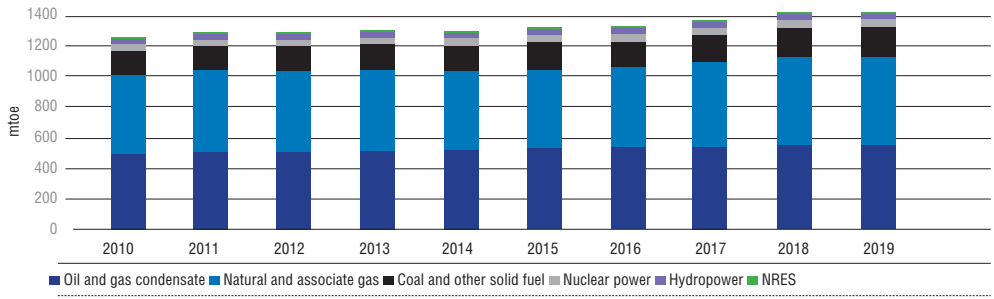
Russia is the third largest producer and consumer of energy resources in the world after China and the United States, providing 10% of world production and 5% of world energy consumption.

The Russian energy complex includes the oil, gas, coal, electricity and heat supply sectors, and plays a key role in generating budget revenues in the Russian Federation.

The Russian energy infrastructure is based on the unified energy system, the unified gas supply system, and the system oil and petroleum products pipelines, is one of the largest in the world and operates in various natural and climatic conditions: from the Arctic to the subtropical zone.

From 2010 to 2019, primary energy production in Russia increased by 10.5%, including oil by 12%, natural gas by 10%, and coal by 30% (Figure 1.1).

Figure 1.1 Primary energy production in Russia in 2010-2019



Source: Rosstat, Ministry of Energy, Energy strategy of the Russian Federation up to 2035

Russia consumes about half of all primary energy produced. In 2018, the demand for energy was about 750 Mtoe, an increase of 9% since 2010. An important driver of consumption growth was the creation of new industrial production, the development of the residential sector and the growth of the population's prosperity (in particular, from 2000 to 2020, the car fleet increased more than twice).

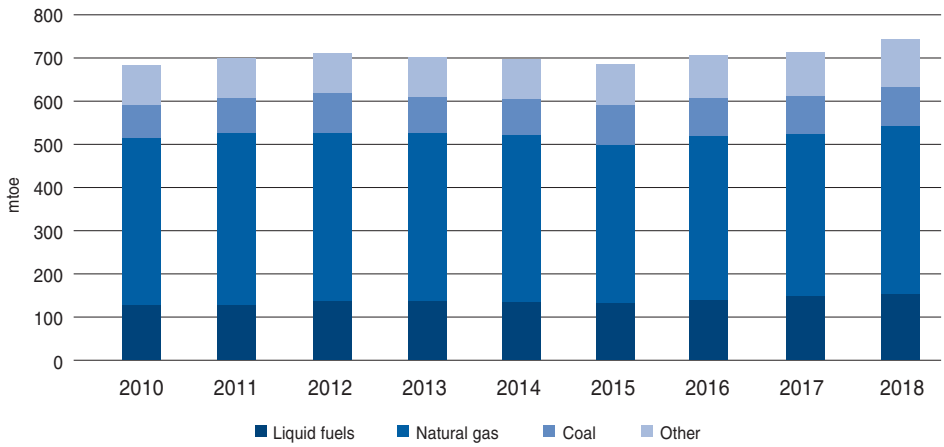
Russia is a net exporter of all types of energy resources, except uranium, and consistently ranks 1st in the world in gas exports, 2nd in oil exports, and 3rd in coal exports.

With an energy production volume of about 1,440 Mtoe, Russia exports about half of the primary energy produced (in 2018, 708 Mtoe), providing 16% of the world's energy trade.

In the future, Russia aims to retain its position as one of the largest suppliers of energy to global markets. According to the Energy strategy of the Russian Federation up to 2035 (hereinafter referred to as the Energy strategy), the total volume of energy exports by 2035 will grow by 1.15-1.46 times and will amount to approximately 800-1000 Mtoe.

Among the largest economies in the world, the Russian energy mix is one of the least carbon-intensive: more than a third of electricity generation is produced through nuclear power, hydropower and other renewable energy sources; about half comes from natural gas (Figure 1.2).

Figure 1.2 Volumes and structure of primary energy consumption in Russia



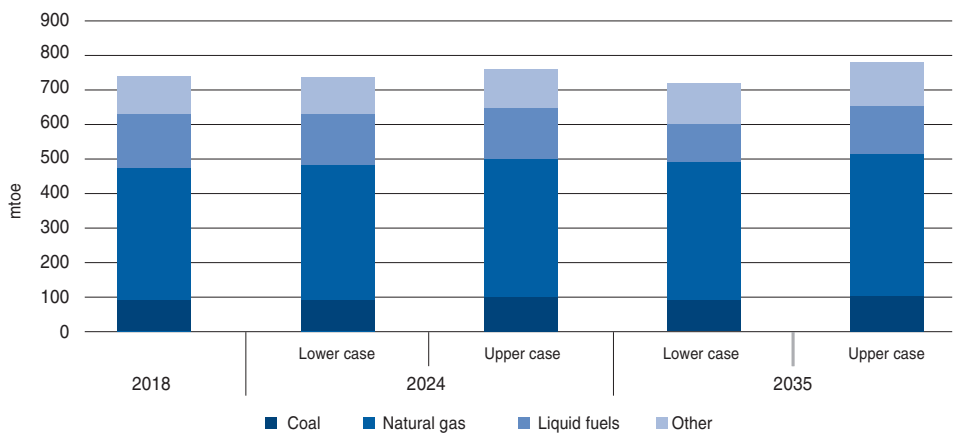
Source: Energy strategy of the Russian Federation up to 2035

According to the forecast of socio-economic development of the Russian Federation up to 2036, the average annual growth rate of GDP in 2019-2036 is expected be 2.8-3.0% and the population will be stable. The growth in demand for energy resources, stimulated by the economic development, will be largely offset by the development of energy saving and energy efficiency. As a result, according to the scenarios of the Energy strategy, energy consumption in the country amount to 1050-1134 million tons of coal equivalent by 2035 (725-785 Mtoe), which signifies a decrease of more than 2% in the lower-case scenario, and an increase of almost 6% in the higher-case.

The share of natural gas, as the cleanest hydrocarbon energy source, in the total volume of primary energy consumption should increase from 51.9% in 2018 to 53-55%, and the share of non-carbon energy sources (nuclear energy, hydropower and other RES) – from 14.8% to 16.5%.

The share of coal in domestic consumption has been declining for a while. In 2000 it was 19.9%, but by 2018 it had fallen to 12.3%, and it will remain at about this level up to 2035.

Figure 1.3 Prospective changes in the Russian energy mix until 2035



Source: Energy strategy of the Russian Federation up to 2035

By 2035, the outlook on oil and oil products consumption shows a decrease in both their share in the fuel and energy balance (15.6-17.8% from 21.0% in 2018) and absolute volumes. Especially notable, the consumption of fuel oil will decrease by 2.5 times. The consumption of gasoline and diesel fuel will be affected by the spread of transport gasification in the country (Figure 1.3).

GOVERNANCE, PLANNING AND REGULATORY FRAMEWORK

Russia possesses a fairly extensive legislative framework that regulates the production, transport and consumption of all major energy resources, energy conservation and energy efficiency.

Since 2014, the state system of strategic planning has been in operation. The fundamental documents of strategic planning in the energy sector are: the Energy Security Doctrine of the Russian Federation and the Energy Strategy.

The Energy Security Doctrine defines the main challenges, threats and risks for energy stability, as well as the main directions and tasks for its assurance.

The Energy Strategy is based on the analysis of the current situation and prospective trends in the development of the global and Russian energy sector. It defines the goals and main directions of energy development, tasks, indicators and key measures to ensure the achievement of the set goals.

In accordance with the strategic planning architecture, the Energy strategy implements the provisions of the national security strategy, the socio-economic development strategy, the spatial development strategy, and the scientific and technological development strategy, taking into account a number of long-term forecasts.

The provisions of the Energy strategy, in turn, are detailed, taken into account and implemented within the framework of strategies and General schemes for the development of individual energy industries, the "Energy Development" state program and corporate development strategies of leading energy companies.

MAIN CHALLENGES

Among the key challenges that stimulate the development of Russian energy, the following should be noted noted:

- moving the focal point of global economic growth to the Asia-Pacific region;
- slowing down the growth of global energy demand and changing its structure, due to the substitution of petroleum products with other types of energy resources, the development of energy conservation and energy efficiency;
- increasing the global hydrocarbon resource base, increasing competition among energy exporters, due to the emergence of new exporters;
- changing international regulation in the field of energy and the conditions for the functioning of world energy markets, strengthening the position of consumers;
- increasing the share of renewable energy sources in the global energy mix;
- intensification of international efforts for implementation climate policy and accelerated the transition to a "green economy";

- Russia's transition to a new model of socio-economic development, which implies a structural transformation of the economy, balanced spatial and regional development, modernization of the main production assets of organizations, and a significant increase in labor productivity and economic efficiency;

- development and spread of breakthrough technologies in the energy sector;

- imbalance in the location of energy production and consumption centers, creates an unprecedented and constantly growing volume of the most expensive long-distance overland transport of fuel.

Cross-border threats to Russia's energy security, which are also important for the energy security of other countries, are:

- terrorist and subversive activities that are detrimental to the infrastructure and energy facilities;

- illegal use of information and telecommunications technologies, including hacker attacks on information infrastructure and communication networks used to organize their interaction, which can lead to interruption of the functioning of infrastructure and energy facilities;

- adverse and dangerous natural phenomena, changes in the environment that may lead to disruption of normal functioning and destruction of infrastructure and energy facilities.

STRATEGIC GOALS FOR ENERGY DEVELOPMENT

The goal of Russian energy development, according to the Energy strategy, is twofold: on the one hand, to maximize the country's socio-economic development, and on the other – to strengthen and preserve the Russian Federation's position in the global energy sector, at least for the period up to 2035.

In order to achieve this goal in the context of the projected changes in the global and Russian economy, an accelerated transition – a modernization spurt – to a more effi-

cient, flexible and sustainable energy industry that can adequately respond to challenges and threats and overcome existing problems will be crucial.

The characteristics of this spurt include:

- structural diversification, which implies that: carbon energy will be supplemented by non-carbon energy; centralized energy supply with the decentralized; energy exports with the exports of Russian technologies, equipment and services in the energy sector; expansion of the use of electric energy, liquefied natural gas and gas as fuel;

- digital transformation and intellectualization of the fuel and energy industries, which will result in a new quality of all processes in the energy sector, new rights and opportunities for consumers of products and services of the energy industries;

- optimization of the spatial distribution of energy infrastructure, which will create oil and gas mineral resource production centers and petrochemical complexes in Eastern Siberia, the Far East and the Arctic regions of the Russian Federation; expansion of the infrastructure for transporting energy resources, will make Russia a leading player in the energy markets of the Asia-Pacific region;

- reducing the negative impact of energy industries on the environment and adaptation to climate change; which will allow Russia to make a significant contribution to the transition to low-carbon development of the global economy, and to international efforts to preserve the environment and counter climate change.

It is also worth noting the strategic goal of developing hydrogen energy, aimed at making Russia one of the world leaders in the production and export of hydrogen.

The main actions aimed at achieving these goals of Russian energy development are:

1) efficient provision of the needs of socio-economic development of the Russian Federation, including the national programs and projects, with the corresponding volumes of balanced, available and sustainable energy supply, while maintaining sufficient export volumes and revenues;

2) spatial and regional development of the energy sector, which implies the transformation and optimization of energy infrastructure, taking into account the development of domestic and global markets for energy products and services, political and economic integration processes and changes in international relations;

3) achievement of technological independence of the energy sector and increasing its competitiveness, meaning the provision of equipment, materials, software and related services produced in the Russian Federation and territories under the jurisdiction of the Russian Federation sufficient for sustainable functioning and development the energy sector on the state-of-the-art level;

4) improving government administration and developing international relations in the energy sector.

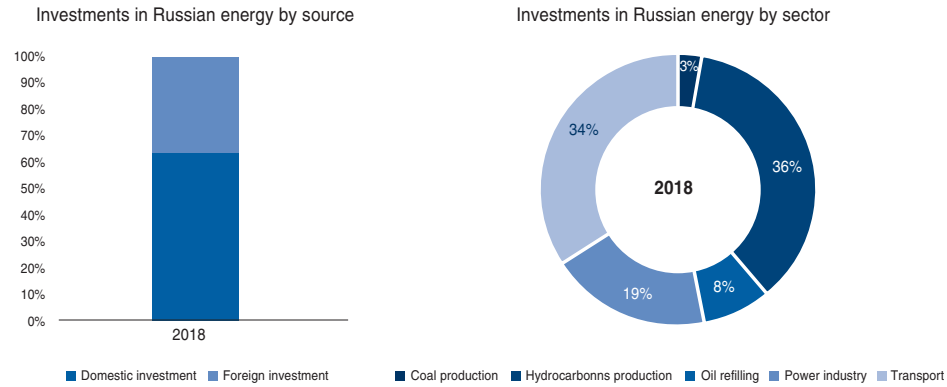
The priorities of the state energy policy are:

- guaranteed energy security of the country as a whole and at the level of the subjects of the Russian Federation, especially those located in geostrategic areas;
- priority on satisfaction of internal demand for energy-related products and services;
- transition to clean and resource-saving energy;
- development of competition in competitive activities of the fuel and energy sector in the domestic market;
- environmental management and energy efficiency;
- maximum use of domestically produced equipment;
- improving the efficiency and effectiveness of all levels of management in the energy sector;
- maximize the benefits of centralized power supply systems.

ECONOMIC STRUCTURE, INVESTMENT AND FINANCING

In 2018, energy sector accounted for about 37% of the total investment in fixed assets in the Russian Federation, which, according to Rosstat data, amounted to 5.0 trillion rubles. 1.9 trillion rubles were directed to the upstream segment of the oil and gas industry, 1.8 trillion rubles was spent on the development of pipeline and other land transport needs of the energy complex, 1 trillion was accounted by power sector, with almost 36% of the total investment provided by external actors (Figure 1.4).

Figure 1.4 Structure of investments in the Russian energy sector by investment sources and types of activity

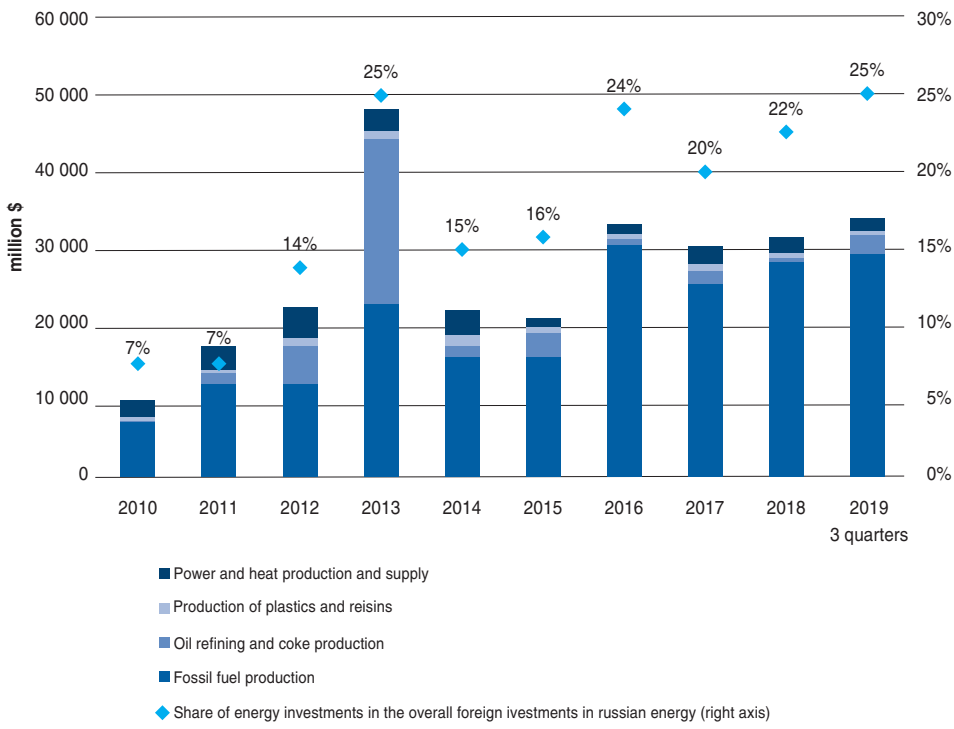


Source: Official website of the Central Bank of the Russian Federation. Direct investment in Russia: operations by type of economic activity. Available at: https://cbr.ru/vfs/statistics/credit_statistics/direct_investment/08-dir_inv.xlsx; EMISS. State statistics «Investments in fixed assets by type of economic activity for a full range of economic entities». Available at: https://www.fedstat.ru/indicator/59048

The Russian energy sector has long been an attractive asset for foreign investors, who invested three times more in it in 2019 than in 2010 (Figure 1.5), and this is an estimate only for direct investments, excluding portfolio acquisitions of shares and other securities of Russian energy companies. The share of the energy sector in total direct investment in Russia has increased from 8% in 2010 to 25% by 2019, which indicates the confidence of investors in the ability of Russian oil, gas and electricity companies to maintain stability and successfully conduct business even in the face of discriminatory restrictions from a number of countries and significant transformations taking place in the global energy markets.

In order to improve the business climate and create conditions for increasing the investment attractiveness of the Russian economy, the Government of the Russian Federation approved an action Plan in 2019 to accelerate the growth rate of fixed capital investment and increase its share in gross domestic product to 25%. According to the document, the target value of investment in fixed assets of the energy sector in 2024 is 7.8 trillion rubles.

Figure 1.5 Foreign direct investment in the Russian energy sector



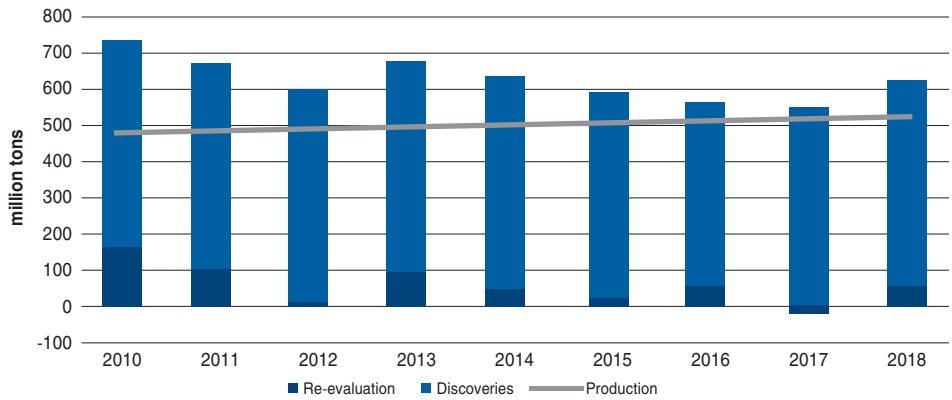
Source: Source: Official website of the Central Bank of the Russian Federation. Direct investment in Russia: operations by type of economic activity. Available at: https://cbr.ru/vfs/statistics/credit_statistics/direct_investment/08-dir_inv.xlsx

1.2.2_ENERGY INDUSTRIES

LIQUID FUEL

Russia has extensive proven reserves of oil and gas condensate, and is ranked 6th in the world by this indicator. As of January 2019, the country's technologically recoverable reserves of liquid hydrocarbons in categories A, B,and C1 amounted to 33.9 billion tons, and resources-55 billion tons. The loss of reserves due to oil production is constantly compensated by regular geological exploration (Figure 1.6).

Figure 1.6 Dynamics of growth/loss of recoverable oil reserves and crude oil production in 2010-2018



Source: Ministry of natural resources of the Russian Federation. State report «on the state and use of mineral resources of the Russian Federation in 2018». Available at: http://www.mnr.gov.ru/docs/gosudarstvennye_doklady/gosudarstvenny_doklad_o_sostoyaniy_i_ispolzovanii_mineralno_syrevykh_resursov_rossiyskoy_federatsii/

The structure of reserves has been deteriorating in recent years, both in terms of the quality of oil (density, viscosity, sulfur content), and in terms of the growth of production costs due to the predominance of hard-to-recover oil in newly discovered fields and the need to develop greenfields in remote areas with little-to-none infrastructure.

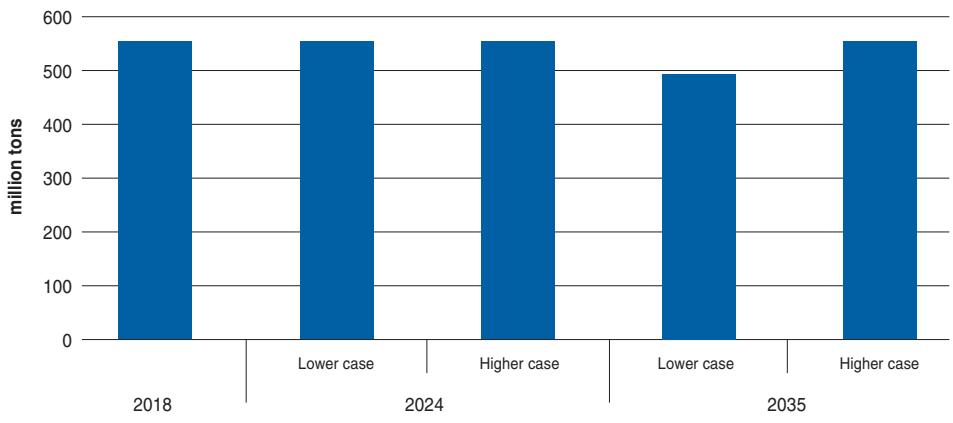
These factors pose additional challenges for the industry, including technological ones, and are also taken into account when forming regulatory policy. Methods of tax incen-

tives are being introduced; in particular, starting from 2019, the transition to taxation of financial results (tax on added income) is being tested.

Production of oil with condensate in 2018 compared to 2008 increased by more than 14 percent, including due to the start of large-scale development of fields in Eastern Siberia (Vankor cluster) and the Republic of Sakha (Yakutia), as well as fields located in the Caspian sea. The Prirazlomnoye field has been developed on the Arctic continental shelf of the Russian Federation.

In 2018, oil and gas condensate production amounted to 555.7 million tons. The achieved level of oil production significantly exceeds the forecasted domestic needs of the Russian Federation until 2035. In the future, these production volumes are expected to be maintained in the "higher case" scenario of the Energy strategy (Figure 1.7). The "lower case" scenario considers a reduction in production volumes, mainly due to a decrease in the profitability of production at higher complexity fields, waterlogging and reserves depletion.

Figure 1.7 Production of liquid hydrocarbons in Russia in 2019 and 2024-2035



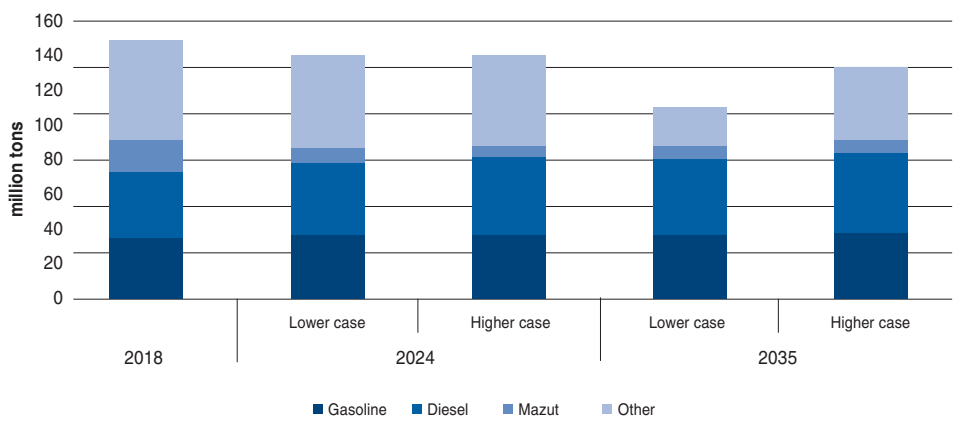
Source: Energy strategy of the Russian Federation up to 2035

In 2018, about 285 million tons of oil was refined into petroleum products. The volume of oil processing increased by almost 23% compared to 2008, the refining depth went up by over 10 points. Over the course of the large-scale modernization of Russian refineries 83 of secondary refining units have been deployed, since the 1st of January, 2016 only fuels of the highest ecological class are supplied to the domestic market.

Consumption of oil and petroleum products in Russia in 2018 amounted to 149.3 million tons, of which almost half came from consumption of key motor fuels: gasoline and diesel. In the future, the total domestic demand for petroleum products is expected to gradually decrease, with a slight increase in demand for gasoline (by 5% by 2035) and a significant increase in demand for diesel fuel (by 20%) (Figure 1.8).

Prices for petroleum products in Russia are at a relatively low level, which ensures wide availability of fuel for the population. The price per liter of gasoline is about 62 US cents, which is comparable to fuel prices in major oil-producing countries: UAE (56 cents/liter) and Iraq (63 cents per liter). The Energy strategy implies measures to smoothen out sharp fluctuations in prices on the domestic market of petroleum products while maintaining market pricing principles.

Figure 1.8 Consumption of petroleum products in Russia by type



Source: Energy strategy of the Russian Federation up to 2035

The main task in the refining segment is to improve the efficiency, availability and quality of petroleum products for meeting domestic demand. This aim, in particular, is to be achieved through the completion of oil refineries modernization program, which implies the commissioning of more than 50 additional units of secondary oil processing and attaining the refining technological level of the most advanced countries.

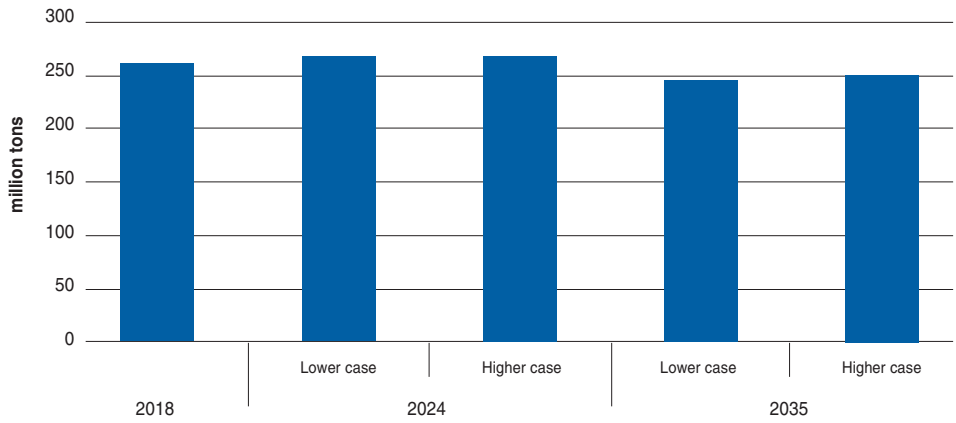
In terms of pipeline transport, large-scale projects to develop a system of pipelines for transporting oil and petroleum products, from both the established and new oil-producing areas aimed at diversifying export routes and increasing the competitiveness of Russian oil and petroleum products on global markets have been completed. The first and second stages of the Eastern Siberia – Pacific Ocean pipeline system (ESPO), the Skovorodino-Mohe-Daqing oil pipeline, and the Baltic pipeline system-2 have been commissioned. The project "North" to increase supplies of oil products to port Primorsk and project "South" – to the port Novorossiysk have been implemented. A number of oil pipelines have reached a surplus of capacity, which makes it possible to quickly change the direction of oil supply.

The volume of crude oil exports in 2018 was 7.2% higher than in 2008 and amounted to 260.6 million tons. The volume of oil supplies to Russian producers the markets of Europe and the Commonwealth of Independent States declined in the Asia-Pacific region increased more than 3 times.

Despite difficulties with expanding the share of the Russian Federation in the world market of petroleum products due to tough competition, exports of petroleum products increased by 27.2%, mainly due to the increased supply of light petroleum products.

In the foreseeable future, Russia will maintain its position as one of the largest oil suppliers on the world market. However, based on the forecast estimates, some reduction in exports is still possible (Figure 1.9).

Figure 1.9 Assumptions on the exports of crude oil from Russia

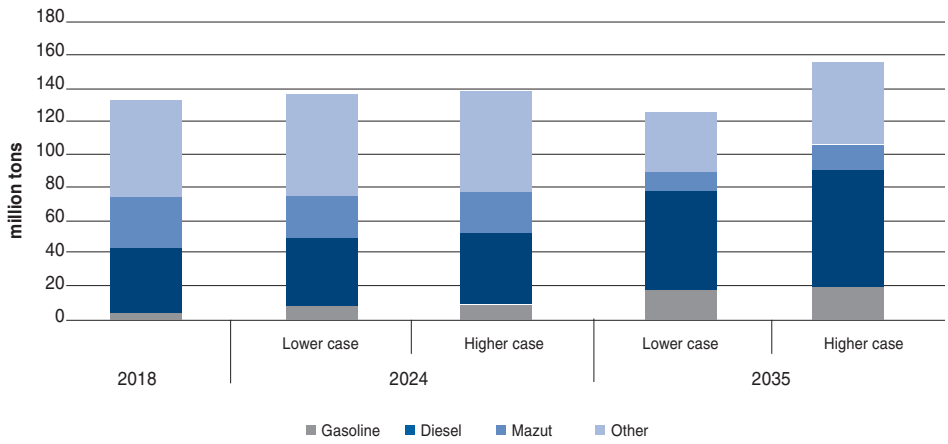


Source: Energy strategy of the Russian Federation up to 2035

A similar pattern is observed in the export of petroleum products. The Energy strategy scenarios assume a possibility of a decrease in the volume of exports of petroleum, at the same time the value of the basket of exported petroleum products is to increase by reducing the share of fuel oil in favor of valuable light petroleum products (Figure 1.10).

At least until 2025, due to the need to concentrate and improve investment efficiency, vertically integrated companies will dominate the main activities of the oil industry. However, due to the deterioration of the structure of hydrocarbon reserves, the need to increase innovative activity, flexibility and adaptability to changes in market conditions, the role of small and medium-sized oil and gas companies will increase.

Figure 1.10 **Assumptions on the exports of petroleum products from Russia**



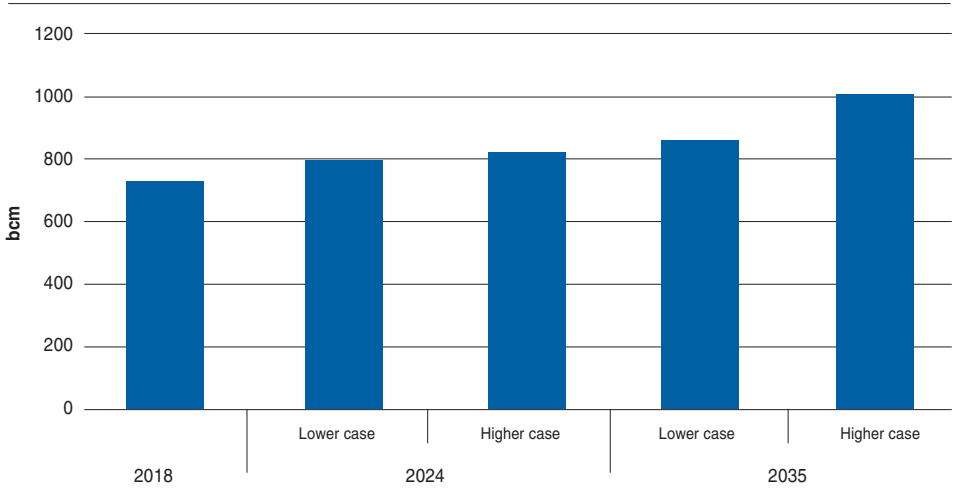
Source: Energy strategy of the Russian Federation up to 2035

NATURAL GAS

Russia has the largest natural gas reserves. As of January 1, 2019, Russia's technically recoverable natural gas reserves are 49.3 trillion cubic meters – 20% of the world's total.

By 2018 gas production increased by 9.1 percent compared to 2008 and reached 727.6 billion cubic meters. Large deposits are being developed in the Yamal Peninsula, in Eastern Siberia and the Republic of Sakha (Yakutia), and in the Irkutsk region. The deep-lying strata and deposits of the Zapolyarnoye and Urengoi fields are involved in production. An innovative project for extracting methane from coal seams is being implemented in Kuzbass. Gas production has started using underwater mining complexes on the shelf of the Okhotsk Sea. In all scenarios, up to 2035 natural gas production is expected to increase steadily (Figure 1.11).

Figure 1.11 Gas production in Russia assumptions



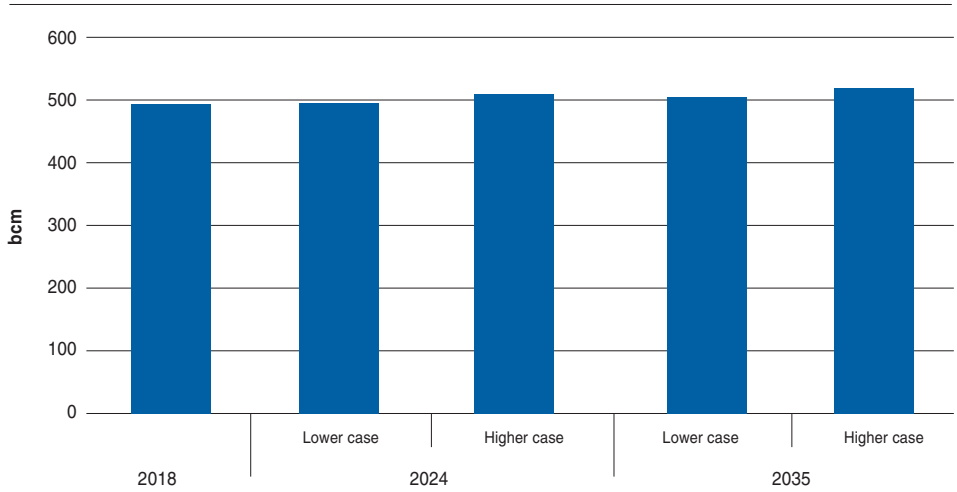
Source: Energy strategy of the Russian Federation up to 2035

Over a half (494 billion cubic meters) of the gas produced is supplied to the domestic market. In the future, gas consumption is expected to increase, both in the heat and electricity generation segment, and through the use of liquefied and compressed natural gas as motor fuel (figure 1.12).

Russia possesses the world's largest gas pipeline system with a total length of 172.6 thousand km. The main part of the existing gas pipelines is part of the unified gas supply system (UGSS) of Russia, located mainly in the European part of the country. High branching with a large number of bypass routes and the inclusion of underground gas storage facilities in the supply chain provides an unprecedented level of reliability of natural gas supplies, both for domestic and foreign consumers. In addition to supplying its own Russian gas, the UGSS provides gas supply from Central Asia and the Caspian region to Europe, acting as a transit system.

In the Eastern regions of the country, a gas program is being implemented, under which Sakhalin island is connected to the continental part and gas pipelines are being built to provide gasification to several regions and gas supplies for export. There are also several closed gas supply systems.

Figure 1.12 **Gas demand assumptions in Russia**



Source: Energy strategy of the Russian Federation up to 2035

The development of transport infrastructure continues to transport gas from new fields, including projects on the Yamal Peninsula.

The Nord Stream gas pipeline has become a fundamentally new route for Russian gas exports to Europe. In December 2019, the Power of Siberia gas pipeline was commissioned from the Chayandinskoye field to the border with China, and in 2020, the Turkish stream gas pipeline was commissioned. Construction of the Nord Stream-2 gas pipeline is underway.

The production of liquefied natural gas (LNG) has become a new direction of industry development. In 2009, the first LNG plant in the country (Sakhalin-2) was commissioned in the Russian Federation with a design capacity of 9.6 million tons per year. In 2017–2018, as part of the Yamal LNG project, production lines with a total design capacity of 16.5 million tons per year were put into operation. In addition, within the framework of this project, a transport infrastructure has been created, including the seaport and Sabetta airport.

Currently, work is underway to design large-scale production facilities in the Arctic zone of the Russian Federation, such as Arctic LNG-2 (with a capacity of 19.8 million tons)

and Arctic LNG-3. The Arctic projects will be implemented using gravity-type platforms produced at the Murmansk shipyard. Outside the Arctic zone of the Russian Federation, it is planned to implement such major projects as the construction of the third technological line of the Sakhalin-2 LNG plant, the construction of Far Eastern LNG – a complex for processing and liquefying natural gas in the area of Ust-Luga settlement.

The energy strategy assumes increasing LNG production from 26.9 billion cubic meters in 2018 to 108-189 billion cubic meters by 2035. The goal is to make the Russian Federation one of the world leaders in LNG production and export in the medium term.

The geography of production and consumption of natural gas as a motor fuel is expanding. The total number of stationary gasified vehicles infrastructure facilities put into operation by the end of 2018 reached 419 (an increase of 80 percent), and the volume of gas sales at automobile gas-filling compressor stations to 680 million cubic meters. For several years, a program has been in place to subsidize the cost of purchasing gas-powered equipment from the federal budget. Also, more than half of the regions.

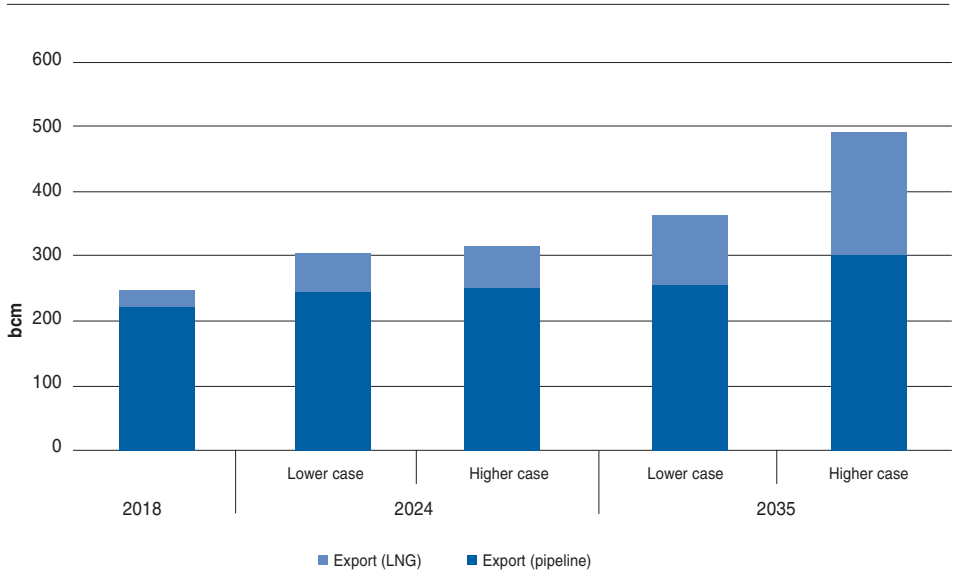
The Russian Federation are implementing regional programs for the development of this segment. The projects to use LNG as a motor fuel for road, rail and water transport using quarry equipment, as well as a bunker fuel for ships are also being developed.

Russia is the world's largest supplier of natural gas to world markets, and it is envisaged that in the future until 2035, it will retain the 1-2 place in the world in gas exports (pipeline and LNG) (Figure 1.13).

The Energy strategy assumes the retention of the single export channel for pipeline gas. If the will be a necessity to accelerate the growth rate and increase the volume of pipeline gas exports, the possibility of supplying gas from independent producers through a single export channel will be considered.

Given the huge importance of natural gas as the main fuel for the development of the country's economy, natural gas prices in the Russian domestic market are among the lowest in the world. In 2019, in Moscow, they ranged from $ 70 to $ 85 per thousand cubic meters, depending on the consumer category. Prices are regularly revised to reflect consumer price inflation, but remain regulated based on the principles of availability and social significance of natural gas.

Figure 1.13 **Gas exports assumptions**



Source: Energy strategy of the Russian Federation up to 2035

The Energy strategy assumes a gradual transition from regulation of wholesale gas prices to market pricing mechanisms (with the exception of the residential and equivalent categories of consumers). In particular, it is planned to increase the share of gas sold at unregulated prices in the total volume of supplies to the domestic market to 35% by 2024 and 40% by 2035.

To achieve the objectives of the Energy strategy of the development of production and increase in consumption of gas as motor fuel (including those with CNG) the tax incentives for infrastructure production and sales of motor fuel are set up, incentives are planned for the manufacturers of vehicles and equipment to increase production and expand the model range of natural gas powered vehicles.

PETROCHEMISTRY

Production of petrochemical raw materials (ethane, liquefied petroleum gas, naphtha) has increased by 64% in 2018 compared to 2008, and its use for the production of petrochemical products and large-capacity polymers increased by almost 43%. Since 2012, the petrochemical industry has started an active stage of implementation of a number of major investment projects. Facilities for the production of polystyrene, ABS plastics, polyethylene terephthalate, propylene, polypropylene and polyvinyl chloride were put into operation, and a product pipeline was constructed to transport light hydrocarbon feedstock.

The following main objectives of the development of oil and gas chemistry in the Energy strategy have been defined:

- ensure sustainable satisfaction of domestic demand for Russian petrochemical products and increase their competitiveness in the world markets;
- increasing the efficiency of the use of petrochemical raw materials.

COAL

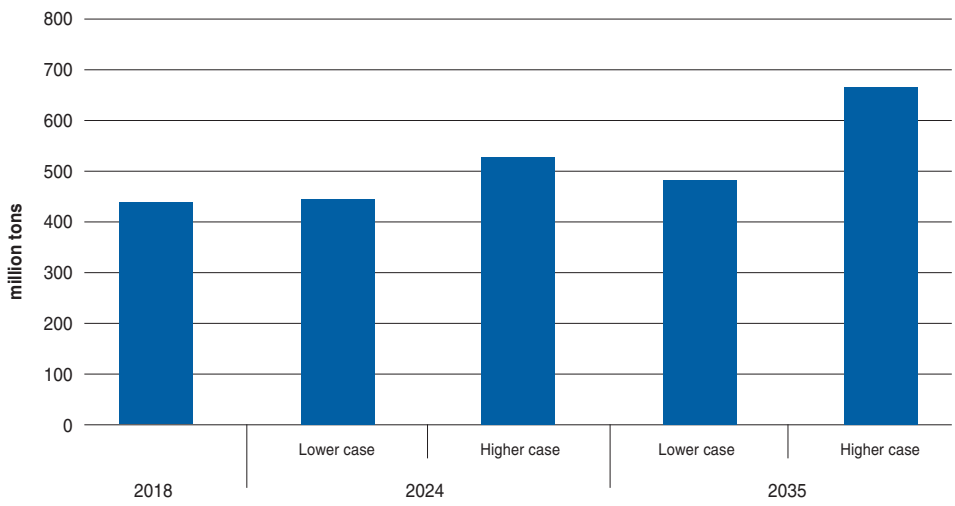
Technically recoverable coal reserves in Russia amount to 196.8 billion tons as of January 1, 2019, and forecast resources are 673.2 billion tons. According to this indicator, the country ranks fifth in the world, behind the fellow BRICS countries – China and India, as well as Australia and Indonesia.

Most of the coal mines are located in the Kuznetsk Basin of the Kemerovo region, which provides more than half of all coal production.

In 2018, the volume of coal production reached 439,3 million tons. According to the Energy strategy until 2035, this volume should increase to 448-530 million tons by 2024 and to 485-668 million tons by 2035, depending on the volume of export niches for Russian coal (Figure 1.14).

Russia allocates slightly less than half of the country's coal output (205.3 million tons at the end of 2018) to cover domestic demand. In the future, in the lower scenario of the Energy strategy, domestic demand for coal is expected to stagnate, while in the upper scenario, it is expected to grow slightly (Figure 1.15).

Figure 1.14 Forecast of coal production in Russia

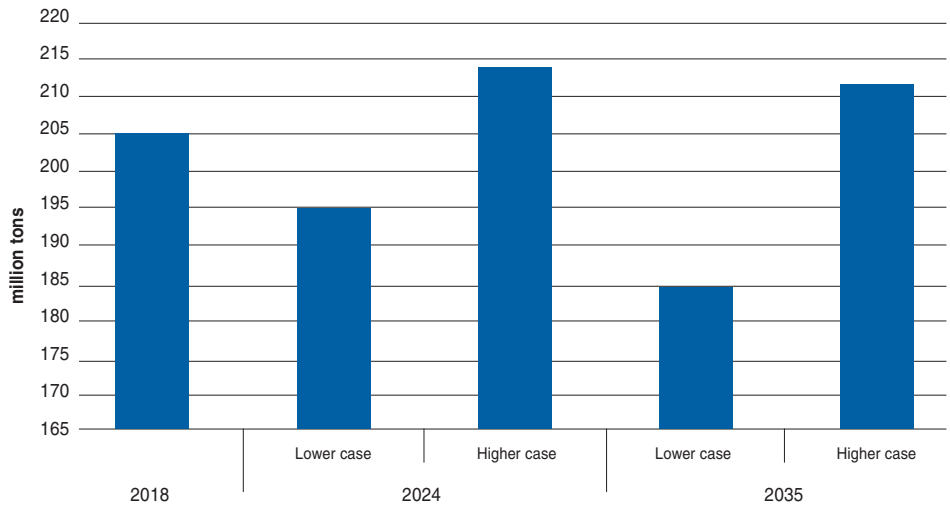


Source: Energy strategy of the Russian Federation up to 2035

Most of the coal in Russia is transported by rail.

Exports of coal and its processed products from Russia in 2018 amounted to 210 million tons. In the future, all scenarios of the Energy strategy are expected to increase coal exports, primarily due to the expansion of supplies in the Eastern direction to the countries of the Asia-Pacific region (Figure 1.16).

Figure 1.15 Coal consumption in Russia



Source: Energy strategy of the Russian Federation up to 2035

The capacity for transshipment of coal for export exceeds 165 million tons, and is located in 27 ports on the territory of Russia, with 8 ports located in the North-West, 8 in the South (the black sea, the Caspian, and the Azov sea), and 11 in the far East.

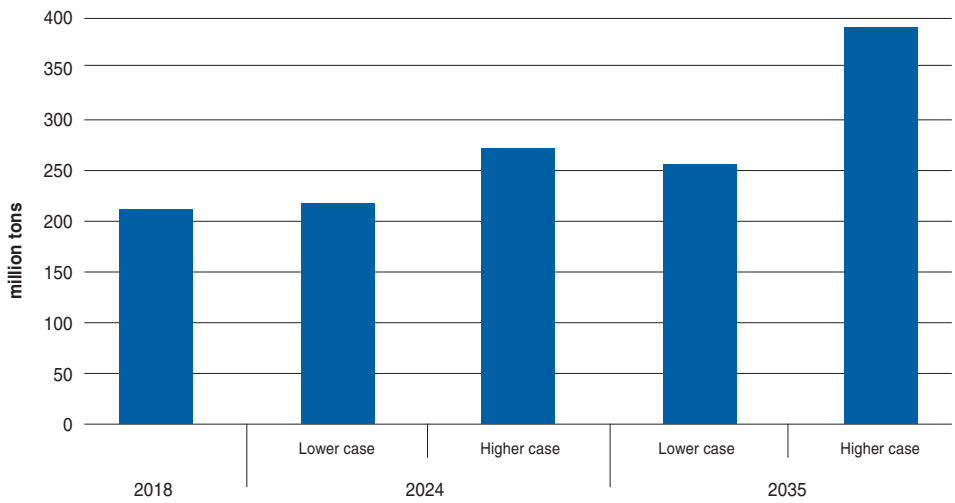
Despite the already existing significant capacities, the port infrastructure in the Far East of the country continues to develop, which will bring the total capacity of the far Eastern ports for coal transshipment to 165 million tons per year.

Port facilities are also being developed in the Western direction with access to the Baltic, Black and Barents seas. As part of the implementation of Arctic projects, port infrastructure is being developed along the Northern sea route.

Key challenges for the development of the coal industry are the following:

- improving the efficiency of meeting domestic demand for coal products, maintaining the volume of supply to the domestic market in the range of 174-192 million tons in 2024 and 170-196 million tons by 2035;

Figure 1.16 Coal export assumptions



Source: Energy strategy of the Russian Federation up to 2035

- strengthening the position in the global coal market, increasing the share of Russian supplies from 14% in 2018 to 18-20% by 2024 and 23-25% by 2035.

ELECTRIC POWER SECTOR

Electricity production in 2018 compared to 2008 increased by 5.3% and amounted to 1092 billion kWh, consumption – by 5.4%, installed capacity of power plants – by 11% (43.4 GW of new installed capacity was introduced).

Most of the output was provided by gas and coal-fired thermal power plants, with nuclear power plants in second place and hydroelectric power plants in third place (Figure 1.17).

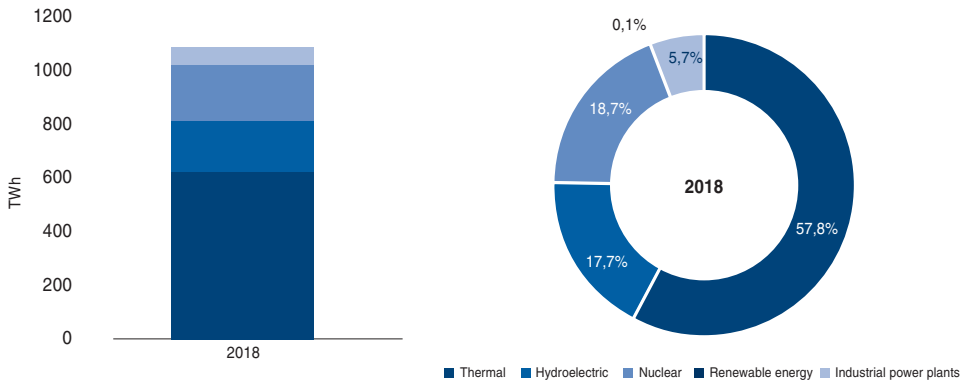
In 2035, electricity production may reach 1393 billion kWh.

Russia possesses excessive generating capacity which amounts to just under 250 GW. In the long term, according to the Energy strategy, to ensure the necessary volumes of

electricity production, it is necessary to maintain the installed capacity of power plants in the period up to 2024 at the level of 252 GW, and in the period up to 2035 – in the range of 251-264 GW (Figure 1.18).

In general market for electric power and capacity has been formed and is successfully functioning.

Figure 1.17 Structure of electric power production in Russia in 2018



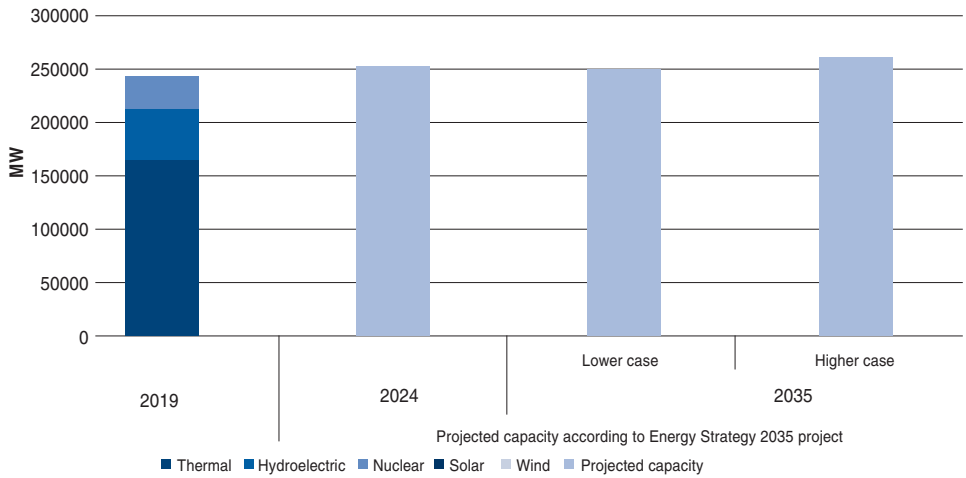
Source: Energy strategy of the Russian Federation up to 2035

Electricity prices in Russia are among the lowest in Europe. The average final cost for industrial consumers in 2019 was about 7 cents per kWh. The population receives electricity at social regulated rates, which are below the industrial price.

In terms of improving the tariff system, the Energy strategy includes measures to gradually eliminate cross-subsidization by switching to the formation of economically justified prices (tariffs) for electric energy, if necessary – with the involvement of Federal budget funds.

Russia is a net exporter of electricity, supplying it to a number of neighboring countries, including China. In 2018, electricity amounted to 20 TWh, while imports were 5 TWh. The Energy Strategy assumes a reduction in the volume of foreign trade in electric energy in the forecast period. At the same time, Russia has the potential to increase exports, but the realization of this potential depends to a large extent on the situation in the markets of neighboring countries (Figure 1.19).

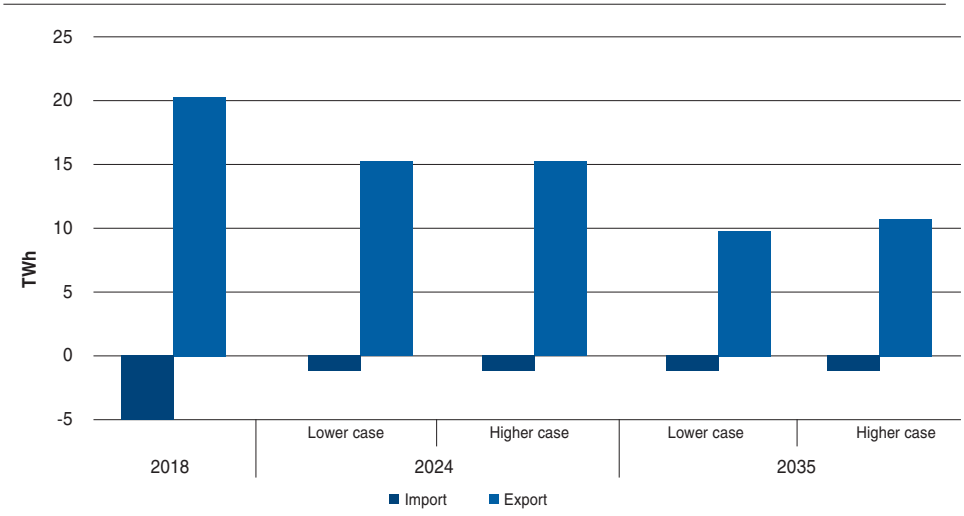
Figure 1.18 Current volume and plans for expansion of generation capacity



Source: Energy strategy of the Russian Federation up to 2035

The strategic goal for the electric power sector is to increase the reliability and quality of energy supply to consumers to a level comparable to the best world standards, while ensuring the economic efficiency of such services.

Figure 1.19 Import and export of electric energy from Russia



Source: Energy strategy of the Russian Federation up to 2035

An important task is also to improve the efficiency of the electric grid complex. A number of measures are to be taken along these line, including the transition to risk-based management of production assets based on digital technologies and the introduction of intelligent.

NUCLEAR POWER

Electricity generation from nuclear power plants increased by 25% between 2008 and 2018, reaching 204 billion kWh. 10 nuclear power plants (36 power units) with a total capacity of 28.3 MW are in operation. New power units of nuclear power plants with high-capacity reactors are being built. It is planned to put into operation a floating nuclear thermal power plant with a capacity of 70 MW.

Russia is one of the few countries in the world that has a full-cycle nuclear power industry. The state Corporation for nuclear power sector Rosatom is capable of all operations over the nuclear production cycle from mining and enrichment of uranium ores to disposal of nuclear waste.

The Russian Federation is leading the way in creating a new energy technology for nuclear power, which involves parallel operation of thermal and fast neutron reactors connected by a common closed nuclear fuel cycle. Such a system helps to solve the problems of nuclear fuel reproduction, minimize radioactive waste, and comply with the non-proliferation regime for nuclear materials.

The main problems and risks of nuclear power development are associated with relatively high costs for ensuring nuclear and radiation safety and the need to manage spent nuclear fuel and radioactive waste taking into account the requirements of environmental safety

The objectives of nuclear power development are:

- improving the efficiency of nuclear power, including ensuring the economic competitiveness of new nuclear power plants, taking into account their full life cycle;
- development and implementation of a new energy technologies in the field of nuclear power, involving parallel operation of thermal and fast neutron reactors in order to ensure a closed nuclear fuel cycle.

RENEWABLES

The main type of renewable energy in the Russian Federation is hydroelectric power, which is a significant part of the entire electric power industry.

Russia's hydropower potential is about 9% of the worlds and provides large-scale opportunities for the development of hydropower. The share of hydroelectric power plants, including hydro-accumulating power plants (HPP), in the structure of generating capacity in Russia is about 20%. The total capacity of small hydroelectric power plants exceeds 1.2 GW.

According to the Energy strategy, the main goal of hydropower until 2035 is to improve the efficiency of HPP operation.

The use of other renewable energy sources, such as solar, wind and geothermal energy, is growing. The installed capacity of renewable energy (excluding hydropower) in Russia in 2018 reached 1.018 GW (solar stations-0.834 GW, wind stations-0.184 GW).

The main problem of RES use in Russia is their insufficient economic competitiveness in relation to other technologies of electric energy production.

The mechanism of state support for the use of renewable energy in the wholesale electricity and capacity market of Russia through contracts for the supply of capacity has increased the investment attractiveness of the renewable energy industry.

The production of high-tech innovative equipment and the market of engineering services for the creation of solar and wind power facilities of various capacities and complexity have been developed.

On the basis of Russian technologies, a high-tech production of highly efficient heterostructured photovoltaic modules with a photovoltaic cell efficiency of more than 23 percent has been established. Recent scientific developments make it possible to obtain stable energy in diffused light and extremely low and high temperatures. Since 2017, Russian-made photovoltaic cells, as well as engineering services in the field of solar energy, are being exported and the geography of is constantly expanding.

Russia does not set overly-ambitious goals for the construction of new generating capacities based on RES, but it fully supports the development of technological competencies in the field of renewable energy and expands the use of RES as a source of decentralized generation to improve the efficiency of energy supply to remote and isolated territories.

ENERGY EFFICIENCY

Energy intensity of the Russian economy since 2008 decreased by 9.3% (from 10.8 to 9.8 tons of coal eq./million rubles of GDP in 2016 prices). The main factors that helped reduce energy intensity were the technological modernization (increased energy efficiency of energy-consuming equipment) and the level of capacity utilization.

In the long term according to the Energy Strategy, with an average assumed GDP growth rate of 2.3 – 3.0 % per year, due to appropriate measures, the average growth rate of energy consumption will be 0.3 – 0.6%.

In the energy industries a noticeable reduction in energy intensity was achieved compared to 2008: i.e. the utilization factor of associated petroleum gas increased by 9.2 percentage points. and reached 85.1%,; the specific fuel consumption for electricity production at thermal power plants decreased by 7.8%; losses in power grid systems decreased from 13 to 10.6 percent.

The key measures to realize the potential of energy saving and energy efficiency in Russia include:

- improvement of the regulatory framework, including the introduction of restrictions on the production and use of energy-inefficient equipment, buildings, and technological processes;
- tax and non-tax incentives for companies to use the best available technologies (BAT), including the development and application of appropriate BAT reference sources and registers for technical and environmental regulation, as well as the purchase of energy-efficient equipment;

- use of funds from budgets of various levels, extra-budgetary funds, funds of development institutions, organization of preferential loan financing for projects in the field of energy efficiency and energy saving (including compensation of the interest rate on the corresponding loans);
- improving the regulatory framework of the energy services market;
- updating existing and implementing new energy management systems in accordance with the requirements of ISO 50001: 2018;
- exchange of experience and dissemination of best practices in energy saving and energy efficiency in the energy sector industries.

An important consequence of the energy saving policy is also a significant hindrance on the growth of greenhouse gas emissions and reducing the negative impact of the energy sector on the environment.

Among all areas of cooperation in the energy sector with the BRICS countries Russia considers cooperation on energy saving and improving energy efficiency as one of the main priorities.

1.2.3_PROSPECTS FOR INTERNATIONAL COOPERATION – GOALS, PRIORITY AREAS

Russia has established energy cooperation with all BRICS member countries. The key areas are joint exploration and production of hydrocarbons in Russia and other BRICS countries, projects in the field of hydrocarbon processing and petrochemistry, cooperation in the nuclear and renewable energy sectors, and implementation of infrastructure projects.

Exploration and production of hydrocarbons in Russia is already carried out in cooperation with Chinese and Indian companies. Partnership with Brazilian companies that have unique experience in developing deep-water offshore fields can become potentially attractive. The possibility of importing the appropriate equipment and expertise is under discussion. The possibilities of expanding cooperation in the field of oil, gas and coal production are being considered.

Abroad, Russian companies are represented in the upstream segment in India, South Africa, and Brazil, and also cooperate with BRICS companies in implementing projects in third countries. In Brazil, a project of exploration and development of hydrocarbons at licensed areas in the river basin of Solimoes (Amazonas, Brazil), the possibility of new projects, supply of LNG to Brazil as well as the construction of gas storages are under consideration. In South Africa, negotiations are underway to participate in the development of oil and gas fields. Russian and Chinese companies also have experience in implementation of joint projects in third countries.

The segments that produce products with high added value, in particular in oil refining and hydrocarbon chemistry see active development in cooperation. Russian companies are involved in oil refining projects in India, preparations are underway to implement a new project for an oil refining and petrochemical complex in China, and an agreement has been signed with a Chinese company to establish a gas processing plant in the Gulf of Finland region in Russia. Cooperation with other BRICS countries in this area may be promising.

Russia's extensive experience and advanced technologies in the field of nuclear energy contribute to expanding the use of nuclear power in the BRICS countries. Russian companies have already built and commissioned several nuclear power plants in India and China. New power units are under construction. In parallel, specialists are being trained. Together with the Chinese side, work is underway to create a new fast-neutron reactor. Regular deliveries of nuclear fuel are made to China and India, and cooperation has begun on the supply of uranium to Brazil. Projects for the construction of stationary and floating nuclear power units are also being discussed with Brazil. Russia is open for active cooperation with South Africa in the field of nuclear energy.

Russian companies are implementing projects in the field of renewable energy in South Africa and India. Construction of the Beloporozhskaya HPP is being completed in Karelia, Russia, with the participation of Chinese partners and the new BRICS development Bank. Russia and other BRICS countries provide cross-supplies of equipment for renewable energy sources.

Given the critical importance of connecting infrastructure for the energy market, many projects in this area are already being implemented within the BRICS countries, primarily between Russia and China.

In addition to implementing joint projects in the energy sector, Russia is involved in active energy trade with the BRICS countries. Oil and petroleum products of Russian origin are present on the markets of all BRICS member countries, with the exception of Brazil. Russian natural gas (both pipeline and LNG) has already secured a niche in the Chinese market, while LNG supplies to India and Brazil are being considered. Coal is supplied mainly to China

[1.3]

INDIA

1.3.1_GENERAL OVERVIEW

ENERGY MIX (PRODUCTION, CONSUMPTION, EXPORT AND IMPORT)

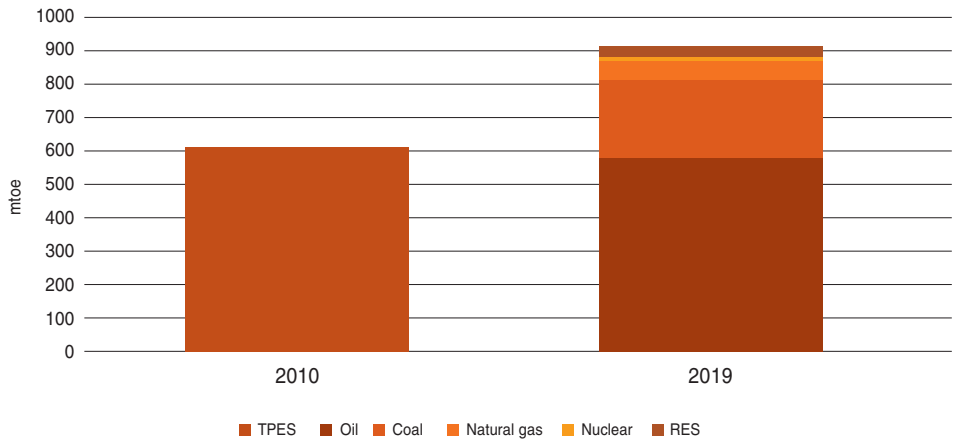
India is the world's third largest energy consumer country (after the United States and China) while generating about 6% of global demand. From 2010 to 2019, energy consumption in the country increased by 50%. At the same time, coal provides 56% of the total primary energy supply (Figure 1.20).

India provides just over half of its energy consumption through its own production and both the volume and structure of energy production have undergone significant changes from 2010 to 2019: the volume of energy production has increased by 40% and the share of traditional biomass replaced by coal has significantly decreased in the energy mix (Figure 1.21).

The Government of India targets 450 GW installed renewable capacity by 2030 and also 20% blending of ethanol in petrol by 2030 as per National Biofuel Policy.

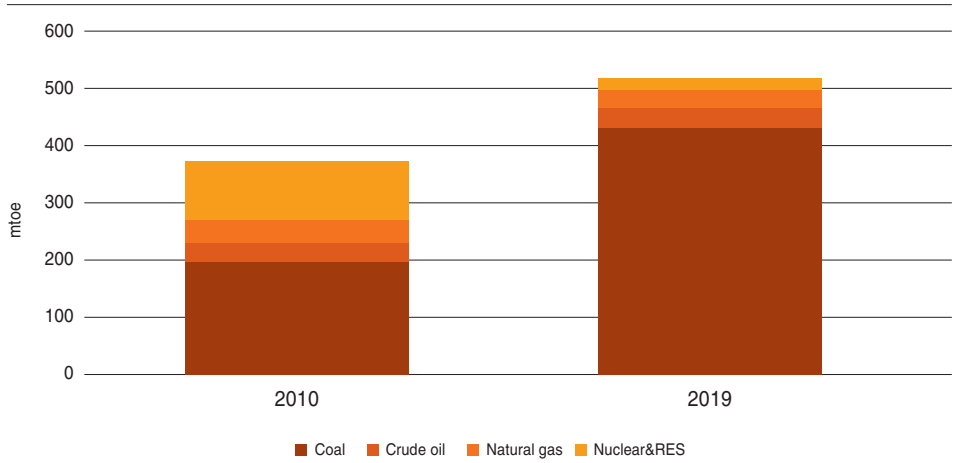
In the future, by 2040, the demand for energy in India will grow by 1.8-2.1 times, according to national estimates. Coal will remain the main energy resource.

Figure 1.20 **Total primary energy consumption in India in 2010-2019**



Source: Energy Balance of India for 2020, Central Statistics Office Ministry of Statistics and Programme Implementation Government of India

Figure 1.21 **Primary energy production in India in 2010-2019**



Source: Energy Balance of India for 2020, Central Statistics Office Ministry of Statistics and Programme Implementation Government of India

Table 1 Final Energy Demand (Mtoe)

Sectors	2019	2030	
	Actual	BAU	Ambitious
Buildings	37	79	73
Industry	262	451	395
Transport	162	302	263
Agriculture	35	59	45
Telecom	12	6	5
Cooking	62	43	36
Total	**570**	**940**	**817**

Table 2 Final Electricity Demand (TWh)

Sectors	2019	2030	
	Actual	BAU	Ambitious
Buildings	407	896	848
Industry	485	1,135	1,166
Transport	31	157	181
Agriculture	208	417	325
Telecom	23	47	48
Cooking	4	14	22
Total Electricity	**1,158**	**2,666**	**2,590**

Source: National Energy Policy The National Institution for Transforming India (NITI Aayog), Government of India, 2017(Revised)

MAIN CHALLENGES

The key energy challenges faced by the country in the energy sector are:

a. infrastructure bottlenecks for petroleum and natural gas supply, transportation of coal, power distribution and evacuation infrastructure for renewable power;

b. Training and upskilling the labour force and to build a robust pipeline of skilled talent;

c. Investments in R&D

1) Changes in the energy mix – The world is moving away from overwhelming dependence on fossil fuel, and within the fossil fuels, away from coal and oil in favour of gas. Against 88% total share of fossil fuels globally in the primary energy mix in the year 2005, the same fell to 86% in the year 2015. The share of oil has in particular fallen from 36% to 33%, while that of natural gas has increased from 23% to 24%, and that of renewable energy (including nuclear and large hydro) has gone up from 12.5% to14% in the period 2005-15. The above trends, principally owing to climate change concerns, are expected to be maintained over the medium term.

2) Abundance in supply of natural gas – The success of horizontal drilling combined with the technology of hydraulic fracture has come to be established in the US where the production of natural gas went up from 511 BCM in 2005 to 767 BCM in 2015. This has boosted the already rising production of natural gas in the world from 2791 BCM in 2005 to 3539 BCM in the year 2015. As the price of gas is lower than that of oil, and is also one-third lesser as carbon emitting than oil, the ascendency of gas vis-a-vis oil is likely to continue in the near foreseeable future. However, in India domestic production of natural gas is far less than the demand and therefore, liquefied natural gas (LNG) is being imported to meet the demand supply gap.

3) Maturity of renewable energy technologies – The sharp decline in the prices of wind and solar technologies in the recent years by about 60% and 52% respectively between 2010 and 2015 (in kWh terms), has led to a change in the relative importance of energy sources. Tropical countries, including India, are richly endowed with the above resources, and can harness them in an innovative manner to meet energy requirements at decentralised locations. In the recent auctions, solar and wind energy prices have achieved bus bar grid parity at the generation end.

4) **Climate change concerns** – The adverse effects of climate change are much more discernible than ever before, with a better understanding of the relationship between energy use and poor environmental outcomes. While the global agenda is of common concern, there is a heightened consciousness of the need to fix poor air quality standards in Indian cities, which is being reflected in tough administrative actions and court mandated orders»[1].

5) **Energy Efficiency** – The India has made significant progress on improving energy efficiency. Efficiency gains since 2000 resulted in the avoidance of 15% more energy use in 2018, with the industrial and service sectors providing the largest source of savings. However, these efficiency gains have been greatly overwhelmed by the impact of activity linked to increased economic growth, improved living standards and demand for energy services, which more than doubled India's energy use between 2000 and 2018.

As India continues to grow rapidly, there are significant opportunities to further increase the ambition of the country's energy efficiency policies and programmes. Energy efficiency can also play a key role not only in fostering economic efficiency and competitiveness, but also in achieving India's objectives to limit greenhouse gas (GHG) emissions growth under the country's Nationally Determined Contribution (NDC). Successful implementation of various energy efficiency endeavors have resulted in

- Electrical energy savings of 140 Billion Units, worth USD 9.9 billion.
- Thermal energy savings of 12.00 Million Tonnes of oil Equivalent, worth USD 3.2 billion.
- Total energy savings of 23.73 Million Tonnes of oil Equivalent i.e. 2.69% of total primary energy supply of the country.
- Total cost savings worth USD 13.1 billion approximately which is equivalent to reduction in carbon dioxide emission of around 151.74 Million Tonnes. (Source: India 2020: Impact Assessment of various energy efficiency measures taken during 2018-19).

[1] National Energy Policy The National Institution for Transforming India (NITI Aayog), Government of India, 2017

STRATEGIC GOALS FOR ENERGY DEVELOPMENT

There are four main key objectives of Indian energy policy (NEP: Version as on 27.06.2017):

1) Access at affordable prices

Considering poverty and deprivation in India, access to energy for all at affordable prices is of utmost importance. We have achieved near 100% electrification in 2019 itself. However, a considerable populationstill depends on Biomass for cooking fuel. In this regard, the Pradhan Mantri UjjwalaYojana (PMUY) was launched by Hon'ble Prime Minister, Shri Narendra Modi on 1st May 2016. The scheme aims to provide clean cooking fuel to the women belonging to the 'Below Poverty Line' (BPL) households across the country. So far, we have already released over 80 million (8crore) UjjwalaLPG connections to women beneficiaries from below poverty line (BPL) households across the country under this program (as of September, 2019). While it is envisaged that financial support will be extended to ensure merit consumption to the vulnerable sections, competitive prices will drive affordability to meet the above aims.

2) Improved security and Independence

Improved energy security, normally associated with reduced import dependence, is also an important goal of the policy. Today, India is heavily dependent on oil and gas imports while also importing coal. In so far as imports may be disrupted, they undermine energy security of the country. Energy security may be enhanced through both diversification of the sources of imports and increased domestic production and reduced requirement of energy. Given the availability of domestic reserves of oil, coal and gas and the prospects of their exploitation at competitive prices, there is a strong case for reduced dependence on imports. In due course, we may also consider building strategic reserves as insurance against imported supplies.

3) Greater Sustainability

The goal of sustainability acquires added importance and urgency in view of the threat of catastrophic effects of climate change as well as the detrimental effects of fossil fuel usage on local air quality. In India, sustainability is also closely linked with energy security. Our fossil fuel requirements, which comprise nearly 90% of our commercial

primary energy supply, are increasingly being met by imports. This means that cutting fossil fuel consumption would promote the twin goals of sustainability and security. Hence the policy lays heavy emphasis on de-carbonisation through the twin interventions of energy efficiency and renewable energy.

4) Economic Growth

Finally, the energy policy must also support the goal of rapid economic growth. Efficient energy supplies promote growth in two ways. First, energy is the lifeblood of the economy. It is an important enabling factor of growth and its availability at competitive prices is critical to the competitiveness of energy-intensive sectors. Second, being a vast sector in itself, its growth can directly influence the overall growth in the economy. For example, petroleum products have been an important direct contributor to our growth in recent years by attracting large investments in refining/distribution, and also fuelling economic activity"[2].

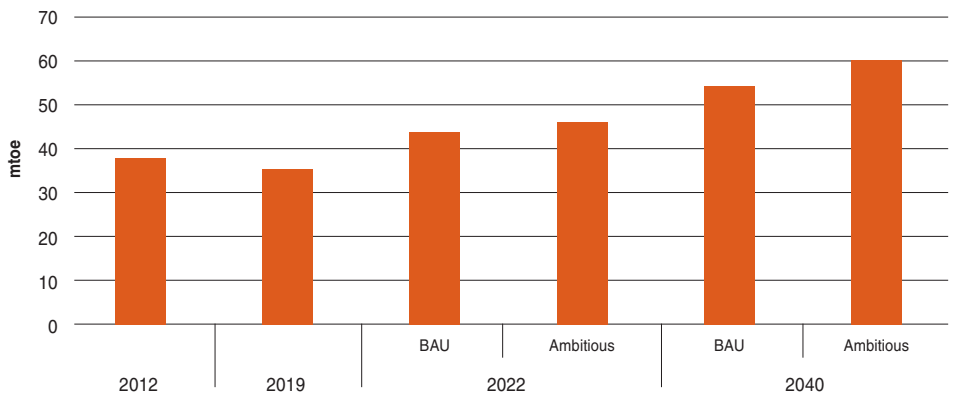
1.3.2_ENERGY INDUSTRIES

LIQUID FUEL

Crude oil production in India in 2019 amounted to 35 million tons, or about 16% of the country's own refining capacity. At the same time, the NEP notes that the country has a significant potential for increasing production (only about 19% of the sedimentary area has been studied by survey drilling). To ensure production growth, it is proposed: to disclose potential for opening up the upstream data business to the private sector by easing controls on data sharing, to separate the upstream regulatory regime and contract administration for an arms-length administration of upstream matters and to migrate the existing hydrocarbons regime (both Nomination and PSCs) to the emerging framework of market-determined prices and marketing freedom. As a result, the country's production may increase to 44-46 million tons in 2022. (Figure 1.22).

[2] National Energy Policy The National Institution for Transforming India (NITI Aayog), Government of India, 2017.

Figure 1.22 **Production of liquid hydrocarbons in India assumptions**



Source: National Energy Policy The National Institution for Transforming India (NITI Aayog), Government of India, 2017

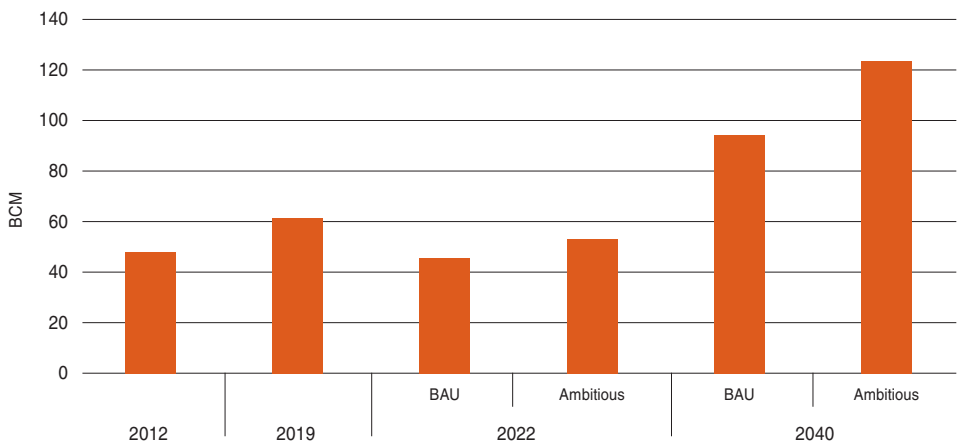
Currently, the country's refining capacity exceeds its own demand for petroleum products by 25%. Yet India may become a net importer of refined products in the near future. Hence, there is a need for the Government to encourage capacity expansion and setting up of Greenfield refineries, preferably at coastal locations, through measures, including facilitating market access for new refineries.

NATURAL GAS

Gas consumption in the country by 2040 should triple from the current volume (according to both scenarios of the National Energy Policy). At the same time, it is planned to significantly expand the capacity of the National Gas Grid, simplify the process of issuing licenses to gas supply organizations, and ensure the involvement of (including private and foreign partners) in the gas infrastructure expansion and operations. It is also planned to develop decentralized energy supply to small towns and villages based on liquefied petroleum gases.

Gas production in India reached 61 billion cubic meters in 2019, by 2022, according to national estimates, it will decrease to 46-53 billion cubic meters, and then, thanks to the commissioning of new license areas, it will grow to 95-124 billion cubic meters by 2040 (Figure 1.23).

Figure 1.23 Production of natural gas in India assumptions



Source: National Energy Policy The National Institution for Transforming India (NITI Aayog), Government of India, 2017

Although such an increase in production has a significant positive impact on the country's energy security, it does not allow for complete independence from gas imports. LNG and gas supplies via pipelines from Western and Central Asia should be assimilated into the Indian energy system.

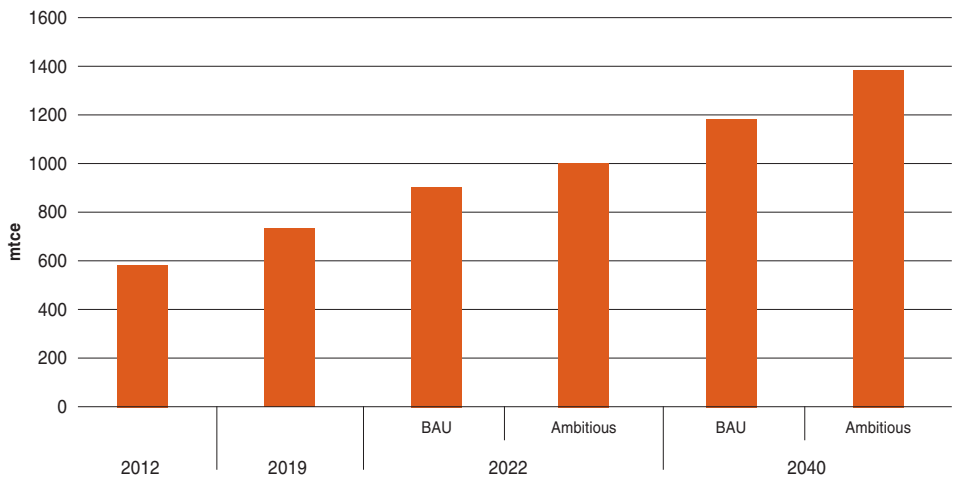
COAL

NEP of India predicts that the coal generation capacity (194.4 GW in March, 2019[3]) will increase to 330-441 GW by 2040, which will require a significant increase in the country's own coal production. From 728 Mtce in 2019 to 1190-1385 Mtce by 2040 (Figure 1.24).

Coal prices in India are currently regulated, but the country aims to create a truly open and competitive coal market, reduce price differentiation between imported coal and its own, and eliminate the practice of cross-subsidizing various categories of consumers

[3] Energy Balance of India for 2020, Central Statistics Office Ministry of Statistics and Programme Implementation Government of India

Figure 1.24 **Production of coal in India, assumptions**



Source: National Energy Policy The National Institution for Transforming India (NITI Aayog), Government of India, 2017

while maintaining targeted subsidies for socially vulnerable consumers. At the same time, generating companies will pay the full market price for coal.

ELECTRIC POWER SECTOR

The development of the power sector in India is one of the key areas to achieve the goals of ensuring sustainable economic growth and improving the quality of life for the population. And the goal of universal electrification by 2022 in 24/7 mode is one of the main tasks of the country's energy policy. In addition, in accordance with global trends, NEP expects not only a large-scale increase in energy consumption due to the increase in the level of electrification of the country, but also due to the growth of the share of electricity in all energy consumption sectors, partly due to a reduction in electricity prices achieved by reducing the cost of generation from RES, partly due to higher comparative efficiency of electrical devices compared to alternatives using other types of energy.

It is expected that electricity generation will increase from 1,371. 8 TWh in 2019 to 4,753-4,773 TWh by 2040, which will require an almost 3.5-fold increase in the country's installed generating capacity, with the main increase in capacity coming from the NRES (Table 3).

Table 3 Structure of installed generating capacity in India in 2019 and projections for 2030 (TWh)

Generation Sources	2019	2030	
	Actual	BAU	Ambitious
Gas Power Stations	50	71	90
Coal power stations	1,022	1,367	1,640
Carbon Capture Storage (CCS)	0	14	67
Total Fossil Fuel Electricity	**1,072**	**1,452**	**1,797**
Nuclear power	38	142	197
Hydro Power Generation	135	240	272
Total Nuclear and Hydro Electricity	**173**	**382**	**469**
Solar PV	39	271	340
Solar CSP	–	10	14
Onshore Wind	62	186	216
Offshore Wind	–	72	90
Small Hydro	9	33	38
Distributed Solar PV	–	109	140
Biomass Based Electricity& Biogas	16	87	130
Waste to Electricity	1.2	4	6
Total Renewable Based Electricity	**127**	**772**	**974**
Total	**1,372**	**2,606**	**3,240**

Source: National Energy Policy The National Institution for Transforming India (NITI Aayog), Government of India, 2017 (Revised)

RENEWABLES

India expects that NRES (other than large Hydro) will account for 50-56% of the installed generating capacity by 2040 and provide 29-36% of electricity generation.

An important role in organizing electricity supply will remain with large HPP (capacity more than 25 MW) with an energy supply policy that such projects should be given maximum attention, given the potential use of HPP+PHES for the organization of a stable uninterrupted power supply, to offset instabilities of solar and wind power.

NUCLEAR POWER

To meet the potentially huge demand for energy in the country, India is not going to give up any energy sources, including nuclear, which has been abandoned in many other countries of the world in recent years. India understands its significant potential for using renewable sources – solar and wind, but given the uneven nature of generation at such plants, it considers nuclear power, with its smooth production schedule, to be an essential part of the energy mix of basic electricity consumption. India considers the development and launch of fast neutron and closed-cycle reactors capable of providing energy supply for several centuries to be the most important technological directions in the energy sector.

India plans to increase installed nuclear capacity to 12 GW by 2022 and to 23-34 GW by 2040 (per the scenarios National Energy Policy), and in scenarios Nationally Determined Contributions, prepared by India as a party to the Paris agreement deals with the bringing of installed nuclear capacity to 63 GW by 2040.

1.3.3_PROSPECTS FOR INTERNATIONAL COOPERATION – GOALS, PRIORITY AREAS

India imports oil and coal from all BRICS countries, exporting petroleum products to China, South Africa and Brazil.

The main foreign projects in the field of hydrocarbon production are related to Russia and Brazil. Indian companies participate in consortia for the development of oil and gas fields in the Far East, in the Tomsk region in Russia, as well as in consortia for the development of deep-water fields in Brazil.

Table 4 Import Dependence

Fuels	2019	2030	
	Actual	BAU	Ambitious
Coal	26%	38%	12%
Oil	84%	85%	80%
Gas	47%	40%	33%
Overall	40%	43%	28%

Russian companies are actively interested in Indian oil refining. They are co-owners of refineries, retail networks of gas stations, and partners in the creation of petrochemical industries.

India actively cooperates with other BRICS countries in the field of renewable energy. Chinese companies are widely represented in the solar panel market, providing services for the construction and supply of technologies for high-voltage transmission lines, photovoltaics, intelligent power systems and energy conservation. Russian companies are developing cooperation with Indian companies in the field of hydropower and solar cell production.

[1.4]

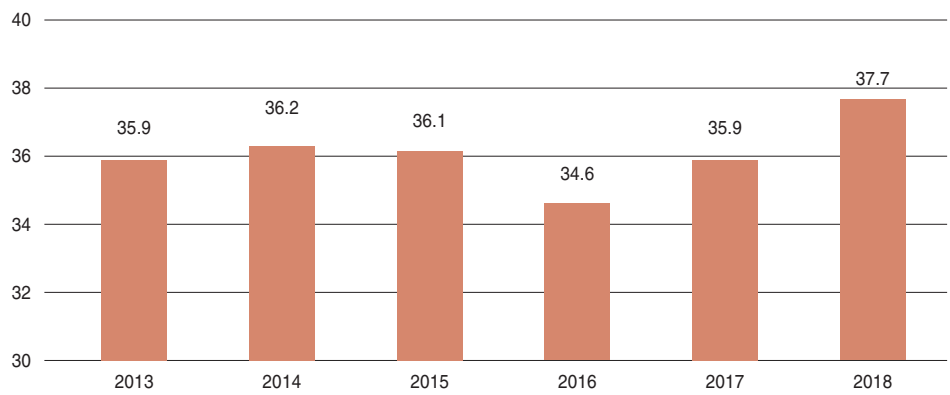
CHINA

1.4.1_GENERAL OVERVIEW

ENERGY PRODUCTION

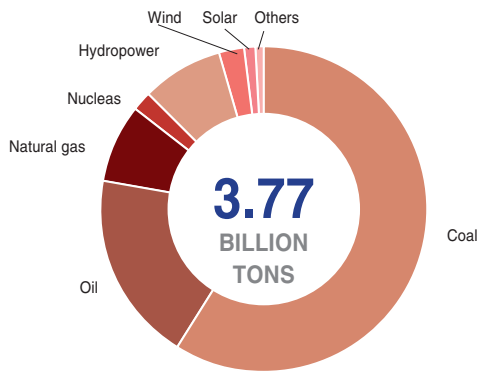
In 2018, China's energy production increased steadily, reaching 3.77 billion tons of coal equivalent, a year-on-year increase of 5.0% and the highest level in the latest 6 years, accounting for 18.7% of the world's total production (Figure 1.25).

Figure 1.25 Primary energy production in 2013-2018 (10^8 tons of coal equivalent)



In 2018, fossil energy production accounts for 81.8% of China's energy production, including coal for 69.1%, and non-fossil accounts for 18.2%. China has become the largest hydropower, wind power and solar power installed capacity country around the world (Figure 1.26).

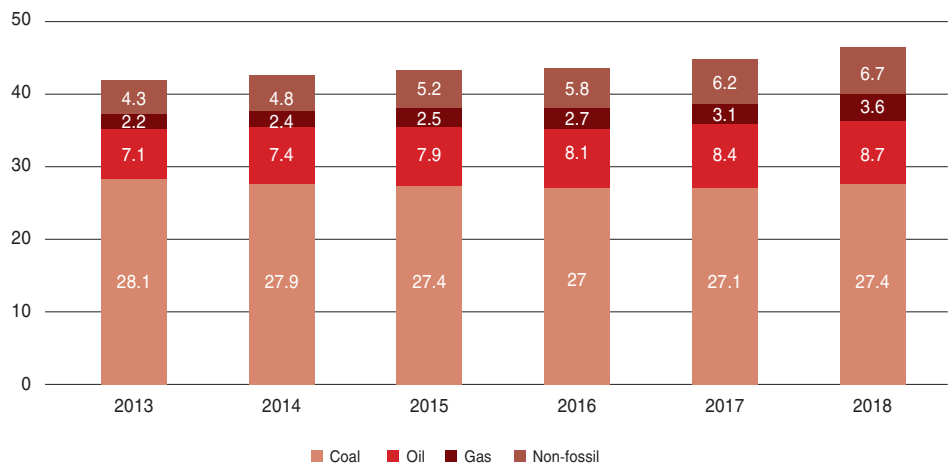
Figure 1.26 Energy production mix in 2018 of China



ENERGY CONSUMPTION

In 2018, China's total energy consumption was 4.64 billion tons of coal equivalent, a year-on year increase of 3.3%. China's low growth rate of energy consumption supports the medium-high speed economic growth (Figure 1.27).

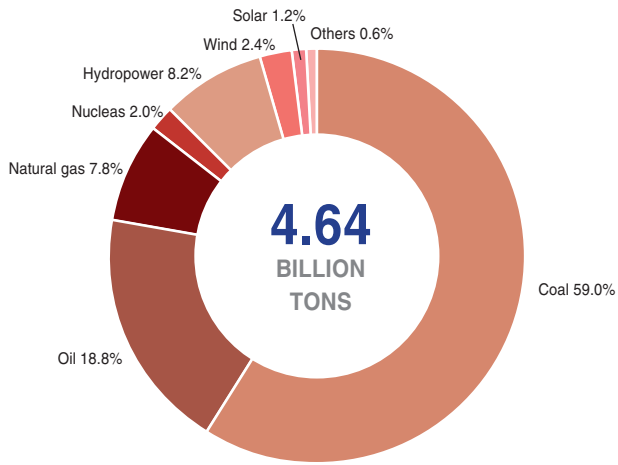
Figure 1.27 Energy consumption in 2013-2018 (10^8 tons of coal equivalent)



CHINA

Non-fossil energy and natural gas are the main driving forces of energy consumption growth. China's total energy consumption in 2018 is 150 million tons of coal equivalent higher than that in 2017, of which 50 million tons of non-fossil energy, 50 millions of natural gas, 30 million tons of coal and 30 million tons of oil. Coal, oil, natural gas and non-fossil energy account for 59.0%, 18.8%, 7.8% and 14.3% of the primary energy consumption, respectively (Figure 1.28).

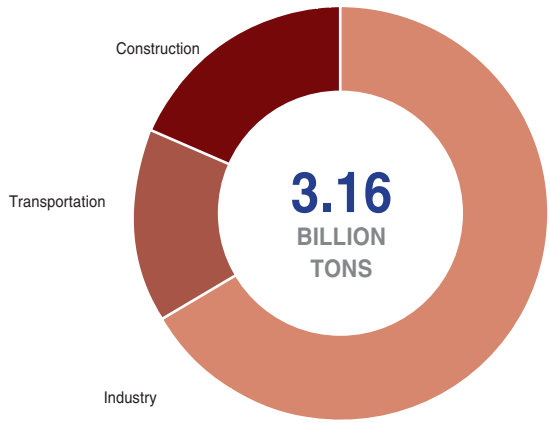
Figure 1.28 Energy consumption mix in 2018 of China



In 2018, China's terminal energy consumption is about 3.16 billion tons of coal equivalent, a year-on-year increase about 3%. Industrial consumption increases 1.4% to 2.09 billion tons, transportation consumption increases 6.0% to 0.53 billion tons and construction consumption increases 7.5% to 0.58 billion tons (Figure 1.29).

In 2018, China's per capita energy consumption is about 3.33 tons of coal equivalent, about 1.3 times the world average level.

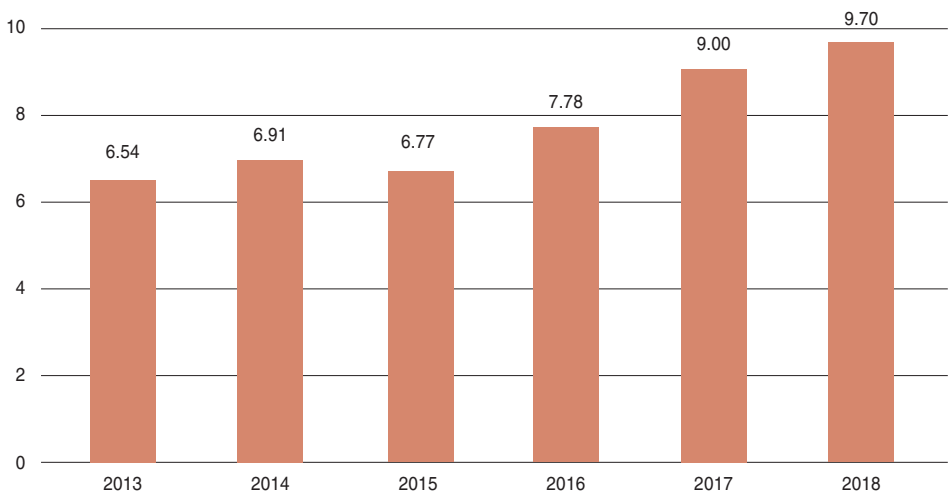
Figure 1.29 Terminal energy consumption mix of China in 2018



IMPORT AND EXPORT

After overtook America as the largest oil importer in 2017, China surpassed Japan as the largest natural gas importer in 2018, too (Figure 1.30).

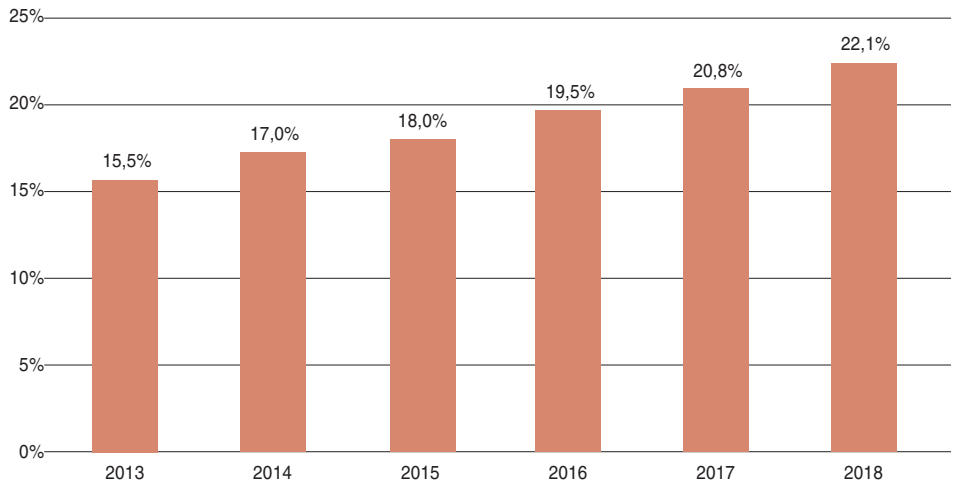
Figure 1.30 Primary energy import of China in 2013-2018 (10^8 tons of coal equivalent)



EVOLUTION OF ENERGY MIX

In 2018, the share of coal in energy consumption accounts for 59.0%, down 1.4 percentage points from 2017. The share of clean energy, such as natural gas, hydropower, nuclear, solar and wind power, has been gradually increased. The energy mix has been developing to be cleaner and in higher-quality. The consumption of clean energy accounts for 22.1% of the total energy consumption, of which non-fossil energy accounts for 14.3% and renewable energy for 12.4% (Figure 1.31).

Figure 1.31 **Share of clean energy in total energy consumption in 2013-2018**



In 2018, the share of electric in terminal energy consumption continued to increase to 25.5%, 0.6 percentage points higher than that in 2017.

1.4.2_ENERGY INDUSTRIES

LIQUID FUEL

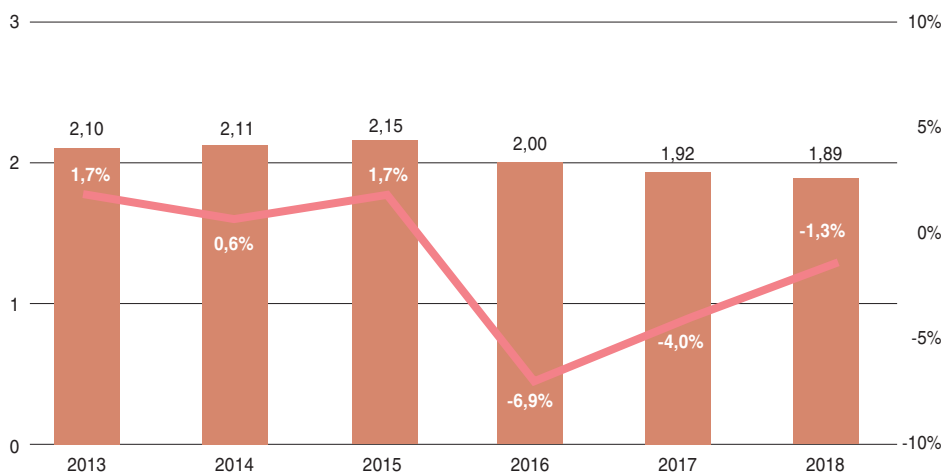
Reserves

By the end of 2018, China's proven remaining recoverable oil reserves were 3.573 billion tons, ranking 13th in the world, with a reserve production ratio of 18.7, accounting for about 1.5% of the world's total.

Production

In 2018, crude oil production was 189 million tons, down 1.3% over the previous year, accounting for about 4.4% of the world's total production, ranking 7th in the world (Figure 1.32).

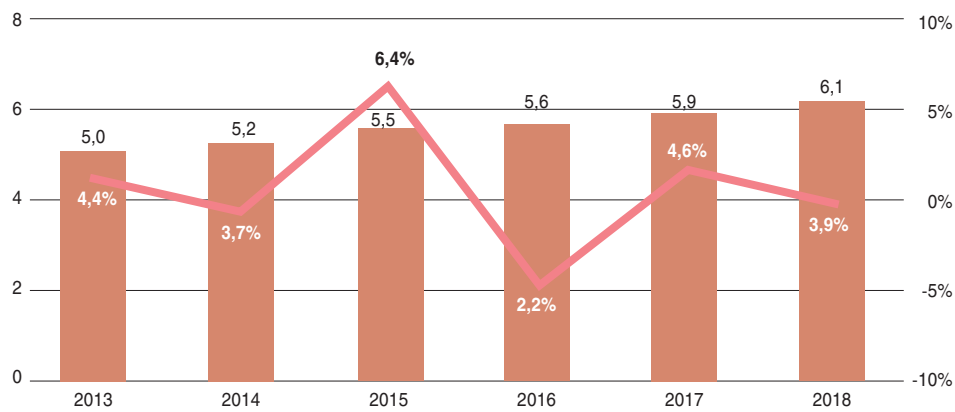
Figure 1.32 Crude oil production in 2013-2018 (10^8 tons)



Consumption

The annual oil consumption is about 610 million tons, up 3.4% year on year, down 1.2 percentage points from the previous year, accounting for 13.3% of the world, ranking second in the world. China's per capita oil consumption was about 0.43 tons, about 72% of the world's per capita consumption (Figure 1.33).

Figure 1.33 Crude oil consumption in 2013-2018 (10^8 tons)



The consumption of oil products is about 340 million tons, up 4.2% year on year. Among them, gasoline increased by 7.8% and diesel increased by 4.1%. In terms of varieties, the overall market consumption shows a trend of "gasoline slowing down, kerosene booming and diesel heating up". The ratio of diesel to gasoline consumption continued to decline to 1.22.

Refinery

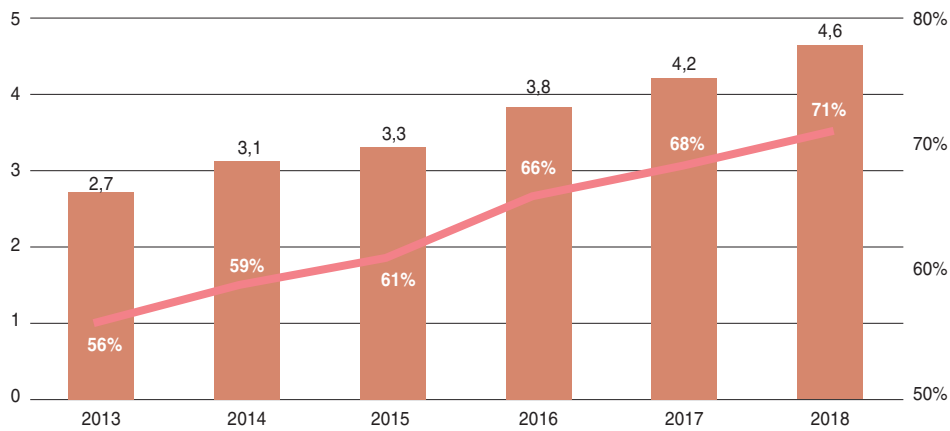
The release of new capacity led to the rapid growth of crude oil processing. In 2018, the crude oil processing volume was 6.04 billion tons, an increase of 6.8% over the previous year. The production of refined oil is 368 million tons, an increase of 2.7% over the previous year, of which the production of gasoline is 139 million tons, an increase of 4.6% over the previous year; the production of diesel is 174 million tons, a decrease of 5.2% over the previous year; the production of kerosene is 47.7 million tons, an increase of 12.7% over the previous year.

Import

In 2018, China's net import of crude oil reached 460 million tons, ranking first in the world with a year-on-year growth of 10% (Figure 1.34).

With the increase of oil import in China and decrease in USA, China's import exceeded that of USA for the first time in 2017, becoming the world's largest crude oil importer.

Figure 1.34 Crude oil import in 2013-2018 (10^8 tons)



NATURAL GAS

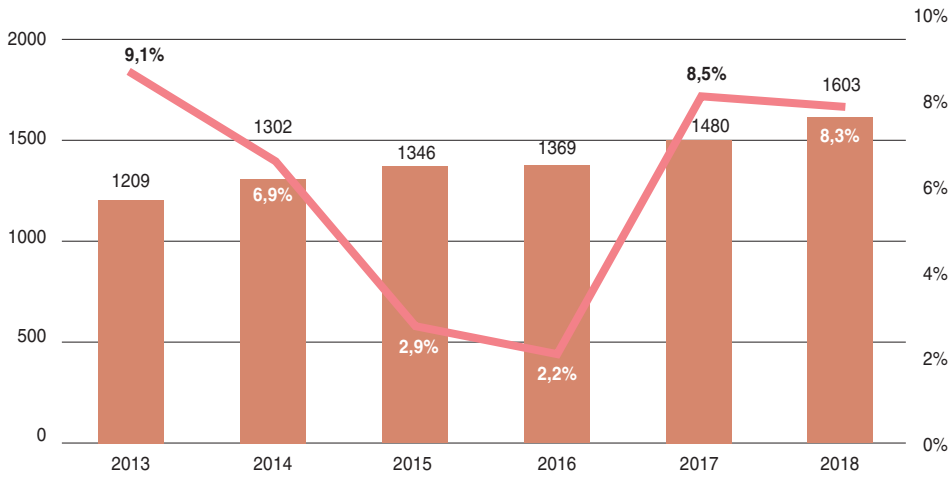
Reserves

By the end of 2018, China's proved remaining recoverable reserves of natural gas was 6.1 trillion cubic meters, accounting for 3.1% of world's total reserves, ranking 7th in the world, with a reserve-production ratio of 37.6.

Production

In 2018, natural gas production in China was about 160.3 billion cubic meters, an increase of 8.3% year on year, accounting for about 4.2% of the world's total, ranking 6th in the world. The main reason is that the implementation and promotion of environmental protection policies have made the demand for natural gas consumption continue to rise, leading to a substantial increase in production (Figure 1.35).

Figure 1.35 Natural gas production in 2013-2018 (10^8 cubic meters)

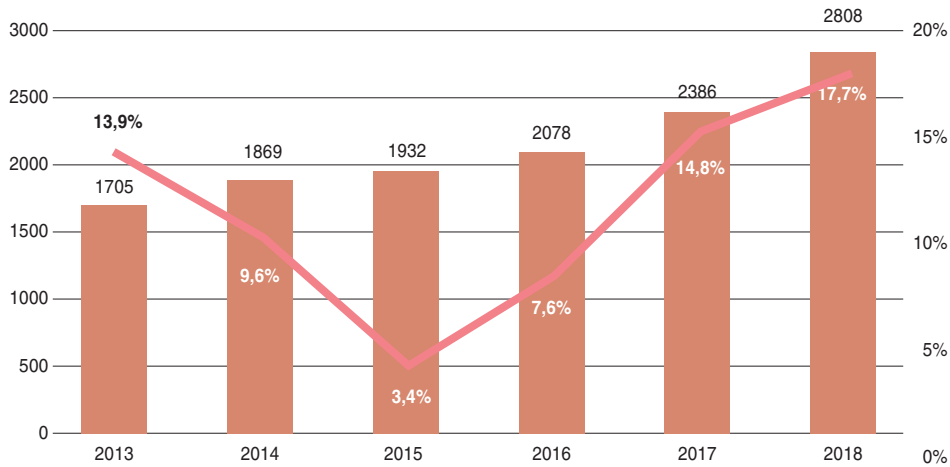


The production of unconventional natural gas increased significantly, with the output of about 18.7 billion cubic meters, up 11.5% year on year. In terms of varieties, shale gas production continued to rise, about 10.3 billion cubic meters, an increase of 1.3 billion cubic meters over the previous year. The production of coalbed methane is 5.6 billion cubic meters, an increase of 1.3 billion cubic meters over the previous year. The production of coal to gas is 2.8 billion cubic meters, an increase of 600 million cubic meters over the previous year. The production of conventional gas increased by 7.7% to about 141.6 billion cubic meters, an increase of 9 billion cubic meters over the previous year.

Consumption

In 2018, with the continuous promotion of the national economic and environmental protection policies, the annual consumption of natural gas exceeded expectations, reaching 280.8 billion cubic meters, ranking 1st in the world, with an annual increase of 42.2 billion cubic meters, a year-on-year increase of 17.7%, accounting for about 7.4% of the world's total. The per capita consumption of natural gas is 172 cubic meters, about 35% of the world (Figure 1.36).

Figure 1.36 Natural gas consumption in 2013-2018 (10^8 cubic meters)



Urban gas: influenced by the growth of population using gas, the establishment of coal prohibition zones in Beijing, Tianjin, Hebei and surrounding cities, and the explosive growth of LNG, the consumption of urban gas is 115 billion cubic meters, an increase of 24.3% year on year.

Industrial fuel: affected by the improvement of industrial economy, the transformation of coal to gas and the elimination of small coal-fired plants, the consumption of industrial fuel is 91 billion cubic meters, up 21.3% year on year.

Power generation: gas-fired power generation increased by 10.3% year on year, while natural gas distributed energy projects using developed rapidly, using 47 billion cubic meters, an increase of 14.1% year on year.

Chemical industry: the output of chemical products increased, and the chemical gas consumption was 27.5 billion cubic meters, reversing the downward trend, with a year-on-year increase of 1.9%.

Import

In 2018, China's natural gas import exceeded 90 million tons, a year-on-year increase of 32%. Among them, the import of liquefied natural gas is 53.78 million tons, up 41% year on year, accounting for 59% of the total import of natural gas. The import of natural gas from the pipeline was 36.61 million tons, an increase of 20%, accounting for 41%.

In 2018, China exceeded Japan to become the world's largest natural gas importer.

COAL

Reserves

By the end of 2018, China's basic coal reserves reached 258.746 billion tons, of which Shanxi, Inner Mongolia and Xinjiang were the top three provinces (regions), respectively 90.99, 59.226 and 17.015 billion tons, accounting for 64.6% of the country's total.

Production

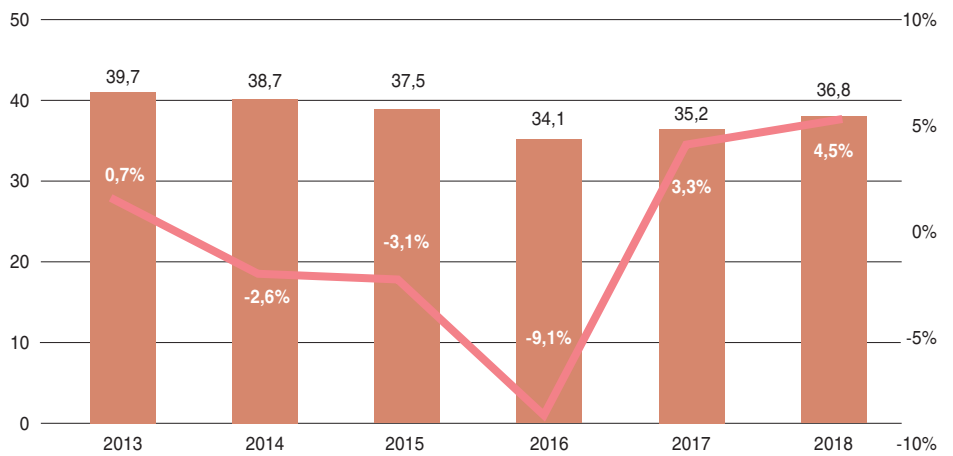
In 2018, the annual production of coal was 3.68 billion tons, an increase of 4.5% year-on-year, with an increase for two consecutive years, accounting for 45.6% of the world's total production, ranking first in the world. The structural reform of the coal supply side has been pushed forward in depth. De-capacity of coal in the 13th Five Year Plan is 800 million tons, and the main goal has been basically achieved (Figure 1.37).

The coal development was further optimized, and the production continued to focus on areas with good resource and strong competitiveness, such as Shanxi, Shaanxi, Inner Mongolia and Xinjiang. In 2018, the production of coal in Inner Mongolia, Shanxi, Shaanxi, Xinjiang, Guizhou, Shandong, Henan and Anhui accounted for 88.1% of the national total, an increase of 0.9 percentage points on a year-on-year basis; among them, the production of coal in Shanxi, Shaanxi, Inner Mongolia and Xinjiang accounted for 74.3% of the national total, an increase of 1.8 percentage points on a year-on-year basis.

Consumption

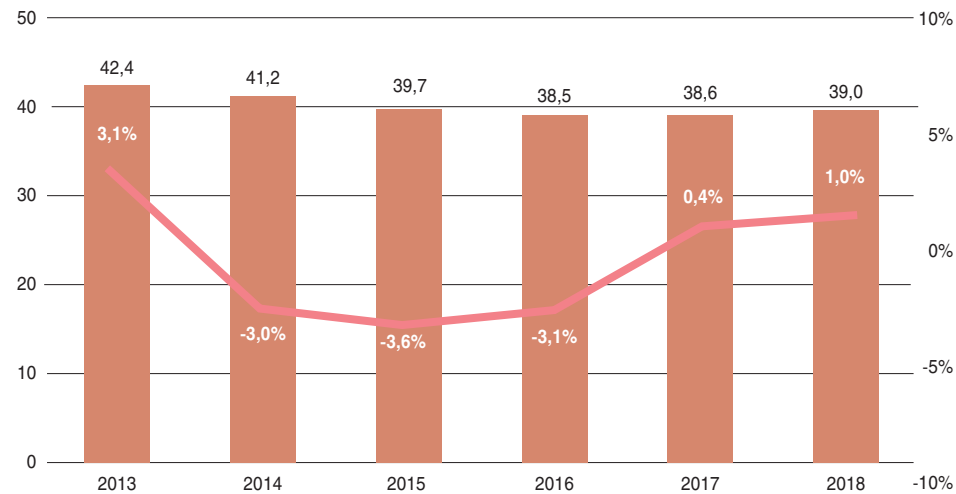
In 2018, China's total coal consumption reached 3.9 billion tons, a year-on-year increase of 1.0%. This is the second consecutive year of coal consumption growth since 2017 (Figure 1.38).

Figure 1.37 Production of coal in 2013-2018 (10^8 tons)



From the perspective of major coal consumption industries, it is estimated that the annual coal consumption of electric power is about 2.1 billion tons, steel industry for 620 million tons, construction industry for 500 million tons, chemical industry for 280 million tons, and other industries for about 60 million tons.

Figure 1.38 Coal consumption in 2013-2018 (10^8 tons)



Import

In 2018, coal import reached 280 million tons, an increase of 3.9% year on year. Among them, the import of hard coal is 190 million tons, up 3% year-on-year; the import of lignite is 90 million tons, up 17% year-on-year.

Clean utilization of coal

Influenced by the energy resource condition, coal has always been the primary energy with the highest proportion in China's energy structure. In recent years, the Chinese government has resolutely implemented the priority policy of energy conservation, put energy conservation throughout all areas of the whole process of economic and social development, accelerated the formation of an energy-saving society, accelerated the transformation of traditional energy utilization mode, and significantly accelerated the transformation of clean and low-carbon. The proportion of coal consumption dropped by 9.5% and historically dropped below 60%.

China attached great importance to the green development of coal industry, adhered to the concept of "Lucid waters and lush mountains are invaluable assets", run the requirements of ecological civilization construction throughout the whole process of coal development and utilization, and urged the transformation of coal development and utilization mode. The following works were carried out in recent years.

First, conscientiously organize and implement the guiding opinions on promoting safe and green development and clean and efficient utilization of coal and the action plan for clean and efficient utilization of coal (2015-2020), actively promote green mining technologies such as filling mining, water conservation mining, coal and gas mining, strengthen the management of recovery rate and comprehensive utilization of resources in production coal mines, and explore development road of coal-based, diversified, emission reduction and ecological restoration, promote the formation of various characteristic circular economic models in mining areas.

Second, strengthen the quality management of commercial coal. Actively implement the Interim Measures for the quality management of commercial coal, urge relevant local governments to improve the supervision system for the quality of commercial coal, strengthen the supervision over the quality of commercial coal, and cooperate

with the General Administration of Customs and other departments to restrict the import of inferior coal.

Third, through the 13th Five Year Plan for the development of coal industry, guide enterprises to vigorously develop washing and processing, continue to require large and medium-sized coal mines to build supporting coal preparation plants or central coal preparation plants, accelerate the upgrading and transformation of existing coal preparation facilities, and improve the quality of coal from the source.

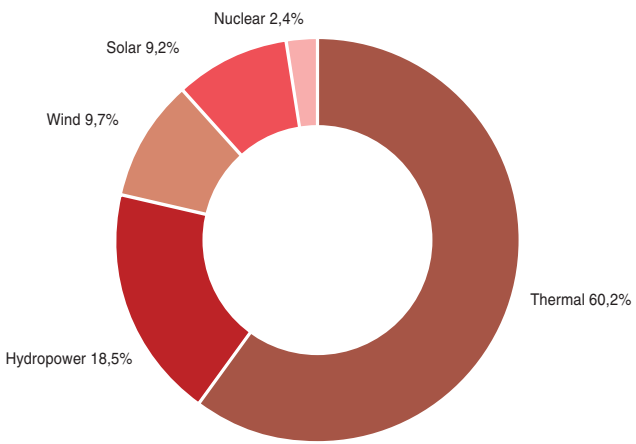
Fourth, promote green mining, water conservation mining, filling mining and other technologies according to local conditions to minimize the impact of coal mining on the ecological environment.

POWER ELECTRICITY

Production

By the end of 2018, China's installed power capacity was about 1.9 billion kilowatts, ranking first in the world, with a year-on-year growth of 6.5%, of which 120 million kilowatts was newly installed in 2018. The annual power generation is about 7.0 trillion kWh, up 8.4% year on year, accounting for 26.7% of the world's total power generation, ranking first in the world (Figure 1.39).

Figure 1.39 Power installation structure in 2018

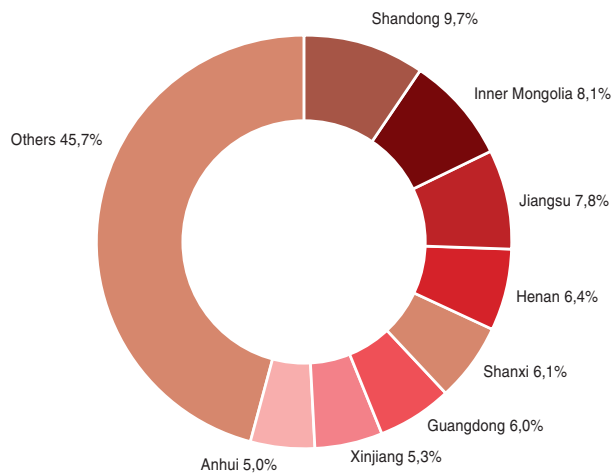


In 2018, China's installed capacity of coal-fired power plants is 1.01 billion kilowatts, accounting for 53.0% of the total installed capacity of power supply. The annual power generation is about 4.45 trillion kWh, an increase of 7.3% year on year. The increase of power generation is about 300 billion kWh, accounting for 55.9% of the increase of power generation.

The utilization hours of thermal power plants in China were 4361 hours, a year-on-year increase of 143 hours, among which the utilization hours of coal-fired power plants were more than 4400 hours.

By the end of 2018, the installed capacity of coal power in eight provinces (regions) of Shandong, Inner Mongolia, Jiangsu, Henan, Shanxi, Guangdong, Xinjiang and Anhui exceeded 50 million kilowatts, accounting for 54.3% of the total installed capacity of coal-fired power plants in China (Figure 1.40).

Figure 1.40 Proportion of installed capacity of coal power in different regions of China



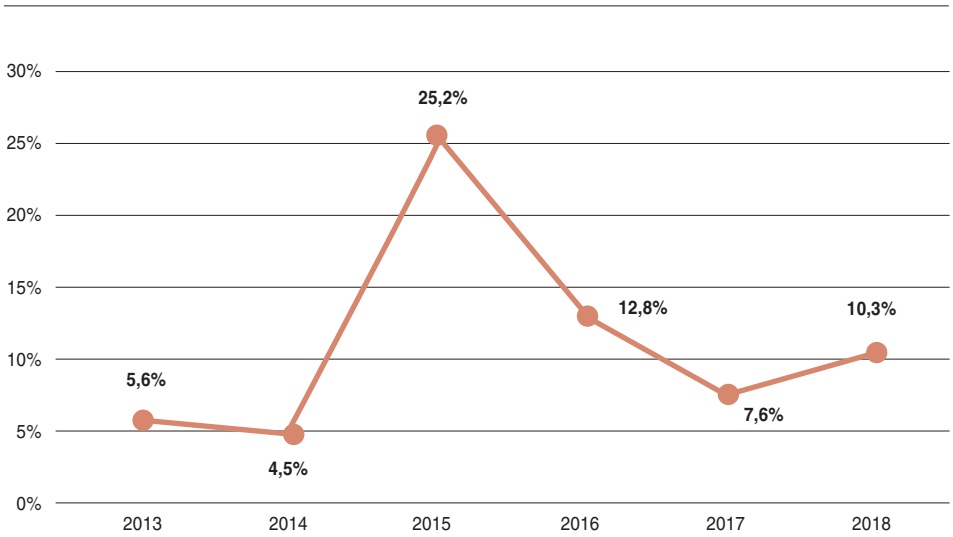
In terms of clean coal-fired power generation, China is actively eliminating and shutting down coal-fired units, and implementing ultra-low emissions and energy-saving transformation of coal-fired power generation. We have successively implemented such policies and measures as the action plan for the upgrading and transformation of energy conservation and emission reduction of coal power (2014-2020), the work plan

for the comprehensive implementation of ultra-low emission and energy conservation transformation of coal-fired power plants, and implemented more stringent energy efficiency and environmental protection standards for coal-fired power plants, which requires that the pollutant emissions of newly built coal-fired power units in China basically meet or approach the emission limit of gas-fired power plants. Ultra-low emission transformation of coal power is implemented to be 580 million kilowatts by 2020 nationwide. The overall goal of energy saving transformation is 340 million kilowatts during the 13th Five Year Plan.

By the end of 2018, over 810 million kilowatts of ultra-low emission coal-fired power plants have been achieved, 689 million kilowatts of energy-saving transformation have been completed, and 20 million kilowatts of coal-fired power units have been eliminated in advance during the 13th Five Year Plan. China has built the world's largest clean coal power supply system, and the air pollutant emission index has leapt to the world's advanced level.

In 2018, the total installed capacity of gas-fired power plant in China was 83.3 million kilowatts, accounting for 4.4% of the total installed capacity of power supply in China, with a year-on-year growth of 10.0%. In the whole year, the gas-fired power generation was about 223.6 billion kWh, up 10.3% year on year (Figure 1.41).

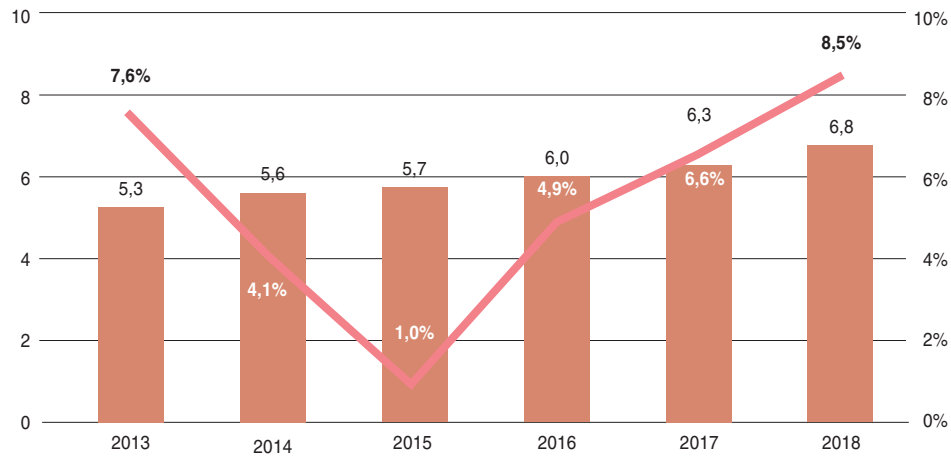
Figure 1.41 Gas power plant generation in 2013-2018



Consumption

In 2018, the total electricity consumption was about 6.8 trillion kWh, up 8.5 % than that of 2017, accounting for about 26 percent of the world's electricity consumption and ranking first in the world. Per capita electricity consumption is 4915 kWh, about 1.5 times of the world's per capita electricity consumption (Figure 1.42).

Figure 1.42 Total electricity consumption in 2013-2018 (trillion kWh)



In terms of different industries, the growth rate of electricity consumption in various industries has been significantly improved compared with 2017. The growth rate of electricity consumption in the secondary industry is 7.2%, reached a new high since 2012, and the tertiary industry increased for 12.7%, and domestic consumption for 10.4%. The growth rate of electricity consumption in the mining industry and manufacturing industry has been significant.

The rapid growth of electricity consumption in 2018 is affected by several factors. First, affected by fixed investment factors such as real estate, the central and western regions actively undertaking industrial transfer from the East and upgrading of manufacturing industry, power consumption of mining industry, iron metallurgy, metal products and other industries increased significantly. Second, the "coal to electricity" and other energy

substitution projects have been effectively promoted in the manufacturing industry and other fields. In 2018, the total amount of electricity substitution in China is about 150 billion kWh, which correspondingly drived the rapid growth of secondary power consumption in the manufacturing industry. Third, with the continuous improvement of residents' living standards, the corresponding power consumption of lives, education, wholesale and retail has maintained a growth trend of more than 10%. In addition, power consumption on information transmission, software and information technology service industries has maintained a rapid growth.

Infrastructure

By the end of 2018, transmission lines of 220 kV and above reached 733000 kilometers (including 691000 kilometers of AC lines and 42000 kilometers of DC lines), a year-on-year increase of 7.0%. The new power capacity of 220 kV and above is 240 million kVA, accumulatively reaching 4.02 billion kVA, up 6.2% year on year. Among them, the capacity of AC substation equipment is 3.69 billion kVA, and DC converter capacity is 340 million kW.

Table 5 China's power grid infractructure

AC transmission lines		
Voltage	Length	Ratio
220kV	20670 km	54.8%
330kV	828 km	2.2%
500kV	14511 km	38.5%
750kV	1573 km	4.2%
1000kV	129 km	0.3%
Substation		
Voltage	Capacity	Ratio
220kV	84.2 million kVA	38.1%
330kV	6.12 million kVA	2.8%
500kV	110.1 million kVA	49.9%
750kV	11.4 million kVA	5.2%
1000kV	9 million kVA	4.1%

By 2018, China has formed a large-scale power grid with 6 main parts, Northeast, North, Northwest, Central, East and South, with AC and DC interconnection between regions and covering all provinces (regions, cities). Among them, 500 kV main grid structure has been formed in Northeast China; two horizontal and one vertical AC UHV main grid structure has been formed in North China; 750 kV main grid structure has been formed in Northwest China; UHV ring network will be finished soon in East China; preliminary work on UHV main grid structure of four provinces in Central China and East China is carrying out; Sichuan has realized 500 kV network with Tibet; Southern Power Grid has formed eight AC and ten DC transmission lines from West to East. By the end of 2018, there were 165 regional and provincial AC transmission lines with a total length of 30710 km, 29 DC transmission lines with a total length of 39040 km and 4 DC back-to-back projects.

By the end of 2018, the capacity of substation in China was 3.67 billion kVA, with a year-on-year growth of about 8.2%, among which the capacity of high-voltage substation was 2.07 billion kVA, with a year-on-year growth of about 5.6%, and the capacity of medium-voltage substation was 1.6 billion kVA, with a year-on-year growth of about 12.0%. The length of power distribution line was 5.618 million kilometers, an increase of about 3.7% year on year, among which the high-voltage distribution lines was 1.019 million kilometers, an increase of 3.3% year on year, and the medium-voltage distribution line was 4.599 million kilometers, an increase of about 3.8% year on year. In 2018, the construction investment on distribution line was about 321.43 billion yuan, an increase of about 9.3% year on year.

In the first three years of the 13th Five Year Plan, 581.2 billion yuan was invested in rural power grid, among which 189.8 billion yuan in 2018, up 1.05% year on year. In 2018, 26 provinces and cities, including Beijing, Jiangsu, Hubei, etc., completed power transformation tasks for 2311 villages, added up to 80300 villages in total, achieving a rural power supply reliability rate of 99.795% and a rural comprehensive voltage qualification rate of 99.752%.

Import and export

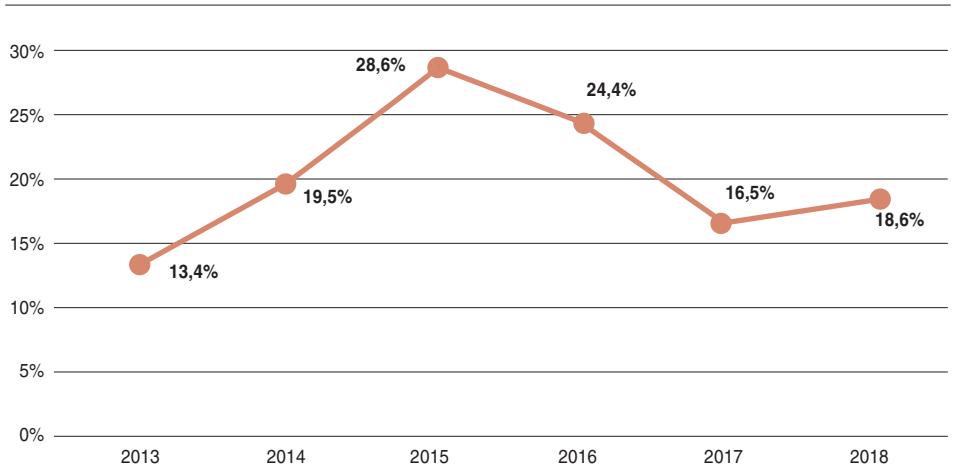
China has achieved power line interconnection and border trade with Russia, Mongolia, Myanmar, Vietnam, Laos and other countries, mainly supplying power for border facilities and remote areas of neighboring countries.

NUCLEAR

Production

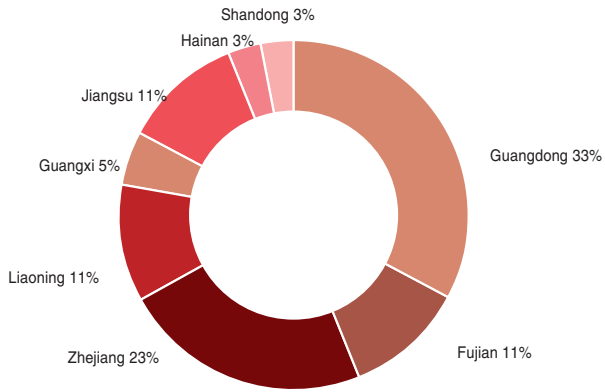
By the end of 2018, there were 44 nuclear power plants in operation in China, with a total installed capacity of 44.66 million kilowatts, ranking third in the world, accounting for 2.4% of China's total installed power capacity. There were 12 nuclear power plants under construction, with a total installed capacity of 13.44 million kilowatts, ranking first in the world. The annual nuclear power generation capacity was 294.4 billion kWh, an increase of 18.6% year on year. In 2018, the average utilization hours of nuclear power plants nationwide was about 7184 hours, up 95 hours from the previous year (Figure 1.43).

Figure 1.43 Nuclear power production in 2013-2018



By the end of 2018, China's nuclear power plants was concentrated in eight coastal provinces (regions) of Liaoning, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong, Guangxi and Hainan. Among them, the total installed capacity of nuclear power in Guangdong, Fujian and Zhejiang provinces is 31.09 million kilowatts, accounting for 69.6% of the total installed capacity of nuclear power in China (Figure 1.44).

Figure 1.44 Nuclear power capacity in different regions in 2018

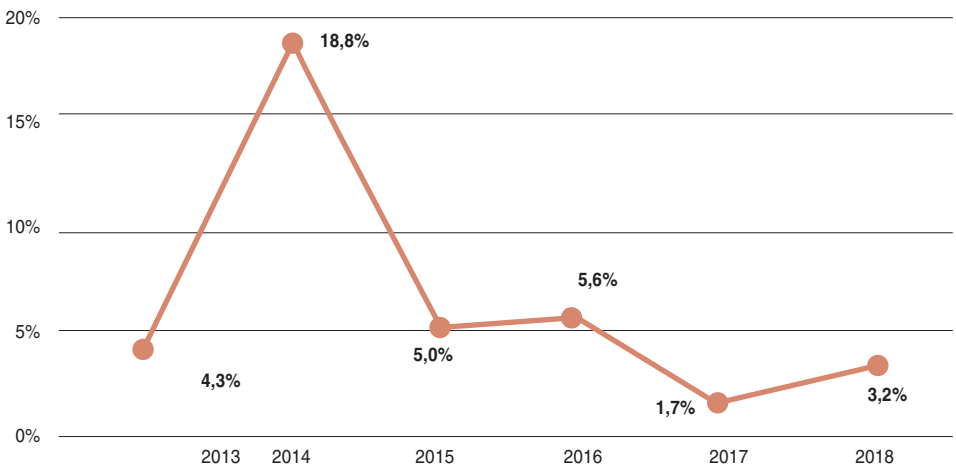


RENEWABLE ENERGY

Production

In 2018, China's renewable energy generation reached 1.87 trillion kWh, accounting for 26.7% of the total generation, an increase of 170.5 billion kWh compared with 2017, a year-on-year increase of 10.1%.

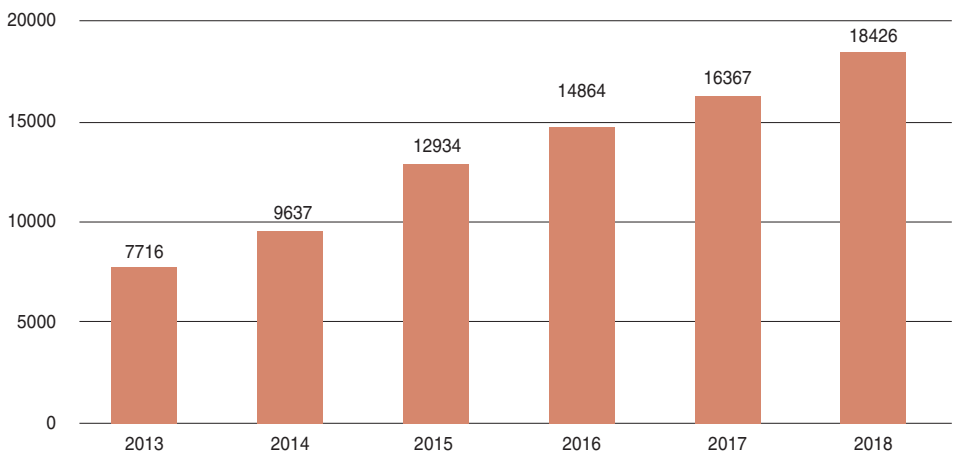
Figure 1.45 Hydropower production in 2013-2018



By the end of 2018, China's total installed capacity of hydropower has reached 350 million kilowatts, ranking first in the world, including 320 million kilowatts of conventional hydropower, accounting for 18.5% of the wind power capacity.

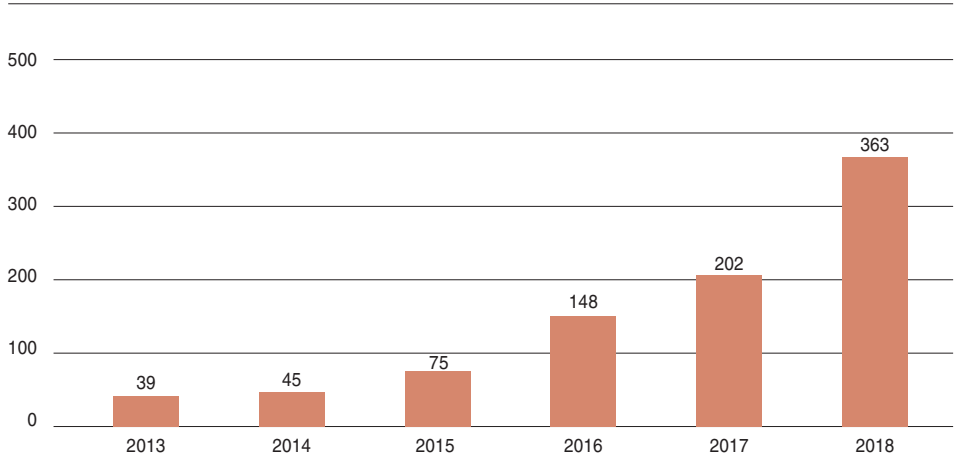
In 2018, China's hydropower generation capacity was 1.23 trillion kWh, an increase of 3.2% year on year, and hydropower accounted for 10.1% of primary energy production. The utilization hours of hydropower plants are 3613 hours, an increase of 16 hours over 2017. (Figure 1.45).

Figure 1.46 Wind power installed capacity in 2013-2014 (10^4 kW)



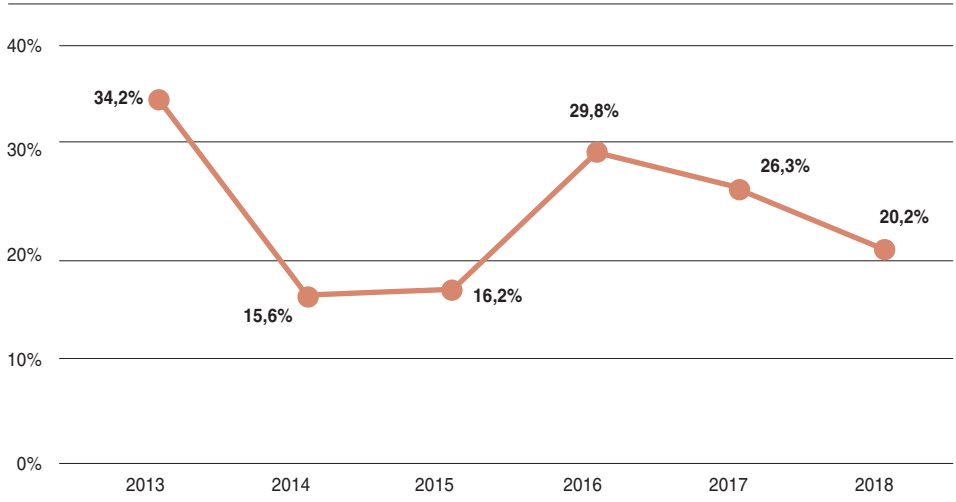
In 2018, China's wind power continued to maintain a rapid development momentum. By the end of 2018, China's total installed capacity of wind power reached 184 million kilowatts, accounting for 9.7% of the installed capacity of power generation, ranking first in the world for nine consecutive years. (Figure 1.46).

Figure 1.47 Offshore wind power capacity in 2013-2018 (10^4 kW)



In 2018, China's offshore wind power added 1.61 million kilowatts of installed capacity and accumulated 3.63 million kilowatts, with an annual growth rate of 80%, showing a trend of accelerated development. The scale of offshore wind power under construction in China is about 8 million kilowatts, and it is expected to achieve the development goal of 5 million kilowatts installed capacity in 2020 (Figure 1.47).

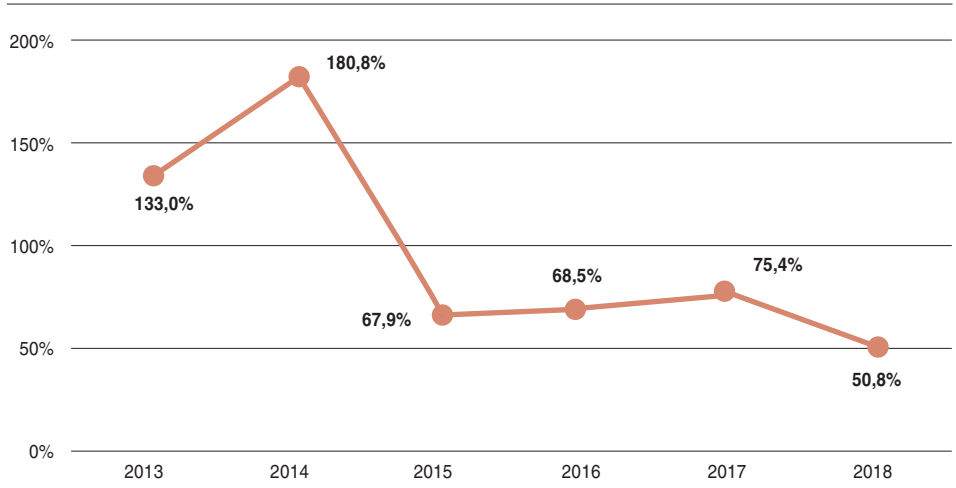
Figure 1.48 Wind power generation in 2013-2018



In 2018, the annual wind power generation was 366 billion kWh, an increase of 20.2% year on year, and the power generation accounted for 3.0% of the primary energy production. In 2018, the average utilization hours of wind power in China was 2095 hours, 147 hours higher than that in 2017 (Figure 1.48).

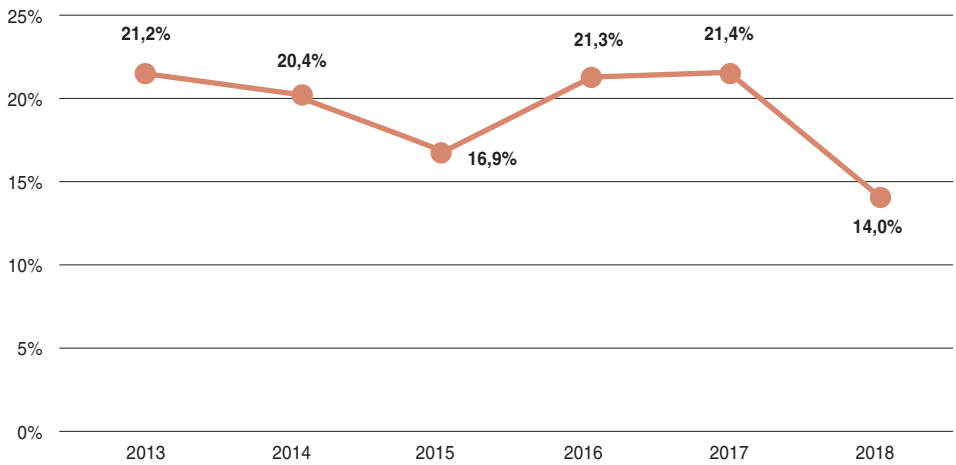
In 2018, the newly installed capacity of photovoltaic in China was 44.26 million kilowatts, with an accumulated installed capacity of 174 million kilowatt hours, accounting for 9.2% of the total installed capacity, ranking first in the world in terms of newly added and accumulated installed capacity throughout the year. In the whole year, solar photovoltaic power generation reached 177.5 billion kWh, an increase of 50.8% year on year, and maintained rapid development. Power generation accounts for about 1.4% of primary energy production. The average utilization hours of photovoltaic power generation in China is 1115 hours, 37 hours higher than that in 2017 (Figure 1.49).

Figure 1.49 **Solar photovoltaic power generation in 2013-2018**



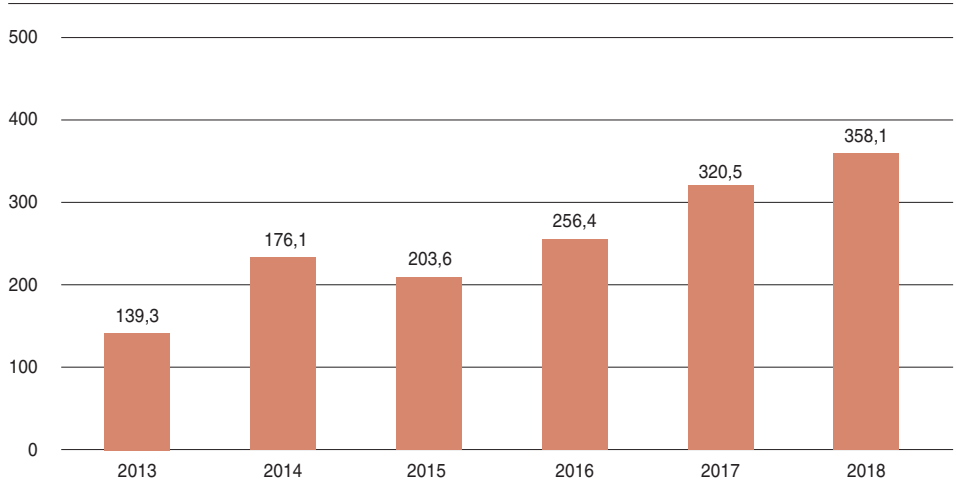
In 2018, the cumulative grid connected installed capacity of solar thermal power generation in China is 220000 kilowatts, and five demonstration projects (about 300000 kilowatts) are stepping up substantive construction.

Figure 1.50 Biomass power generation in 2013-2018



In 2018, the total installed capacity of biomass power generation projects in China was 17.81 million kilowatts, an increase of 3.048 million kilowatts compared with that in 2017. The annual biomass power generation was 90.6 billion kWh, up 14% year on year. The top four provinces in biomass power generation are Shandong, Jiangsu, Zhejiang and Guangdong, with 13.5 billion, 9.5 billion, 9.2 billion and 8.3 billion kWh respectively (Figure 1.50).

Figure 1.51 Exported wind power capacity in 2013-2018 (10^4 kW)



In 2018, China's wind power industry exported 131 wind turbines to foreign countries, with a total capacity of 376000 kilowatts. By the end of 2018, the country has exported 1838 wind turbines with a total capacity of 3.581 million kilowatts(Figure 1.51).

PLAN AND POLICY

In November 2018, the NDRC and NEA issued the clean energy consumption action plan (2018-2020). In 2020, the overall goal is to strive to achieve the average wind power and photovoltaic power utilization rate of about 95% and control the rejection rate of about 5%, achieve the water energy utilization rate of more than 95% and the nuclear power safety and security consumption.

ENERGY EFFICIENCY

China's energy efficiency has been improving in recent years and the intensity of energy consumption in economic activities has continued to decline. In 2018, the energy consumption per unit GDP in China decreased to 0.52 tons of coal equivalent / 10000 yuan, and the power consumption per unit GDP was 760 kWh / 10000 (Figure 1.52).

Figure 1.52 Per unit GDP in 2013-2018 (tons of coal equivalent/10000 yuan)

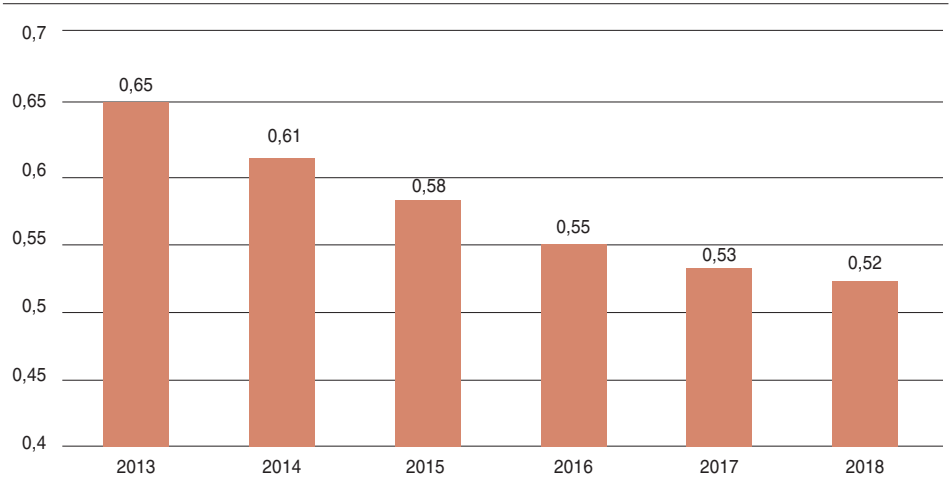
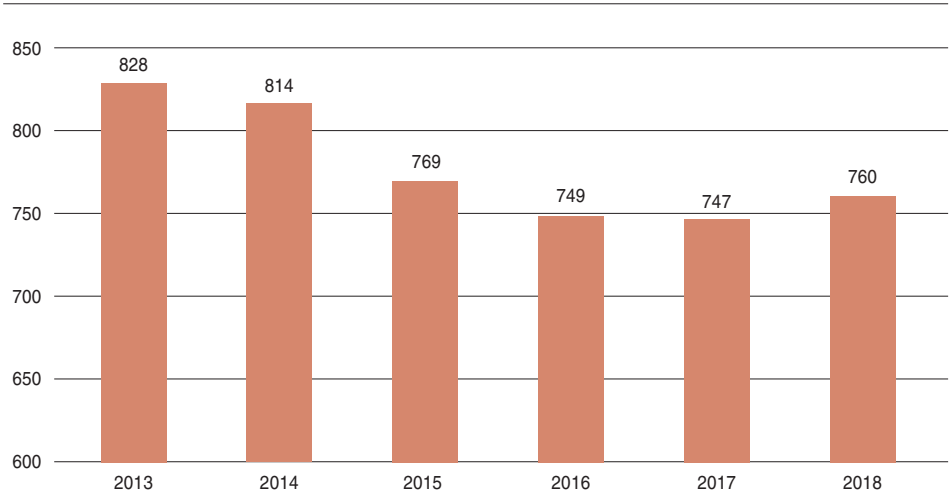


Figure 1.53 Per unit GDP power consumption (kWh/10000 yuan)



In 2018, the average coal equivalent consumption rate of thermal power plants is about 307g/kWh, which continues to decrease by 1g/kWh compared with 2017; the average coal equivalent consumption rate of new plants is lower than 300g/kWh, which continues to maintain the world's advanced level.

The refining industry continued to eliminate old technology and production capacity. In 2018, the comprehensive energy consumption of China's refining industry was about 63kg standard oil/ton, which was the same as that in 2017.

Power grid enterprises continued to strengthen operation management. In 2018, the power grid line loss rate was 6.2%, down about 0.27% year on year.

[1.5]

SOUTH AFRICA

1.5.1_GENERAL OVERVIEW

ENERGY MIX (PRODUCTION, CONSUMPTION, EXPORT AND IMPORT)

South African Republic (SAR) is the second largest energy consumers in the African continent. Total primary energy consumption in South Africa in 2019 amounted to 135 mtoe, which is 5.6% lower than in 2010. The structure of energy consumption is dominated by coal with a share of about 75% (Figure 1.54).

South Africa is a net energy exporter, supplying more than 45 million tons of coal annually to world markets, while its own production of oil and natural gas is extremely limited and most of these fuels are imported. Since 2010, the structure of energy production has remained almost unchanged, but there has been a slight reduction in total production (Figure 1.55).

According to the national plans, energy demand is set to grow and by 2040 should increase by 80% compared to 2019 in a moderate economic growth scenario. At the same time the share of coal in the energy balance should be reduced due to diversification of the energy mix which includes renewable energy, gas and nuclear. (Figure 1.56)

Figure 1.54 Total Primary energy consumption in SAR in 2010-2019

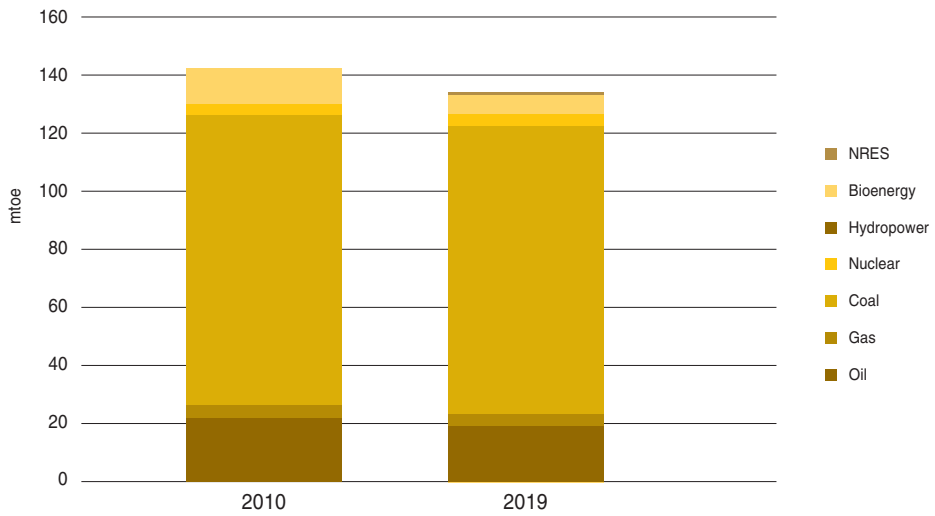


Figure 1.55 Total Primary energy production in SAR in 2010-2019

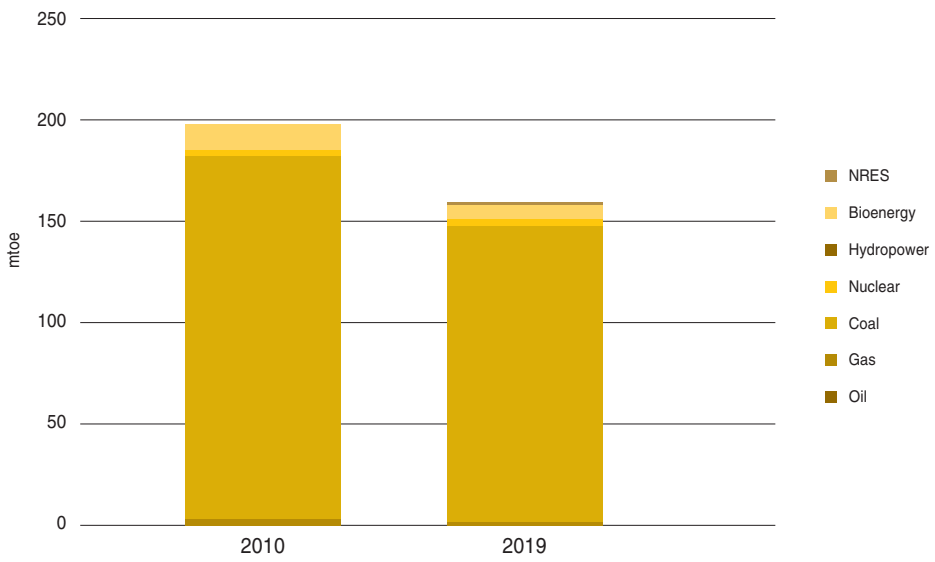
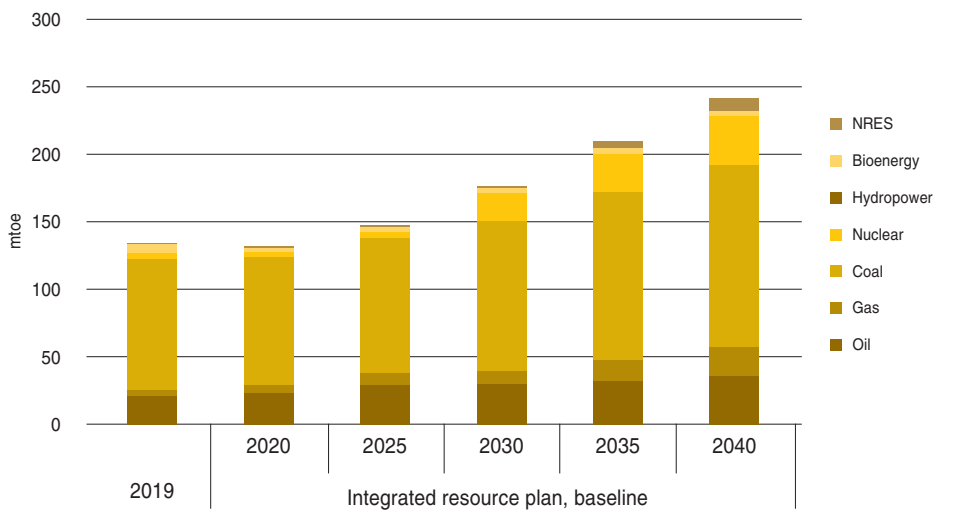


Figure 1.56 **Total Primary energy production in SAR**



Source: South Africa Department of Mineral Resources and Energy (DMRE), Integrated Energy Plan 2016, URL: http://www.energy.gov.za/files/iep_frame.html

RENEWABLES

The National Development Plan (NDP) required the development of 10 000MW additional electricity capacity to be established by 2019 against the 2010 baseline of 44 000MW.

South Africa is regarded as a prime candidate for increased use of renewable energy with its abundant natural resources of sun and wind. The country is highly dependent on coal burning for power generation, but does have a number of small-scale hydroelectric plants and only one nuclear power station. At the same time, South Africa has an abundance of sunshine which lends itself very well for solar water heating and electricity generation.

Given the ever rising cost of traditional fossil fuels based energy, renewable energy is becoming a viable option. South Africa is currently rated as the 12th most attractive investment for renewable energy. The Renewable Energy Independent Power

Producers Procurement Programme (REIPPPP) has to date, attracted investment (equity and debt) to the value of R209.7 billion, of which R41.8 billion (20%) is foreign investment (IPPPP An Overview, 2019). This augurs well for South Africa, as the programme has received international acclaim for fairness, transparency and the certainty of this programme.

The REIPPPP is aimed at bringing additional power into the electricity system through private sector investment in wind, solar, photovoltaic, concentrated solar power (CSP), biomass and small hydro technologies. The REIPPP programme constitutes one of the energy mixes as outlined in the National Development Plan and the Integrated Resource Plan 2010.

In May 2011, the DoE gazetted the Electricity Regulations on New Generation Capacity (New Generation Regulations) under the Electricity Regulation Act (ERA) which enable the Minister of Energy (in consultation with NERSA) to determine what new capacity is required. Ministerial determinations give effect to components of the planning framework of the IRP, as they become relevant. The current new capacity determinations include 14 725MW of renewable energy, comprising of solar PV (6 225MW), wind (6 360MW), CSP (1 200MW), small hydro (195MW), landfill gas (25MW), biomass (210MW), biogas (110MW) and the small scale renewable energy programme (400MW);

The determinations have been implemented in rolling bid windows with seven (1, 2, 3, 3.5, 4, 1S2 and 2S2) bid windows successfully completed in the first five years. All projects in Bid Window 1 (BW1) and Bid Window 2 (BW2), and 10 projects in Bid Window 3 (BW3) are now operational. By the end of June 2017, the REIPPPP had made the following significant impacts:

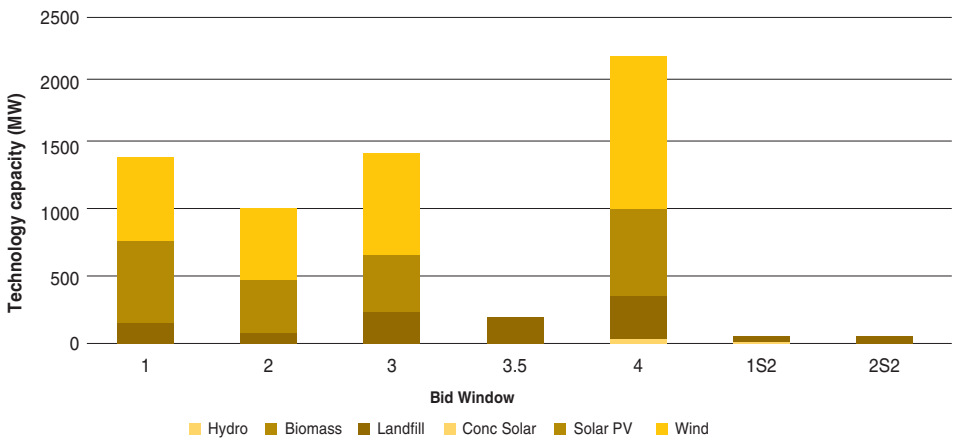
Energy supply capacity impact:

- 6 422MW of electricity had been procured from 112 RE Independent Power Producers (IPPs) in seven bid rounds, that is, Bid windows 1, 2, 3, 3.5, 4 and smalls BW1 (1S2) & smalls BW2 (2S2).
- 3 976 MW of electricity generation capacity from 64 IPP projects has been connected to the national grid.

- 35 669 GWh of energy has been generated by renewable energy sources procured under the REIPPPP since the first project became operational. Renewable energy IPPs have proved to be very reliable. Of the 64 projects that have reached COD, 62 projects have been operational for longer than a year. The energy generated over the past 12 month period for these 62 projects is 10 648 GWh, which is 96% of their annual energy contribution projections (P50) of 11 146 GWh over a 12 month delivery period. Twenty eight (28) of the 62 projects (45%) have individually exceeded their P50 projections.

Due to the success of the renewable programmes, there has been a rapid increase in Small-Medium Enterprises (SMEs) focusing on renewable energy in the country. An influx of large scale energy project developers from many parts of the world, followed by a range of local and overseas investors are keen to shape a new investment frontier; not to mention the construction of the country's first large scale commercially driven renewable energyDue to the success of the renewable programmes, there has been a rapid increase in Small-Medium Enterprises (SMEs) focusing on renewable energy in the country. An influx of large scale energy project developers from many parts of the world, followed by a range of local and overseas investors are keen to shape a new investment frontier; not to mention the construction of the country's first large scale commercially driven renewable energy projects.

Figure 1.57 Allocated capacity in windows 1, 2, 3 and 4, 2017



GOVERNANCE, PLANNING AND REGULATORY FRAMEWORK

INTEGRATED RESOURCE PLAN

The Integrated Resource Plan (IRP) is used to roll out electricity infrastructure development in line with Ministerial Determinations issued under Section 34 of the Electricity Regulation Act. The Ministerial Determinations give effect to planned infrastructure by facilitating the procurement of the required electricity capacity.

At the beginning of the term of the sixth Administration of Government, key priorities outlined for the 2019/2020 financial year in the Budget Vote debate included the finalisation of the IRP as one of the key focus areas.

The IRP 2019 was approved by Cabinet in October 2019. This policy document spells out the electricity generation mix that includes coal, nuclear, gas, renewables and energy storage. Additional capacity to the energy mix as contained in the IRP 2019 for the period up to 2030 is as follows: 1 500 MW of generation from Coal, 2 500 MW from Hydro, 6 000 MW from Photovoltaic, 14 400 MW from Wind, 2 088 MW from Storage and 3 000 MW from Gas.

Coal will continue to play a significant role in electricity generation as the country has the resource in abundance. New investments will be directed towards more efficient clean coal technologies. The Government will also work with Eskom to ensure the utility complies with the minimum emissions standard over time.

It is globally accepted fact that Nuclear as a clean source of energy can contribute significantly to the reduction of emissions. There is a move globally towards the development of small modular reactors that are considered more manageable investment when compared to a large fleet approach. The IRP 2019 provides for the extension of the design life of Koeberg nuclear power station, as well as additional new nuclear capacity in the future.

The IRP 2019 continues to make provision for significant rollout of renewable energy and storage.

Gas to power technologies will provide the flexibility required to complement intermittent renewable energy and meet demand during peaking hours. While in the short term the opportunity is to pursue gas import options, local and regional gas resources will allow for scaling up within manageable risk levels. The IRP 2019 makes provision for gas

from year 2024. Therefore, the gas infrastructre such as regasification plant for liquefied natural gas (LNG) will be required to promote gas development in South Africa.

In support of regional integration and energy trading, South Africa has entered into a Treaty for the development of the Grand Inga Project in the Democratic Republic of Congo (DRC), with some of the power intended for transmission to South Africa across DRC, Zambia, Zimbabwe and Botswana. The necessary agreements must be concluded as soon as possible for the hydro option from Grand Inga to succeed. South Africa will participate in strategic power projects that enable the development of cross-border infrastructure needed for the regional energy trading.

SOUTH AFRICAN BIOFUELS REGULATORY FRAMEWORK AND NATIONAL BIOFUELS FEEDSTOCK PROTOCOL

The Government released the South African Biofuels Regulatory Framework and National Biofuels Feedstock Protocols on the 7th of February 2020.

The purpose of this Biofules Regulatory Framework is to provide a policy and regulatory framework for the implementation of the Biofuels Industrial Strategy of 2007.

The Biofuels framework covers five main areas:

a. Feedstock Protocol – This will regulate the agricultural production of biofuels feedstock to mitigate the risk of the programme to food security.

b. The mandatory blending regulations – These regulations came into effect in 2015 and involve mandatory purchase and blending of locally produced biofuels into liquid transport fuels – to create certainty of biofuels demand through mandatory blending of biofuels into mineral liquid fuels.

c. Biofuels Subsidy Mechanism – this framework supports the financial sustainability for a new biofuels industry by providing for subsidy mechanism to support the development of the new biofuels industry.

d. The cost recovery mechanism for blending of biofuels

e. Selection criteria for biofuels projects requiring a subsidy – to participate in the national biofuels programme.

1.5.2_ENERGY INDUSTRIES

South Africa has a significant coal resource potential, with a third of the volume exported and the rest consumed domestically, but in the event of an expected reduction in domestic consumption and a restrained increase in exports, total production volumes may decrease.

In terms of the balance of production and consumption of other energy resources, South Africa is almost completely dependent on imports of either the resources themselves (in the case of gas and oil), or technologies (for nuclear and renewable energy), and this situation is likely to continue in the long term. National plans take into account the possibility of developing domestic shale gas resources to cover part of the prospective demand, but accurate production estimates are not provided, due to insufficient exploration of these resources. In addition to directly burning coal and natural gas produced in the country for energy needs, South Africa uses them as feedstock for conversion to liquid hydrocarbons, which covers more than half of the country's liquid fuel consumption. National plans are considering maintaining this practice and even expanding Gas-to-Liquid capacity, which will lead to an increase in gas demand.

1.5.3_PROSPECTS FOR INTERNATIONAL COOPERATION – GOALS, PRIORITY AREAS

South Africa's cooperation with other BRICS countries in the energy sector is limited, with the exception of India and China. India and China are the main export destination for coal from South Africa and India receives more than half of the exported solid fuel. There are opportunities for South Africa to cooperate with BRICS countries on energy.

CHAPTER 2

BRICS ENERGY SECTOR AS THE BASIS FOR SUSTAINABLE GLOBAL DEVELOPMENT

[2.1]

STRATEGIC DEVELOPMENT GOALS

The energy sector of the BRICS countries daily solves the problem of supplying energy to 40% of the World's population (3.08 billion people). At the same time, BRICS accounts for about 43% of CO2 emissions, 42% of renewable energy use, and 37% of global energy consumption. In many ways, the trends in the development of energy in the BRICS countries have been, are and will continue to be crucial for the development of the entire global energy sector.

The BRICS countries face complex challenges in ensuring sustainable energy supply, increasing the level of energy availability and minimizing the negative impact on the environment on the backdrop of rapid economic growth.

The BRICS countries strive to develop sustainable, efficient, affordable, eco-friendly energy systems that are harmoniously integrated into the global energy sector. Strategic development goals are formulated at the level of national policies of each country, while common priorities are reflected in BRICS official statements and documents.

Due to the significant differences in the energy systems of the BRICS countries, each of the countries faces different challenges in the development of the fuel and energy sector and sets different development goals.

At the same time, the BRICS countries have a number of 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 in order to create a favorable environment for sustainable economic growth;

- Expanding access to energy, ensuring universal energy security of the population as a means to improving living standards and ensuring social stability;

- Maximum efficient use of own energy resources;

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

To achieve these goals for the BRICS energy sector the countries set the following objectives:

- Development of energy efficiency and energy saving. It includes the development and implementation of energy-saving technologies throughout the entire energy supply chain from production to final consumption;

- Energy infrastructure development;

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

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

- Increasing the use of natural gas in the energy mix as an eco-friendly and economically efficient fuel, which will facilitate the transition to low-emission economies, increased access to energy and sustainable development;

- Diversification of energy consumption in the transport sector;

- Improving governance of the energy sector.

The situation in 2020 has created new challenges for the energy sector. The global energy sector has had to work under the conditions of increased uncertainty caused by significant fluctuations in demand and prices, and the disruption of well-established inter-country logistics. Many energy facilities have faced limited functioning opportunities due to mass infection of personnel. And the current events are bound to have long-term consequences. The countries' economies will have to recover from the recession, which actually pushes back the economic development for months and for some countries for years. The decline in investment activity will lead to the postponement of the launch of new energy capacities. For energy systems, there are additional requirements for ensuring the sustainability of supply, taking into account the risks of a pandemic. The current events have also affected the BRICS countries, both in terms of the changed working conditions of domestic energy systems and in terms of international trade.

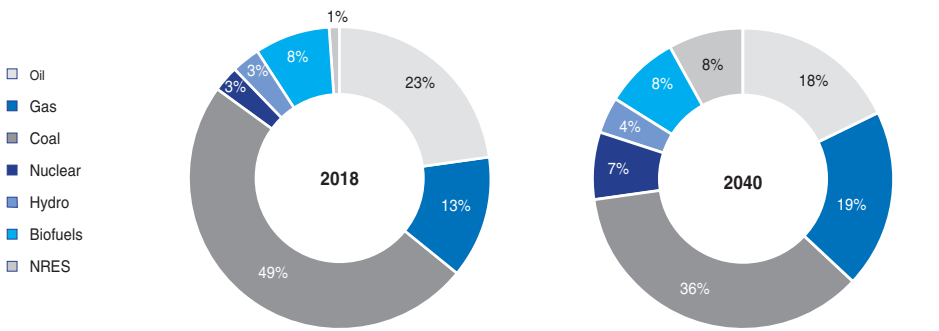
Against the background of scientific and technological progress in the energy sector, the requirements for personnel who will work with new equipment, carry out calculations, and organize work are increasing.

[2.2]

CURRENT STATE AND PROSPECTS OF ENERGY DEVELOPMENT IN THE BRICS COUNTRIES

Currently, the energy balance of the BRICS countries is dominated by fossil fuels. Coal accounts for almost half of the total energy consumed, petroleum products share amounted to 23%, and natural gas' to 13%. In the future, the structure of the energy balance is expected to change through the increase in the share of RES, natural gas and nuclear power while reducing the utilization of coal and oil (Figure 2.1).

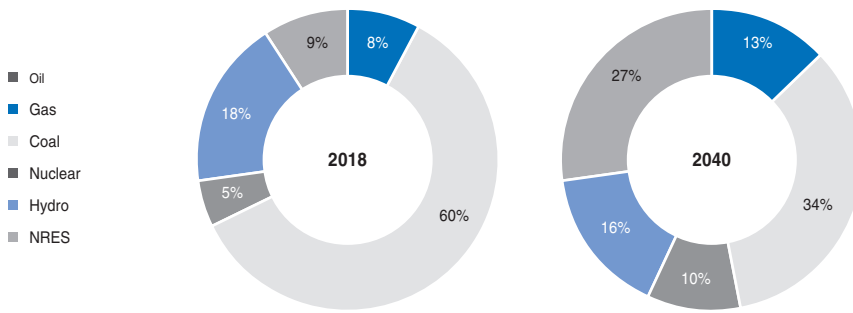
Figure 2.1 Energy balance of BRICS in 2018 and 2040



Source: BRICS countries data and estimates

Against the background of decisions on the development of low-carbon energy, the share of coal-fired generation in the power industry of the BRICS countries is expected to decrease by almost 2 times by 2040, with a slight decrease in the absolute volume of coal use. The main growth of electricity consumption will be provided by renewable energy sources, nuclear energy and gas (Figure 2.2).

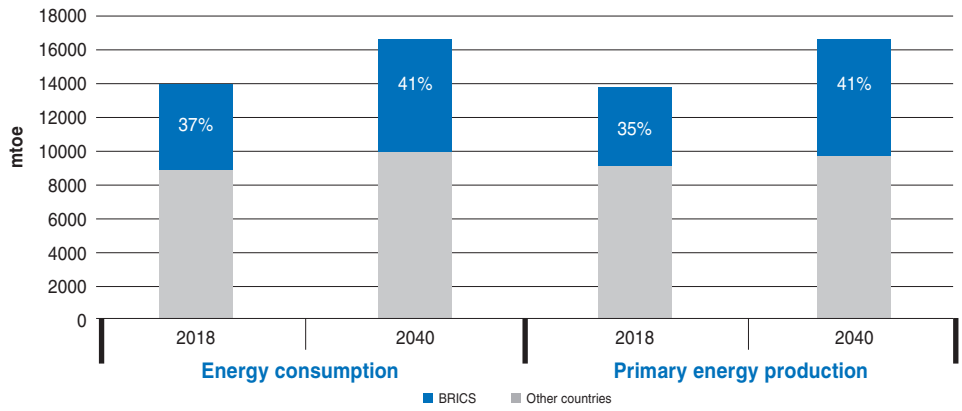
Figure 2.2 Power generation energy mix of BRICS in 2018 and 2040



Source: BRICS countries data and estimates

The BRICS countries are systematically working to build state-of-the-art, environmentally friendly energy systems. Between 2008 and 2019 BRICS provided a 30% of the increase in global gas consumption, 52% increase of renewable energy consumption (including hydro) and only thanks to BRICS was able to show positive global dynamics in power generation at nuclear power plants, compensating for the closure of facilities in Japan, Germany and some other countries. Without BRICS contribution, the reduction in nuclear energy production would have been 12%, but BRICS allowed to bring the global figure to growth of 2%, while the BRICS countries themselves increased nuclear power output by 2.3 times. Great progress has been made in the development of

Figure 2.3 BRICS contribution to global energy demand and production

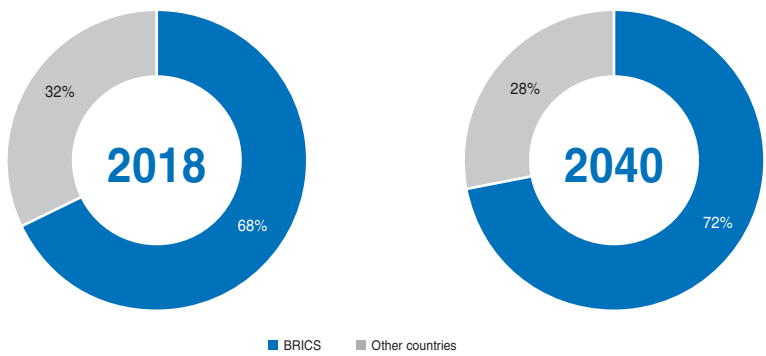


Source: BRICS countries data and estimates

nuclear, gas and renewable energy technologies, which makes it possible to supply relevant equipment to most countries of the world, as well as to provide consulting and educational support.

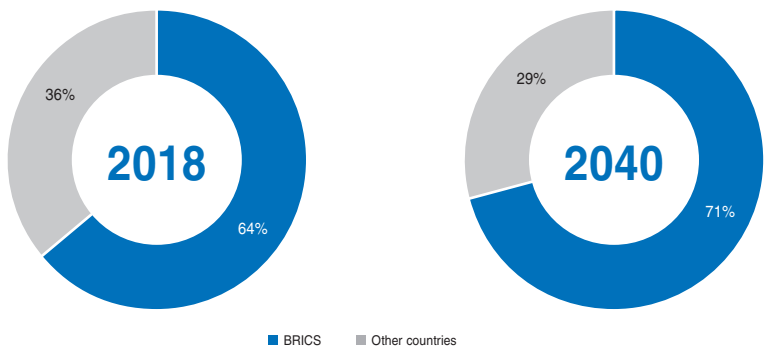
The BRICS countries accumulate 37% of total global energy consumption and provide 34% of primary energy production. Against the background of population growth and faster than the global average level of economic growth, by 2040, the BRICS share in both world consumption and energy production is expected to increase to 41% (Figure 2.3).

Figure 2.4 BRICS share in global coal consumption in 2018 and 2040



Source: BRICS countries data and estimates

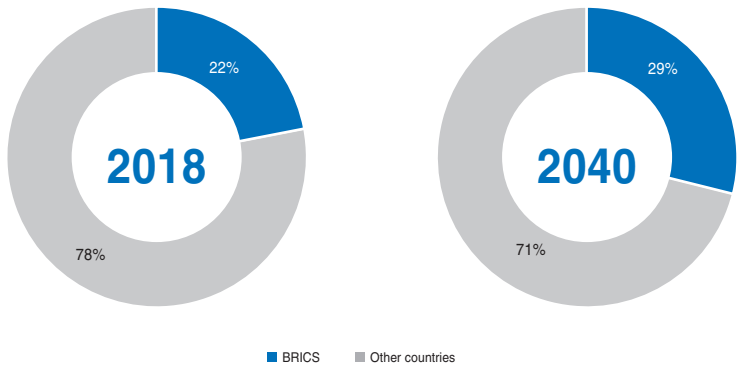
Figure 2.5 BRICS share in global coal production in 2018 and 2040



Source: BRICS countries data and estimates

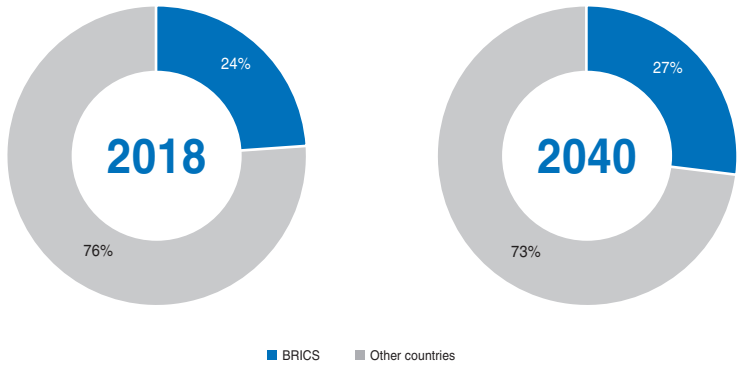
In the next 20 years, the BRIC countries will remain key players in the global coal market, providing about 70% of its overall consumption (Figure 2.4). At the same time it will be possible to bring the production of coal to a level almost sufficient to satisfy BRICS demand (Figure 2.5).

Figure 2.6 BRICS share in global gas consumption in 2018 and 2040



Source: BRICS countries data and estimates

Figure 2.7 BRICS share in global gas production in 2018 and 2040



Source: BRICS countries data and estimates

The development of the world gas market largely depends on the BRICS countries. Among the representatives of the Group are the fastest growing major gas consumers in the world – India and China, as well as its leading exporter Russia. By 2040, the BRICS share in both global gas consumption and production is expected to grow significantly (Figure 2.6, Figure 2.7).

Figure 2.8 BRICS share in global oil products consumption in 2018 and 2040

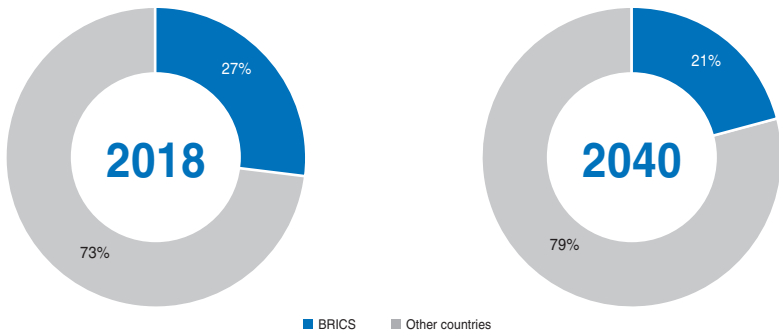
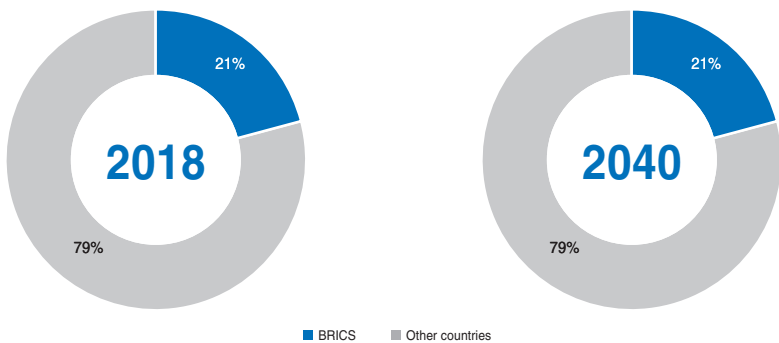


Figure 2.9 BRICS share in global crude oil production in 2018 and 2040



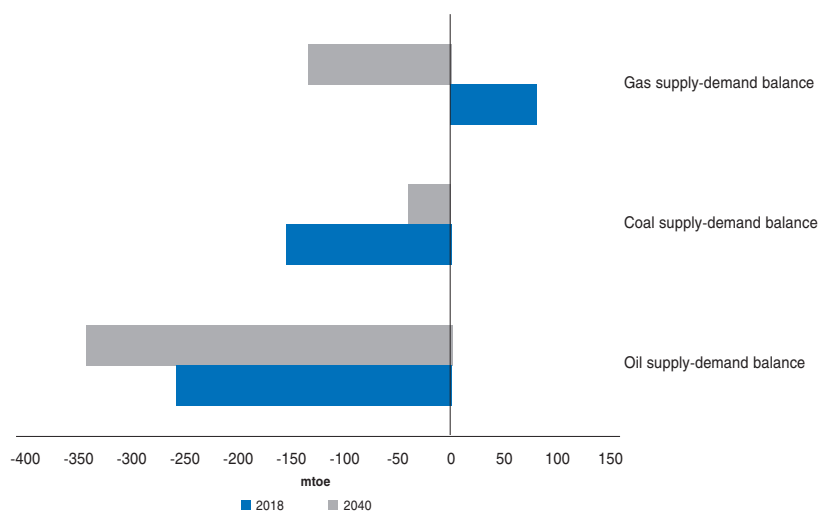
Source: BRICS countries data and estimates

Currently, the BRICS countries consume about a quarter of the world's oil products and produce 22% of the world's crude oil. At the same time, 30% of the world's oil refining capacity is accumulated in BRICS. This is the only market where the share of BRICS countries in global demand for petroleum products is expected to decrease by 2040 (Figure 2.8). This will be facilitated by large-scale programs for the introduction of alternative transport, launched and planned in all BRICS member countries, including programs for the development of transport using electricity, gas, biofuels, and hydrogen. At the same time the share of BRICS countries in the global oil supply will remain at 21% (Figure 2.9).

The BRICS countries are represented by both net importers of energy (China, India) and net exporters of energy resources (Russia, Brazil, South Africa). Cooperation between countries in terms of energy trade makes a significant contribution to solving the problems of energy supply and improving the stability of energy systems.

The demand for oil and gas imports by the BRICS countries will increase against the background of increasing demand, while the supply of coal, on the contrary, will decrease (Figure 2.10).

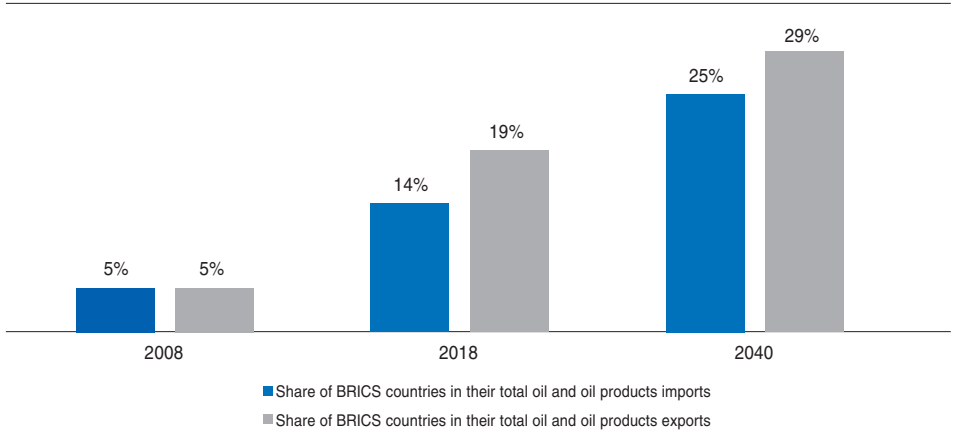
Figure 2.10 Energy supply of the BRICS Group by energy sources (the difference between production and consumption by all BRICS countries)



Source: BRICS countries data and estimates

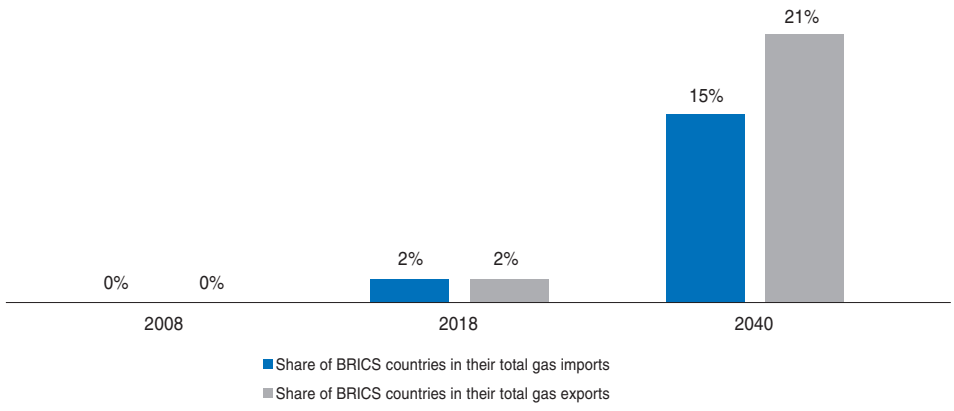
The BRICS countries are actively developing mutual trade in energy resources, as well as cooperation in the field of nuclear and renewable energy. Over the decade from 2008 to 2018, the share inter-BRICS trade in the structure of oil and petroleum products supply increased by 9% and 14% respectively. And the importance and volumes of mutual trade are expected to continue increasing in the long term (Figure 2.11).

Figure 2.11 Share of BRICS countries in their overall energy trade (oil and oil products)



Source: BRICS countries data and estimates

Figure 2.12 Share of BRICS countries in their overall energy trade (gas)

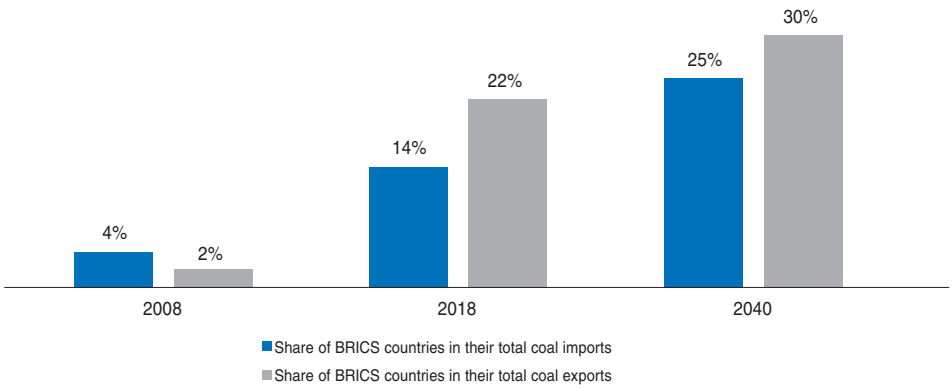


Source: BRICS countries data and estimates

By 2040, a significant increase in the volume of natural gas trade between the BRICS countries is expected, mainly due to the launch of new pipeline and LNG capacities from the territory of Russia (Figure 2.12).

The mutual share of BRICS countries is also expected to increase in the coal trade (Figure 2.13).

Figure 2.13 Share of BRICS countries in their overall energy trade (coal)



Source: BRICS countries data and estimates

Analysis of the prospects for fuel markets shows that trade in energy resources between the BRICS countries will inevitably grow, which creates good prerequisites for simultaneously increasing investment and scientific and technical cooperation.

The growth of trade requires appropriate infrastructure development. For this purpose, new port, railway and pipeline capacities are being created in the BRICS countries. Additional opportunities for trade are opening up thanks to the development of the Northern sea route, which, after switching to year-round operation, will allow for the shortest distance to supply energy resources from Arctic fields to Asian countries. All this will lead to optimization of trade logistics schemes.

[2.3]

COVID-19 INFLUENCE ON BRICS COUNTRIES ENERGY SECTOR AND ANTI-CRISIS MEASURES

The coronavirus pandemic has had an unprecedented impact on the global economy. As of mid-2020, it is still not possible to accurately assess this impact, since most countries, in one form or another, maintain restrictive measures for economic and social activity. This will be the largest economic decline since the great Depression of the 1930s and even without a second wave of infections; global annual GDP is expected to decline in almost every country in 2020. At the same time, the number of unemployed continues to grow. Around the world, about 300 million full-time jobs could be lost, and nearly 450 million companies face the risk of major disruptions.

Naturally, a crisis of this magnitude has had a huge impact on the energy sector. It is important to note that the order of statistical accounting of energy consumption in a large part of the world do not allow us to quickly assess the impact of crisis on energy consumption, but the first estimates have already appeared.

The crisis hit the global coal industry the hardest, causing significant decline in the production and demand in this sector. The demand for petroleum fuels has also been significantly affected (quarantine measures in the form of reduced air and transport links between and within countries). Global demand for natural gas has suffered the least among fossil fuels.

BRICS countries have made every effort to minimize the negative impact of the pandemic on national economy and energy sectors and provide affordable energy supply for the population and industry through:

- stimulating consumer demand for the fastest recovery of national economies;
- targeted subsidies for vulnerable categories of consumers;
- providing soft loans and government grants to the companies most affected by the pandemic;
- providing tax incentives to various sectors of the economy.

At the same time, the countries kept their plans for infrastructure development and implementation of major energy projects, realizing that the current crisis, despite its scale, is temporary, and the economic downturn will most likely turn to by growth, which will reinstate the issue of sustainable energy supply for national economies and energy sectors.

The pandemic had grave consequences for the well being of the population of the member states and negatively affected national economies including energy sector. All BRICS states experienced decline in energy production and consumption in the first half of 2020 and will suffer from overall contraction of economy and sharp decline in energy sector investment in 2020.

On the positive side the national energy systems demonstrated relative resilience to the crises situation, no energy shortage or supply interruptions took place.

Due to timely actions undertaken by national governments the situation is gradually improving. However, time will be needed for full recovery of the energy industry. The national support measures covered all energy sectors, particular emphasis was put on helping distribution operators and consumers.

BRAZIL

In Brazil, market recession in 2020 has led to a revision in annual GDP growth estimates from 0% to -5%, according to the Load Quarterly Revision for the Period 2020-2024. It is expected that in 2021 the Brazilian economy will present a more significant recuperation (thanks to the recuperation of export commodities and infrastructure investments, which will in turn generate positive impacts on the productivity of the economy). It is expected that the economy will growth by 2,3% next year.

The main challenges brought by COVID-19 for Brazil refer to a fall in the demand for fuels, a fall in oil prices, a reduction in the demand of electricity and the need to maintain exploration, production and trade in minerals.

Accordingly, actions to maintain energy security, the sustainability of mining and structural policies have been prioritized. Such actions are based on the development of scenarios aimed at gauging to the best extent possible the challenges to be surmounted to overcome the crisis, taking into consideration the expertise of agents and lessons learned from past crisis.

All actions are founded on the pillars of national energy planning, based on the respect for contracts, regulatory coherence and stability, transparency, and dialogue with society to promoted public interest.

In order for such actions to be successful, it was considered to be of fundamental importance the establishment of an efficient governance system at strategic, technical/operation and structural level. Committees have been established to face the crisis in all fronts, such as the Crisis Committee at the Presidency, the Executive Committee of the Ministry of Energy and Mines, Sectorial Committees and the Program Pro-Brazil.

In the sector of oil and gas, the main objective was to ensure the supply through measures that include non-interference in prices and free determination of prices by the agents in the market. In order to maintain the functioning of the production sector, it was considered to be an essential activity of national interest, given its socially sensitive nature.

With regard to the electricity sector, the main action undertaken was to reduce tariff pressure on low income consumers thereby ensuring sustainability of the supply chain, predictability in view of an uncertain scenario and respect to contracts.

In addition, the Pro-Brasil Program addresses cross-cutting issues aiming at ensuring competitiveness, employment, income, supply and investment attraction.

The policies in place focus on two important aspects. The first one is related to making sure that the fall in consumption stemming from economic recession does not further

contaminate the energy sector and does not give birth to a systemic crisis. In this context, the granting of financing schemes and the renegotiation of debts can restore short-term liquidity in the market. However, it will also be necessary to implement long term measures in case the effects of the crisis persist beyond current expectations.

The second aspect had as a basic principle the support to low income consumers, whose bills were paid by the National Treasure, while not adding any burden to the tariff. Provisional Measure 950/2020, in place from 1 April to 30 June 2020, allowed for an 100% discount on electricity bills of 220 KWh/month or less. Resources worth 900 million Realis were allocated to cover tariff discounts that benefited 9 million people.

Other measures undertaken had a short term structural nature: giving more flexibility to ethanol purchase obligations; the decision by the National Agency of Oil, Gas and Biofuels to suspend the 17th oil bidding; coordinated monitoring actions with the Federal Revenue Agency; and the decision to consider as an essential activity the mining supply chain (“Portaria 135/2020).

RUSSIA

To soften the negative impact of the pandemic on the country’s economy, in March 2020 Russian Government has developed a «Plan of priority measures (actions) to ensure sustainable economic development in the face of a worsening situation due to the spread of a new coronavirus infection». The plan contains measures along the following main lines:

1. Provision of essential goods and support to the population;
2. Support for the most vulnerable sectors of the economy (such as: tourism, construction, transport, and some others);
3. Support for small and medium-sized businesses;
4. Systemic measures.

Moreover, the crucial companies (which includes most of the energy sector companies) may receive additional support by the way of soft loans under the Resolution of the Government of the Russian Federation No. 582 from 24.04.2020 and tax cuts and state

guarantees on loans under the Resolution of the Government of the Russian Federation No. 651 «On measures to support system-forming organizations» dated 10.05.2020.

As sectoral measures to support energy companies, as part of the List of instructions from the President of the Russian Federation following the meeting on energy development on 29.04.2020 (from 21.05.2020 no. PR-837), the government of the Russian Federation is charged with ensuring:

- For the oil and gas industry:
  - non-application of penalties for deviation of the oil production level from the indicators, settled in the technological schemes for the development of hydrocarbon deposits for the duration of the agreement on production restrictions within OPEC+;
  - creating the fund of unfinished oil wells;
  - establishment of excise tax deduction for ethane and liquefied petroleum gas used as feedstock for petrochemical industry.
- For the electric power industry, measures are envisaged to equalize and fairly redistribute the tariff burden, and increase payment discipline, including:
  - updating the procedure for calculating tariffs, taking into account the costs associated with ensuring the protection of employees from new coronavirus infection (COVID-19), and the need to minimize the tariff burden on consumers of electric energy;
  - a moratorium on the adoption of regulatory decisions that worsen the business conditions in force on 01.01.2020 in relation to electric power and heat supply organizations for 2020-2021;
  - introduction of additional measures to enforce payment discipline for electric power transmission services to grid operators;
  - temporary non-application of penalties for non-fulfillment of investment programs by regulated organizations-subjects of the electric power industry in 2020-2021;

- temporary non-application of penalties for non-delivery of power to the wholesale market by electricity suppliers caused by equipment downtime due to the unavailability of repair parts and components.

In order to monitor the financial and economic situation and implement these support measures, the Ministry of energy of the Russian Federation has created and approved a list of strategic organizations of the fuel and energy complex by the Government Commission for improving the sustainability of the Russian economy. The industry list of system-forming organizations of the fuel and energy complex is published on the official website of the Ministry of energy of Russia.

INDIA

The impact of COVID-19 in India, with more than 1.3 Billion population, the world's most populous cities, the bulk of the world's industrial activities, energy supply and consumption, and with 46 million migrants, is tremendous due to the concentration of economic activities, demographics, urbanization.,

The pandemic has introduced unprecedented challenges and reminds us of the importance of a stable, affordable, sustainable, and uninterrupted supply of power to meet demand, especially for essential services, such as healthcare, which is crucial to ensure that the global community can overcome this crisis, especially in developing and least developed countries. However, it also shows how quick action, steadfast policies and innovation, displayed by several Asian countries, can effectively deal with this unprecedented outbreak.

The COVID-19 lockdown has led to shut down of all but essential commercial activities across the country. Consequently, the electricity demand from industrial and, commercial customers had reduced initially, however, power demand slump has narrowed to 2.6 per cent in the beginning of July from 9.6 per cent in June, showing improvement in commercial and industrial activities in the country. The slump in power consumption has also narrowed in June to 9.74 per cent from 14.86 per cent registered in May and 23.21 per cent recorded in April this year.

The Government of India has announced the Special economic and comprehensive package of ₹ 20 lakh crores – accounting for 10% of India's GDP, to deal with impact of COVID-19. The package includes Rs. 1.70 lakh crore relief package under Pradhan

Mantri Garib Kalyan Yojana for the poor for helping them fight the battle against Corona Virus, Rs 3 lakh crores Collateral-free Automatic Loans for Businesses, including MSMEs, Rs. 90,000 crore infusion of liquidity in power distribution companies at the state level through loans against receivables; Rs. 50,000 cr. Equity infusion for MSMEs through Fund of Funds, Rs 20,000 crores Subordinate Debt for Stressed MSMEs and various other reforms.

All RE Projects were treated as Must Run even in the lock-down period. RE Generation and Construction were declared as part of essential services.

As on 1st July, 2020 work on 859 projects worth approx. ₹ 3,57,000 crore involving in refinery, E&P, marketing infrastructure, pipelines, City Gas Distribution network and in the entire value chain of oil & gas is going on in full swing. These oil & gas projects will further enhance energy accessibility, create new employment opportunities and give stimulus to economic growth. For the period of 20th April to 30th June 2020, employment of more than 48.96 lakh man-days have been generated in the execution of these oil & gas projects. Further, ₹1395 crore has been disbursed to workers as payout during this period.

India took advantage of global crude oil price crash since the beginning of March this year for filling the unfilled Strategic Petroleum Reserves of 16 million barrels in all the three locations – Vishakhapatnam, Mangalore and Padur. We initiated swift action in not only securing additional Government budgetary support but also in reaching out to friendly countries in the Middle East.

In view of the COVID19 situation in India, Hon'ble PM had announced supply of free LPG cylinders to over 80 million beneficiaries under our flagship programme Ujjwala scheme from April to June 2020. Hence, the demand of LPG went up significantly. A budgetary allocation of ₹ 13,500 Crores has been earmarked to provide free LPG cylinders for 3 months. LPG demand went up by 13 % in 1st Qtr. of FY 2020-21 compared to 1st Qtr. of FY 2019-20. Further, GoI has taken decision to extend the time limit for availing free LPG cylinders under Pradhan Mantri Garib Kalyan Yojana, this will benefit poor households who have yet not been able to consume the 3 refills provided to PMUY beneficiaries.

In the coal sector, the actions being taken include – minimum assured level of supply under Fuel Supply Agreements (FSAs) has been increased from upto 100% of Annual Contract Quantity (ACQ); levy of Performance Incentive for Power Sector under FSAs

have been waived off upto Q2 of FY 2020-21; Reserve Price under all e-auction schemes have been brought down at par with Notified Price upto 2nd quarter of FY 2020-21; 5% service charges levied on to Non-FSA customers have been withdrawn; Mine specific cost plus price has been reduced; Dues to MSME and other stakeholders are being cleared promptly to prevent distress to them, etc.

CHINA

COVID-19 pandemic has caused a sharp reduction in China energy demand this year, and the steady supply of China's energy industry chain has also been greatly affected. The decline of oil price has a certain impact on the domestic oil and gas exploration and development industry, but the domestic product oil price remains basically stable. Due to the strong epidemic prevention and control measures taken by the Chinese government, the production of the energy industry has gradually recovered, and the main energy varieties have not decreased, but have increased slightly. In the first half of this year, 97.15 million tons of crude oil, 94 billion cubic meters of natural gas and 1.81 billion tons of raw coal were produced, a year-on-year increase of 1.7%, 10.3% and 0.6%, respectively. The power generation from January to June was 3364.5 billion kWh, down 1.4% year-on-year, of which the power generation in June was 630.4 billion kWh, a year-on-year increase of 6.5%.

To combat the pandemic, China has implemented more than 90 activities in 8 key national policy areas. Targeted support was provided to the most important enterprises, including significantly reduced taxes and fees, completely removed tolls on motorways, introduced state-subsidized loans and credits, expanded price subsidies for certain categories of goods, and reduced energy prices[4]. In particular, the price of electricity for enterprises was reduced by 5%, and a two-part tariff was introduced, which is also expected to save electricity costs.

China plans to focus on 6 economic growth fronts: employment, the financial sector, foreign trade, foreign investment, domestic investment, and expectations. The six seas refer to job security, basic living needs, operations of market entities, food and energy security, stable industrial and supply chains, and the normal functioning of primary-level govern-

[4] REPORT ON THE WORK OF THE GOVERNMENT Delivered at the Third Session of the 13th National People's Congress of the People's Republic of China on May 22, 2020 Li Keqiang

ments. And sets priorities: steadily pursue the strategy of expanding domestic demand, ensure economic development and social stability, complete the targets and tasks for winning the battle against poverty, and bring to completion the building of a moderately prosperous society in all respects[5].

SOUTH AFRICA

The Covid-19 pandemic has disrupted the world and RSA. This reality forced us to appreciate that, as we are hard at work trying to save lives, we must also adapt and adjust our programme to also save livelihoods. South Africa has responded to the pandemic and its resultant economic shock with an unprecedented set of measures. In doing so, our government has been working together closely with the private sector, labour, community and private finance to work out strategies for sustainable recovery plans.

Many economic sectors, including small businesses have been severely impacted by the Covid-19 crisis and require government support to continue operations. Our Government has announced support packages such as tax relief, wage support, funding for small business and a disaster release fund in support for distressed industries. However, these are short term interventions and a bold and radical strategy is required to be aligned with long-term planning. Cross-border and International collaboration would be essential to re-establish some international supply chains disrupted by the Covid-19 crisis.

As government and industry, our attention must now turn to economic recovery. We contend that there is a once-in-a-generation opportunity to re-prioritise innovation efforts and align them with our long-term ambitions to reshape the future global energy and indeed the global economic landscape.

In this effort, our Health and frontline services must receive priority. With all its negative effects, COVID-19 has also provided space for us to re-imagine a new economic future and possibilities. For instance, with regard to re-establishing manufacturing and industrial capacity in Africa, the starting point should be the localised manufacturing of

[5] REPORT ON THE WORK OF THE GOVERNMENT Delivered at the Third Session of the 13th National People's Congress of the People's Republic of China on May 22, 2020 Li Keqiang

the much needed healthcare Personal Protective Equipment (PPE), including masks, sanitizers and related materials and equipment. This could greatly aid the development of production capacity on the continent.

Infrastructure investment must be the flywheel by which we grow the economy and Energy sector should position itself a central catalyst in this regard. Recently, our President, HE Cyril Ramaphosa hosted a successful Sustainable Infrastructure Development Symposium, drawing in sector specialists, technical and financial structuring experts and policy departments. The Symposium considered 177 infrastructure projects across public and private sectors, with energy projects comprising the lion's share, again affirming the criticality of the sector to economic growth and development.

As part of the longer term approach, South Africa plans to, amongst others, convert old coal mines and plants into gas, solar and wind power generators to reduce our carbon footprint. Central to these initiatives must of course be a sustainable plan to create jobs at these old power stations and mines, by taking advantage of the existing skills and infrastructure to facilitate this.

South Africa is focusing on implementing our Integrated Resource Plan, which will see an additional 20 gigawatt of solar and wind renewable generation added to our grid by 2030. Similarly, we are investing in the development of Liquefied natural gas infrastructure and power generation facilities as part of the ongoing work we do to promote the development of a gas economy in the country. The country will also implement expansion of our nuclear fleet at a scale and pace and at a level that will be affordable to the country.

South Africa remains an attractive investment destination, and our International partners are eligible and invited to be part of the infrastructure development in the energy space. Supporting these projects, and overall economic transformation in our country and region will provide an immediate boost in employment and economic output, in a mutually beneficial manner for all parties involved.

For South Africa, and the African continent as a whole, our approach to energy transitions is premised on an all-fuels, all-technologies approach, and maximises the potential of a diversified energy mix. As we transition to low-carbon emission trajectories as developing economies, we are expecting that developed economies will acknowledge our efforts and

support us. The commitments made in the Paris agreement must be honoured and this requires a lot of support from developed economies. We must continue to give due recognition to our mixed levels of development and appreciate the need for common but differentiated goals as we embark on this journey. We must practically give meaning to a "Just Transition" anchored on social justice and equality.

We need to harness our collective energies and wisdom to find solutions that address energy poverty and access, especially on the African continent. Our joint effort could benefit more from increased collaboration with international partners, through policy analysis, research, access to finance, technology transfer and capacity building initiatives. Such enhanced international cooperation and collaborative efforts will also support African countries' pursuit of greater environmental sustainability, electrical power sector reform considerations, renewables integration and improved energy efficiency.

CONCLUSIONS

The BRICS countries consider the systematic development of energy sector to ensure a sustainable affordable energy supply with minimal negative impact on the environment to be of outmost priority. The introduction of new capacities should be synchronized with the needs of growing economies and the demand of the population.

BRICS countries will continue to play a significant role in dealing with global energy issues. By 2040, fossil fuels will continue to dominate in the energy balance of the BRICS countries, satisfying almost three-quarters of all demand, however the use of nuclear and renewable energy will also increase and become more prominent. The share of gas in the energy mix will grow significantly as the shares of oil and coal decline. At the same time, simultaneous increase in overall energy consumption will lead to an increase in the net use of all energy resources, except coal.

The goals of BRICS energy cooperation can be summarized as: strengthening energy security of BRICS states through the development of national energy systems; deployment of new technologies; improving the investment climate in energy sector; ensuring stability of the international energy markets and enhancing the role of BRICS in global discourse on topical energy issues.

Cooperation between the BRICS countries in the field of energy is successfully developing. Energy trade is expanding, joint projects are being implemented in the field of extraction and processing of fossil energy sources, renewable energy both within the BRICS states and as part of consortiums in third countries, new infrastructure for the growth of trade is actively developing.

BRICS provides a wide range of opportunities to exchange experience, coordinate the actions of participants and directly support projects to achieve the goals facing the member-states. This is facilitated by established mechanisms, including Summits, Ministerial meetings, Working groups, New Development Bank, Energy Research Cooper-

ation Platform and BRICS STI framework program that provides financing mechanisms for joint research projects.

The analysis showed that the most promising areas of BRICS cooperation in the energy sector include:

- Creation conditions for development and sharing of advanced energy technologies, as well as promoting investment in relevant projects, including through BRICS instruments;
- Development of information and technological cooperation in the field of energy efficiency and energy saving, as well as support for individual projects; improve energy awareness of population in BRICS countries;
- Scientific and technical cooperation and exchange of experience in the implementation of projects for the extraction, processing and transport of fossil fuels involving participants from various BRICS countries;
- Promotion of programs and exchange of experience in expanding the use of natural gas in various sectors of the economy;
- Expansion of scientific and technological cooperation and exchange of experience in the field of diversification of consumption in the transport sector, including the use of biofuels, gas-powered transport and the introduction of electric and hydrogen vehicles.
  As a result, the availability of vehicles, the stability of transport power systems are expected to increase, while reducing the negative environmental impact of transport;

- Exchange of experience on improving the efficiency of governance in the energy sector;
- Facilitating stability of energy markets and enhancing the role of BRICS in global discourse on topical energy issues;
- Involvement of youth into energy cooperation and research activities among BRICS countries;
- Improving the sustainability of the fuel and energy sector, including cooperation in the field of anti-terrorist protection of energy facilities, environmental and technological security;
- Expansion of payments and direct investments in national currencies to ensure the stability of trade relations and stimulation of economic development;
- Exchange of experience in areas and methods of training youth and retraining specialists, joint students exchange programs;
- Enhancing research activities, including through BRICS Energy Research Cooperation Platform.

BRICS has already accumulated vast experience in implementing energy projects of various complexity, which are ready to be used not only within the framework of the Group, but also in the course of cooperation with other states. Advanced scientific and technical potential and broad investment opportunities provide a good basis for launching new projects with the participation of BRICS companies in various parts of the world.

Mutually beneficial cooperation is an essential for coping with challenges of ensuring access to affordable, reliable and sustainableenergy supply in the time of transition towards cleaner, more efficient and flexible energy systems.

DISCLAIMER

This publication contains forward-looking statements and comments that represent a forecast of events. Any statements in these materials that are not statements of historical fact are forward-looking statements that involve known and unknown risks, uncertainties, and other factors that may cause actual outcomes and figures to differ materially from any future results and outcomes reflected in or implied by such forward-looking statements. We do not undertake any obligation to update any forward-looking statements contained herein to reflect actual results, changes in assumptions, or changes in factors affecting such statements. Neither BRICS nor any of its respective representatives, employees and experts accept liability for any inaccuracies or omissions or for any direct, indirect, special, consequential or other losses or damages of whatsoever kind in or in connection with this publication or any information contained in it.

Report citation: BRICS Energy Research Cooperation Platform.
2020 BRICS Energy Report. October 2020.

BRICS

RUSSIA | 2020

BRICS

ENERGY RESEARCH COOPERATION PLATFORM

9 785914 380332